Descriptive Notes

This map area covers the surficial geology and landslide inventory of the southern 23 km of Douglas Channel. Douglas Channel surficial geology extends from Promise Island to Kiskosh Inlet on the west side and from the southwestern tip of Gribbell Island to the southern portion of Hawkesbury Island. The highest elevation in this map area is 1089 m at Mount Jenkinson on southern Hawkesbury Island. Surficial geology compilation was carried out following the Geological Survey of Canada Surficial Data Model (Deblonde et al., 2012; Cocking et al., 2016) combined with the British Columbia Terrain Classification System (Howes and Kenk, 1997). The map area is one of six surficial geology maps that cover all of Douglas Channel.

The main objective of the surficial geology compilation is to provide baseline information on surface sediments and slope processes for stakeholders and decision-makers. In addition to the surficial geology, we have compiled information about landslides that were observed in the map area (Table 1).

Most of the surficial geology consists of colluvium or a veneer of organic material cover (folisol; Agriculture Canada, 1998) partially mantling steep bedrock slopes. In lower lying areas, there are pockets of till that were deposited during the last glaciation dating back to the Pleistocene. Some of the valleys located close to the shoreline are filled with glaciomarine sediments. The highest elevation in this map area where glaciomarine deposits are found is at roughly 80 m, located at the southwest edge of Gribbell Island. Superimposed on the glacial and deglacial deposits are modern Holocene stream sediments resulting from alluvial processes.

The bedrock polygons have been labeled R2 and R3 indicating dominantly igneous and metamorphic rocks, respectively, based on available bedrock geology maps (Aldrick, 2002; Nelson et al., 2014).

Interpretation of landslides was carried out using Cruden and Varnes' (1996) classification. Mappable landslide deposits and landslide tracks without mappable deposits are compiled in Table 1. The mappable landslide deposits are mainly labeled Cf (debris flow fans). Active talus slopes, mapped as unit Ca, are less common and larger, pre-historic bedrock slumps and rock avalanches, mapped as unit Cz, are only identified in a few places. A large number of map units consists of colluvium that may not have been assigned to a specific landslide process (e.g. Cb = colluvial blanket; Cv = colluvial veneer). These units are included in Table 1 because they commonly contain small areas of landslide deposits. The most common type of landslide that occurs on these fjord slopes are small, shallow-seated translational slides. Their deposits are usually too small to be mapped or they run out into the ocean. These slides are labeled on the map as sediment transport arrows and are included in Table 1. Sediment transport arrows depict debris slides and flows consisting of mineral and organic material (folic debris slides; Nagel 2000), small rock slides and rockfalls, and/or a combination of these.

The south end of Hawkesbury Island contains deep-seated gravitational deformational structures (DSGSS) (e.g. Bovis, 1990; Crosta et al., 2013) that appear geologically controlled, which may or may not be active (Figure 1).

Terrain stability mapping was also carried out for the map area following the method described by British Columbia Ministry of Forests (1999) for the Forest Practices Code. Although this method was developed for the forestry sector, it has been used in assessing terrain stability for environmental assessments for resource development projects, such as mining and wind farms in British Columbia and Yukon. Terrain stability mapping is intended to qualitatively highlight the potential landslide source areas based on slope gradient, surficial materials, material texture, material thickness, slope morphology, moisture conditions, and ongoing geomorphic processes (British Columbia Ministry of Forests, 1999). Terrain polygons were rated as stable to unstable (Class I–V, respectively) and colour coded from green to red, respectively, for all types of landslides (Figure 2). In some cases on the surficial map, two adjacent polygons have the same map label, e.g. Cv. They were not joined as a single polygon because the two were rated differently in terms of terrain stability. The reader has the option to generate a terrain stability map from the downloadable dataset associated with this map area.

Acknowledgments

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Unit	Description	No. of Occurrences
	Landslide deposits and tracks	
Cf	Fan sediments	27
Ca	Apron or talus scree deposits	17
Cz	Bedrock landslide deposits	2
	Sediment transport direction	256
	Colluvial deposits	
Cv	Veneer	247
Cb	Blanket	82

Table 1. Compilation of the types of colluvial deposits (Cc) in the map area, either associated with a landslide process, which includes smaller events that are indicated by arrows, or deposits that are not specifically tied to a landslide process (i.e. colluvial blanket and veneer).

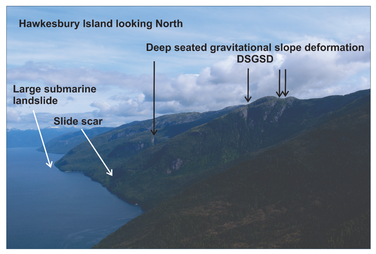

Figure 1. Photograph looking north of west shore of Hawkesbury Island showing deep seated gravitational slope deformation (DSGSD; black arrows), also called tension cracks or "sackungen." The location of a large submarine landslide is one of two documented in Conway et al. (2013).

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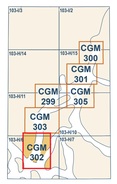
Abstract

Douglas Channel is a 100 km long fjord located south of the municipality of Kitimat, in northwest British Columbia. The Hartley Bay map area covers the southern portion of Douglas Channel where it meets Wright Sound and Verney Passage. The area also covers Promise Island, the southwest portion of Gribbell Island, southwest Hawkesbury Island, and a stretch of the western shore of Douglas Channel (mainland) that extends over about 17 km southward from Kiskosh Inlet. Mapping of surficial sediments, compilation of landslide deposits, and preliminary interpretation of bedrock types up to height of land were primarily carried out using British Columbia airphotos dated from 2001, 2003, and 2007 ranging in scales from 1:15 000 to 1:25 000. Older, field-based mapping by the authors in some isolated parts of the study area was incorporated into this mapping, complemented with additional, reconnaissance-level field observation in 2015 and 2016. The photograph (Figure 1) taken from the southwest side of Hawkesbury Island, looking north, shows the surface expression of deep-seated gravitational slope deformation features (DSGSD; black arrows) also called tension cracks or "sackungen".

Résumé

Le chenal Douglas est un fjord de 100 km de longueur, situé au sud de la municipalité de Kitimat, dans le nord-ouest de la Colombie-Britannique. La région cartographique de Hartley Bay couvre la partie sud du chenal Douglas, là où il rencontre le détroit Wright et le passage Verney. La région recouvre également l'Ile Promise, la partie sud-ouest de l'Ile Gribbell, le sud-ouest de l'Ile Hawkesbury et la rive ouest du chenal Douglas (continent), sur une distance d'environ 17 km vers le sud depuis le bras Kiskosh. La cartographie des sédiments superficiels, la compilation des dépôts de glissements de terrain et l'interprétation préliminaire des types de substratum rocheux jusqu'à la ligne de faîte ont été effectuées à l'aide de photos aériennes de la Colombie-Britannique à des échelles de 1/15 000 à 1/25 000 datant de 2001, 2003 et 2007. Les résultats d'anciens travaux de cartographie réalisés par les auteurs dans des endroits isolés de la région d'étude ont été incorporés à la compilation cartographique, à laquelle s'ajoutent aussi des observations complémentaires provenant de travaux de reconnaissance sur le terrain effectués en 2015 et 2016. La photo (fig. 1), prise de la côte sud-ouest de l'Ile Hawkesbury en direction nord, montre des structures correspondant à l'expression en surface d'une déformation gravitaire de pente profondément enracinée (flèches noires), que l'on appelle « fissures de tension » ou « sackungen ».



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

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CANADIAN GEOSCIENCE MAP 302

SURFICIAL GEOLOGY

HARTLEY BAY, DOUGLAS CHANNEL AREA

British Columbia

parts of NTS 103-H/6 and 11

1:25 000

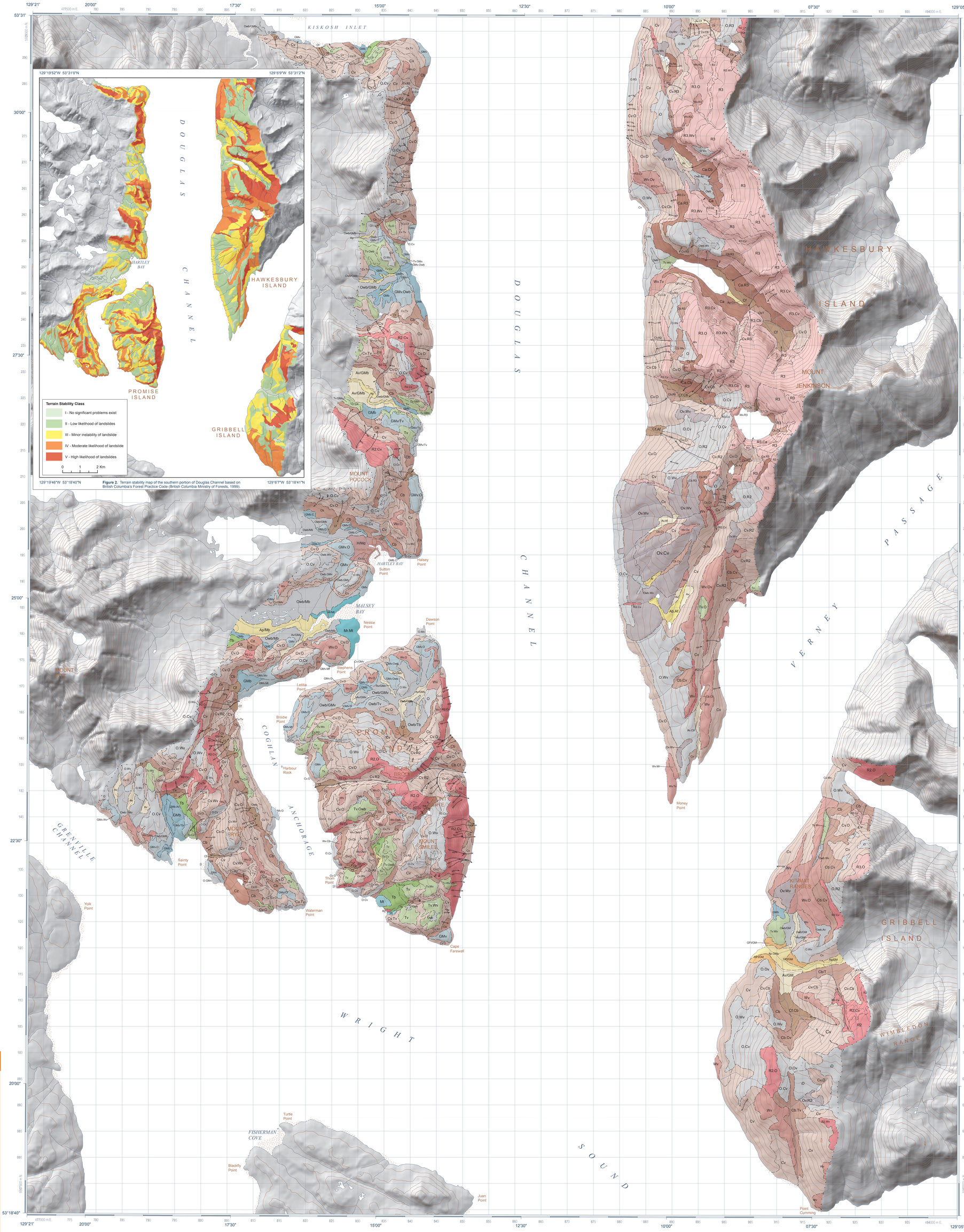

Figure 2. Terrain stability map of the southern portion of Douglas Channel based on British Columbia's Forest Practice Code (British Columbia Ministry of Forests, 1999).

QUATERNARY

POST-FRASER GLACIATION

NONGLACIAL ENVIRONMENT

ANTHROPOGENIC DEPOSITS: rubble, diamicton, gravel and other foundation materials; usually less than 5 m thick; emplaced by human activity for residential and industrial infrastructure.

H — **Undifferentiated anthropogenic deposits:** Hartley Bay village.

ORGANIC DEPOSITS: accumulations of plant material in various stages of decomposition; typically 1 to 3 m thick forming fens and bogs in wetlands; folic material greater than 10 cm thick over bedrock in upland locations; organic deposits too small to be shown at this scale occur within other units.

Owb — **Organic deposits, bog:** peat, decomposing plant material, and muck; saturated with the groundwater table at or near the surface; generally greater than 2 m thick; forming level to gently sloping freshwater wetlands.

Ov — **Organic veneer:** peat, decomposing plant material, and muck in a freshwater wetland; less than 2 m thick; may have somewhat discontinuous coverage.

O — **Undifferentiated folic material:** upland organic material of forest origin (leaf litter, twigs, branches, mosses and muck) accumulated directly over bedrock; greater than 10 cm thick; more than 40 cm thick overlying till; occurring on upland and sloping locations in cool, moist and humid forest ecosystems; rarely saturated with water; prone to debris slides and debris avalanches when disturbed or when saturated during intense rainfall events.

COLLUVIAL AND MASS-WASTING DEPOSITS: diamicton and rubble; non-sorted to poorly sorted; massive to moderately stratified; accumulated from gravity-induced movement or various mass-wasting processes, ranging from slope wash to large landslides; composition dependent on source materials and type of depositional process.

Cf — **Colluvial fan sediments:** diamicton and rubble; variable thickness; may contain organics; may be moderately stratified; accumulated as a fan or cone at the mouth of a steep-gradient stream or gully from debris slides and flows, debris floods and/or snow avalanches.

Ca — **Colluvial apron or talus scree:** rubble and block accumulations; 1 to 10 m thick; massive; forming aprons and cones at the base of steep (greater than 40°) slopes; often accumulated due to rock fall and/or small rock slides.

Cz — **Undifferentiated landslide debris:** rubble and block fragments of bedrock; forming hummocky accumulations on lower slopes and valley floors; derived from large but inactive or dormant rock slides and slumps; generally 1 to 10 m thick, but may exceed 10 m thickness near the toe of large landslides.

Cv — **Colluvial veneer:** diamicton and rubble; less than 2 m thick; mainly derived from disintegration of upslope bedrock on moderate to steep slopes; strongly conforms to the surface expression of the underlying landform.

Cb — **Colluvial blanket:** diamicton and rubble; 2 to 5 m thick; mainly derived from disintegration of upslope bedrock on moderate to steep slopes; typically conforms to the surface expression of the underlying landform and may include smaller deposits of unconsolidated debris at the toe of minor landslide and snow avalanche tracks.

C — **Undifferentiated colluvial deposits:** diamicton and rubble accumulated from slow gravity-induced movement and/or various smaller mass movement processes; 1 to 3 m thick. Occurs in secondary unit only.

ALLUVIAL (FLUVIAL) SEDIMENTS: gravel and sand with minor silt; commonly stratified; generally well sorted except in alluvial fans; deposited by modern streams.

Ap — **Floodplain sediments:** usually sandy, gravelly deposits; 1 to 5 m thick; forming flat to gently sloping surfaces adjacent to stream and river level; prone to flooding; larger, low-gradient channels are often bordered by low surfaces mantled by overbank sand, silt, and organic material.

Af — **Alluvial fan sediments:** sand and gravel, with diamicton; poorly sorted; usually 2 to 10 m thick, located at the toe of slopes where a stream issues from a confined channel and at the mouths of narrow valleys.

Av — **Alluvial veneer:** sand and gravel; deposited by streams; less than 2 m thick.

Ab — **Alluvial blanket:** sand and gravel; deposited by streams; greater than 2 m thick.

MARINE SEDIMENTS: clay, silt, sand, and gravel settled from suspension in salt water or deposited by submarine gravity flows; well to moderately well sorted; well stratified to massive; shells may be present; beach sediment accumulated or modified by shoreline processes; occurs close to present-day shorelines.

Mt — **Marine terrace sediments:** clay, silt and sand; variable thickness; forming low terraces above the present sea level.

Mr — **Marine beach sediments:** sand and gravel; well-sorted; well rounded; variable thickness; accumulated by wave action.

Md — **Marine deltaic sediments:** sand and gravel with minor silt and clay, likely grading finer with depth; variable thickness; low, gently sloping surface above the present sea level; deposited at the mouth of a stream. Occurs in secondary unit only.

Mv — **Marine veneer:** clay, silt and sand; less than 2 m thick.

Mb — **Marine blanket:** clay, silt and sand; more than 2 m thick. Occurs in secondary unit only.

POSTGLACIAL ENVIRONMENT ASSOCIATED WITH DEGLACIATION

GLACIOMARINE SEDIMENTS: clay, silt, sand, and gravel; massive or laminated; ice-rafted stones, rhythmic bedding (mm to cm thick) and marine shells may be present; bedding may be distorted due to submarine gravity flows; deposited in a marine environment in relatively close proximity to glacier ice, ice shelves or floating ice, or sediment-laden glacial meltwater streams.

GMv — **Glaciomarine veneer:** mainly clay, silt, and sand; less than 2 m thick; sediment cover may be discontinuous in places and follows the underlying morphology.

GMb — **Glaciomarine blanket:** mainly clay, silt, and minor sand; greater than 2 m thick; extensive deposits may exceed 10 m thickness.

GM — **Undifferentiated glaciomarine sediments:** of unknown texture, extent, and thickness; usually overlain by later post-glacial or Holocene sediments or exposed on an erosional slope (scarp). Occurs in secondary unit only.

FRASER GLACIATION (WISCONSINAN)

PROGLACIAL AND GLACIAL ENVIRONMENT

GLACIOFLUVIAL SEDIMENTS: sand and gravel with minor diamicton; well sorted to poorly sorted; well to poorly stratified; variable thickness; deposited by glacial meltwater at or in close proximity to stagnating or retreating glaciers; bedding may have been disrupted locally following the melting of supporting ice.

GFt — **Glaciofluvial terrace sediments:** sand and gravel; stratified to massive; 1 to 10 m thick; forming terraced deposits along valley walls or associated with meltwater channels and perched well above modern alluvial deposits.

GFv — **Glaciofluvial veneer:** sand and gravel; generally less than 2 m thick; sediment cover may be discontinuous in places and follows the underlying morphology.

GLACIAL ENVIRONMENT

TILL: diamicton consisting of poorly sorted pebbles, cobbles, and boulders in a sandy to clayey matrix; directly deposited by glaciers; may contain small inclusions of glaciofluvial sediments, especially in valley bottoms and near the mouths and banks of meltwater channels; includes till that has been reworked due to gravity on steep slopes.

Tv — **Till veneer:** diamicton; less than 2 m thick on average; underlying bedrock morphology is discernible and where till cover is discontinuous, bedrock outcrops are abundant.

Tb — **Till blanket:** diamicton; more than 2 m thick on average; continuous till cover with few bedrock outcrops; conforming to and locally obscuring topography of underlying units.

T — **Undifferentiated till:** till deposits of unknown extent and thickness; usually overlain by post-glacial non-glacial sediments; till exposed on an erosional slope (scarp). Occurs in secondary unit only.

WEATHERED BEDROCK: rock fragments of rubble to block size, with variable amounts of residual silt, sand or clay, depending on the original bedrock type; derived from bedrock that is decomposed or disintegrated in-situ by mechanical or chemical weathering.

Wv — **Weathered bedrock veneer:** less than 2 m thick; discontinuous cover with abundant bedrock outcrops.

PRE-QUATERNARY

BEDROCK: Paleozoic, Mesozoic and Cenozoic igneous and metamorphic bedrock outcrops; includes bedrock covered by unconsolidated or organic material that is less than 10 to 20 cm thick.

R2 — Dominantly igneous bedrock.

R3 — Dominantly metamorphic bedrock.

Complex units: two map-unit designators are used in cases where the surficial cover forms a complex area and the map units are too small to be mapped individually, yet constitute a significant areal extent of the total polygon (e.g. Owb,Tb designates an area of organic bog deposits with numerous outcrops of till blanket). In such instances a dot (`.`) is used to separate the map-unit designator.

Stratigraphic relationship: a stratigraphic relationship is shown with two map-unit designators separated by a slash (`/`) (e.g. GFv/Tb indicates glaciofluvial veneer overlying till blanket).

Geological boundary (confidence approximate)

Limit of mapping

Landslide track, sediment transport direction

Recommended citation
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Celebrating 175 yrs

Geological Survey of Canada
Canadian Geoscience Maps

Authors: D.E. Maynard, I.C. Weiland, A. Blais-Stevens, and M. Geertsema

This map was produced by Natural Resources Canada in co-operation with Transport Canada.

Geology by D.E. Maynard, I.C. Weiland, and A. Blais-Stevens, 2015

Geology conforms to Surficial Data Model v. 2.2

Geomatics and cartography by W. Chow, C.L. Wagner, and S. van Stavel

Joint initiative of the Geological Survey of Canada and the World Class Tanker Safety Project at Transport Canada, conducted under the auspices of North Coast activity as part of Natural Resources Public Safety Geoscience Program.

Map projection Universal Transverse Mercator, zone 9. North American Datum 1983

Base map at the scale of 1:50 000 from Natural Resources Canada, with modifications. Elevations in metres above mean sea level

SURFICIAL GEOLOGY

HARTLEY BAY, DOUGLAS CHANNEL AREA

British Columbia

parts of NTS 103-H/6 and 11

1:25 000

500 0 500 1000 1500 2000 m

Shaded relief image derived from the Canadian Digital Elevation Model (CDEM) supplied by Natural Resources Canada. Illumination: azimuth 315°, altitude 45°; vertical factor 1x

Magnetic declination 2017, 18°09'E, decreasing 12.9' annually.

This map is not to be used for navigational purposes.

Title photograph: Hawkesbury Island; Deep seated gravitational deformation structures on southwest Hawkesbury Island, southeast Douglas Channel, British Columbia. Photograph by A. Blais-Stevens. 2016-059

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

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Preliminary publications in this series have not been scientifically edited.

CANADIAN GEOSCIENCE MAP 302
SURFICIAL GEOLOGY
HARTLEY BAY, DOUGLAS CHANNEL AREA
British Columbia
parts of NTS 103-H/6 and 11

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