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CANADIAN GEOSCIENCE MAP 203

SURFICIAL GEOLOGY

DISTRICT OF NORTH VANCOUVER

British Columbia

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Preliminary

Canadian Geoscience Maps

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Cover Illustration

North Vancouver from the Ironworkers Memorial Bridge, North Vancouver, British Columbia. Photograph by N. Hastings. 2014-164

ABSTRACT

The map area on the flank of North Shore Mountains is incised by three glacially-widened valleys. Glacial cycles caused sporadic erosion and deposition of sediments mantling the slopes. Most surficial deposits are from the last glaciation; however, some exposures and seismic data show older sediments, especially within buried valleys. During deglaciation, the sea level reached 200 m and meltwater issuing from the valleys formed glaciomarine deltas. Falling postglacial sea levels caused the deltas to be incised. Modern rivers mainly re-mobilize the older sediments. Other contemporary deposits include alluvial fans and debris flows on steep mountain slopes, and landslides on the flanks of incised valleys. Anthropogenic alterations of the landscape include land reclamation along the waterfront and infilling of valleys and slopes to provide level building sites and to mitigate the affects of flooding from mountain streams.

Résume

La zone de la carte qui couvre le flanc des montagnes du North Shore est découpée par trois vallées élargies par la glaciation. Les cycles de glaciation ont causé une érosion sporadique et ont déposé des sédiments qui recouvrent les pentes. Bien que la plupart des dépôts superficiels remontent à la dernière glaciation, certains affleurements rocheux et des données sismiques indiquent la présence de sédiments plus anciens, notamment dans les vallées enfouies. Lors de la déglaciation, le niveau de la mer s'est haussé de 200 m et l'eau de fonte coulant dans les vallées a créé des deltas glaciomarins. La baisse postglaciale du niveau de la mer a causé l'encaissement des deltas. Les rivières modernes remobilisent surtout des sédiments plus anciens. Parmi les autres dépôts contemporains, on peut compter les cônes alluviaux et les coulées de débris sur les pentes raides des montagnes, ainsi que les glissements de terrain sur les flancs des vallées encaissées. Le paysage a été modifié par les humains, notamment les terre-pleins sur le front de mer, et le remplissage des vallées et des pentes pour aplanir les terrains à bâtir et atténuer les effets des inondations par les ruisseaux de montagne.

About the Map

General Information

Author: J.M. Bednarski

Geology by J.M. Bednarski, 2010–2011

Airphoto, Lidar, and satellite interpretation by J.M. Bednarski, 2010–2011

Geology conforms to Surficial Data Model v. 2.0.1

Geomatics and cartography by M. Lagassé and W. Chow

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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

Waterbody and Indian Reserves data obtained from District of North Vancouver's GeoWeb. Contains information licensed under the Open Government Licence - North Vancouver.

Some geographic names on this map are not official.

Shaded relief image derived from the digital elevation model supplied by the District of North Vancouver. Illumination: azimuth 345°, altitude 65°, vertical factor 1x

Magnetic declination 2014, 16º53'E, decreasing 11' annually.

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

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

This map is not to be used for navigational purposes.

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

The surfical geology map for North Vancouver was used to help inform a detailed earthquake risk assessment for the District of North Vancouver. Outputs of this assessment are now being used by the community in development of an earthquake ready action plan to make the community more disaster resilient. In particular, this new surficial geology map was combined with information about the physiography and groundwater depth to assess the likelihood and magnitude of ground failure by liquefaction and earthquake triggered landslides and to inform the development of a site amplification map. Lessons learned from this case study are transferable to other communities who may face similar risks.

This map covers the lower flank of the North Shore Mountains from the shore of Burrard Inlet to about 500 m in elevation. The land rises northward to ~1400 m over a distance of 10 km from the sea. Except for a narrow deltaic plain, most of the area is characterized by steep slopes incised by high energy streams flowing in narrow flood plains. The bedrock is mainly diorite and granodiorite, part of an uplifted and faulted complex of plutonic and metamorphic rocks. Minor outcrops of terrestrial sedimentary rocks occur in the southern part of the area.

The mountains were extensively modified by glacial cycles during the Quaternary. Major south-trending valleys were eroded along fault-weakened rocks and fracture zones. In general, each glacial cycle of advance and retreat was characterized by erosion and deposition of glacial, glaciofluvial, and glaciomarine sediments. Intervening non-glacial intervals were dominated by fluvial, mass wasting, and marine processes. Successive glaciations with sporadic erosion, deposition, and recycling of sediments resulted in a thick accumulation of unconsolidated deposits mantling the slopes of the north shore.

During past glaciations, valley glaciers flowed southward off the mountains into the Capilano, Seymour, and Lynn valleys while a large trunk glacier in Burrard Inlet abutted the flank of Mount Seymour as it flowed westward. The expanded glaciers depressed the crust so that sea levels were high and extensive marine inundation took place in front of the ice margins. Following several glacial cycles, the coastal lowlands became covered by thick sequences of glacial, glaciomarine, and fluvial sediments. Seismic data show old valleys that were completely infilled by glacial sediments. The floor of a buried valley along the Capilano River lies well below present sea level. In general, the surficial deposits are thickest below ~200 m elevation, the upper level of postglacial marine inundation, but thickness can vary considerably as the underlying bedrock topography is rugged. Bedrock is the dominant surface at higher elevations with only a thin discontinuous veneer of glacial deposits or colluvium.

At least two episodes of glaciation (stades) with intervening non-glacial intervals are recorded by stratigraphic sections in the map area, but most of the surficial deposits are associated with the last glaciation (Fraser Glaciation) and postglacial period. Any older sediments were probably reworked during the last glaciation. In the map area, the main deposits of the Fraser Glaciation are Quadra Sand, an advance phase outwash, and the overlying Vashon Drift. Deposits from minor ice advances have been recognized in parts of the Fraser lowland but have not been differentiated here. Vashon Drift is overlain by postglacial Capilano Sediments, which were deposited by glacial meltwaters flowing into formerly high sea and lake levels. Capilano Sediments are usually associated with rapid changes in base levels as the land rebounded. Modern deposits on contemporary slopes, lakes, and the sea are classed as Salish Sediments.
In summary, the Fraser Glaciation began ~26 000 radiocarbon years ago (BP) when glaciers accumulated in the cirques and uplands of the Coast Mountains, and culminated in an extensive ice sheet at least 1800 m thick. Initial ice flow was down mountain valleys but in time the Coast Mountains and lowlands where completely inundated. Two main ice-flow directions were recognized in the map area, although they may not have been coeval. The western two-thirds of the map area was dominated by ice flow from north to south and south-southwest caused by coalescent valley glaciers flowing off the North Shore Mountains. In contrast, the eastern third of the map area records a dominant ice flow along the flank of Mount Seymour to the south-west caused a trunk glacier flowing along the main axis of Burrard Inlet. The recorded ice flows were ultimately influenced by topography, however, it is not known whether the pattern formed beneath a thick contiguous ice sheet or by distinct glaciers or ice lobes during deglaciation. In any event, a thick glacial load depressed the earth's crust causing sea level to rise relative to the land. Consequently, the glaciers at first advanced into a high sea and floated producing extensive glaciomarine deposits. As glaciation intensified, thicker ice became grounded and in time the sea was completely displaced from the Strait of Georgia. Glacial till was deposited throughout the region during the glacial maximum. With deglaciation ~12 500 BP, the thinning ice was again susceptible to calving and glaciomarine sedimentation dominated once more. Deglaciation of the Georgia depression was probably rapid because the thinning ice margin would have became unstable with high seas flooding newly exposed fiords and bays. Accordingly,

Vashon Drift is a collective term that includes not only till, but also the advance and retreat glaciomarine sediments, as well as some glaciofluvial deposits, especially those deposited close to former ice margins. This is in contrast to Quadra Sand which is thought to be distal outwash related to the Vashon advance.

Based on shore lines in the map area, the early postglacial sea inundated the North Shore to ~200 m elevation. Deltas formed at the valley mouths where large volumes of sediment-laden meltwater issued from the retreating glaciers immediately upvalley. Moraines and ice-contact glaciofluvial terraces associated with the upper deltas mark the former ice margins near the marine limit. Nevertheless the high relative sea level was short-lived because of rapid crustal uplift. By ~10 000 BP sea level was only about 10 m above present. Consequently, the oldest, uppermost delta terraces were incised and/or reworked by channels grading to ever lower base levels. This resulted in stepped delta and river terraces descending to present sea level. Postglacial deposits related to these higher than modern base levels were classed as Capilano Sediments. Although deposition in the map area was mainly in a marine environment, Capilano Sediments could also include lacustrine and fluvial deposits. Sediments deposited less than ~5 m above base level where classed as Salish Sediments, however, Capilano Sediments may include deposits related to base levels below present sea level. There is evidence from elsewhere that sea level was at least 10 m below present ~8 000 BP.

Salish Sediments refer to recent deposits associated with present sea, lake or river levels. However, Salish Sediments often contain reworked material, especially where modern rivers flow within valleys containing older Capilano outwash. The outwash provides a readily available source material for terraces and deltas. On steeper slopes, Salish Sediments include mass wasting deposits such as landslides and steep channels incised on the mountain slopes feed alluvial fans and occasional debris flows. Humans have altered the original landscape to the map area with major land reclamations along the waterfront, significant infilling of some valleys and slopes to provide level building sites, and structures to mitigate flooding from mountain streams.

References

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Author Contact

Questions, suggestions, and comments regarding the geological information contained in the data sets should be addressed to:

Jan Bednarski
Geological Survey of Canada
9860 West Saanich Road
P.O. Box 6000 V8L 4B2
Jan.Bednarski@NRCan-RNCan.gc.ca

Coordinate System

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

Bounding Coordinates

Western longitude: 123°08’12” W
Eastern longitude: 122°55’23” W
Northern latitude: 49°22’44” N
Southern latitude: 49°17’21” N

Data Model Information

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:

Deblonde, C., Plouffe, A., Eagles, S., Everett, D., Huntley, D.H., Inglis, E., Kerr, D.E., Moore, A., Parent, M., Robertson, L., Smith, I R., St-Onge, D.A., Weatherston, A., 2014. Science language for an integrated Geological Survey of Canada data model for surficial geology maps, version 2.0; Geological Survey of Canada, Open File 7631, 464 p. doi:10.4095/294225

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ACCORD DE LICENCE

Voir l'accord de licence à http://donnees.gc.ca/fra/licence-du-gouvernement-ouvert-canada