Natural Resources Canada
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CANADIAN GEOSCIENCE MAP 174

PREDICTIVE SURFICIAL GEOLOGY

DENMARK BAY–QIKIQTAGAFAALUK AREA

Victoria Island, Nunavut
NTS 67-C and F

Map Information Document

Geological Survey of Canada
Canadian Geoscience Maps

2023

Canada

MAP NUMBER

Natural Resources Canada, Geological Survey of Canada
Canadian Geoscience Map 174

TITLE

Predictive surficial geology, Denmark Bay–Qikiqtagafaaluk Area, Victoria Island, Nunavut, NTS 67-C and F

SCALE

1:250 000

CATALOGUE INFORMATION

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ABSTRACT

This 1:250 000 predictive surficial geology map of Denmark Bay–Qikiqtagafaaluk area combines remote predictive mapping (RPM) and visually interpreted imagery from LANDSAT and SPOT data. Machine-automated classification of training data, conversion to surficial geology and terrain reclassification were integrated with landform and regional ground-truth data. The map captures a sediment mosaic because spectral data realistically record moisture content on terrain surfaces in this permafrost setting. Tonal character of moisture content is controlled by sediment texture, topography, vegetation, and material thickness. Visual analysis of terrain form, with expert knowledge, reveals a series of crosscut streamlined flow fields recording complex glacial history, including marine inundation limits. Scoured bedrock in flow fields indicates erosional terrains, with little or no sediment cover. RPM methods are efficient and accurate in mapping surface spectral details, allowing more time to develop geological models of glaciated terrain. This publication includes the predictive surficial geology data in two formats: Sheet 1, raster (~75%)/vector (~25%), and Sheet 2, vector.

RÉSUMÉ

Cette carte de la géologie prédictive des formations superficielles de la région cartographique de Denmark Bay–Qikiqtagafaaluk à l'échelle 1/250 000 combine la télécartographie prédictive et l'interprétation visuelle d'images obtenues par LANDSAT et SPOT. La classification automatique des données d'apprentissage, la conversion en une carte des formations superficielles et la reclassification des terrains ont été intégrées à des données sur les formes de terrain ainsi qu'à des données de la réalité de terrain à l'échelle régionale. La carte représente une mosaïque de sédiments car les données spectrales enregistrent de manière réaliste la teneur en eau des surfaces du terrain dans ce milieu à pergélisol. Le caractère tonal des données spectrales, qui reflète la teneur en eau, dépend de la texture des sédiments, de la topographie, de la végétation et de l'épaisseur des matériaux. L'analyse visuelle des formes de terrain par des spécialistes révèle une série de champs de formes profilées d'écoulement qui présentent entre eux des relations de recoupement, témoignant ainsi d'une histoire glaciaire complexe, ainsi que l'existence de limites de submersion marine. Le substratum rocheux affouillé dans les champs d'écoulement est l'indication de terrains d'érosion, qui présentent peu ou pas de couverture de sédiments. Les méthodes de télécartographie prédictive sont efficaces et précises pour cartographier les détails spectraux de la surface, ce qui donne aux géologues plus de temps pour produire des modèles géologiques des terrains glaciaires. Cette publication comprend des données de la géologie prédictive des formations superficielles en deux formats : feuille 1, matriciel (~75%)/vectoriel (~25%), et feuille 2, vectoriel.

LICENCE AGREEMENT

ACCORD DE LICENCE

Sheet 1 of 2, Predictive surficial geology (raster)

General Information

Authors: D.R. Sharpe, J.-E. Lesemann, W. Parkinson, L. Armstrong, and E. Dods

Geology by D.R. Sharpe, 1985, 1987, and 1988

Geological compilation by D.R. Sharpe, 2014 and D.E. Kerr, 2015

Geology conforms to Surficial Data Model v. 2.3.14 (Deblonde et al., 2018).

Geomatics by L. Armstrong, E. Dods, and S. Eagles

Cartography by S. Eagles, R. Chan, E. Everett, and M.J. Baldock

Scientific editing by A. Weatherston

Initiative of the Geological Survey of Canada, conducted under the auspices of the Remote Predictive Mapping activity as part of Natural Resources Canada's Geo-mapping for Energy and Minerals (GEM) program

Map projection Universal Transverse Mercator, zone 13
North American Datum 1983

Base map at the scale of 1:250 000 from Natural Resources Canada, with modifications
Elevations in metres above mean sea level

Proximity to the North Magnetic Pole causes the magnetic compass to be erratic in this area.
Mean magnetic declination 2023, 2°35'E, increasing 7.4' annually
Readings vary from 1°30'W in the NE corner to 6°04'E in the SW corner of the map.

This map is not to be used for navigational purposes.

Title photograph: Raised marine shoreline terraces that extend to a large sediment upland, Albert Edward Bay, Nunavut. Photograph by D.R. Sharpe.
NRCan photo 2014-066

The Geological Survey of Canada welcomes corrections or additional information from users (gscpublications-cgcpublications@nrcan-rncan.gc.ca).

Data may include additional observations not portrayed on this map. *See* map info document accompanying the downloaded data for more information about this publication.

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

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.

Cartographic Representations Used on Map

This map utilizes ESRI Cartographic Representations in order to customize the display of standard GSC symbols for visual clarity on the PDF of the map only. The digital data still contains the original symbol from the standard GSC symbol set. The following legend features have Cartographic Representations applied:

- Photo point symbols, Striations, Geomorphology lines

Definition Queries Used on Map

This map utilizes definition queries in order to customize the display for visualization on the PDF of the map only and does not affect the digital data. The following features have a definition query applied:

- Field stations, Geomorphology points

Descriptive Notes

This surficial geology map of Denmark Bay–Qikiqtagafaaluk area, Nunavut, combines a remotely predicted map (RPM) and visually interpreted imagery elements.

Remote Predictive Mapping

The procedure used to produce a remotely predicted map of Denmark Bay–Qikiqtagafaaluk area, Victoria Island, Nunavut, consists of classifying a series of satellite images that were merged into a seamless image mosaic *see* Figure 1 in documentation accompanying the digital data). The key steps used for classification follow.

a) Data used in this map include ~3 to 4 LANDSAT ETM+ images (30 m resolution), tiled into a mosaic for Qikiqtagafaaluk area including NTS 67-F and NTS 67-C. SPOT panchromatic imagery (5 m pixel size) and aerial photographs were also used during training and classification to make use of their improved spatial resolution. Digital terrain models (30 m pixel size) were used to re-classify pixels.

b) Training data associate spectral signatures to a defined area representing a distinctive terrain type, map unit or landform. Training was performed directly on the LANDSAT imagery and was informed by the spectral characteristics of the surface (material, vegetation, and slope), and by landform types and landform associations. Six classes were identified based on variation in surface moisture content, and include two types of bedrock and various sediments.

c) Image classification used a Random Forest (RF) classifier; a statistical algorithm adds random training and validation before classification. Different variables were assessed for their predictive capacity within the RF model derived from LANDSAT data (e.g. band ratios, textures, transformation) and digital terrain data (e.g. relative height, slope, aspect). Model outputs provide an estimate of overall accuracy and a probability estimate (e.g. Parkinson, 2012).

d) Classification for a surface-material map was produced when the spatial variability of bedrock and moisture content of surface sediment was converted to materials using a series of expert-knowledge rules related to the understanding of texture, landforms, and geomorphic processes.

e) Evaluation of the map used statistical outputs from the algorithm and qualitative assessment relative to known terrain elements, from aerial photographs, SPOT imagery, and from field-site observations and photos from the study area, and expert knowledge from completed mapping in an adjacent area (e.g. Sharpe, 1993).
f) Reclassification with additional training data may not resolve spectral variability, thus user-defined rules were used to help guide pixel reclassification. i) Glaciomarine deposits were captured by reclassifying moist (colluvial) sediments below marine limit mapped at ~100 to 125 m a.s.l. ii) Thick sediment was captured in hummocky topography (not in this area) where some better drained hillcrests have a spectral signature associated with dry, vegetation-poor, and apparently thin sediments (<1 m thick). This is spectrally accurate, yet geologically inaccurate since hummock tops record thick sediment with buried ice determined from previous field work (e.g. Sharpe, 1992).
g) Final remotely predicted map of surficial geology
The final map results from the automated classification based on training data, the post-classification conversion to a surficial materials map, the evaluation of the classified image, and on any needed reclassification following expert evaluation. Integration of landform data (mapped by visual image interpretation aided by regional field site and photographs - see below) with the surface materials map results in a remotely-predicted map of surficial geology.

Visual Interpretation of Imagery

SPOT imagery and aerial photographs were interpreted visually with the aid of field-site observations and ground photographs. Visual interpretation focussed on important landforms and terrain types that spectral imagery was not able to reliably map. These include shoreline features (marine and lacustrine), eskers, meltwater channels, deltas, hummocky terrain, bedrock areas, and eolian sand. Some landforms, streamlined forms, eskers, and moraine ridge were imported and modified as interpreted layers from published sources (e.g. Storrar and Stokes, 2007). Additional information and interpretation of this map is available in the Map Information Document accompanying this map.

REFERENCES

Deblonde, C., Cocking, R.B., Kerr, D.E., Campbell, J.E., Eagles, S., Everett, D., Huntley, D.H., Inglis, E., Parent, M., Plouffe, A., Robertson, L., Smith, I.R., and Weatherston, A., 2018. Surficial Data Model: the science language of the integrated Geological Survey of Canada data model for surficial geology maps; Geological Survey of Canada, Open File 8236, ver. 2.3.14, 1 .zip file. https://doi.org/10.4095/308178

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https://doi.org/10.4095/184168

Storrar, R. and Stokes, C.R., 2007. A glacial geomorphological map of Victoria Island, Canadian Arctic; Journal of Maps, v. 3, no. 1, p. 191–210. https://doi.org/10.1080/jom.2007.9710838

Additional Information

The Additional Information folder of this product's digital download contains figures and tables that appear in the map surround as well as additional geological information not depicted on the map, nor this document, nor the geodatabase.

- Figures, Photos, Supplemental notes

SHEET 2 OF 2, PREDICTIVE SURFICIAL GEOLOGY (VECTOR)

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North American Datum 1983

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DEFINITION QUERIES USED ON MAP

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DESCRIPTIVE NOTES

The predictive surficial geology raster-based remote predictive mapping (RPM) map was generalized in order to conform to cartographic standards for a 1:250 000 vector-based surficial geology map sheet, based on the Surficial Data Model (SDM), v. 2.3.14 (Deblonde et al., 2018). Linking this new mapping to the standard SDM in vector format facilitates the infilling of designated unmapped areas and co-ordinating the new mapping to previously mapped adjoining areas. The common science language and common legend is to enable and facilitate the efficient digital compilation, interpretation, management, and dissemination of geological map information in a structured and consistent manner. This provides an effective knowledge-management tool designed around a geodatabase which can expand following the type of information to appear on new surficial geology maps.

The generalization process included 4 iterations of a 3 X 3 pixel majority filter, conversion of the data from raster to vector format and removal of polygons less than 30 000 m^2. Polygons below this minimum size threshold were replaced with the neighbouring classes using the expand tool in ArcGIS.

Special treatment was given to predicted bedrock outcrops to maintain the spatial distribution of small discrete outcrops without overloading the map sheet with bedrock clusters. Predicted bedrock polygons smaller than 15 000 m^2 were removed, and the ones between 15 000 and 30 000 m^2 were converted to points (“x” symbol) using the centroid command in ArcGIS. The outline of the polygon was also smoothed by 150 m using the smooth line command in ArcGIS. Any existing vector data was maintained.

It is customary over the last few years for the Geological Survey of Canada to include any relevant legacy data in new vector-based predictive surficial geology maps that cover unmapped areas. The reason is because these predictive surficial geology maps are meant to represent our best summary of knowledge over large areas where traditional systematic mapping has not been done. Some of these additional features, many being field observations, include drumlinoids and crag-and-tails (Fyles, 1963), and major moraine ridges (Fyles, 1963). Some terrain features identified in RPM training areas by air-photo interpretation are included locally. The corresponding geodatabase for this map (Sheet 2) is included in this publication.

A widespread series of crosscut, streamlined flow fields record the complex glacial history of eastern Victoria Island, including marine-limit water plains. Scoured bedrock in several flow fields indicates that these are erosional terrains, with little or no sediment cover.

REFERENCES

Deblonde, C., Cocking, R.B., Kerr, D.E., Campbell, J.E., Eagles, S., Everett, D., Huntley, D.H., Inglis, E., Parent, M., Plouffe, A., Robertson, L., Smith, I.R., and Weatherston, A., 2018. Surficial Data Model: the science language of the integrated Geological Survey of Canada data model for surficial geology maps; Geological Survey of Canada, Open File 8236, ver. 2.3.14, 1 .zip file. https://doi.org/10.4095/308178

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- Figures, Photos, Supplemental notes

AUTHOR CONTACT

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

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Coordinate System
Projection: Universal Transverse Mercator
Units: metres
Zone: 13
Horizontal Datum: NAD83
Vertical Datum: mean sea level

Bounding Coordinates
Western longitude: 104°00′00″W
Eastern longitude: 100°00′00″W
Northern latitude: 71°00′00″N
Southern latitude: 69°00′00″N

Software Version
Data has been originally compiled and formatted for use with ArcGIS™ desktop version 10.8.2 developed by ESRI®.

Data Model Information

Surficial

The Geological Survey of Canada (GSC) through the Geo-mapping 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:

Deblonde, C., Cocking, R.B., Kerr, D.E., Campbell, J.E., Eagles, S., Everett, D., Huntley, D.H., Inglis, E., Parent, M., Plouffe, A., Robertson, L., Smith, I.R., and Weatherston, A., 2018. Surficial Data Model: the science language of the integrated Geological Survey of Canada data model for surficial geology maps; Geological Survey of Canada, Open File 8236, ver. 2.3.14, 1 .zip file. https://doi.org/10.4095/308178