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TECTONIC MAP OF ARCTIC CANADA

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ABSTRACT

The Tectonic map of Arctic Canada (TeMAC) presents a tectonic synopsis of all onshore and offshore areas north of latitude 60°N at a scale of 1:4 000 000. Data sources include territorial and national compilations locally incorporating field work up to 2010 at scales of 1:100 000 to 1:5 000 000 and new compilation work for parts of Nunavut and Northwest Territories. One hundred and two tectonic domains are documented and include: 5 cratons, 37 basins, 2 platforms, 3 shelves, 2 plains, 1 ridge, 3 oceanic domains, 7 cover sequences, 15 accreted terranes, 16 magmatic suites, and 11 orogens. Stripe patterns are utilized to indicate the extent of orogenic overprinting with stripe colour keyed to individual orogens. Applications of TeMAC include 1) providing a new tectonic compilation and database context for Arctic Canada; 2) encouraging frontier mineral and energy exploration; and 3) providing general support for the geological framework developed for the delineation of the outer limits of Canada's Arctic continental shelf.

RÉSUMÉ

La carte tectonique de l'Arctique canadien (TeMAC) présente un sommaire tectonique de tous les domaines de roche en place sur terre et sous mer au nord de la latitude 60°N à l'échelle de 1/4 000 000. TeMAC fait usage de compilations territoriales et nationales incorporant localement les travaux de terrain jusqu'à 2010 à des échelles allant de 1/100 000 à 1/5 000 000. De plus TeMAC inclus de nouveaux travaux de compilation pour une partie de Nunavut et les Territoires du Nord-Ouest. Cent deux domaines tectoniques sont documentés par TeMAC et comprennent: 5 cratons, 37 bassins, 2 plates-formes, 3 marges, 2 plaines, 1 dorsale, 3 domaines océaniques, 7 séquences de couverture, 15 terrains d'accrétion, 16 suites magmatiques et 11 orogènes de compression. Des patrons de lignes parallèles diagonales sont utilisés pour indiquer les zones de surimpression orogénique, avec la couleur des lignes étant spécifique à chaque orogenèse. Les applications identifiées pour TEMAC comprennent: 1) fournir une nouvelle compilation tectonique et un contexte de base de données pour l'Arctique canadien; 2) encourager l'exploration pour des minerais et l'énergie; et 3) fournir un appui général pour le cadre géologique développé pour la délimitation de la limite extérieure du plateau continental canadien dans l'Arctique.

ABOUT THE MAP

General Information

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This map is part of the Geo-mapping for Energy and Minerals (GEM) Program, Tri-territorial bedrock database and map compilation (TriT) project, led by the Geological Survey of Canada (GSC) in collaboration with the Canada-Nunavut Geoscience Office (C-NGO), the Northwest Territories Geoscience Office (NTGO) and the Yukon Geological Survey (YGS).

Map projection Stereographic North Pole, standard parallel 70°00’N.
Coordinate System WGS 1984

Base map at the scale of 1:1 000 000 from the Atlas of Canada, with modifications.

This map is not to be used for navigational purposes.

Title photograph: Cambrian sandstone and dolostone and Ordovician limestone/dolostone strata of the Prince Regent basin unconformably overlying shallow-

dipping, granulite-facies quartzofeldspathic gneisses of the early Paleoproterozoic Inglefield orogen, Dundas Harbour, Devon Island, Nunavut. View looking west. Height of cliff is 400 m. Photograph by M.R. St-Onge, 2011. 2014-228

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

Data may include additional observations not portrayed on this map.
See documentation accompanying the data.
Additional descriptive notes are included in the map information document.

This publication is available for free download through GEOSCAN (http://geoscan.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

Explanatory Notes

INTRODUCTION
As part of a seven-country project to produce a new Tectonic Map of the Arctic (TeMAr), the Geological Survey of Canada (GSC) has provided Canadian data and information in preparation for, and following, a workshop organized by the Commission for the Geological Map of the World (CGMW) in Paris, France, during the week of February 17, 2014. Release of the tectonic compilation map and related digital map database at a scale of 1:5 000 000 by the national geological surveys of Canada, the USA, Norway, Denmark & Greenland, Sweden, Finland, and Russia is planned for 2016. The present publication (CGM 187) focusses specifically on the Canadian portion and comprises a new Tectonic Map of Arctic Canada (TeMAC) that presents a complete tectonic synopsis of all onshore and offshore bedrock areas north of latitude 60°N at a scale of 1:4 000 000.

Identified applications of TeMAC and its associated map database include 1) providing a new tectonic compilation and database context for all Precambrian and Phanerozoic map units that can be shown at 1:4 000 000 scale in the Canadian polar region north of latitude 60°N; 2) documenting and understanding the spatial relationships between mineral/energy resources and onshore/offshore tectonic units and history; 3) encouraging frontier mineral and energy exploration through wider dissemination of national geology data sets; 4) delivering publicly accessible tools to facilitate industry, university, and government project planning; 5) providing a tectonic context for resource and ecosystem management, environmental-impact assessment, geotechnical concerns, and infrastructure development; 6) assessing tectonic parameters that relate to natural hazards, metals in the environment, watershed and groundwater issues; and 7) documenting a tectonic history of Arctic Canada that provides general support for the geological framework developed for the delineation of the outer limits of Canada's continental shelf in the Arctic. TeMAC will not, however, have a direct impact on Canada's submission under the United Nations Convention on the Law of the Sea process.

Data sources that contributed to TeMAC include regional, territorial national, and international compilations including locally field work up to 2010 (Figure 1) simplified from original spatial data at scales ranging from 1:100 000 to 1:5 000 000. New compilation work includes parts of two of the northern territories (Nunavut and Northwest Territories). Existing published material was derived from digital maps of Yukon (1:1 000 000 scale), and other selected parts of Arctic Canada (1:5 000 000 scale). Captured

analog sources cover the northwest Atlantic Ocean and the Arctic Ocean (1:5,000,000 scale). Basin isopach maps were provided by coauthors Tom Brent (Sverdrup basin, Baffin Bay basin), Bernie Maclean (northern Mackenzie platform), and Chris Jauer (Saglek basin). Other isopach maps are derived from published sources.

TIME SCALE

Standardization of map-unit attributes, including map colours for sedimentary strata, has been facilitated by the International Chronostratigraphic Chart (February 2014 version) published by the International Commission on Stratigraphy (ICS) (http://www.stratigraphy.org/ICSchart/ChronostratChart2014-02.pdf), which draws on the absolute scale for the Precambrian and the relative time scale for Ediacaran and younger rocks.

TECTONIC DOMAINS

One hundred and two tectonic domains of Precambrian and Phanerozoic age are recognized in Arctic Canada. These include 5 cratons, 37 basins, 2 platforms, 3 shelves, 2 plains, 1 ridge, 3 oceanic domains, 7 cover sequences, 15 accreted terranes, 16 magmatic suites and 11 compressional orogens. All but the latter are assigned a unique 2-letter code, which is listed in the legend and featured on the map; because of the unique overprinting nature of orogens, they are treated differently (see Patterns section below).

The tectonic domains are organized based on age and domain type. The age parameter makes use of the International Chronostratigraphic Chart, whereas the domain types are those listed above. The resulting tectonic architecture of Arctic Canada is thus revealed on the map and features, from youngest to oldest:

- Neogene basins, distinguished by name (Arctic coastal plain, Continental shelf);
- Oceanic crust of Paleocene and younger age, distinguished by name (Eurasian Basin, Labrador-Baffin rift)
- a Paleogene orogen (Eurekan orogen) and foreland (Eurekan foreland basin);
- a Cretaceous-Paleocene ocean ridge (Lomonosov ridge);
- Cretaceous-Neogene ocean basins, distinguished by name (Amerasian basin, Beaufort-Mackenzie basin, Canada basin, Baffin Bay-Labrador Sea basins, Saglek basin);
- Cretaceous oceanic crust (Canada basin)
- a Cretaceous to Paleocene orogen (Cordilleran orogen) and related cover sequences (Cordilleran cover, Hudson cover, Yukon Flats-Old Crow cover, Kluane basin);
- Jurassic to Paleogene foreland basins, distinguished by name (Banks basin, Mackenzie plain, Western Canada sedimentary basin);
- Silurian to Quaternary magmatic units within the Cordilleran orogen;
- Jurassic and younger terranes, distinguished by name (Alexander terrane, Arctic Alaska terrane, Cache Creek terrane, Cassiar terrane, Chugach terrane, Quesnel terrane, Slide Mountain terrane, Stikine terrane, Wrangell terrane, Yukon-Tanana terrane);
- a Mississippian to late Cretaceous basin, (Sverdrup basin);
- a Devonian-Carboniferous orogen (Ellesmerian orogen);
- a Devonian foreland basin (Ellesmerian foreland basin);
- a Silurian-early Devonian uplift and fold belt, distinguished by name (Boothia uplift, Cornwallis fold belt) and cover (Boothia cover);

- a Silurian terrane (Pearya terrane);
- a Silurian to Devonian basin (Elk Point basin);
- Ordovician to Devonian basins, distinguished by name (Foxe basin, Hudson Bay basin, Hudson Strait basin);
- Cambrian to Devonian basins and platforms, distinguished by name (Arctic platform, Mackenzie platform, M'Clintock basin, Prince Regent basin);
- a Neoproterozoic to Permian shelf (Mackenzie shelf);
- Neoproterozoic to Devonian basins and platforms, distinguished by name (Hazen trough, Franklinian shelf, Selwyn basin, Yukon Flats-Old Crow basin);
- a Neoproterozoic magmatic suite (Franklin suite);
- late Mesoproterozoic to Neoproterozoic basins, distinguished by name (Amundsen basin, Mackenzie Mountain basin, Windermere basin);
- Mesoproterozoic basins, distinguished by name (Borden basin, Fury and Hecla basin, Thule basin);
- a Mesoproterozoic magmatic suite (Mackenzie suite);
- late Paleoproterozoic basins, distinguished by name (Aston basin, Elu basin, Hornby Bay basin, Thelon basin; Wernecke basin);
- a middle-late Paleoproterozoic magmatic suite (Nueltin suite);
- early and middle Paleoproterozoic orogens, distinguished by name (Arrowsmith orogen, Inglefield orogen, New Quebec orogen, Snowbird orogen, Taltson-Thelon orogen, Trans-Hudson orogen, Wopmay orogen);
- middle Paleoproterozoic magmatic suites, distinguished by name (Burwell arc, Cumberland batholith, Etah metaigneous complex, Great Bear batholith, Hepburn batholith, Hudson suite, Mara River sheets, Qikiqtarjuaq suite, Taltson-Thelon magmatic suite);
- early-middle Paleoproterozoic terranes, distinguished by name (Hottah terrane, Meta Incognita micro-continent, Narsajuaq terrane, Purtuniq ophiolite);
- early-middle Paleoproterozoic basins, distinguished by name (Baker Lake basin, Coronation basin, Etah basin, Great Slave basin, Kilohigok basin, Nonacho basin);
- early-middle Paleoproterozoic cratonic cover, distinguished by name (Hearne craton cover, Rae craton cover, Superior craton cover);
- Archean cratons, distinguished by name (Hearne craton, North Atlantic craton, Rae craton, Slave craton, Superior craton).

TECTONIC ENVIRONMENTS

In addition to being organized into the tectonic domains listed above, map units are also coded in terms of the dominant lithotectonic environment of formation. Lithotectonic variation is expressed by 24 associations, which include seven sedimentary associations based on gross depositional setting (back-arc basin, deep water basin, intracratonic rift basin, molasse basin, stable shelf basin, transtensional rift basin, and sedimentary: undivided); eight extrusive associations (alkaline sequence, back-arc sequence, basalt-komatiite sequence, continental arc sequence, flood basalt sequence, mafic sill and dyke complex,

volcanic rift margin, and volcanic: undivided); six intrusive associations (alkaline and subalkaline suite, anorthosite suite, I-type granite suite, S-type granite suite, layered mafic and/or ultramafic complex, plutonic: undivided); two metamorphic associations (amphibolite-facies gneiss and migmatite, granulite facies gneiss); and an ophiolitic association. For each of these, a unique two-letter code is listed in the database and mostly expressed as patterns on the map and legend.

OCEANIC CRUST

Oceanic crust is present in the Canada basin (Cretaceous) and in the Labrador Sea and Baffin Bay (Paleogene). A distinct colour scheme is indicated based on age range and magnetic chrons (see map legend). Where isopached sedimentary basins occur on top of oceanic crust, the isopachs (1 km contour interval) are illustrated with dashed lines.

VECTOR AND POINT DATA

Geological vector data portrayed on the map include spreading ridges, geological contacts and a range of faults. Lithotectonic point features are identified with distinct marker symbols as shown on the legend chart. These include: alkaline and subalkaline granite and syenite, anorthosite, carbonatite, extinct volcano, impact structure, I-type and S-type granites, kimberlite, lamproite, and salt diapir. For clarity not all lithotectonic point features are shown on the paper map. A key to the symbols utilized for the lithotectonic point features is provided in the map legend.

COLOUR DESIGN

Onshore tectonic domains

The colour design of the map for onshore and offshore Phanerozoic tectonic domains follows as closely as possible that of the International Chronostratigraphic Chart, with new colour shades added for broader age divisions or to distinguish contrasting tectonic domains of similar age. For Precambrian onshore and offshore tectonic domains, a more nuanced colour scheme than available on the chronostratigraphic chart was selected in order to adequately portray the rich Canadian rock record. Thus in order to discern the various Archean cratonic nuclei, varying shades of pale pink or salmon were utilized. To illustrate Paleoproterozoic sedimentary strata, shades of yellow and sand were chosen; for Mesoproterozoic strata, shades of brown, and for Neoproterozoic strata shades of pale orange and flesh. To differentiate Precambrian or Phanerozoic magmatic suites or accreted terranes from sedimentary basins of a similar age, shades of red, fuchsia, dark pink, and violet were used for the magmatic arcs and shades of blue, green, grey, brown and mauve were utilized for the terranes. Throughout, an effort was made to choose colours for Precambrian tectonic units that were not used for the Phanerozoic. Some colours, however, are repeated.

Colours for onshore and offshore Phanerozoic sedimentary basins, in addition to following as closely as possible those of the International Chronostratigraphic Chart, are further modified to convey isopach information where available, with saturation increasing with thickness (Figure 2).

Only the larger lakes are shown on the tectonic map. Small lakes and all northern ice fields aren't shown because they interfere with a clear portrayal of tectonic domains and lithotectonic units.

Offshore tectonic domains

Offshore tectonic units are designated by labels and contact boundaries and are coloured much in the same way as the onshore units. In order that the onshore and offshore regions nevertheless clearly stand out a white buffer seaward of the coastline serves to highlight the distinction between land and offshore areas.

PATTERNS

Repeat patterns are used to illustrate selected lithotectonic units with, notably, separate patterns for extrusive, intrusive, metamorphic, and ophiolitic rock associations. There are three patterns for selected sedimentary associations (deep water basin, molasse basin, transtensional rift basin), eight patterns for extrusive associations (alkaline sequence, back-arc sequence, basalt-komatiite sequence, continental arc sequence, flood basalt sequence, mafic sill and dyke complex, volcanic rifted margin, and volcanic: undivided); six patterns for intrusive associations (alkaline and subalkaline suite, anorthosite suite, I-type granite suite, S-type granite suite, layered mafic and/or ultramafic complex, plutonic: undivided); two patterns for metamorphic associations (amphibolite-facies gneiss and migmatite, granulite facies gneiss); and one pattern for ophiolitic association.

Pencil stripe patterns are utilized to indicate the extent of orogenic overprinting (mostly right-dipping stripes) with the colour of the stripes keyed to individual orogens as indicated in the map legend. If a tectonic domain is overprinted by two orogenic events, a paired set of right dipping stripes is shown and in cases of three orogenic overprints, a triad of right-dipping colour stripes is shown. An example with three phases of orogenic overprinting is shown in Figure 3.

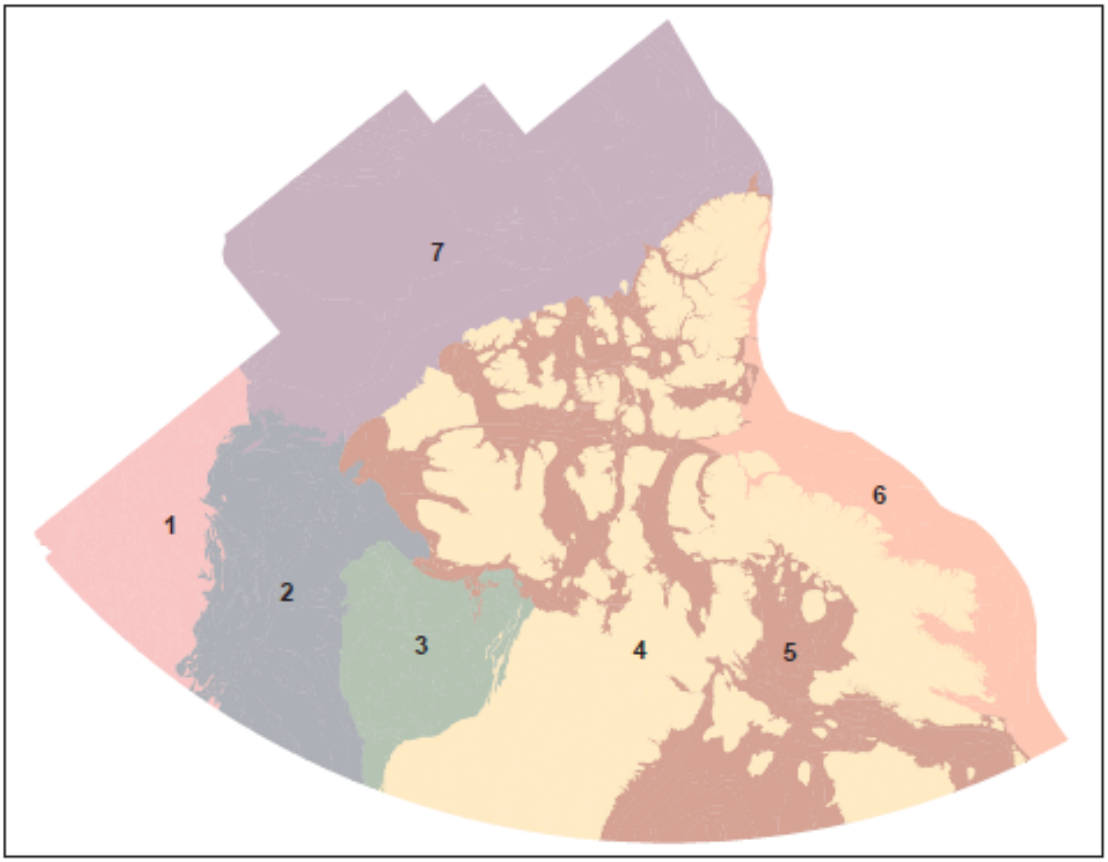

Figure 1. Key to compilation areas with source map references listed below.

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4. Central and eastern Nunavut, parts of Labrador, Northwest Territories, and Quebec

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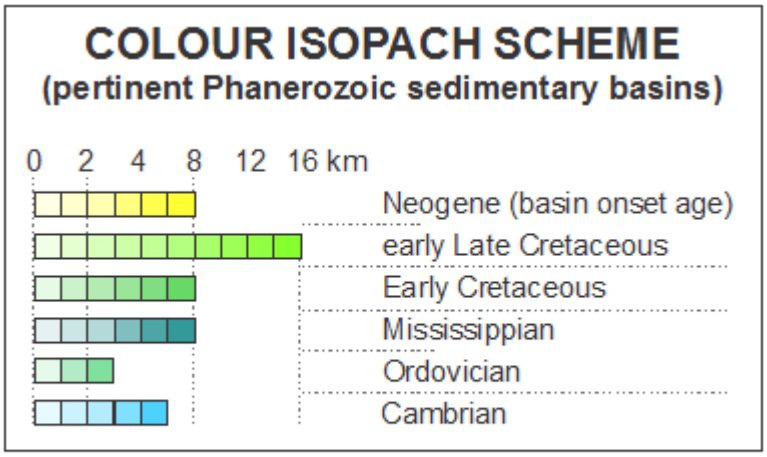

Figure 2. Colour isopach scheme for pertinent Phanerozoic sedimentary basins.

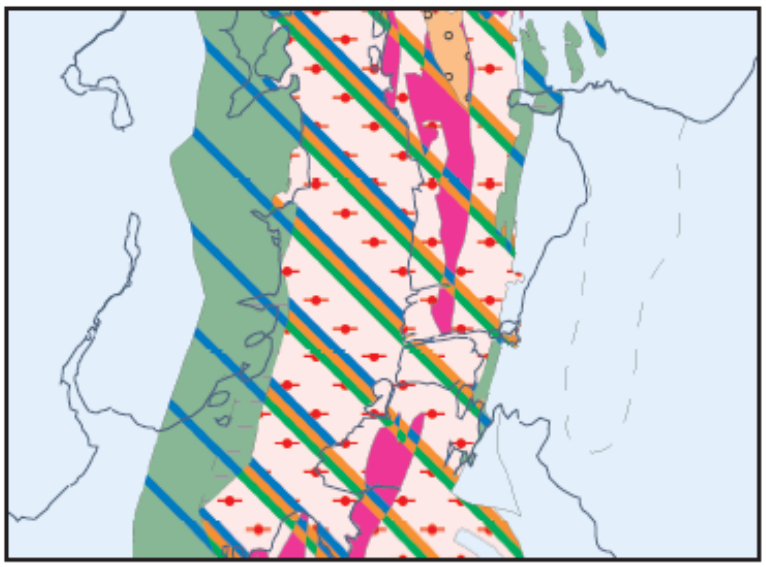

Figure 3. Example of pencil stripe patterning for an area west of Boothia Peninsula recording three phases of orogenic overprinting. The first orogenic overprinting of early Paleoproterozoic age (Arrowsmith orogen) is shown with the green stripes, the second orogenic overprinting of middle Paleoproterozoic age (Taltson-Thelon orogen) is shown with orange stripes, and the third orogenic overprinting of Silurian-early Devonian age (Cornwallis foldbelt) is shown with the blue stripes.

Tectonic code	Tectonic domain	Domain type
HE	Hearne craton	craton
NA	North Atlantic craton	craton
RA	Rae craton	craton
SL	Slave craton	craton
SU	Superior craton	craton
HC	Hearne craton cover	craton cover
RC	Rae craton cover	craton cover
SC	Superior craton cover	craton cover
AM	Amerasian basin	basin
AB	Amundsen basin	basin
AS	Aston basin	basin
BF	Baffin Bay-Labrador Sea basins	basin
BL	Baker Lake basin	basin
BA	Banks basin	basin
BM	Beaufort-Mackenzie basin	basin
BO	Borden basin	basin
CA	Canada basin	basin
CB	Coronation basin	basin
EP	Elk Point basin	basin
EL	Ellesmerian foreland basin	basin
EB	Elu basin	basin
ET	Etah basin	basin
EU	Eurekan foreland basin	basin
FO	Foxe basin	basin
FU	Fury and Hecla basin	basin
GS	Great Slave basin	basin
HA	Hazen trough	basin
HB	Hornby Bay basin	basin
HY	Hudson Bay basin	basin
HS	Hudson Strait basin	basin
KI	Kilohigok basin	basin
KL	Kluane basin	basin
MM	Mackenzie Mountain basin	basin
MC	M'Clintock basin	basin
NO	Nonacho basin	basin
PR	Prince Regent basin	basin
SG	Saglek basin	basin
SE	Selwyn basin	basin
SV	Sverdrup basin	basin
TB	Thelon basin	basin
TH	Thule basin	basin
WE	Wernecke basin	basin
WC	Western Canada sedimentary basin	basin
WI	Windermere basin	basin
YU	Yukon Flats, Old Crow basin	basin
AP	Arctic platform	platform
MP	Mackenzie platform	platform
CO	Continental shelf	shelf
FS	Franklinian shelf	shelf
MS	Mackenzie shelf	shelf
AC	Arctic coastal plain	plain
MN	Mackenzie plain	plain
LO	Lomonosov ridge	ridge
BU	Burwell arc	magmatic suite
CZ	Cenozoic magmatic suite	magmatic suite
K	Cretaceous magmatic suite	magmatic suite
CU	Cumberland batholith	magmatic suite
EC	Etah metaigneous complex	magmatic suite
FR	Franklin suite	magmatic suite
GB	Great Bear batholith	magmatic suite
HP	Hepburn batholith	magmatic suite
HU	Hudson suite	magmatic suite
J	Jurassic magmatic suite	magmatic suite
MA	Mackenzie suite	magmatic suite
MR	Mara River sheets	magmatic suite
NU	Nueltin suite	magmatic suite
QI	Qikiqtarjuaq suite	magmatic suite
SD	Silurian-Devonian magmatic suite	magmatic suite
TT	Taltson-Thelon magmatic suite	magmatic suite
AL	Alexander terrane	terrane
AA	Arctic Alaska terrane	terrane
CC	Cache Creek terrane	terrane
CS	Cassiar terrane	terrane
CH	Chugach terrane	terrane
HO	Hottah terrane	terrane
MI	Meta Incognita micro-continent	terrane
NQ	Narsajuaq terrane	terrane
PE	Pearya terrane	terrane
PU	Purtuniq ophiolite	terrane
QU	Quesnel terrane	terrane
SM	Slide Mountain terrane	terrane
ST	Stikine terrane	terrane
WR	Wrangell terrane	terrane
YT	Yukon-Tanana terrane	terrane
EA	Ocean crust of Eurasian basin	oceanic crust
LB	Ocean crust of Labrador-Baffin rift	oceanic crust
OC	Ocean crust of Canada basin	oceanic crust
BT	Boothia cover	cover
CV	Cordilleran cover	cover
HD	Hudson cover	cover
YC	Yukon Flats, Old Crow cover	cover

Table 1. Tectonic domain codes (part of map legend).

Author Contact

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Coordinate System

Projection: Stereographic North Pole, standard parallel 70°N
Units: metres
Horizontal Datum: WGS 1984
Vertical Datum: mean sea level

Bounding Coordinates

Western longitude: 127°52’28” W
Eastern longitude: 0°0’15” W
Northern latitude: 69°20’40” N
Southern latitude: 52°06’35” N

Data Model Information

This Canadian Geoscience Map does not conform to the Bedrock Mapping Geodatabase Data Model.

LICENCE AGREEMENT

ACCORD DE LICENCE