1:2 000 000 Scale Geological Compilation of the Superior Craton

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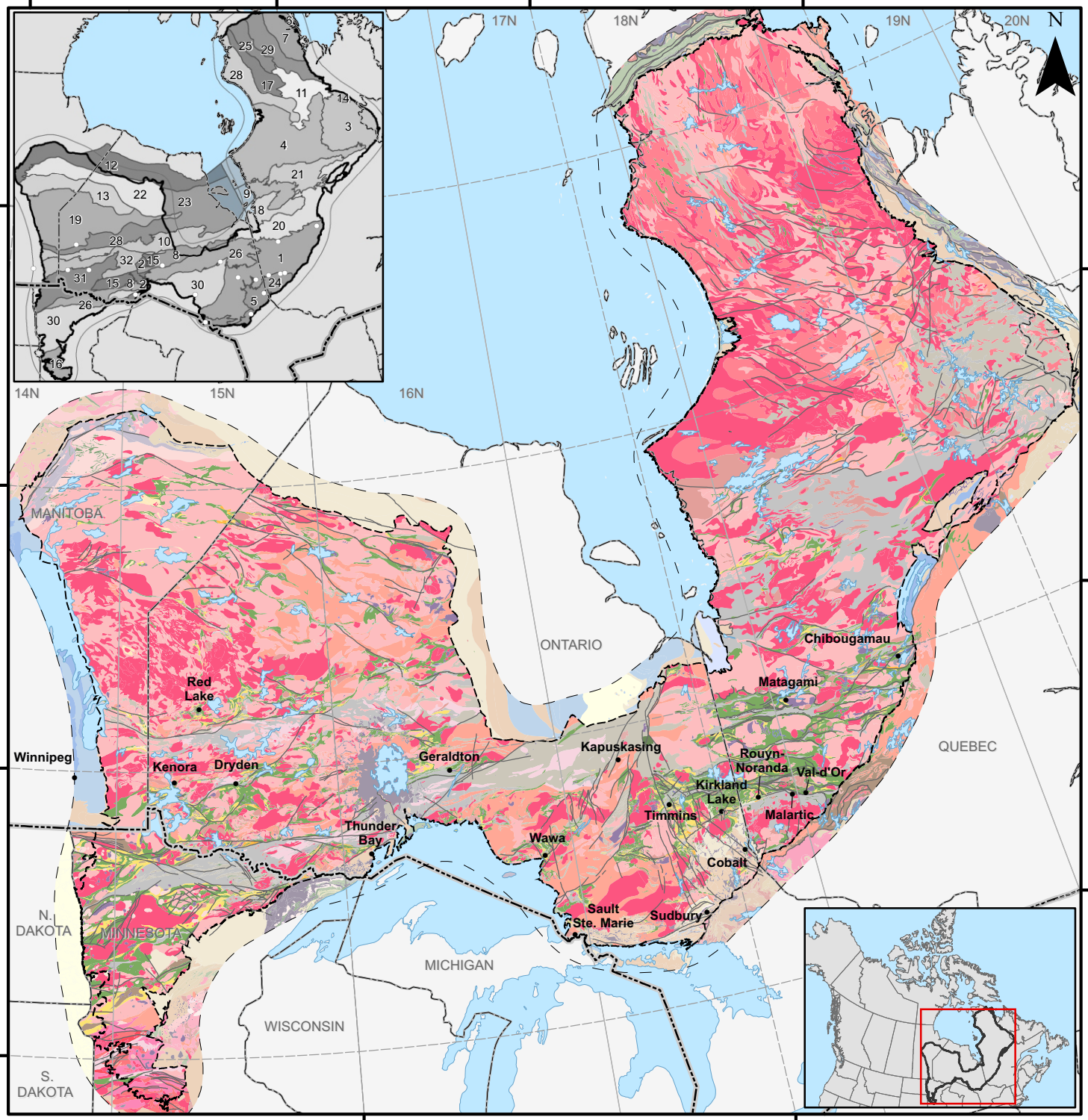

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These compiled GIS layers were prepared for the sole purpose of portraying recent, publically available bedrock geology layers of the Superior Craton at 1:2 000 000 scale. It should not be used for any other purpose. Use of this compilation map/dataset is governed by the following principles:

1) The compilation map is scale dependent. Use of the information from the compilation at any scale other than 1:2 000 000 is unwarranted and will result in erroneous conclusions.

2) To enable the rapid dissemination of information, this digital compilation has not received a thorough technical edit. Discrepancies may occur for which the Mineral Exploration Research Center does not assume liability. The compilation does not fully portray the complex geology of the Superior Craton and users should verify critical information.

3) New data and observation are continually collected, synthesized and compiled. Users should be aware that the digital compilation was current at time of posting, but new information may substantially change the interpretation in any area. Users should verify the currency of data in any area before proceeding. Users are also directed to check the Metal Earth Website http://merc.laurentian.ca/metalearth/superior_compilation) for future updates and any newer versions of this map compilation

4) The GIS layers were prepared from compilation of available province/state-scale products from relevant public surveys. These maps were updated within the confines of the available time with information collected post–1990. No attempt was made to check source material published prior to the creation of the manuscript maps.

5) The geology was subdivided to aid identification of economically important rock units.

For legend and addtional information related to this map, see the Metal Earth website (http://merc.laurentian.ca/metalearth/superior_compilation)

METAL EARTH

MERC Mineral Exploration Research Centre AT THE HARQUAIL SCHOOL OF EARTH SCIENCES

Laurentian University Université Laurentienne

CANADA FIRST RESEARCH EXCELLENCE FUND | APOGÉE CANADA FONDS D'EXCELLENCE EN RECHERCHE

1:11,000,000

NAD 1983 CSRS Canada Lambert WKID 3979

0 62.5 125 250 375 500

Kilometers

1:2 000 000 Scale Geological Compilation of the Superior Craton
Legend

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Abstract

The Superior Craton is the world's largest Archean craton and has been the subject of geologic research for over 100 years. The craton is comprised of amalgamated fault bounded, lithotectonic subprovinces that trend northeast to southwest. Subprovinces alternate between granite-greenstone regions and high-grade gneissic blocks, separated by metasedimentary-dominated domains. The 1:2 000 000 scale compilation presented here integrates recent province/state-scale mapping products from public domain sources for the Superior Craton. The geospatial dataset includes Precambrian bedrock geology layers and geophysical grids. Original work contained within the compilation include new interpretations such as updated subprovince boundaries, reclassified lithologies into a standardized legend and classification of fault traces based on scale. Compilation work was done in collaboration with the Ministère de l'Énergie et des Ressources Naturelles, Ontario Geologic Survey, Minnesota Geological Survey, Manitoba Mineral Resources, and Geological Survey of Newfoundland and Labrador. The map provides a basis for future craton-scale and thematic projects within the Superior Craton as it presents recent regional mapping products throughout the craton and across political boundaries.

Acknowledgements

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Special thanks to our research partners, the Ministère de l'Énergie et des Ressources Naturelles, Ontario Geologic Survey, Minnesota Geological Survey, Manitoba Mineral Resources, and Geological Survey of Newfoundland and Labrador, for their contribution of datasets through their public, online portals as well as correspondence and collaboration.

This product was significantly improved through assistance and support from Metal Earth technical staff, Ryan Paquette and Jacqueline Edwards. Additionally, the various researchers working on the Metal Earth project contributed through stimulating discussion during the course of the project.

In general, older bedrock units are named after younger ones.

- Towns and cities
- Highways (inset map only)
- Fault traces
- Canada - United States border
- Waterbodies
- Political boundaries
- UTM zone boundaries
- Boundary of the Superior Craton (exposed at surface)
- Area of interest (50 km buffer to Superior Craton)

Tectonic Subdivisions (inset map only)

1. Abitibi
2. Animikie Basin
3. Ashuanipi
4. Beinville
5. Cobalt Embayment
6. Diana
7. Douglas Harbour
8. Eastern Wabigoon
9. Eastmain
10. English River
11. Goudalie
12. Hudson Bay Terrane
13. Island Lake
14. La Grande
15. Marmion
16. Minnesota River Valley
17. Minto
18. Nemiscau
19. North Caribou Core
20. Opatica
21. Opinaca
22. Oxford-Stull
23. Oxford-Stull / Uchi
24. Pontiac
25. Qalluviartuuq
26. Quetico
27. Tikkerutuk
28. Uchi
29. Utsalik
30. Wawa
31. Western Wabigoon
32. Winnipeg River

PHANEROZOIC (present - 542.0 Ma)

QUATERNARY (present - 2.58 Ma)

17us Unconsolidated Quaternary sediments

PALEOZOIC (251.0 Ma - 542.0 Ma)

Carbonate units[2]

16cu Unsubdivided carbonate

16cd Dolomite

16cl Limestone

PRECAMBRIAN[1] **(0.542 Ga - <3.85 Ga)**

PROTEROZOIC (0.542 Ga - 2.50 Ga)

Impactites[2]

15is Sudbury units (1.85 Ga)

15ic Carbonatites **Age varies. Varies from broadly gabbroic units to suevite*

Granitoids[2]

14gu Unsubdivided granitoid units: *Includes all units listed below in areas without detailed maps*

14gg Massive granodiorite to granite: *Massive to foliated granodiorite to granite*

14gd Diorite-monzonite- granodiorite suite: *Diorite, tonalite, monzonite, granodiorite, syenite and hypabyssal equivalents*

14gm Muscovite-bearing granitic rocks: *Muscovite-biotite and cordierite-biotite granite, granodiorite-tonalite*

14gf Foliated tonalite suite: *Tonalite to granodiorite – foliated to massive*

14gt Gneissic tonalite suite: *Tonalite to granodiorite – foliated to gneissic – with minor supracrustal inclusions*

14gp Pyroxene-bearing granitic rocks: *Granitic rocks containing pyroxene, including charnokites, enderbites etc.*

Mafic and ultramafic intrusions[2]

13mu Unsubdivided mafic and ultramafic intrusions: *Generally based on geophysical interpretation*

13mm Mafic intrusions: *Gabbroic units, fine to coarse grained*

13mi Ultramafic intrusions: *Vary from anorthosite to various pyroxene-bearing units to dunite*

Clastic metasedimentary[2]

12su Unsubdivided clastic metasedimentary units: *Largely based on regional mapping or geophysical interpretation*

12si Iron formation: *Dominantly oxide facies minor sulfide, carbonate & silicate facies*

12sc Coarse clastic metasedimentary units: *Dominantly coarse clastic metasedimentary rocks (sandstone to coarse conglomerate), with minor, mainly alkali, mafic to felsic metavolcanic flows, tuffs and breccias*

12sf Fine grained clastic metasedimentary rocks: *Wacke, arkose, argillite, slate, marble, chert, minor metavolcanic layers*

12sm Migmatized supracrustal rocks: *Migmatized metasedimentary rocks with minor migmatized metavolcanic content*

Metavolcanic units[2]

11vu Unsubdivided metavolcanic units: *Based on reconnaissance mapping – largely mafic*

11vm Mafic to ultramafic metavolcanics: *Mafic metavolcanic rocks with minor komatiite, minor metasedimentary, and minor pyroclastic rocks*

11vi Mafic to intermediate metavolcanics: *Basaltic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks, related migmatites*

11vf Felsic to intermediate metavolcanics: *Rhyolitic, rhyodacitic, dacitic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks; related migmatites*

ARCHEAN (2.5 Ga - <3.85 Ga)

Granitoids[2]

4gu Unsubdivided granitoid units: *Includes all units listed below in areas without detailed maps*

4gn Diorite-Nepheline syenite suite: Pyroxenite, diorite, monzonite, syenite, nepheline syenite

4go Granitic orthogneiss and migmatite: *Granitic orthogneiss and migmatite units from the Minnesota River Valley Gneiss (MRVG) suite. Possibly later than other MRVG units listed below.*

4gga Massive granodiorite to granite: *Massive to foliated granodiorite to granite*

4ggb Granitoid gneiss with dioritic to amphibolitic enclaves: *Granitoid gneiss from the Minnesota River Valley Gneiss suite. Probably representing engulfment of earlier supracrustal units by granitoid units; produces moderately high and varied gravity and magnetic signatures.*

4gd Diorite-monzonite- granodiorite suite: *Diorite, tonalite, monzonite, granodiorite, syenite and hypabyssal equivalents*

4gm Muscovite-bearing granitic rocks: *Muscovite-biotite and cordierite-biotite granite, granodiorite-tonalite*

4ga Amphibolitic to dioritic gneiss: *Relic volcanic units within the Minnesota River Valley Gneisses*

4gf Foliated tonalite suite: *Tonalite to granodiorite – foliated to massive*

4gta Gneissic tonalite suite: *Tonalite to granodiorite – foliated to gneissic – with minor supracrustal inclusions*

4gtb Foliated to gneissic tonalite and granodiorite: *Amphibole and/or pyroxene bearing gneisses from the Minnesota River Valley Gneiss suite*

4gp Pyroxene-bearing granitic rocks: *Granitic rocks containing pyroxene, including charnokites, enderbites etc.*

Mafic and ultramafic intrusions[2]

3iu Unsubdivided mafic and ultramafic intrusions: *Generally based on geophysical interpretation*

3im Mafic intrusions: *Gabbroic units, fine to coarse grained*

3ii Ultramafic intrusions: *Vary from anorthosite to various pyroxene-bearing units to dunite*

Metasedimentary units[2]

2sma Migmatized clastic and chemical metasedimentary units: *Migmatized clastic and chemical metasedimentary rocks with or without komatiites*

2smb Migmatized Successor Basin units: *Migmatized Successor Basin metasedimentary units with undefined or mixed grain size classification*

2sua Clastic and chemical metasedimentary units: *Clastic and chemical metasedimentary rocks with or without komatiites*

2sub Unsubdivided Successor Basin units: *Mixed conglomerate and wacke Successor Basin units*

2si Iron formation: *Dominantly oxide facies minor sulfide, carbonate and silicate facies*

2sca Coarse clastic metasedimentary units: *Dominantly coarse clastic metasedimentary rocks (sandstone to coarse conglomerate), with minor, mainly alkali, mafic to felsic metavolcanic flows, tuffs and breccias*

2scb Coarse Clastic Successor Basin units: *Late (2680-2675 Ma), conglomerate dominated, Timiskaming-type sedimentary units*

2sfa Fine grained clastic metasedimentary units: *Wacke, arkose, argillite, slate, marble, chert, minor metavolcanic rocks*

2sfb Fine Clastic Successor Basin units: *Early (2690-2680 Ma), wacke dominated, Porcupine-type successor basin units*

Metavolcanic units[2]

1vu Unsubdivided metavolcanic units: *Based on reconnaissance mapping – largely mafic*

1vm Mafic to ultramafic metavolcanics: *Mafic metavolcanic rocks with minor komatiite, minor metasedimentary, and minor pyroclastic rocks*

1vi Mafic to intermediate metavolcanics: *Basaltic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks, related migmatites*

1vf Felsic to intermediate metavolcanics: *Rhyolitic, rhyodacitic, dacitic and andesitic flows, tuffs and breccias, chert, iron formation, minor metasedimentary and intrusive rocks; related migmatites*

[1] Subdivisions of Precambrian geologic time and units characterized by a range of ages are cited in terms of Ga. The subdivisions of geologic time correspond to international standards. All ages of individual units cited in the legend are based on high precision U/Pb zircon ages, and are cited in terms of Ma.

[2] Rocks in these groups are subdivided lithologically. The order does not imply age relationship within or among groups

References

Chandler, V.W., Lively, R.S., 2015, Density, Magnetic susceptibility, and Natural Remnant Magnetization of Rocks in Minnesota, An MGS Rock Properties Database: Manitoba Geological Survey, v. 2.0, (available at https://conservancy.umn.edu/handle/11299/175581) D.O.I. 10.13020/D63S3D

Chandler, V.W., Lively, R.S., 2007, Upgrade of Minnesota Statewide Aeromagnetic Databases at the Minnesota Geological Survey: Minnesota Geological Survey, Regents of the University of Minnesota (available at http://www.mngs.umn.edu/magnetics.htm)

Environmental Resources Research Institute (ESRI), 2018a, USA States: Environmental Resources Research Institute (ESRI) Online GIS Library (available at http://www.arcgis.com/home/item.html?id=1a6cae723af14f9cae228b133aebc620)

Environmental Resources Research Institute (ESRI), 2018b, ESRI World GIS, States and Provinces: Environmental Resources Research Institute

Frieman, B. M., Kuiper, Y. D., Kelly, N. M., Monecke, T., Kylander-Clark, A., 2017, Constraints on the geodynamic evolution of the southern Superior Province, U-Pb LA-ICP-MS analysis of detrital zircon in successor basins of the Archean Abitibi and Pontiac subprovinces of Ontario and Quebec, Canada: Precambrian Research, v. 292, p. 398-416, doi: 10.1016/J.PRECAMRES.2017.01.027, ISSN: 0301-9268

Geological Survey of Canada (GSC), 2013, Canadian Geochronology Knowledgebase: Geological Survey of Canada, Earth Science Sector, Natural Resources Canada, (available at http://www.nrcan.gc.ca/earth-sciences/geography/atlas-canada/geochron/18211#cgkbcsv)

Gosselin, P., Dubé, B., 2005, Gold deposits of Canada, distribution, geological parameters and gold content: Geological Survey of Canada, Earth Science Sector, Natural Resources Canada Open File 4896

HIFLD Admin, 2016, Political Boundaries (Area): ESRI released data from HIFLD Admin, ESRI (available at https://www.arcgis.com/home/item.html?id=b2f558133f3d4718b1def95a254fc2a8)

James, D.T., 1997, Geology of the Archean Ashuanipi Complex in western Labrador (parts of NTS map areas 23G/6, G/7, G/10, G/11, G/13, G/14, G/15): Newfoundland Department of Mines and Energy, Geological Survey of Newfoundland and Labrador, Government of Newfoundland and Labrador Map 97-03, scale 1:100 000

James, D.T. and van Gool, J., 1997, Geology of the Archean Ashuanipi Complex and Paleoproterozoic Knob Lake Group, western Labrador (parts of NTS map areas 23G/2, G/3, 23B/14): Newfoundland Department of Mines and Energy, Geological Survey of Newfoundland and Labrador, Government of Newfoundland and Labrador Map 97-04, scale 1:100 000

James-Abra, E., Bastedo, J., 2006, Canadian Shield, The Canadian Encyclopedia, (available at http://www.thecanadianencyclopedia.ca/en/article/shield/), [January, 2018]

Jirsa, M.A., Boerboom, T.J., and Chandler, V.W., 2010, Geologic map of Minnesota, Precambrian bedrock geology: Minnesota Geological Survey, Regents of the University of Minnesota State Map Series S-22, scale 1:500 000

Manitoba Mineral Resources (MMR), 2013, Bedrock geology , Manitoba Map Gallery – Geoscientific Maps: Manitoba Mineral Resources, Government of Manitoba, (available at https://www.manitoba.ca/iem/geo/gis/index.html#content) [December 15, 2017]

Ministère des Ressources Naturelles Géologie Québec (MERN), 2018, Geoboutique: Ministère des Ressources Naturelles Géologie Québec, (available at http://geoboutique.mern.gouv.qc.ca/edel/pages/recherche/critereRechercheEdel.faces)

Ministère des Ressources Naturelles Géologie Québec (MERN), 2017, Geological Map of Quebec – 2017 Edition: Ministère des Ressources Naturelles Géologie Québec, Gouvernement du Québec Système d'information géominière de Québec (SIGEOM), (available at http://sigeom.mines.gouv.qc.ca/signet/classes/I1108_afchCarteIntr#)

Ministère des Ressources Naturelles Géologie Québec (MERN), 2012, Geological Map of Quebec – 2012 Edition: Ministère des Ressources Naturelles Géologie Québec, Gouvernement du Québec data release DV 2012-04

Mining Innovation, Rehabilitation and Applied Research Corporation (MIRARCO) 2005, Integrated GIS compilation of geospatial data from the Abitibi greenstone belt, northeastern Ontario, Discover Abitibi Initiative: Ontario Geological Survey Miscellaneous Release—Data 186

Ministry of Natural Resources and Forestry Ontario (MNRF), 2017, Land Information Ontario (LIO) Warehouse Open Data – File Geodatabase: Ministry of Natural Resources and Forestry Ontario, Government of Ontario, (available from https://www.ontario.ca/page/land-information-ontario)

Minnesota Department of Transportation (MnDOT), 2013, Route Segments: Trunk Highways: Minnesota Department of Transportation, (available at https://www.dot.state.mn.us/maps/gdma/gis-data.html)

Montsion, R.M., Vaillancourt, A., de Kemp, E.A., in prep, Geospatial Compilation of Bedrock Faults for Canada 3D: Geological Survey of Canada, Earth Science Sector, Natural Resources Canada, Open File

Natural Resources Canada (NRCAN), 2017a, Canadian Geographic Names Database (CGNDB): Natural Resources Canada, (available at http://www.nrcan.gc.ca/earth-sciences/geography/place-names/10786)

Natural Resources Canada (NRCAN), 2017b, GeoBase – Aboriginal Lands: Natural Resources Canada, Lands and Mineral Sector, Surveyor General Branch, Cadastral Information Service, (available at https://open.canada.ca/data/en/dataset/522b07b9-78e2-4819-b736-ad9208eb1067?activity_id=564231bf-2dad-444c-9ec1-843740d376b1

Natural Resources Canada (NRCAN), 2016, Geoscience Data Repository for Geophysical Data: Natural Resources Canada, (available at http://gdrdap.agg.nrcan.gc.ca/gdrdap/dap/search-eng.php?tree-0=Physical+Rock+Properties+-+Propri%C3%A9t%C3%A9s+physiques+des+roches&tree-1=Click+here+for+more+options&tree-2=Click+here+for+more+options&tree-3=Click+here+for+more+options&datatype-ddl=&layer_name=&submit_search=Submit+Search#results)

Natural Resources Canada (NRCAN), 2015, National Topographic System Index of Maps: Natural Resources Canada, (available at https://open.canada.ca/data/en/dataset/055919c2-101e-4329-bfd7-1d0c333c0e62)

Natural Resources Canada (NRCAN), 2010, Canadian Airborne Geophysical Database (CAGDB): Natural Resources Canada, (available at https://open.canada.ca/data/en/dataset)

Newfoundland and Labrador Geological Survey (NLGS), 2013, Index of Bedrock Geology Maps: Newfoundland Department of Mines and Energy, Geological Survey of Newfoundland and Labrador, Government of Newfoundland and Labrador GeoScience Atlas OnLine, (available at http://geoatlas.gov.nl.ca) [November, 2017]

Ontario Geological Survey (OGS), 2017a, Ontario Airborne Geophysical Surveys, Magnetic Data, Grid Data (ASCII and Geosoft® Formats), Magnetic Supergrids: Ontario Geological Survey, Ministry of Northern Development and Mines, Government of Ontario Geophysical Dataset 1037-Revised

Ontario Geological Survey (OGS), 2017b, Mineral Deposit Inventory-October 2017 update, Ontario Geological Survey, Ministry of Northern Development and Mines, Government of Ontario, (available at https://www.ontario.ca/data/mineral-deposit-inventory-ontario)

Ontario Geological Survey, 2012, OGS Earth: Resident Geologist District Offices: Ontario Geological Survey, Ministry of Northern Development and Mines, Government of Ontario, (accessed at https://www.mndm.gov.on.ca/en/mines-and-minerals/applications/ogsearth/administrative-boundaries-and-spatial-reference-grids)

Ontario Geological Survey (OGS), 2011, 1:250 000 scale bedrock geology of Ontario: Ontario Geological Survey, Ministry of Northern Development and Mines, Government of Ontario Miscellaneous Release–Data 126 - Revision 1, scale 1:250 000, (available at http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=MRD126-REV1) [June 2017]

Parks, J., Shoufa, L., Davis, D., and Corkery, T., 2006, New high-precision U-Pb ages for the Island Lake greenstone belt, northwestern Superior Province, implications for regional stratigraphy and the extent of the North Caribou terrane: Canadian Journal of Earth Sciences, no. 43, p. 789-803, doi:10.1139/E06-044

Rivers, T., 1985, Geology of the Lac Virot area, Labrador/Quebec: Newfoundland Department of Mines and Energy, Geological Survey of Newfoundland and Labrador, Government of Newfoundland and Labrador, GS#LAB/0696, Map 85-025, Scale 1:100 000

Statistics Canada, 2017, Road Network File, Reference Guide 2017: Statistics Canada Catalogue no. 92-500-G, (available at https://open.canada.ca/data/en/dataset/8e089409-8b6e-40a9-a837-51fcb2736b2c)

Statistics Canada, 2016, Boundary Files, Reference Guide, Census Year 2016: Statistics Canada, Government of Canada, (available at http://www12.statcan.gc.ca/census-recensement/2011/geo/bound-limit/bound-limit-2011-eng.cfm)

Stoeser, D. B., Green, G. N., Morath, L. C., Heran, W. D., Wilson, A. B., Moore, D. W., Van Gosen B. S., 2005a, Preliminary integrated geologic map databases for the United States, Central States, Montana, Wyoming, Colorado, New Mexico, Kansas, Oklahoma, Texas, Missouri, Arkansas, and Louisiana, North Dakota, South Dakota, Nebraska, and Iowa – The State of North Dakota, United States Geological Survey Open-File Report 2005-1351, (available at https://pubs.usgs.gov/of/2005/1351/)

Stoeser, D. B., Green, G. N., Morath, L. C., Heran, W. D., Wilson, A. B., Moore, D. W., Van Gosen B. S., 2005b, Preliminary integrated geologic map databases for the United States, Central States, Montana, Wyoming, Colorado, New Mexico, Kansas, Oklahoma, Texas, Missouri, Arkansas, and Louisiana, North Dakota, South Dakota, Nebraska, and Iowa – The State of South Dakota, United States Geological Survey Open-File Report 2005-1351, (available at https://pubs.usgs.gov/of/2005/1351/)

Stott, G.M., 2011, A revised terrane subdivision of the Superior Province in Ontario: Ontario Geological Survey, Ministry of Northern Development and Mines, Government of Ontario Miscellaneous Release—Data 278.

Stott, G. M., Corkery, M. T., Percival, J. A., Simard, M., Goutier, J., 2010, Project Units 98-006 and 98-007. A revised Terrane Subdivision of the Superior Province, in Summary of Field Work and Other Activities 2010, Ontario Geological Survey, Ministry of Northern Development and Mines, Government of Ontario Open File Report 6260, p. 20-1 to 20-10

Thériault, R., and Beauséjour, S., 2012, Geological Map of Québec: 2012 Edition: Ministère de l'Énergie et des Ressources Naturelles, ed. J. Nadeau, DV-201207, Scale 1:2 000 000, ISBN: 978-2-550-66220-4, (available at http://www.mngs.umn.edu/mgs_s21_bedrock.lyr) [July, 2017]

Thurston, P.C., Ayer, J.A., Goutier, J., and Hamilton, M.A., 2008, Depositional Gaps in Abitibi Greenstone Belt Stratigraphy: A Key to Exploration for Syngenetic Mineralization: Economic Geology, v. 103, p. 1097–1134, (available at http://dx.doi.org/10.2113/gsecongeo.103.6.1097)

United States Geological Survey (USGS), 2012, Global Digital Elevation model (DEM) GTOPO30, Tile GT30W100N90: United States Geological Survey, (available at https://lta.cr.usgs.gov/GTOPO30)

Wheeler, J.O., Hoffman, P.F., Card, K.D., Davidson, A., Sanford, B.V., Okulitch, A.V., and Roest, W.R., 1997, Geological Map of Canada: Geological Survey of Canada, Map D1860A, (available at https://geoscan.nrcan.gc.ca/starweb/geoscan/servlet.starweb?path=geoscan/fulle.web&search1=R=208175), scale 1:5 000 000, DOI: 10.4095/208175