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National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division



Grand Portage National Monument

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Grand Portage National Monument

grpo_geology.pdf

Version: March 2012

Geologic Resources Inventory Map Document for Grand Portage National Monument

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Geologic Resources Inventory Map Document



Grand Portage National Monument, Minnesota

Document to Accompany Digital Geologic-GIS Data

[grpo_geology.pdf](#)

Version: March 2012

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Grand Portage National Monument, Minnesota (GRPO).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

For information about the status of GRI digital geologic-GIS data for a park contact:

Tim Connors
Geologist/GRI Mapping Contact
National Park Service Geologic Resources Division
P.O. Box 25287
Denver, CO 80225-0287
phone: (303) 969-2093
fax: (303) 987-6792
email: Tim_Connors@nps.gov

For information about using GRI digital geologic-GIS data contact:

Stephanie O'Meara
Geologist/GIS Specialist/Data Manager
Colorado State University Research Associate, Cooperator to the National Park Service
1201 Oak Ridge Drive, Suite 200
Fort Collins, CO 80525
phone: (970) 491-6655
fax: (970) 225-3597
e-mail: stephanie.omeara@colostate.edu

About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: <http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm>

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: <http://irma.nps.gov/App/Reference/Search>. To find GRI data for a specific park or parks select the appropriate park

(s), enter "GRI" as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: <http://www.nature.nps.gov/geology/inventory>, or contact:

Bruce Heise
Inventory Coordinator
National Park Service Geologic Resources Division
P.O. Box 25287
Denver, CO 80225-0287
phone: (303) 969-2017
fax: (303) 987-6792
email: Bruce_Heise@nps.gov

The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Grand Portage National Monument, Minnesota (GRPO) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., PCdp - Plagioclase porphyry diabase dikes). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the Geologic Unit Information (UNIT) table included with the GRI geology-GIS data.

Geologic Map Units

Normal polarity denoted as (+)
Reversed polarity denoted as (-)

Mesoproterozoic

[PCdp](#) - Plagioclase porphyry diabase dikes (Mesoproterozoic) (+)
[PCdpam](#) - Plagioclase porphyry, aphyric and late magnetic diabase dikes (Mesoproterozoic) (+)
[PCdpmr](#) - Plagioclase porphyry and late magnetic diabase dikes, late felsic plugs and quartz porphyry dikes (Mesoproterozoic) (+)
[PCd](#) - Aphyric diabase dikes (Mesoproterozoic) (+)
[PCdo](#) - Pigeon River diabase (Mesoproterozoic) (+)
[PCdm](#) - Late magnetic diabase dikes (Mesoproterozoic) (+)
[PCdmr](#) - Late magnetic diabase dikes, late felsic plugs and quartz porphyry dikes (Mesoproterozoic) (+)
[PCdr](#) - Late felsic plugs and quartz porphyry (Mesoproterozoic) (+)
[PCppp](#) - Sill on Pigeon Point, granitoid rocks (Mesoproterozoic) (+)
[PCppa](#) - Sill on Pigeon Point, intermediate rocks (Mesoproterozoic) (+)
[PCppgb](#) - Pigeon Point gabbro (Mesoproterozoic) (+)
[PCdiab](#) - Diabase (Mesoproterozoic) (+)
[PCgpy](#) - Granophyre to intermediate rocks (Mesoproterozoic) (+)

-----Pole Boundary-----

[PCs](#) - Ilmenite-bearing diabase sills (Mesoproterozoic) (-)
[PCdi](#) - ilmenite-bearing diabase dikes (Mesoproterozoic) (-)
[PCbhrd](#) - Brule Lake-Hovland gabbro (Mesoproterozoic) (-)
[PCfgpu](#) - Undivided granophyric rocks (Mesoproterozoic) (-)
[PClsdb](#) - Logan Intrusion-diabase (Mesoproterozoic) (-)
[PCndba](#) - Deronda Bay andesite (Mesoproterozoic) (-)
[PCngpb](#) - Grand Portage basalts (Mesoproterozoic) (-)
[PCnhvl](#) - Hovland lavas (Mesoproterozoic) (-)
[PCnrrr](#) - Red Rock rhyolite (Mesoproterozoic) (-)
[PCkps](#) - Puckwunge Sandstone (Mesoproterozoic) (-)

Paleoproterozoic

[PCrv](#) - Rove Formation (Paleoproterozoic) (-)
[PCra](#) - Rove Formation, argillite (Paleoproterozoic) (-)
[PCrq](#) - Rove Formation, quartzite (Paleoproterozoic) (-)
[PCrm](#) - Rove Formation, meta-argillite (Paleoproterozoic) (-)

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below.

PCdp - Plagioclase porphyry diabase dikes (Mesoproterozoic)

Plagioclase porphyry diabase dikes. *GRI Source Map ID 2626* ([M-36](#)).

PCdpam - Plagioclase porphyry, aphyric and late magnetic diabase dikes (Mesoproterozoic)

This unit was mapped as the combination of the following units: [PCd](#), [PCdm](#) and [PCdp](#).
GRI Source Map ID 2626 ([M-36](#)).

PCdpmr - Plagioclase porphyry and late magnetic diabase dikes, late felsic plugs and quartz porphyry dikes (Mesoproterozoic)

This unit was mapped as the combination of the following units: [PCdr](#), [PCdm](#) and [PCdp](#).
GRI Source Map ID 2626 ([M-36](#)).

PCd - Aphyric diabase dikes (Mesoproterozoic)

Aphyric diabase dikes. *GRI Source Map ID 2626* ([M-36](#)).

PCdo - Pigeon River Diabase (Mesoproterozoic)

do - olivene diabase dikes (Mesoproterozoic) Olivene diabase dikes containing 20 percent euhedral olivene (Fo_{55-60}), 60 percent plagioclase (An_{60-64}), and 3 percent euhedral ilmenite (Il_{98} Hem₂) set in zoned augite (Ca_{36-46} Mg₃₀₋₄₄ Fe₂₀₋₂₄) oikocrysts. *GRI Source Map ID 2626* ([M-36](#)).

prdb - Pigeon River diabase (Mesoproterozoic) Olivine diabase; forms thick, northeast- and northwest-trending dikes cutting Rove Formation (unit Prv) and volcanic rocks of the lower northeastern sequence. *GRI Source Map ID 3985* ([M-119](#)).

PCdm - Late magnetic diabase dikes (Mesoproterozoic)

Late magnetic diabase dikes, aphyric to aphanitic diabase with small primocrysts of plagioclase and magnetite and oikocrysts of augite.
GRI Source Map ID 2626 ([M-36](#)).

PCdmr - Late magnetic diabase dikes, late felsic plugs and quartz porphyry dikes (Mesoproterozoic)

This unit was mapped as the combination of the following units: [PCdm](#) and [PCdr](#).
GRI Source Map ID 2626 ([M-36](#)).

PCdr - Late felsic plugs and quartz porphyry (Mesoproterozoic)

Late felsic plugs and quartz porphyry dikes characterized by partially resorbed 3 mm phenocrysts of quartz and plagioclase having myrmekitic rims set in a hypidiomorphic granitic groundmass; extensive hydrothermal alteration. *GRI Source Map ID 2626* ([M-36](#)).

PCppp - Sill on Pigeon Point, granitoid rocks (Mesoproterozoic)

Granitoid rock, bright red, medium- to coarse grained; 50 percent plagioclase phenocrysts ($An_{60 \text{ core}}, An_{40-10 \text{ rim}}$) set in a granophyric groundmass (30 percent) consisting of quartz and potassium feldspar ($Or_{60-80}Ab_{15-40}An_{0-6}$). Accessory minerals include muscovite, sphene, biotite, apatite, zircon, hematite, ilmenite ($Ilm_{98}Hem_2$), magnetite ($Mag_{40}Usp_{60}$), and 5 cm laths of amphibole replaced by chlorite and magnetite. *GRI Source Map ID 2626* ([M-36](#)).

PCppa - Sill on Pigeon Point, intermediate rocks (Mesoproterozoic)

Intermediate rock, reddish gray, coarse- to very coarse grained; two feldspar gabbro grading upward into diorite and granophyric syenite. Unit generally contains 60 percent plagioclase (An_{60-15}), 20-30 percent amphibole ($Fe/Fe + Mg = .29$), 5 percent potassium feldspar, 0-5 percent biotite, ($Fe/Fe + Mg = .80$), 0-5 percent olivene (Fo_{24}), 0-18 percent augite ($Ca_{39-37}Mg_{40}Fe_{21-27}$), 0-3 percent quartz, 4-7 percent ilmenite ($Ilm_{100-94}Hem_{0-6}$), magnetite ($Mag_{27-49}Usp_{73-51}$) and trace amounts of pigeonite ($Ca_{12}Mg_{46}Fe_{42}$) and muscovite. *GRI Source Map ID 2626* ([M-36](#)).

PCppgb - Pigeon Point Gabbro (Mesoproterozoic)

PPo - Sill on Pigeon Point, olivene gabbro (Mesoproterozoic)

Olivene gabbro, medium- to coarse-grained; unit contains 60-70 percent cumulus plagioclase (An_{74-43}), 15-20 percent cumulus olivene (Fo_{60-24}), 15-20 percent ophitic augite ($Ca_{33-41}Mg_{43-38}Fe_{19-26}$) and pigeonite ($Ca_{6-14}Mg_{60-47}Fe_{30-46}$), 1-3 percent ilmenite ($Ilm_{94-98}Hem_{6-2}$) and magnetite ($Mag_{36-70}Usp_{64-30}$) and trace amounts of biotite ($Fe/Fe + Mg = .70$ to $.26$). *GRI Source Map ID 2626* ([M-36](#)).

ppgb - Pigeon Point gabbro (Mesoproterozoic)

Olivine gabbro, intermediate rocks, and granophyre; forms south-dipping, 120-m-thick, differentiated intrusion emplaced in Rove Formation (unit prv); includes units PPO, PPA, and PPP of Mudrey (1977). *GRI Source Map ID 3985* ([M-119](#)).

PCdiab - Diabase (Mesoproterozoic)

Extent not well mapped, poorly exposed, or inferred from linear aeromagnetic high. *GRI Source Map ID 3985* ([M-119](#)).

PCgpy - Granophyre to intermediate rocks (Mesoproterozoic)

Extent not well mapped or poorly exposed; age uncertain. *GRI Source Map ID 3985* ([M-119](#)).

PCs - Ilmenite-bearing diabase sills (Mesoproterozoic)

Ilmenite-bearing diabase sills. Characterized by 60 percent plagioclase (An_{40} heavily sericitized), 1 percent relict augite ($Ca_{35-40}Mg_{35}Fe_{25-30}$), 8 percent hornblende, 7 percent chlorite, 7 percent opaques ($Ilm_{94}Hem_6$), 10 percent granophyre (quartz-feldspar-biotite intergrowths) and trace amounts of muscovite and apatite. Unit characterized by moderate to extreme hydrothermal alteration. *GRI Source Map ID 2626* ([M-36](#)).

PCdi - Ilmenite-bearing diabase dikes (Mesoproterozoic)

Ilmenite-bearing diabase dikes. Characterized by 60 percent plagioclase (An_{40} heavily sericitized), 1 percent relict augite ($Ca_{35-40}Mg_{35}Fe_{25-30}$), 8 percent hornblende, 7 percent chlorite, 7 percent opaques ($Ilm_{94}Hem_6$), 10 percent granophyre (quartz-feldspar-biotite intergrowths) and trace amounts of muscovite and apatite. Unit characterized by moderate to extreme hydrothermal alteration. *GRI Source Map ID 2626* ([M-36](#)).

PCbhrd - Brule Lake-Hovland Gabbro (Mesoproterozoic)

Diabase. Ophitic olivine gabbro, locally monzodioritic, fine- to coarse-grained; locally layered and foliated; forms shallow-dipping sheet; Reservation River diabase of Jones (1963). *GRI Source Map ID 3985* ([M-119](#)).

PCfgpu - Undivided granophyric rocks (Mesoproterozoic)

Small, isolated areas of felsic rocks not associated with major granophyre bodies. *GRI Source Map ID 3985* ([M-119](#)).

PCIsdb - Logan Intrusion-diabase (Mesoproterozoic)

Diabase to gabbro, locally granophyric, fine- to coarse-grained, ophitic to intergranular; upper part commonly plagioclase-phyrlic; commonly altered; forms thick (50–200 m) sills and dikes in Rowe Formation; U-Pb age 1108.8 + 4/- 2 Ma for sill in Ontario (Davis and Sutcliffe, 1985). *GRI Source Map ID 3985* ([M-119](#)).

PCndba - Deronda Bay Andesite (Mesoproterozoic)

No - North Shore Volcanic Group (Mesoproterozoic)

Pillowed, porphyritic diopside-olivene-bearing basalt flows, olivene-bearing aphyric basalt, plagioclase-bearing basalt, and red, cross-bedded, medium- to coarse-grained sandstone beds and clastic dikes. *GRI Source Map ID 2626* ([M-36](#)).

ndba - Deronda Bay andesite (Mesoproterozoic)

Brown, aphanitic to fine-grained, sparsely plagioclase-phyric flow; thickness about 90 m. *GRI Source Map ID 3985* ([M-119](#)).

PCngpb - Grand Portage Basalts (Mesoproterozoic)

Intergranular transitional basalt and basaltic andesite flows; compositions become more evolved upward in sequence from augite-phyric and pillowed basal flow at Grand Portage. *GRI Source Map ID 3985* ([M-119](#)).

PCnhvl - Hovland Lavas (Mesoproterozoic)

Mixed suite of intergranular basalt, basaltic andesite, icelandite, and rhyolite; commonly plagioclase-phyric, some glomerporphyritic; U-Pb age 1107.7 ± 1.9 Ma (Davis and Green, 1997). *GRI Source Map ID 3985* ([M-119](#)).

PCnrrr - Red Rock Rhyolite (Mesoproterozoic)

Reddish to tan, aphanitic; contains quartz, K-feldspar, and oxidized mafic phenocrysts; thickness about 70 m; U-Pb age 1107.9 ± 1.8 Ma (Davis and Green, 1997). *GRI Source Map ID 3985* ([M-119](#)).

PCkps - Puckwunge Sandstone (Mesoproterozoic)

Pf - Puckwunge Formation (Mesoproterozoic)

Coarse-grained, white quartzite and fine-grained, quartzose sandstone. Upper 10 m exposed on Lucille Island and possible lower contact exposed along south shore of Susie Island. *GRI Source Map ID 2626* ([M-36](#)).

kps - Puckwunge Sandstone (Mesoproterozoic)

Quartz arenite; gray, cross-bedded; some quartz-pebble conglomerate. *GRI Source Map ID 3985* ([M-119](#)).

PCrv - Rove Formation (Paleoproterozoic)

Argillaceous siltstone, carbonaceous shale, mudstone and graywacke; recrystallized near Duluth Complex and Logan intrusions (unit lsdB).

GRI Source Map ID 3985 ([M-119](#)).

PCra - Rove Formation, argillite (Paleoproterozoic)

Thin-bedded, gray argillite. *GRI Source Map ID 2626 ([M-36](#)).*

PCrq - Rove Formation, quartzite (Paleoproterozoic)

Fine- to medium-grained, light medium gray, well sorted, feldspathic quartzite and fine- to medium-grained quartzite having minor amounts of chert and feldspar. *GRI Source Map ID 2626 ([M-36](#)).*

PCrm - Rove Formation, meta-argillite (Paleoproterozoic)

Meta-argillite, fine- to medium- grained biotite schist with 2-4 mm plagioclase porphyroblasts and recrystallized granoblastic quartzite restricted to within 20 mteters of the top of the sill on Pigeon Point. *GRI Source Map ID 2626 ([M-36](#)).*

GRI Source Map Citations

The GRI digital geologic-GIS maps for Grand Portage National Monument, Minnesota (GRPO) were compiled from the following sources:

Mudrey, M.G., Jr., 1977, Geologic Map of Pigeon Point Quadrangle, Cook County, Minnesota, Minnesota Geological Survey, Miscellaneous Map Series M-36, 1:24000 scale ([M-36](#)). (*GRI Source Map ID 2626*)

Miller, J.D., Jr., Green, J.C., Severson, M.J., Chandler, V.W., and Peterson, D.M., 2001, Geologic Map of the Duluth Complex and Related Rocks, Northeastern Minnesota, Minnesota Geological Survey, Miscellaneous Map Series M-119, 1:200000 scale ([M-119](#)). (*GRI Source Map ID 3985*)

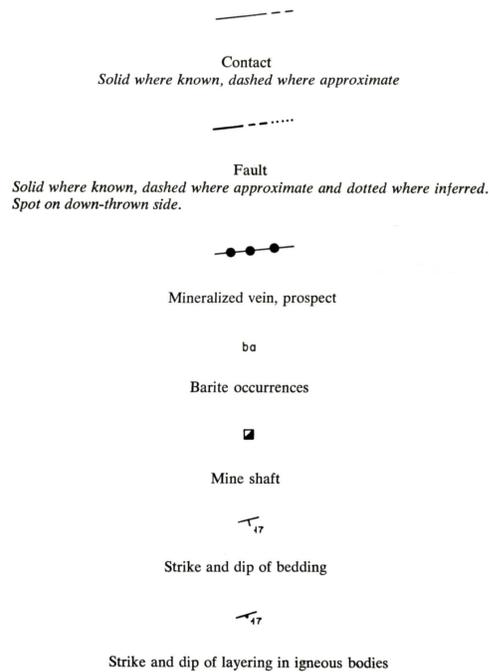
Rosenthal, Jeff, 2012, Fluvial Terraces of Grand Portage Creek, Grand Portage National Monument, GeoCorps, 1:24000 scale (*GRI Source Map ID 75609*) *Note: This terrace data is included in the NPS GRI digital geologic dataset for Grand Portage National Monument as terraces, lake terraces and paleoshorelines.*

Additional information pertaining to each source map is also presented in the Source Map Information (MAP) table included with the GRI geology-GIS data.

Geologic Map of the Pigeon Point Quadrangle (M-36)

Mudrey, M.G., Jr., 1977, Geologic Map of Pigeon Point Quadrangle, Cook County, Minnesota, Minnesota Geological Survey, Miscellaneous Map Series M-36, 1:24000 scale. (*GRI Source Map ID 2626*) *Note: Due to the preliminary nature of this map, correspondence with the map author and comparison with an older field version of the map were both utilized to resolve incomplete areas.*

Legend



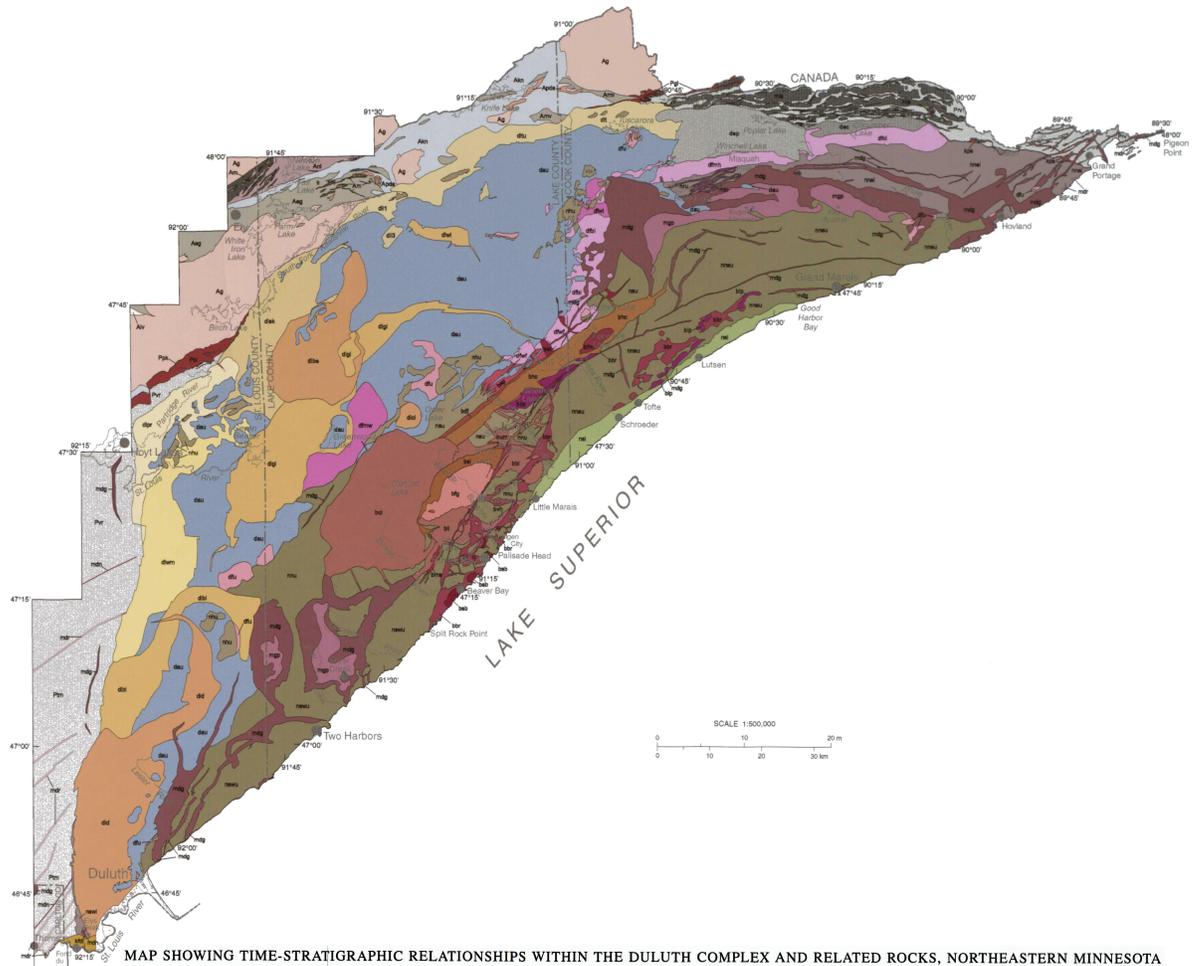
Extracted from: [\(M-36\)](#).

Geologic Map of the Duluth Complex and Related Rocks of Northeastern Minnesota (M-119)

Miller, J.D., Jr., Green, J.C., Severson, M.J., Chandler, V.W., and Peterson, D.M., 2001, Geologic Map of the Duluth Complex and Related Rocks, Northeastern Minnesota, Minnesota Geological Survey, Miscellaneous Map Series M-119, 1:200000 scale. (*GRI Source Map ID 2626*)

Other data related to the Duluth Complex Map such as a geologic report, aeromagnetic data, bedrock densities, and a full list of references can be accessed through the Minnesota Geological Survey at the following website: <http://conservancy.umn.edu/handle/183>

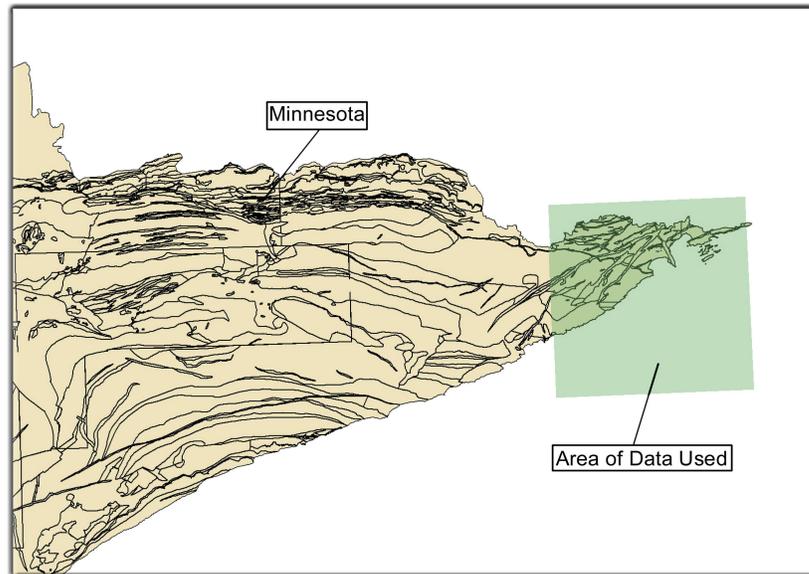
Generalized Geologic Map of the Duluth Complex



Extracted from: [\(M-119\)](#).

Index Map

Index map showing the extent extracted from M119 for use in the NPS GRI GIS product for Grand Portage National Monument.



Legend

MAP SYMBOLS	
Geologic contact	
—	Approximate
---	Speculative
Fault	
- - -	Inferred
- - -	Speculative
Fold axis	
—	Anticlinal
—	Synclinal
Mafic sill	
—	Mafic dike of unknown polarity
Bedding in sedimentary rocks	
↘	Inclined
⊕	Horizontal
⊗	Vertical
↘	Overtured
Inclined bedding in volcanic rocks	
↘	Inclined bedding in volcanic rocks
Modal layering in igneous rocks	
↘	Inclined
⊕	Horizontal
⊗	Vertical
Foliation in igneous rocks	
↘	Inclined
⊕	Horizontal
⊗	Vertical
Joints	
↘	Mineralized
↘	Open

Extracted from: ([M-119](#)).

GRI Digital Data Credits

This document was developed and completed by Ian Hageman (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory(GRI) Program. Quality control of this document by Jim Chappell (Colorado State University).

The information contained here was compiled to accompany the digital geologic-GIS map(s) and other digital data for Grand Portage National Monument, Minnesota (GRPO) developed by Jim Chappell, Max Jackl and Derek Witt (Colorado State University).

GRI finalization by Stephanie O'Meara and James Chappell (Colorado State University).

GRI program coordination and scoping provided by Bruce Heise and Tim Connors (NPS GRD, Lakewood, Colorado).