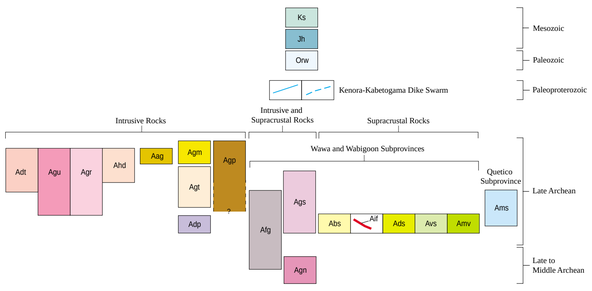
UNIVERSITY OF MINNESOTA

MINNESOTA GEOLOGICAL SURVEY
D.L. Southwick, Director

SUPPORTED IN PART BY THE MINNESOTA MINERALS DIVERSIFICATION PROGRAM AS ADMINISTERED BY THE MINERALS COORDINATING COMMITTEE FOR THE MINNESOTA LEGISLATURE

MISCELLANEOUS MAP SERIES
MAP M-92
Bedrock Geology, Northwestern Minnesota

CORRELATION OF MAP UNITS



INTRODUCTION

The impetus for the preparation of this map was the need for a digital version of its predecessor (Jirsa and others, 1994) by various parties, including the Minnesota Geological Survey itself, the Division of Minerals of the Minnesota Department of Natural Resources, and mineral explorationists. The process of digitization created an opportunity for desired modifications, including a change of scale from 1:250,000 to 1:200,000, the extension of the eastern boundary of the map several miles to longitude 95°30'W., and minor revision of the geologic interpretation. Users of the revised version are referred to the 1994 paper map for more detailed descriptions of map units and a discussion of the regional geology.

DESCRIPTION OF MAP UNITS

No bedrock outcrop is present within the map area. The delineation of map units is based on drill-hole records, drill cores, and geophysical maps and data.

PHANEROZOIC ROCKS

Mesozoic and Paleozoic Sedimentary Rocks

[Archean map units underlying Phanerozoic units are indicated by magenta contact lines and unit labels enclosed in parentheses.]

Ks — **Sedimentary rocks, undivided (Cretaceous)**—Pebbly basal sandstone overlain by gray to green, silty claystone having local lignite interbeds. Typically less than 35 meters thick.

Jh — **Hallock red beds (Jurassic?)**—Heterolithic sequence of green, gray, brown, and red shale, limestone, dolostone, sandstone, and siltstone. Locally as thick as 30 meters.

Orw — **Winnipeg and Red River Formations (Ordovician)**—The Winnipeg Formation consists of basal sandstone overlain by gray, green, and red shale. The Red River Formation consists of gray, tan, and yellow limestone having red and green shale interbeds. Maximum total thickness of Ordovician units is less than 100 meters.

PALEOPROTEROZOIC ROCKS

[Not shown where overlain by Phanerozoic map units (Ks, Jh, and Orw)].

Diabasic and gabbroic dikes—Variably magnetic dikes of the Kenora-Kabetogama swarm.

Dikes inferred to have normal magnetic polarity.

Dikes inferred to have reversed magnetic polarity.

ARCHEAN ROCKS

Late Archean Intrusions

Agm — **Granitoid intrusions**—Variably magnetic and commonly magnetically zoned. Rock types include hornblende-, pyroxene-, and biotite-bearing syenite, monzonite, and diorite. Discrete adjacent intrusions are indicated by a contact.

Agp — **Gabbro, peridotite, and pyroxenite**—Typically coarse to very coarse grained, oxide-rich, and moderately to strongly magnetic. Discrete adjacent intrusions are indicated by a contact.

Aag — **Anorthosite, gabbroic anorthosite, and anorthositic gabbro of the Mentor mafic intrusive complex.**

Adt — **Tonalite to leucodiorite**—Medium grained, equigranular to porphyritic, quartz poor, and bearing hornblende, biotite, and pyroxene. Magnetic and gravity signatures are subdued.

Agr — **Granite and granodiorite**—Massive, locally coarse grained to pegmatitic, and salmon red in drill core. Variably low magnetic signatures and subdued gravity signatures.

Agu — **Granitoid rocks, undifferentiated**—Inferred from geophysical map patterns. Discrete adjacent intrusions are indicated by a contact.

Ahd — **Hornblende diorite to granodiorite**—Red to gray, medium to coarse grained, typically magnetic.

Agt — **Granodiorite to tonalite**—Biotite bearing, weakly foliated, nonmagnetic.

Adp — **Dacitic to latitic porphyry**—Typically small stocks and dikes in map unit Ads; only one occurrence is large enough to be portrayed at map scale.

Late Archean Supracrustal Rocks

Ams — **Schist of graywacke protolith**—Rocks of the Quetico subprovince of the Superior Province.

Abs — **Biotite-cordierite-quartzofeldspathic schist of graywacke and tuffaceous graywacke protolith.**

Ags — **Paragneiss and schist of intermediate tuff and tuffaceous graywacke protolith, and orthogneiss of granodioritic composition.**

Alf — **Iron-formation**—Largely inferred from narrow magnetic anomalies. Not shown where overlain by Phanerozoic map units (Ks, Jh, and Orw).

Avs — **Volcanic and volcaniclastic sedimentary rocks**—Mafic to felsic volcanic composition.

Ads — **Sedimentary and volcanic rocks of dacitic composition**—Includes conglomerate, tuff, and graywacke. Clasts resemble dacitic to latitic porphyry (map unit Adp).

Amv — **Mafic to intermediate volcanic and volcaniclastic rocks**.

Late to Middle Archean Rocks

Afg — **Foliated biotite granite, granodiorite, and tonalite**—Locally cut by pegmatitic dikes.

Agn — **Orthogneiss, paragneiss, migmatite, and younger granitic pegmatite**—Unit constitutes the core zone of the Roseau River gneiss. Amphibolite- to granulite-grade rocks having relatively shallow foliation were intersected in core.

EXPLANATION OF MAP SYMBOLS

Inferred geologic contact—Dashed where less clearly defined by geophysical maps and drill hole information.

Inferred contact of Archean unit where overlain by Phanerozoic strata—

Geophysical discontinuity inferred to be a fault—Solid line implies sharp geophysical discontinuity; dashed line indicates less clarity of geophysical expression. Offset shown where it can be interpreted from geophysical trends.

Inferred Archean fault where overlain by Phanerozoic strata.

Inferred trajectory of foliation in supracrustal and some gneissic rocks—Inferred from sinuous to linear highs on first vertical derivative aeromagnetic maps. Geophysical modeling and core indicate that foliations are steeply dipping, except locally within gneissic and schistose units (Agn, Afg, Abs, and Ags). Not shown where overlain by Phanerozoic units (Ks, Jh, and Orw).

Approximate direction of stratigraphic younging—Interpreted from grading and contact relationships gleaned from drill core.

Approximate direction and angle of dip of the main foliation (bedding, cleavage, gneissic banding, and igneous layering)—Inferred from drill core and geophysical maps.

Drill holes—Those having an identifying name or number are critical to the geologic interpretation shown on the map; most such drill holes recovered core.

Vertical exploration drill hole that intersected bedrock.

Inclined exploration drill hole—Showing direction of inclination.

Test holes—Drilled by the Minnesota Geological Survey (Jirsa and Boerboom, 1993) and U.S. Geological Survey (unpublished data on file at the Minnesota Geological Survey). All holes are vertical and most intersect Precambrian bedrock.

Water well—Most intersected bedrock; some are deep holes that did not. Location approximate, rock type uncertain.

ACKNOWLEDGMENTS

Mapping is based on (1) scientific test drilling supported by the Minnesota Minerals Diversification Program as administered by the Minerals Coordinating Committee for the Minnesota Legislature; (2) geophysical data provided through funding approved by the Minnesota Legislature as recommended by the Legislative Commission on Minnesota Resources from the Minnesota Future Resources Fund; and (3) water-well and other drilling records maintained by the Minnesota Department of Natural Resources, Division of Minerals, Hibbing, and the Minnesota Geological Survey.

Digitization and minor revision of Miscellaneous Map Series Map M-80 (Jirsa and others, 1994) was supported by the Minnesota Minerals Diversification Program as administered by the Minerals Coordinating Committee for the Minnesota Legislature.

REFERENCES CITED

Jirsa, M.A., and Boerboom, T.J., 1993, Scientific and exploration drilling in northwestern Minnesota: Minnesota Geological Survey Information Circular 40, 106 p.

Jirsa, M.A., Runkel, A.C., and Chandler, V.W., 1994, Bedrock geologic map of northwestern Minnesota: Minnesota Geological Survey Miscellaneous Map Series Map M-80, scale 1:250,000.

GENERALIZED GEOLOGY OF ARCHEAN BEDROCK IN NORTHWESTERN MINNESOTA, INCLUDING SUBPROVINCES WITHIN THE SUPERIOR PROVINCE

LOCATION OF MAP AREA

Digital base modified from 1990 Census TIGER/Line Files of U.S. Bureau of the Census (source scale 1:100,000); county border files modified from Minnesota Department of Transportation files; digital base annotation by Minnesota Geological Survey

Universal Transverse Mercator Projection, grid zone 15
1927 North American Datum

SCALE 1:200 000

5 0 5 10 MILES

5 0 5 10 15 KILOMETERS

GIS compilation and cartography by Joyce Meints
Graphic design by Richard Lively

BEDROCK GEOLOGIC MAP OF NORTHWESTERN MINNESOTA

By

Mark A. Jirsa, Val W. Chandler, and Anthony C. Runkel

1999