UNIVERSITY OF MINNESOTA
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PLATE 1 OF 2 — BEDROCK GEOLOGY

PRELIMINARY BEDROCK GEOLOGIC MAP OF EAST-CENTRAL, MINNESOTA

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SCALE 1:100 000

1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 7 8 KILOMETERS

MAP UNITS

PHANEROZOIC

K — CRETACEOUS, UNDIVIDED - poorly lithified sandstone, siltstone, shale, and marl, typically gray to bluish gray.

C — SEDIMENTARY ROCKS (CAMBRIAN) - *Mt. Simon Sandstone* and possibly other units of Cambrian age.

MIDDLE PROTEROZOIC

Pks — Sedimentary rocks - *Hinkley Sandstone and Fond du Lac Formation*, both of the *Keweenawan Supergroup*. The Hinckley is tan to yellow, coarse-grained sandstone. The Fond du Lac contains red arkosic sandstone, siltstone, and shale.

Pkd — Diabasic to gabbroic dikes - Inferred from northeast-trending negative aeromagnetic anomalies to be reversely polarized diabasic dikes associated with the Keweenawan Midcontinent Rift System.

EARLY PROTEROZOIC

Intrusive units that post-date the regional Penokean metamorphic event (most units locally contain evidence for weak metamorphism—presumably contact and deuteric in origin)

Prd/Pnd — Diabasic and gabbroic dikes - northwest- and east-northeast-trending, variably magnetic dikes - inferred partly from magnetic polarity; Prd—reversed polarity, Pnd—normal polarity.

Pp — Mafic and ultramafic plug-like plutons - composed of serpentinized peridotite, pyroxenite, hornblendite, hornblende- and phlogopite-bearing diorite and gabbro.

Pqd — Quartz feldspar porphyry dikes - pink, fine- to medium-grained biotitic quartzofeldspathic groundmass containing coarse quartz and feldspar phenocrysts.

Pfb — Granite of the Foley batholith - pink to salmon-colored includes small dikes of granitic porphyry and aplite.

Pfm — Variably magnetic zones of the Foley batholith, macroscopically similar to Pfb.

Psg — St. Cloud Granite - pink, coarse-grained, hornblende biotite granite.

Pgr — Granite - pink to red, hornblende- and biotite-bearing.

Pgu — Granitoid rocks, undifferentiated.

Ppz — Pierz Granite - light gray, medium-grained, equigranular, and typically massive.

Pwi — Warman and Isle Granites - The Warman is light gray, medium- to coarse-grained, massive biotite hornblende granite. The Isle is similar, though somewhat coarser grained and more irregular in grain size and composition.

Pag — Granite of the Ann Lake pluton - light gray and black sodic granite containing rare mafic cognate xenoliths. Massive, medium- to coarse-grained, biotite- and hornblende-bearing.

Ptam — Inferred mafic phase of Ann Lake pluton, not exposed.

Pmi — Magnetic intrusions - granodioritic to dioritic, includes Freedhem Granodiorite, Little Rock pluton, Glendorado pluton, and other unnamed bodies.

Prg — Reformatory Granodiorite - hornblende biotite granodiorite, light gray, medium- to coarse-grained, and displaying a moderately well developed trachytoid foliation. Locally cut by many granitic dikes of unit Psg.

Pwd — Watab Diorite - dark greenish gray to gray, fine- to medium-grained hornblende ferrodiorite to granodiorite.

Pbg — Bradbury Creek Granodiorite - red, light gray, and dark gray, variably foliated granodiorite to diorite.

Pbm — Bradbury Creek mafic phase - poorly exposed, outcrops are red to salmon-colored, medium- to coarse-grained granodiorite; however, gravity expression indicates that more dioritic compositions are also present.

EARLY PROTEROZOIC

Intrusive and supracrustal units which are synchronous with or pre-date Penokean metamorphism

Plf — Little Falls Formation - gray, quartzofeldspathic biotite schist of pelitic protolith, inferred from outcrops and drill holes in adjacent areas.

Psz — Shear zone - most is mylonite to cataclasite of granitic protolith, cut by a swarm of northeast-trending, magnetic diabase dikes (unit Pnd).

Pmg — Metagabbro and amphibolite.

Psv — Schist of volcanic, volcaniclastic, and granitoid intrusive protolith.

Psm — Schist of mafic volcanic and hypabyssal intrusive protolith.

EARLY PROTEROZOIC AND ARCHEAN

Ages poorly known

Aph — Hillman Migmatite - contains garnet cordierite biotite schist and amphibolitic schist paleosome, migmatized by tonalitic to granodioritic neosome, metamorphosed to amphibolite to granulite grade. These are cut by orange, west-northwest-trending microgranite dikes.

Aps — Sartell Gneiss - gray to red, medium-grained gneiss that varies from granitic to noritic composition.

Apg — Undifferentiated quartzofeldspathic gneiss, schist, and granite.

CORRELATION OF MAP UNITS

Sedimentary Rocks

K	Cretaceous, undivided	MESOZOIC
C	Cambrian, undivided	PALEOZOIC

Intrusive Rocks

Pkd — *Keweenawan Supergroup* — MIDDLE PROTEROZOIC

Prd / Pnd — *(dikes locally trend differently than shown here)*

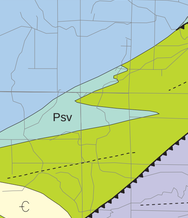
EARLY PROTEROZOIC: Pp; Pfb, Pfm, Psg, Pgr; Pgu; Ppz, Pwi, Pag, Ptam; Pmi; Prg, Pwd; Pbg, Pbm; Pqd

Metamorphic Rocks (both intrusive and supracrustal protoliths)

EARLY PROTEROZOIC: Pmg; Psz; Psv, Psm; Plf

ARCHEAN AND EARLY PROTEROZOIC: Apg; Aph; Aps

- Inferred contact
- Inferred fault (offset unknown)
- Inferred thrust fault - teeth on the upper plate
- Narrow aeromagnetic anomalies inferred to represent trajectories of foliation
- Strike and dip of bedding in sedimentary rocks - inclined, vertical
- Strike and dip of magmatic foliation - inclined, vertical
- Strike and dip of cleavage, schistosity, and gneissic banding - inclined, vertical
- Strike and dip of narrow, dominantly brittle shear zones - inclined, vertical
- Trend and plunge of mineral lineation
- Trend and plunge of fold axis
- Strike and dip of small diabasic dikes (units Pnd,Prd) - inclined, vertical
- Strike and dip of small granitic dikes, includes quartz feldspar porphyry (unit Pqd) and dikes of aplite and microgranite - inclined, vertical.



MAP LOCATION

This map and accompanying Information Circular 42 are based on scientific test drilling, analyses of archived drill core, outcrop mapping, and geophysical interpretation. Geophysical data were provided by Legislative funding on recommendation from the Legislative Commission on Minnesota Resources. Although the authors compiled this map, it was produced by the additional efforts of MGS staff members whose names do not appear in the authorship: we acknowledge field geologists Emily Bauer, Alan Knaeble, andTerrence Boerboom for drill-site logging; Jane Cleland and Joyce Meints for database construction and GIS work; and John Mossler and Anthony Runkel for interpretation of cuttings and downhole geophysical data related to the Phanerozoic strata. The Stearns County portion of this map is after Boerboom and others, 1995, in: Meyer, G.N., Geologic Atlas of Stearns County, Minnesota, MGS County Atlas Series, C-10, Part A.

Every reasonable effort has been made to ensure the accuracy of the factual data on which this map interpretation is based; however, the Minnesota Geological Survey does not warrant or guarantee that there are no errors. Users may wish to verify critical information; sources include both the references listed here and information on file at the offices of the Minnesota Geological Survey in St. Paul. In addition, effort has been made to ensure that the interpretation conforms to sound geologic and cartographic principles. No claim is made that the interpretation shown is rigorously correct, however, and it should not be used to guide engineering-scale decisions without site-specific verification.

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