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EXPLANATION FOR THE GEOLOGIC MAP OF THE DULUTH
COMPLEX IN THE BABBITT-HOYT LAKES AREA, MINNESOTA

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Allen, Babbitt, Babbitt NE, Babbitt SE and
Babbitt SW 7½-minute quadrangles

Use of lithologic symbols

Two sizes of letter symbols are used to indicate lithology. Small symbols refer to rock types at specific outcrops, whereas large symbols indicate rock types in areas containing several outcrops.

Parentheses that enclose a lithologic symbol indicate the rock type is an inclusion. For example, t (ag) indicates that an outcrop consists of troctolite containing gabbroic anorthosite inclusions.

LATE PRECAMBRIAN (KEWEENAWAN) ROCKS

Troctolitic rocks

Plagioclase and olivine typically are contemporaneous in these rocks and are earlier than associated minerals. The rocks generally are medium-grained, but locally are fine or coarse; most contain 60-80 % plagioclase, 10-35 % olivine and 0-15 % pyroxenes and opaque oxides (magnetite and/or ilmenite). Foliation and mineralogical layering are well-developed locally, but are weakly-developed or not in evidence in most exposures. In addition to including rocks with more olivine than pyroxene or opaque oxides, the troctolitic group of rocks locally includes rocks in which augite or oxides are more abundant, but paragenetically later, than olivine.

- t troctolite: plagioclase and olivine with insignificant quantities of other minerals.
- ta augite troctolite: contains more than about 5 % augite.
- tm magnetite troctolite: includes rocks with ilmenite as the opaque oxide.
- tam augite magnetite troctolite: includes rocks with ilmenite as the opaque oxide.
- tu troctolite: undifferentiated as to type.

Anorthositic rocks

Plagioclase typically is earlier than associated olivine, pyroxene, or opaque oxides in these rocks. The rocks generally are medium- to coarse-grained and contain 70-95 % plagioclase, with as much as 10-15 % olivine, pyroxene and opaque oxides. Plagioclase foliation is more common than in the troctolitic rocks; it is weakly-developed or not in evidence in some exposures, however. Many of the anorthositic rocks are older than the troctolitic rocks as they occur as inclusions in troctolite or are intruded by troctolitic bodies; other bodies of anorthositic rock evidently are contemporaneous with associated troctolitic rocks.

- a anorthosite: negligible amounts of all minerals except plagioclase.
- at troctolitic anorthosite: contains more than about 5 % olivine.
- ag gabbroic anorthosite: contains more than about 5 % pyroxene.
- am magnetite anorthosite: contains more than about 5 % magnetite and ilmenite.
- atg pyroxene-bearing troctolitic anorthosite: contains 5 % or more olivine and pyroxene; olivine exceeds pyroxene in abundance.
- atm magnetite-bearing troctolitic anorthosite: contains 5 % or more olivine and opaque oxides; olivine exceeds opaque oxides in abundance.
- atgm pyroxene-magnetite-bearing troctolitic anorthosite: contains 5 % or more olivine, pyroxene, and opaque oxides; olivine exceeds pyroxenes and opaque oxides in abundance.
- agt olivine-bearing gabbroic anorthosite: contains 5 % or more pyroxene and olivine; pyroxene exceeds olivine in abundance.
- agm magnetite-bearing gabbroic anorthosite: contains 5 % or more pyroxene and opaque oxides; pyroxene exceeds opaque oxides in abundance.
- agtm olivine-magnetite-bearing gabbroic anorthosite: contains 5 % or more pyroxene, olivine and opaque oxides; pyroxene exceeds olivine and opaque oxides in abundance.
- au anorthositic rock: undifferentiated as to type.

Gabbroic rocks

This group consists mainly of medium-grained rocks that contain abundant plagioclase and have more augite than olivine. The age relationships of the various gabbro bodies to the anorthositic and troctolitic rocks is unclear. This is a diverse group of rocks and it is unlikely that various gabbro occurrences are closely related to one another.

- g_1 medium- to coarse-grained magnetite-bearing gabbro that occupies most of sections 7, 8, and 18, T. 59 N., R. 12 W. and parts of adjoining sections; Babbitt SW quadrangle. Typically contains about 50 % plagioclase, 30 % augite, and 20 % olivine plus opaque oxides. Apatite is comparatively abundant and the interstitial augite grains characteristically are clouded with oriented opaque inclusions (ilmenite-?).
- g_2 fine- to medium-grained gabbro containing variable quantities of olivine and opaque oxides that occurs adjacent to the footwall rocks in sections 26 and 35, T. 61 N., R. 12 W., and sections 2 and 3, T. 60 N., R. 12 W.; Babbitt NE quadrangle.
- g gabbro, undifferentiated as to type.

Hornfelsic rocks

These rocks generally are grey, fine-grained and have granoblastic textures. They evidently were derived from a variety of initial materials including Virginia Formation, Keweenaw (?) basalts, and former troctolites and gabbros. Most contain 50-60 % plagioclase, 20-40 % pyroxene, 0-15 % magnetite, 0-10 % olivine and local quantities of biotite, hornblende and other minerals.

- hm magnetic hornfels: commonly contains 10-20 % magnetite in addition to abundant plagioclase and pyroxene; thought to have formed from magnetite-rich basalt. Closely associated with non-magnetic hornfels containing ellipsoidal structures that are suggestive of metamorphosed amygdalae.
- h hornfels: undifferentiated as to type.

Miscellaneous rocks

- p periodotite and pyroxenite: generally coarse-grained with significant quantities of opaque oxides, locally feldspathic; generally as dikes, segregations (seg) and other small irregular bodies cutting troctolitic, anorthositic, and hornfelsic rocks.
- gr granitic rocks: occur as thin steeply-dipping dikes locally cutting the other Keweenaw rocks.

- d diabase: fine-grained gabbroic rocks occurring locally as dikes or sills.
- m local segregation (seg) with a high percentage of magnetite that occurs in section 33, T. 59 N., R. 13 W.: Babbitt SW quadrangle.
- mafic pegmatite -- outcrop of gabbroic rock with a pegmatitic grain size in section 20, T. 59 N., R. 13 W.; Allen quadrangle.

MIDDLE PRECAMBRIAN (ANIMIKIAN) ROCKS

- v Virginia Formation; principally greywacke and argillaceous greywacke; pyritic and graphitic shale is abundant and the formation contains local calcareous and quartzose horizons. In the vicinity of the Duluth Complex the formation is metamorphosed to the pyroxene hornfels facies and consists typically of hypersthene, cordierite, plagioclase and biotite with accessory graphite and pyrrhotite.
- bif Biwabik Iron Formation: metamorphosed to the pyroxene hornfels facies in the vicinity of the Duluth Complex.

EARLY PRECAMBRIAN (ALGOMAN) ROCKS

- qm rocks of the Giants Range batholith: typically medium - to coarse-grained porphyritic biotite or hornblende quartz monzonite; varies locally to granite, granodiorite, diorite, syenite and monzonite, with variable textures.

_____ — — — ? — ? —

contact: solid if location is known, dashed if location is approximate, queried if existence is hypothesized, dotted if concealed.

_____ — — — ? — ? —

fault: solid if location is known, dashed if location is approximate, queried if existence is hypothesized, dotted if concealed.

Strike and dip of plagioclase foliation or compositional layering;
also used for layering in hornfels bodies.



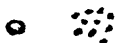
vertical foliation or layering



horizontal foliation or layering



strike of prominent near-vertical closely-spaced joint sets
with local hydrothermal alteration.



outcrop locations: small outcrops, large dots; larger areas of
outcrop or scattered outcrop, small dots.