



**DESCRIPTION OF MAP UNITS**

- DULUTH COMPLEX (UPPER PRECAMBRIAN—KEWEENAWAN)**
- dy, gray, fine-grained, decussate iron-titanium oxides (5%)—hypersthene (11%)—augite (31%)—plagioclase (53%) rock containing visible, diagnostic deuterite biotite and hornblende. Unit closely resembles unit dx.
  - dx, brown or black, fine-grained to ophanitic augite (22%)—plagioclase (66%) rock containing diagnostic local plagioclase phenocrysts; in coarse-grained specimens, some olivine (2%) present. Titanium-iron oxides (7%) are most abundant minor minerals, olivine (2%) and quartz (2%) are common, and apatite and alkali feldspar (1%) are uncommon accessory minerals.
  - dw, coarse-grained, decussate augite (35%)—plagioclase (55%) rock containing randomly oriented plagioclase subhedral and interstitial titanium-iron oxides and augite. Augite is commonly altered to green amphibole.
  - dv, dark gray, coarse-grained, granular titanium-iron oxides (23%)—augite (44%) rock containing interstitial olivine (1%)—plagioclase (8%), and pigeonite (24%).
  - du, brown, medium-grained, granular plagioclase (21%)—titanium-iron oxides (24%)—olivine (49%) rock; plagioclase is interstitial. Augite (4%), hypersthene (2%), and apatite are minor minerals; titanomagnetite is more abundant than ilmenite.
  - dt, black, medium-grained, granular olivine (16-36%)—titanium-iron oxide (57-73%) rock. Varietal minerals include plagioclase (2-10%) and augite (3%); apatite, pigeonite, and ilmenite are uncommon accessories. Unit is characterized in outcrop by distinctive malachite staining.
  - ds, white to greenish-gray, medium-grained, locally coarse-grained, foliated augite (17%)—plagioclase (77%) rock. Pigeonite (2%) and titanium-iron oxides (3%) are abundant minor minerals, and olivine (1%) is present in trace quantities. Brown and black pyroxenes are commonly altered to green amphibole. Contains sparse titanium-iron oxides in one-centimeter oikocrysts and minor chalcopyrite. Local deuterite alteration of plagioclase to montmorillonite (?) and of pyroxenes to amphibole and chlorite; traces of chalcopyrite and bornite occur in the altered rocks.
  - dq, brown, medium-grained, foliated olivine (17%)—plagioclase (83%) rock containing trace amounts of augite, pigeonite, and titanium-iron oxides. Unit is gradational with unit dp except locally where an augite-olivine-plagioclase rock having distinctive augite phenocrysts intervenes. Elongate olivine crystals are characteristic and aid in distinguishing from unit da.
  - dp, fine-grained, foliated augite (32%)—plagioclase (58%) rock characterized by five-millimeter brown olivine phenocrysts (3%) and one-centimeter brown hypersthene oikocrysts (7%). Titanium-iron oxides are minor minerals.
  - do, very coarse grained, decussate quartz-orthoclase-augite-plagioclase rock containing accessory titanium-iron oxides and apatite. Unit occurs as dikes and may represent the crystallization of residual magma, or partial fusion of pre-Duluth Complex sedimentary rocks.
  - dn, fine-grained, granular titanomagnetite (19%)—plagioclase (41%)—augite (40%) rock in which the component minerals are separated into laminae one millimeter to two centimeters thick. Titanomagnetite has undergone ulvöspinel exsolution and ilmenite exsolution.
  - dm, coarse-grained, decussate to weakly foliated pigeonite (13%)—titanium-iron oxide (2%)—augite (24%)—plagioclase (59%) rock. Most common facies contains quartz (1%), alkali feldspar (1%), and apatite or magnetite. Uncommon plagioclase-rich facies are white and plagioclase-rich patches in the pyroxene-bearing facies give the rock a mottled appearance. Pyroxenes are prominent as oikocrysts in the plagioclase-rich facies. Equivalent to unit olg of Davidson (1977) in the Eagle Mountain quadrangle.
  - dk, dikes, pink, fine-grained, granular hornblende-titanium-iron oxides-plagioclase-quartz-orthoclase rock. Other dikes mapped as part of this unit, but probably not co-genetic with it include pink to gray, fine-grained, decussate chlorite-biotite-quartz-alkali feldspar rock. All occurrences are near the base of the Duluth Complex.
  - dj, white, coarse-grained, foliated augite (6-17%)—plagioclase (67-83%) rock containing minor titanium-iron oxides (4-15%). Pyroxenes form large oikocrysts and titanium-iron oxides occur in small lenses. Quartz (1%), alkali feldspar (2%), pigeonite (1-4%) and apatite are minor minerals. Some deuterite alteration of plagioclase and pyroxene.
  - dh, gray to brown, fine-grained, foliate titanium-iron oxides (4%)—olivine (20%)—plagioclase (66%) rock containing minor augite (3%), pigeonite (4%), and apatite (1%); has some deuterite biotite. Unit is distinguished from units da and dg by conspicuous titanium-iron oxides.
  - dg, coarse-grained, strongly foliated olivine-plagioclase or augite-plagioclase rock containing abundant titanium-iron oxides. Mineral abundances vary widely and density-graded layering is prominent. Major facies include titanium-iron oxides-olivine-plagioclase, titanium-iron oxides-augite-olivine-plagioclase, and titanium-iron oxides-augite-plagioclase rocks. Ilmenite is only oxide at the base, but titanomagnetite and ilmenite coexist throughout the remainder of the unit. Deuterite biotite is conspicuous and hydrothermal alteration of olivine and pyroxenes to amphibole and chlorite, with associated chalcopyrite, occurs locally.
  - df, fine- to coarse-grained, decussate augite (10%)—olivine (10%)—plagioclase (68%) rock. Interstitial pigeonite (5%) and ilmenite (7%) generally are abundant and quartz, apatite, and alkali feldspar are present in trace amounts. Deuterite biotite is a characteristic alteration mineral. Patches of quartz, alkali feldspar, and copper sulfides appear sporadically near the base of the unit.
  - de, brown, fine-grained, granoducussate augite (41%)—plagioclase (53%) rock containing accessory titanium-iron oxides (6%), pigeonite, and apatite.
  - dd, gray to brown, very fine grained, granular, moderately magnetic titanium-iron oxides-augite-plagioclase or olivine-titanium-iron oxides-augite-plagioclase rock. Unit is distinguished from unit de by being more magnetic.
  - dc, gray to tan, very fine grained, granular to weakly foliated, weakly magnetic olivine-augite-plagioclase rock having local facies of pigeonite-augite-plagioclase or titanium-iron oxides-augite-plagioclase. Titanium-iron oxides, pigeonite, and apatite are sparse. Some deuterite biotite, amphibole, and chlorite are present.
  - db, medium-grained, strongly foliated rock containing black pyroxene (41%) and gray plagioclase (59%). Major facies include pigeonite-augite-plagioclase grading downward into augite-pigeonite-plagioclase with minor olivine present near base. Titanium-iron oxides and apatite are uncommon. Some pyroxene and all titanium-iron oxides are poikilitic; plagioclase phenocrysts occur locally. Gradational contact with unit da.
  - da, brown, fine-grained, foliated olivine-plagioclase (42-63%) rock containing rhythmic concentrations of olivine. Local facies contain plagioclase or augite phenocrysts. Pigeonite (3-9%) and augite (2-3%) locally abundant, whereas titanium-iron oxides and apatite are uncommon.
- LOGAN INTRUSIONS (UPPER PRECAMBRIAN—KEWEENAWAN)**
- li, Fine- to coarse-grained, locally porphyritic diabase; contains heavily sericitized plagioclase (40-50%), augite-pigeonite (30-40%), magnetite-ilmenite (5-10%), and interstitial granophyric intergrowths. Augite and pigeonite intergrown in a mottled texture and commonly altered to amphibole and chlorite.
- ROVE FORMATION (MIDDLE PRECAMBRIAN)**
- rf, Dominantly thin- to thick-bedded, and black, argillaceous siltstone interlayered with thin to thick beds of fine- to medium-grained, dark gray to very light gray feldspathic graywacke. Locally metamorphosed by the Logan Intrusions to a black, fine-grained, massive hornblende-hornfels, and by the Duluth Complex to a medium-grained, granoblastic pyroxene-hornfels.
- GUNFLINT IRON FORMATION (MIDDLE PRECAMBRIAN)**
- gif, Undivided, massive (cherty) iron-poor layers intercalated with thin-bedded (slaty) iron-rich layers.

- Rock unit of uncertain or local extent; line shows approximate strike of dike. Duluth Complex only.
- Approximate areas of outcrop.
- Contact, showing dip—solid where known; long dash where approximate; short dash where gradational or inferred; dotted where concealed by water.
- Contact—inferred from geophysical data.
- Fault—long dash where approximate; short dash where inferred; dotted where concealed by water.
- Strike and dip of inclined beds.
- Strike and dip of foliation—includes mineral orientation and compositional layering in Duluth Complex.
- Grain lineation.
- Strike and dip of sheeting joints.

**GEOLOGIC MAP OF THE SOUTH LAKE QUADRANGLE, COOK COUNTY, MINNESOTA**

By  
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