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GEOLOGIC MAP OF THE SOUTHERN PART OF THE MOUNT HAYES QUADRANGLE, ALASKA

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GENERAL GEOLOGIC AND TECTONIC SUMMARY

The Mount Hayes quadrangle, south of the Denali fault, consists of several fault-bounded tectonostratigraphic terranes. From north to south, the principal terranes are the Maclaren terrane, the Clearwater terrane, and the Wrangellia terrane. The Maclaren terrane (Smith, 1974; Smith and Turner, 1973, 1974; Nokleberg and others, 1980, 1981a) occurs in the central and western parts of the geologic map and is bounded to the north by the Denali fault and to the south by the Broxson Gulch thrust. The Clearwater terrane, as defined by Jones and others (1981), occurs in the western part of the geologic map as a small fault-bounded wedge of metamorphic rock within branches of the Broxson Gulch thrust, between the Maclaren terrane to the north and the Wrangellia terrane to the south. Most of the southern part of the quadrangle is underlain by the Wrangellia terrane (as defined by Jones and others, 1977) which is divided into the Slana River subterrane to the north and the Tangle subterrane to the south. The Wrangellia terrane is bounded to the north by either the Broxson Gulch thrust or Denali fault and extends to the southern edge of the quadrangle. A small portion of the eastern part of the quadrangle is underlain by a small fault-bounded terrane of ultramafic and related rock that occurs between the Wrangellia terrane and the Denali fault.

Maclaren Terrane

The Maclaren terrane consists of penetratively deformed and regionally metamorphosed plutonic rocks, and schist, phyllite, and argillite and metagraywacke. The Maclaren terrane in this report is approximately equivalent to the Maclaren metamorphic belt of Smith (1974), and Smith and Turner (1973, 1974). The northern part of the Maclaren terrane (Nokleberg and others, 1980, 1981a) consists of the regionally deformed and metamorphosed East Susitna batholith and the southern part consists of the Maclaren Glacier metamorphic belt.

The East Susitna batholith consists predominantly of regionally metamorphosed and penetratively deformed diorite and granodiorite, with lesser quartz monzonite. Locally this schistose granitic rock grades into migmatite, migmatitic schist, and schist and amphibolite. Schist and amphibolite consist of older, more intensely regionally metamorphosed and penetratively deformed gabbro and diorite. Small roof pendants of schist, quartzite, and amphibolite occur in the East Susitna batholith near the western edge of the quadrangle. These roof pendants are correlated with the Nenana terrane of Late Triassic age (Jones and others, 1981) in the Healy quadrangle to the west. Sparse dikes of diabase and dacite of Tertiary(?) age crosscut portions of the batholith. A late Cretaceous to Early Tertiary age is indicated for the batholith by a U-Pb zircon age of 70 m.y. on a sample of schistose quartz diorite from the B-6 quadrangle (Aleinikoff and others, 1981), and by one nearly concordant K-Ar hornblende and biotite age of 54.5 to 57.0 m.y. on a late stage pegmatite (Turner and Smith, 1974). Numerous discordant K-Ar age determinations on hornblende, biotite, and muscovite from schistose granitic rock and migmatite range between 29 and 60 m.y. (Turner and Smith, 1974), indicating that regional metamorphism and deformation of the batholith continued into the middle Tertiary. The contact between the East Susitna batholith and the Maclaren Glacier metamorphic belt is a faulted intrusive contact, the Meteor Peak fault along which occur fault-bounded lenses of metamorphic and plutonic rock, and sparse dikes.

The Maclaren Glacier metamorphic belt is a pro-grade Barrovian type metamorphic belt (Smith, 1974; Smith and Turner, 1973, 1974). From south to north, the principal units are argillite and metagraywacke with lower greenschist facies metamorphism, phyllite with upper greenschist facies metamorphism, and schist and amphibolite with amphibolite facies metamorphism. The three map units of the Maclaren Glacier metamorphic belt generally dip moderately to steeply northward, with the lower grade units in the south dipping under the higher grade units to the north, thereby forming an inverted metamorphic sequence. Exposed contacts between the three map units are generally faults with intense shearing and abrupt changes of metamorphic facies at each contact. The Maclaren Glacier metamorphic belt is thrust under the East Susitna batholith to the north along the Meteor Peak fault. A Cretaceous to pre-Cretaceous minimum age for the protolith of the Maclaren Glacier metamorphic belt is determined by the intrusion of the belt by the 70 m.y.-old granitic rocks of the East Susitna batholith immediately to the north of the Maclaren Glacier metamorphic belt. No fossils have yet been found in the Maclaren Glacier metamorphic belt in the Mount Hayes quadrangle or in the nearby portions of the Healy quadrangle to the west. The lack of age control and the highly deformed and metamorphosed character of the Maclaren Glacier metamorphic belt is permissive of this unit containing rocks of diverse origins and ages. The thrust faults between the map units in the Maclaren Glacier metamorphic belt could be sutures separating rocks of diverse origin.

The Maclaren terrane is interpreted as a tectonically detached fragment of an Andean-type plutonic arc of Late Cretaceous and Tertiary age. As suggested by Forbes and others (1973), the rocks forming the Maclaren terrane are correlated with the northern part of the Coast plutonic complex in the Kluane Lake area in the the southern Yukon Territory. The Coast plutonic complex in this area has been subdivided into the Taku and Tracey Arm terranes by Berg and others (1978) and Jones and others (1981). This correlation defines a minimum displacement of the Maclaren terrane along the Denali fault of about 400 km.

Clearwater Terrane

The Clearwater terrane (Jones and others, 1981) consists of a small fault-bounded block of highly deformed chlorite schist, muscovite schist, marble, and greenstone derived from basalt. This terrane occurs near the western edge of the quadrangle within branches of the Broxson Gulch thrust between the Maclaren terrane to the north and the Wrangellia terrane to the south. Upper Triassic *Heterastridium* sp. occur in the marble unit to the west in the Healy quadrangle (Jones and others, 1981). The map units are fault-bounded and the stratigraphic thickness is unknown. Small fault-bounded wedges of Tertiary sandstone and coal, and of the Jurassic to Triassic McCarthy Formation occur along the south margin of the Clearwater terrane. The closest known occurrence of the McCarthy Formation is to the southeast in the western part of the McCarthy quadrangle (MacKevett, 1978).

Wrangellia Terrane

The Wrangellia terrane (Jones and others, 1977) consists predominantly of a sequence of late Paleozoic island arc rocks which are disconformably overlain by the Triassic Nikolai Greenstone and locally by younger rocks. The Slana River subterrane, forming the northern part of the Wrangellia terrane, is bounded to the north by the Broxson Gulch thrust and to the south by the Eureka Creek fault. The Slana River subterrane consists mainly of upper Paleozoic island arc rocks, and disconformably overlying massive rift basalt flows of the Triassic Nikolai Greenstone (Bond, 1976; Richter and others, 1977). The upper Paleozoic island arc rocks consist mainly of andesite flows, breccia, epiclastic rocks, argillite, and limestone of Pennsylvanian to Permian age (Richter and others, 1977). The Nikolai Greenstone consists of massive, subaerial, amydgaloidal basalt flows (Richter and others, 1977). Locally overlying the Nikolai Greenstone in the eastern part of the Slana River subterrane are Triassic limestone, Jurassic to Cretaceous argillite and graywacke of the Gravina-Nutzotin belt, and sparse deposits of Tertiary sandstone, conglomerate, and rhyolite to dacite tuff, breccia, and flows. The stratigraphic bottom of the Slana River subterrane is not exposed.

The Tangle subterrane forms the southern part of the Wrangellia terrane, and consists predominantly, relative to the Slana River subterrane, of a thinner sequence of upper Paleozoic sedimentary and tuffaceous rocks, and a thicker sequence of unconformably overlying pillow lava and subaerial flows of the Triassic Nikolai Greenstone. The Tangle subterrane is bounded to the north by the Eureka Creek fault and extends to the southern boundary of the geologic map. Extensive gabbro dikes, sills, and stratiform cumulate mafic and ultramafic rock intrude the sedimentary and volcanic rock of the Tangle subterrane. Part of the Tangle subterrane, including the mafic and ultramafic complex of Fish Lake, is thrust over the Nikolai Greenstone of the Tangle subterrane along the folded Fish Lake thrust. The stratigraphic base of the Tangle subterrane is fault-bounded.

There are several important differences between the Slana River subterrane and the Tangle subterrane (Nokleberg and others, 1981b). The upper Paleozoic rocks in the Tangle subterrane are much thinner than in the Slana River subterrane. The upper Paleozoic rocks in the Tangle subterrane are predominantly aquagene tuff and argillite with minor andesite, whereas the upper Paleozoic rocks in the Slana River subterrane are mainly andesite flows, breccia, and epiclastic rock. The lower pillow basalt member of the Nikolai Greenstone in the Tangle subterrane is absent in the Slana River subterrane. The massive subaerial basalt flows forming the upper member of the Nikolai Greenstone in the Tangle subterrane are at least three times thicker than similar flows in the Slana River subterrane. And post-Triassic units in the Slana River subterrane are absent in the Tangle subterrane.

Terrane of Ultramafic and Associated Rock

In the eastern part of the geologic map, there is a terrane of ultramafic rock and sparse associated mafic rock and sparse associated granitic rock that occurs in a narrow fault-bounded belt, up to 1-km wide, directly south of the Denali fault and north of the Wrangellia terrane. The ultramafic and mafic rock are locally intruded by deformed and altered tonalite and quartz monzonite. The ultramafic and mafic rock have been intensely tectonically deformed and have also been locally altered by magnesium metasomatism. This terrane represents a crustal-suture belt which trends northwestward across east-central Alaska. This terrane may represent either the oceanic basement for the late Paleozoic island arc rock of Wrangellia, or may represent oceanic lithosphere accreted onto North America just before the accretion of Wrangellia.

Plutonic Rocks, Adjacent Terranes, and Faults

In addition to the schistose granitic rock of the East Susitna batholith in the Maclaren terrane, several non-schistose plutonss intrude the Maclaren River, Clearwater, and Wrangellia terranes. Compositions range from quartz diorite to quartz monzonite and K-Ar ages on hornblende or biotite range from 31 to 44 m.y., and 120 to 149 m.y. (Ragan and Hawkins, 1966; Turner and Smith, 1974). None of the granitic plutons crosscut terrane boundaries. In the Broxson Gulch, Rainbow Mountain and Gulkana Glacier areas in the central part of the geologic map, a few granitic plutons are faulted against late Paleozoic volcanic rocks of the Slana River terrane and against late Tertiary sedimentary and volcanic rock along branches of the Broxson Gulch, McCallum Creek, and Slate Creek faults.

Other terranes that occur adjacent to the various terranes in the southern part of the Mount Hayes quadrangle are discussed by Jones and others (1981) in a preliminary report on tectonostratigraphic terranes of Alaska. The plate kinematics of the Denali fault and Broxson Gulch thrust are discussed by Stout and Chase (1981). Field relations of the McCallum Creek and Slate Creek faults are described by Weber and Turner (1971).

PREVIOUS MAPPING

The earliest geologic mapping was done near the turn of the century by Mendenhall (1903, 1905) and Moffit (1912). The latter continued his work in the area for nearly fifty years (Moffit, 1954). The more recent geologic mapping of bedrock in the area consists of maps of parts or of entire 15-minute quadrangles. These studies include those of Rose (1965; 1966a, b; 1967), Rose and Saunders (1967), Bond (1976), Stout (1976), and Richter and others (1977). There is also unpublished bedrock mapping by Smith (1972) and Matteson (1973). Surficial geologic mapping in the southwestern part of the quadrangle has been published by Kachadoorian and others (1953) and Kachadoorian and Pewe (1955). Originally confidential mapping of surficial geology was done by the U.S. Army Corps of Engineers (1960a, b). A complete bibliography of geological investigations in the Mount Hayes quadrangle through the early part of 1980 is listed in Zehner and others (1980).

DESCRIPTION OF MAP UNITS
SURFICIAL DEPOSITS

ALLUVIAL DEPOSITS

Qa — Alluvium on active flood plains and lowest terraces of major streams, and larger alluvial fans.--Chiefly boulders, gravel, and sand

Qaf — Alluvial fans and cones, chiefly gravel and sand.--Only large well-defined cones are differentiated from colluvium (Qc)

Qoa — Alluvium in high terraces along major streams.--Oldest deposits may be outwash from a late advance of the Wisconsin Glaciation. Chiefly boulders, gravel, and sand

Qfl — FLUVIOLACUSTRINE DEPOSITS.--Lake, pond, and low-gradient stream deposits; Chiefly sand, silt, and clay; locally includes abundant organic matter

COLLUVIAL DEPOSITS

Ql — Landslide deposits.--Chiefly debris avalanches and block slides as evidenced by freshness of form. Older landslide deposits included in undivided colluvium (Qc)

Qc — Undivided colluvium and other deposits on valley walls and hill slopes.--Chiefly talus and other slope debris, but includes alluvium of numerous minor streams, and locally glacial, rock glacier, and mass-wasting deposits. In areas of gentle slopes, chiefly mixed colluvium and alluvium with local bedrock rubble. Unit includes large solifluction lobes on high-level low-gradient slopes that are composed chiefly of bedrock rubble but may include older glacial drift deposits (Qog). Locally grades into deposits of Alaskan, Wisconsin, and older glaciations. Chiefly rubble, gravel, sand, silt, and clay; generally poorly sorted

Qrg — ROCK GLACIER DEPOSITS.--Includes active and recently active rock glaciers and the talus aprons feeding them. Smaller rock glaciers and deposits of old rock glaciers included in undivided colluvium (Qc). Chiefly rubble and diamicton

GLACIAL DEPOSITS

Qam — End and lateral moraines of the Alaskan Glaciation (Richter and others, 1977).--Left after recession of existing glaciers. Chiefly rubble and diamicton

Qwg — Drift of Wisconsin Glaciation.--Includes end, lateral, and ground moraine, and locally fluvioglacial deposits of both main and late stages of Wisconisn Glaciation and may include some deposits of the Alaskan Glaciation (Qam). Unit locally includes postglacial alluvial and pond deposits especially in extensive ground moraines. At higher elevations, drift consists mainly of lateral and end moraines. At lower elevations, drift consists mainly of glaciofluvial deposits.

At higher elevations, deposits merge with and are covered by undifferentiated colluvium (Qc). At lower elevations, deposits merge with and are covered by undifferentiated alluvium (Qa). Chiefly diamicton with minor sand and gravel

Qwf Glaciofluvial deposits of Wisconsin Glaciation.--Generally occur downslope from end moraines of Wisconsin Glaciation. Moderately well-stratified layers and lenses of well-rounded gravel with matrix of silt and sand. Poorly to moderately well sorted. Local lenses of well-sorted sand

Qwm End and lateral moraines of Wisconsin Glaciation.--At higher elevations, deposits merge with and are covered by undifferentiated colluvium (Qc). Locally may include deposits of the Alaskan Glaciation (Qam). Poorly sorted and unstratified. Chiefly till of unconsolidated sand and gravel

Qog Drift of older glaciations.--Includes glacial deposits with subdued geomorphic expression, probably of early Wisconsin or Illinoian age, beyond limit of Wisconsin moraines, and undifferentiated high-level glacial deposits. At higher elevations, deposits merge with and are covered by undifferentiated colluvium (Qc). At lower elevations, deposits merge with and are covered by undifferentiated alluvium (Qa). At higher elevations, chiefly unconsolidated diamicton and boulder deposits. At lower elevations, chiefly unconsolidated glaciofluvial deposits consisting of moderately well-stratified and sorted gravel and sand

PLUTONIC ROCKS AND MELANGE

Occur in Maclaren River, Clearwater, and Wrangellia terranes

Tqm QUARTZ MONZONITE (Tertiary).--Small irregular bodies, dikes, and small to moderate-size plutons of fine- to medium-grained quartz monzonite. Occur chiefly in western part of East Susitna batholith. Fine- to medium-grained. Major minerals are plagioclase, potassium feldspar, quartz, and biotite with sparse secondary white mica and chlorite. Hypautomorphic granular with local undulose extinction and fracturing in feldspar and quartz. Tertiary age based on K-Ar hornblende or biotite ages of 34 to 35 m.y. of Turner and Smith (1974) and on intrusion of quartz monzonite pluton into schistose granitic rock of East Susitna batholith. Only larger bodies shown on geologic map

Tdp DACITE PORPHYRY DIKES (Tertiary(?)).--Small thin dikes of dacite porphyry intruding subaerial flows and pillow basalt of Nikolai Greenstone and older rock in Tangle subterrane. Medium-grained with abundant plagioclase and sparse hornblende phenocrysts. Major minerals are plagioclase and hornblende with sparse quartz and with secondary epidote, sericite, and chlorite. Groundmass consists of very fine-grained plagioclase and sericite. Occur as veery sparse dikes up to a few meters wide

PLUTONIC AND SHALLOW INTRUSIVE ROCKS (Tertiary, Cretaceous, or Jurassic).--Chiefly dikes and small to moderate-size plutons of quartz monzonite, quartz monzonite porphyry, granodiorite, quartz diorite, diorite, gabbro, and diabase. Exclusive of East Susitna batholith. Fine- to medium-grained, subhedral granular to porphyritic, and generally non-schistose. Major igneous minerals in intermediate and siliceous rock are plagioclase, potassium feldspar, quartz, hornblende, and biotite with secondary epidote, chlorite, actinolite, and white mica. Major igneous minerals in mafic rock are plagioclase and clinopyroxene with sparse hornblende and biotite, and with secondary epidote chlorite, and actinolite. Locally highly altered to secondary minerals. Locally contain faintly- to moderately-developed schistosity. Plutons have locally thermally metamorphosed adjacent clastic sedimentary rock, volcanic and volcaniclastic rock, Nikolai Greenstone, and limestone to contact metamorphic rock, including banded hornfels, amphibolite, and marble. Locally iron-stained from weathering of disseminated iron-sulfide minerals, particularly adjacent to faults. Locally occur as fault-bounded masses in either Broxson Gulch, McCallum Creek, and Slate Creek faults. Tertiary, Cretaceous, or Jurassic ages based on K-Ar hornblende and biotite ages of Ragan and Hawkins (1966) and Turner and Smith (1974)

qm Quartz monzonite

qmp Quartz monzonite porphyry

gd Granodiorite

di Diorite and quartz diorite

gb Gabbro

db Diabase

m MELANGE (Tertiary).--Chiefly fault-bounded lenses and blocks of highly sheared and deformed rock generally derived from adjacent bedrock. Occurs generally within branches of Broxson Gulch thrust.

MACLAREN TERRANE

SOUTH OF DENALI FAULT AND NORTH OF BROXSON GULCH THRUST

EAST SUSITNA BATHOLITH (Tertiary to Cretaceous) and
SCHIST, QUARTZITE, AND AMPHIBOLITE (Triassic?)

SOUTH OF DENALI FAULT AND NORTH OF METEOR PEAK FAULT

es SCHISTOSE GRANITIC ROCK.--Chiefly quartz diorite, granodiorite, and quartz monzonite. Regionally metamorphosed and penetratively deformed. Major minerals are fine- to medium-grained schistose aggregates of hornblende, biotite, plagioclase, potassium feldspar, and quartz with lesser epidote and white mica. Strong schistosity defined by parallel-aligned biotite, white mica, feldspar augen and quartz augen. Strong undulose extinction in feldspar and quartz augen. Local intense granulation of margins of feldspar and quartz augen. Augite and hornblende commonly poikiloblastic with abundant inclusions of feldspar and quartz. Local retrograde metamorphism with plagioclase recrystallized to epidote, potassium feldspar to white mica, and augite, hornblende, and biotite to chlorite. Relict hypautomorphic granular texture, and relict igneous plagioclase with complicated twinning, normal zoning, and oscillatory zoning. Fine- to medium-grained. Locally dikes and stopes schists of Maclaren Glacier metamorphic belt. Locally grades into migmatite. Sparse croscutting dikes of nonfoliated gabbro, diabase, rhyodacite, and rhyolite

esgd SCHISTOSE GRANODIORITE.—Separately mapped plutons of East Susitna batholith.

esqm SCHISTOSE QUARTZ MONZONITE.--Separately mapped plutons of East Susitna batholith.

essh SCHIST AND AMPHIBOLITE (Cretaceous?).--Intensely regionally metamorphosed penetratively deformed gabbro, quartz gabbro, diorite, and quartz diorite recrystallized to garnet-biotite-plagioclase schist and amphibolite. Major minerals are fine- to medium-grained schistose aggregates of augite, hornblende, biotite, plagioclase, and quartz, with lesser garnet, chlorite, epidote, and white mica. Local intense granulation of quartz and feldspar augen. Stronng undulose extinction in quartz and feldspar augen. Local retrograde metamorphism with plagioclase recrystallized to white mica, garnet to chlorite and white mica, and augite to biotite and hornblende. Relatively older and more highly metamorphosed variation of schistose granitic rocks of East Susitna batholith mig MIGMATITE (Cretaceous?).--Grades from schistose granitic rock (es), with fragments of nearly completely assimilated schist and amphibolite, to highly contorted schist and amphibolite with diffuse veins of granodiorite. Swirly schistosity. Major minerals are hornblende, biotite, plagioclase, quartz, clinozoisite, white mica, with lesser garnet, potassium feldspar, and chlorite. Transitional rock between migmatitic schist (mgsh) and schistose granitic rock (es). Contains abundant diffuse small to large veins of granitic rock. Veins of granitic rock grade laterally into schistose granitic rock of East Susitna batholith (es). Contains local pods and veins of rose quartz

mgsh MIGMATITIC SCHIST (Cretaceous?).--Grades from schist and amphibolite (essh), with diffuse veins of granitic rock concordant to schistosity, to contorted and partly assimilated schist and amphibolite. Grades laterally into migmatite (mig). Attitude of schistosity generally constant over large outcrops. Major minerals are hornblende, biotite, plagioclase, quartz, clinozoisite, white mica, with lesser garnet, potassium feldspar, and chlorite. Contains fewer veins of granitic rock than migmatite (mig). Diffuse veins of granitic rock consist of hypautomorphic granular to schistose aggregates of biotite, plagioclase, quartz, and potassium feldspar that are fine- to medium-grained

sqa SCHIST, QUARTZITE, AND AMPHIBOLITE (Triassic(?)).--Chiefly calc-silicate schist, amphibolite, and quartzite. Fine-grained, strongly schistose. Major minerals in calc-silicate schist and amphibolite are schistose aggregates of plagioclase, hornblende, augite, calcite, garnet, biotite, and epidote. Calc-silicate schist and amphibolite probably derived mainly from marl. Occur mainly in western part of geologic map. Similar rocks on strike in Healy quadrangle to west contain Pennsylvanian to Triassic conodonts (Sherwood and Craddock, 1979), and fragments of Halobia of Late Triassic age (Jones and others, 1981). Correlated with Nenana terrane of Jones and others (1981). Intruded by schistose granitic rocks of East Susitna batholith. Thickness variable

MACLAREN GLACIER METAMORPHIC BELT

SOUTH OF METEOR PEAK FAULT AND NORTH OF BROXSON GULCH THRUST

msh SCHIST AND AMPHIBOLITE (Cretaceous or pre-Cretaceous).--Includes garnet amphibolite, biotite-garnet schist, hornblende-clinozoisite schist, biotite-white mica-garnet schist, calcite schist, and white mica-quartz schist. Average grain size about 0.1 to 0.3 mm. Common metamorphic minerals are hornblende, garnet, biotite, white mica, plagioclase, and sparse epidote and calcite. Locally abundant poikiloblastic plagioclase with cores containing relict phyllite and(or) argillite and graywacke defined by schistose aggregates of graphite, white mica, and clinozoisite. Sparse sillimanite or andalusite, and staurolite observed in rocks of appropriate bulk composition by Stout (1976). Intensely deformed with numerous isoclinal folds and axial plane faults parallel to strong schistosity. Schistosity locally refolded into isoclinal folds, particularly near fault contacts with adjacent units. Unfossiliferous. A maximum age of Late Cretaceous is determined by intrusion of the schist and amphibolite unit (msh) by dikes of the East Susitna batholith. Maximum structural thickness about 6,700 m. Generally faulted against schistose granitic rocks (es) of East Susitna batholith to north and phyllite (mph) to south

mph PHYLLITE (Cretaceous or pre-Cretaceous).--Includes white mica-plagioclase phyllite, sparse quartzose marble and calcite-plagioclase phyllite. Average grain size about 0.05 to 0.1 mm. Common metamorphic minerals are quartz, plagioclase, biotite, white mica, chlorite, actinolite, clinozoisite, calcite, and sparse garnet and graphite. Local abundant relict igneous plagioclase with normal and oscillatory zonation, and complicated twinning. Local relict patches or areas of argillite and metagraywacke (ma). Intensely deformed with numerous isoclinal folds and axial plane faults parallel to strong schistosity. Schistosity locally refolded into isoclinal folds. Maximum structural thickness about 2,400 m. Generally faulted against argillite and graywacke (ma) to south

ma ARGILLITE AND METAGRAYWACKE (Cretaceous or pre-Cretaceous).--Includes white mica-clinozoisite metagraywacke, and quartz-graphite metasiltstone. Average grain size 0.01 to 0.05 mm. Common metamorphic minerals are quartz, plagioclase, white mica, chlorite, actinolite, clinozoisite, calcite, and graphite. About 20 to 40 percent recrystallized. Abundant relict resorbed quartz phenocrysts, and lesser relict igneous plagioclase with normal and oscillatory zonation, and complicated twinning. Strongly schistose. Schistosity locally refolded into isoclinal folds. Intensely faulted and sheared. Relatively older than East Susitna batholith that intrudes schist and amphibolite that is a prograde variation of the argillite and metagraywacke unit. Maximum structural thickness about 2,000 m. Faulted against rocks of Wrangellia or Clearwater terranes to south along Broxson Gulch thrust

CLEARWATER TERRANE

WITHIN BRANCHES OF BROXSON GULCH THRUST

ccs CHLORITE SCHIST (Upper Triassic?).--Chiefly chlorite-quartz-white mica schist derived from quartz siltstone. Major minerals are chorite, quartz, and white mica with lesser potassium feldspar. Fine-grained, average grain size of 0.02 to 0.5 mm

cms MUSCOVITE SCHIST (Upper Triassic?).--Chiefly white mica-quartz schist and quartz-calcite schist with lesser calcite marble and greenstone. Generally fine-grained, average grain size 0.02 to 0.5 mm. Major minerals in schist are white mica, quartz, calcite, potassium feldspar, and chlorite. Schist derived from fine-grained calc-arenite siltstone and quartz siltstone. Marble consists mainly of schistose calcite. Major primary minerals in greenstone are clinopyroxene and plagioclase with secondary chlorite, actinolite, and epidote. Relic ophitic texture in greenstone. Greenstone derived from fine-grained basalt

cm MARBLE (Upper Triassic).--Chiefly calcite marble with sparse quartz grains. Fine- to medium-grained, average grain size 0.02 to 2 mm. Schistose with coarser calcite and quartz augen in a very fine-grained calcite matrix. Contains Late Triassic *Heterastridium* sp. in the Healy quadrangle to the west (Jones and others, 1981)

cgs GREENSTONE (Upper Triassic?).--Chiefly fine-grained metapillow basalt. Schistose with relic ophitic texture. Average grain size 0.5 mm. Major igneous minerals are clinopyroxene and plagioclase with secondary chlorite, actinolite, and epidote. Relic pillows. Sparse calcite-chlorite veins

WRANGELLIA TERRANE

SOUTH OF DENALI FAULT

SANDSTONE, CONGLOMERATE, AND RHYODACITE TO DACITE TUFF, BRECCIA, AND FLOWS (Eocene to Pliocene).--Unconformably overlie Mesozoic rocks of Slana River and Tangle subterrranes. Commonly occur as fault-bounded lenses within branches of Broxson Gulch, McCallum Creek and Slate Creek faults in north-central part of geologic map. In the area between the Gakona Glacier and the West Fork of the Chistochina River, the conglomerate unit corresponds to the lower portion of the Gakona Formation and the sandstone unit corresponds to the upper portion of the Gakona Formation as described by Mendenhall (1905).

Ts Sandstone (Pliocene).--Interbedded light-colored sandstone, conglomerate, gray siltstone, shale, mudstone, and sparse white rhyodacite ash layers and thin coal layers. Lenticular shape to sandstone and conglomerate layers. Locally abundant organic debris including carbonized leaf impressions and tree trunks. Common fragments include granitic, metamorphic, mafic and ultramafic rock fragments. Localy abundant fragments of white quartzite. Local sparse clasts of dark argillite with upper Paleozoic bryozoa and brachiopod argillite derived from Eagle Creek Formation or upper part of Slana Spur Formation. Abundant cross bedding, ripple marks, and pebble imbrication. Probably channel deposits laid down by braided streams on alluvial fans. K-Ar hornblende age of 5.4 m.y. for white rhyodacite ash from small gully about one-half mile south of the Hoodoos in the north-central part of the geologic map (Bond, 1976; Turner and others, 1980). Sequoia plant leaves from beds immediately above and below rhyodacite ash in the Gulkana River area indicate a Pliocene age (J. A. Wolfe, unpub. data, cited in Turner and others, 1980). Similar age plant fossils from McCallum Creek (Bond, 1976). Top and bottom not exposed; minimum thickness of several hundred meters.

Tc Conglomerate (Eocene to Oligocene).--Coarse-grained conglomerate and lesser sandstone with abundant clasts of rhyodacite to dacite tuff and flows, Nikolai Greenstone, argillite, volcanic sandstone, and andesite to dacite flows of Eagle Creek and Slana Spur Formations, quartz diorite, greenschist, gabbro, and ultramafic rock. Local thin beds of coal in sandstone layers. In area west of Delta River, lacks clasts of Maclaren Glacier metamorphic belt that occurs directly north (Stout, 1976). Sparse layers of white rhyodacite tuff in the area of the Hoodoos (Bond, 1976). Local conglomerate rich in ultramafic rock occurs on hill about 6 km west of Broxson Gulch (Moffit, 1912; Stout, 1976). Rapid decrease of grain size to southward in the area of The Hoodoos (Bond, 1976). Overlies rhyodacite to dacite tuff, breccia and flows in the area from The Hoodoos to the West Fork of the Chistochina River. In Slate Creek area, includes "round wash" conglomerate which contains clasts mainly of metagabbro and diabase, chlorite-epidote schist, amphibolite, granodiorite, and quartz. Locally source of placer gold, particularly in Chistochina district and Broxson Gulch area (Mendenhall, 1905; Moffit, 1912; Yeend, 1981). Plant fossils resembling Alnus evidens (Holl.) from the area between Broxson Gulch and the West Fork of Rainy Creek suggest a late Oligocene age (Stout, 1976). In the area between Gulkana Glacier and the West Fork of the Chistochina River, an Eocene age is indicated by several fossil plants including Sequoia sp. (Mendenhall, 1905). Minimum thickness of several hundred meters.

Tv Rhyodacite and dacite tuff, breccia, agglomerate, flows, and dikes and sills (Eocene to Oligocene) (Moffit, 1912; Rose, 1967; Bond, 1976).--Local andesite and quartz latite flows, vitric-lithic-crystal ash-flow tuff, and volcanic sandstone. K-Ar age of 49 m.y. (Eocene to Oligocene) for sample from about one mile southeast of The Hoodoos (D. L. Turner, oral commun., 1973, cited in Bond, 1976). Maximum exposed thickness about 500 m

Ti RHYODACITE AND DACITE DIKES AND SILLS (Eocene to Oligocene).--Intrude rhyodacite and dacite tuff, breccia, and associated rocks. Only mapped separately in areas of thick individual dikes or thick dike swarms. Fine-grained. Hypautomorphic granular to locally porphyritic. Occur chiefly between the area of the Hoodoos and the West Fork of the Chistochina River

J₸m McCARTHY FORMATION (Lower Jurassic and Upper Triassic).--Consists of rhythmically thin- to medium-bedded calcareous argillite and impure limestone, mainly spiculitic, skeletal, or intraclastic lime packstone (Silberling and others, 1981). Less than 100 m exposed. Abundant pelecypods of the genus Monotis indicate a Norian (Late Triassic) age (N. J. Silberling, oral commun., 1979). Occurs as a small fault-bounded block of highly deformed rock within branches of the Broxson Gulch thrust near the western edge of the geologic map. Maximum thickness approximately a few hundred meters. Nearest occurrence of similar rocks is in type area in McCarthy quadrangle (MacKevett, 1978).

INTRUSIVE GABBRO AND CUMULATE MAFIC AND ULTRAMAFIC ROCK (Upper Triassic?).--Small irregular bodies, dikes, and sills of dark-gray medium- to coarse-grained gabbro throughout Wrangellia terrane. Local abundant fault-bounded lenses of olivine-cumulate and olivine-pyroxene cumulate in Slana River subterrane, particularly in the area between Delta and Maclaren Rivers. Large sills of olivine cumulate, olivine pyroxene cumulate, and pyroxene plagioclase cumulate south of Fish Lake in Tangle subterrane. Intrude Nikolai Greenstone and older rocks in both Slana River and Tangle subterranes. Probably comagmatic with Nikolai Greenstone

₸g Intrusive gabbro.--Small irregular bodies, dikes, and sills of dark-gray medium- to coarse-grained gabbro and diabase. Sills numerous in the lower limestone member of the Eagle Creek Formation in the eastern part of the geologic map. Fine- to medium-grained. Hypautomorphic granular to ophitic. Major minerals consist of clinopyroxene, plagioclase, and magnetite, with very sparse olivine. Locally intensely metamorphosed and schistose. Clinopyroxene recrystallized to chlorite and actinolite, plagioclase to white mica and epidote. Only larger bodies shown on the geologic map

TRoc Olivine cumulate.--Fine- to medium-grained aggregates of euhedral to subhedral olivine and sparse chromite in a matrix of overgrown olivine, clnopyroxene or plagioclase. Generally intensely serpentinized with olivine replaced by serpentinite and magnetite, and matrix replaced by chlorite and(or) sericite. Relict cumulate texture in intensely serpentinized samples

TRopc Olivine-pyroxene cumulate.--Fine- to medium-grained aggregates of euhedral to subhedral olivine, clinopyroxene and sparse chromite in a matrix of overgrown olivine, and clinopyroxene. Local plagioclase matrix. Locally intensely altered with olivine recrystallized to serpentinite and magnetite, clinopyroxene to actinolite and chlorite, and plagioclase to very fine-grained epidote and white mica

TRppc Pyroxene-plagioclase cumulate.--Fine- to medium-grained aggregates of euhedral to subhedral clinopyroxene, plagioclase, and sparse chromite in a matrix of overgrown clinopyroxene or plagioclase. Locally intensely altered with clinopyroxene recrystallized to actinolite and chlorite, and plagioclase to epidote, white mica, and chlorite. Occurs chiefly in Tangle subterrane south of Fish Lake in central part of geologic map

SLANA RIVER SUBTERRANE

SOUTH OF DENALI FAULT AND NORTH OF EUREKA FAULT

Rocks herein assigned to the Slana River subterrane were initially mapped and described by Rose (1965, 1966b, 1967), Bond (1976), Stout (1976), and Richter and others (1977). Unit descriptions revised from Bond (1976) and Richter and others (1977).

KJs MARINE SEDIMENTARY ROCKS (Upper Jurassic to Lower Cretaceous).--Principally deep marine turbidite deposits consisting of graded beds of dark-gray to gray argillite, siltstone, and graywacke that locally alternate with beds of massive graywacke, pebbly graywacke, pebble to cobble conglomerate, and argillite. Graded beds are well developed locally and consist of rhythmically alternating units that range from 1 cm to more than 30 cm in thickness. Massive graywacke and conglomerate beds are as much as 20 m thick. Locally the rocks are isoclinally folded and exhibit a strong slaty cleavage. Occur in eastern part of geologic map. Nonfossiliferous, but similar strata in the Nabesna quadrangle contain locally abundant Buchia assemblages ranging in age from Late Jurassic to Early Cretaceous (Richter, 1976). A portion of the Gravina-Nutzotin terrane as defined by Berg and others (1972), and Berg and others (1978). Thickness probably greater than 1,000 m; top not exposed

TRl LIMESTONE (Upper(?) Triassic).--Gray to dark-gray, fine-grained, medium- to massive-bedded (10 cm to 2 m) limestone with lenses and nodules of gray and black chert and irregular patchworks of disseminated fine-grained quartz. Weathers light gray. Chiefly micrite, dismicrite, or microsparite, locally recrystallized and commonly brecciated and veined by coarsely crystalline calcite. Base of unit generally contains clasts of Nikolai Greenstone. Typically unfossiliferous but contains sparse brachiopods, pelecypods, gastropods, corals, and spongiomorphs of Late(?) Triassic age (Richter and others, 1977). Thickness 20 to 150 m

TRn NIKOLAI GREENSTONE (Upper and Middle Triassic) (Rohn, 1900).--Dark-gray-green, dark-gray-brown, reddish-brown, and maroon-gray subaerial amygdaloidal basalt flows separated locally by thin beds of reddish-brown nonmarine volcaniclastic rocks. Base generally marked by discontinuous conglomerate-breccia containing fragments of basalt and underlying sedimentary rocks. Predominantly intermixed aa and pahoehoe flows with individual flow units ranging from a few centimeters to more than 15 m thick. Fine-grained groundmass with medium- to coarse-grained phenocrysts. Common ophitic texture, locally grading to hypautomorphic granular, porphyritic, or glomeroporphyritic. Major minerals are clinopyroxene, plagioclase, and magnetite with very sparse olivine. Generally metamorphosed and locally schistose. Clinopyroxene recrystallized to actinolite, epidote, and chlorite; plagioclase to epidote, sericite, and chlorite. Rare metamorphic prehnite and pumpellyite. Local abundant pervasive epidote and chlorite alteration, possibly related to magmatic-hydrothermal activity. Amydgules filled with calcite, chlorite, epidote, quartz, and(or) zeolite, locally in conentric zones. Amydgules locally filled with chalcopyrite, bornite, malachite, and(or) azurite in areas of pervasive epidote-chlorite alteration. Sparse quartz veins with local epidote, chlorite, pyrite, chalcopyrite, bornite, malachite, azurite, or calcite. Thickness about 1,500 m

MANKOMEN GROUP (Permian and Pennsylvanian) (Mendenhall, 1905; revised by Richter and Dutro, 1975).--Includes Eagle Creek Formation and underlying Slana Spur Formation. A marine sedimentary rock sequence including an upper formation of nonvolcanogenic argillite and limestone (Eagle Creek Formation) and a lower formation consisting chiefly of volcaniclastic rocks (Slana Spur Formation). The Mankommen Group is equivalent to parts of the Skolai Group in the southern Wrangell Mountains in the McCarthy quadrangle (MacKevett, 1978)

Pe EAGLE CREEK FORMATION (Lower Permian) (Richter and Dutro, 1975).--A conformable sequence of alternating marine argillite and limestone. In eastern part of geologic map, differentiated into two limestone and two argillite members (Richter and others, 1977). In central and western part of geologic map, west of Gulkana Glacier, consists of a lower limestone member composed of calcilutite, calcarenite, and calcirudite, and an upper member of argillite (Bond, 1976). Bioclastic material composed of a heterogeneous mixture of coral, bryozoan, brachiopod, echinoid, crinoid, fusulinid, and algal(?) fragments (Bond, 1976; Richter and Dutro, 1975). Thin- to medium-bedded. Fine- to medium-grained. Local planar cross-bedding in limestone. Limestones deposited in shallow water at or near wave base (Bond, 1976). Abundant brachiopods, corals, cephalopods, and foraminifera indicate an Early Permian age. Grades upward into thin (less than 40 m thick) radiolarian chert, shale, and limestone (Richter and others, 1977) of Permian age (N. J. Silberling, written commun., 1981). Thickness approximately 895 m

Pea Undifferentiated argillite of either upper or lower argillite member

Pel Undifferentiated limestone of either upper or lower limestone member

Peva Upper argillite member.--Chiefly thin-bedded dark-gray argillite with thin lenses and laminae of gray siltstone and minor bioclastic limestone, calcareous siltstone, and pyritic sandstone. Locally contains a thin (0 to 40 m) upper unit of shale, limestone and chert. Thickness about 125 m

Pevl Upper limestone member.--Thin-bedded gray siliceous limestone that locally weathers an ocherous yellow orange and thin argillite interbeds and discontinuous lenses of massive light-gray-weathering limestone as much as 50 m thick. Argillite content increases in lower part of member. Locally metamorphosed to a conspicuous white crystalline marble. Thickness probably ranges between 75 and 150 m

Pela Lower argillite member.--Chiefly thin-bedded dark-gray shaly argillite and gray-green locally calcareous siltstones with subordinate dark-gray dirty bioclastic limestone (bryozoan biostromes) and thin-bedded gray limestone. Gray limestone increases in abundance in upper part of member, forming a ribboned unit that grades into limestone-argillite beds of upper limestone member. Member locally cut by a number of irregular intrusive masses, dikes, and sills of equigranular gabbro and porphyritic diorite. Thickness of member about 400 m

Pell Lower limestone member.--Massive and thin-bedded gray limestone, locally contains nodules and lenses of black and light-gray chert, with subordinate beds of dark-gray calcareous volcanic grit, sandstone, and siltstone, and clastic limestone. Clastic beds generally graded and locally cross bedded. Gabbro sills, some as much as 25 m thick, relatively numerous. Thickness about 275 m

Pda SHALLOW-LEVEL DACITE STOCKS, DIKES, AND SILLS (Permian(?)).--Small to moderate size bodies, stocks, dikes and sills of fine- to medium- grained dacite with lesser rhyodacite, andesite, and diabase. Restricted to Slana Spur Formation and older rocks. Commonly fine-grained; locally medium-grained with abundant plagioclase phenocrysts. Primary igneous minerals are plagioclase and sparse hornblende, biotite, potassium feldspar, and quartz. Local resorbed quartz microphenocrysts. Intensely hydrothermally altered to very fine-grained aggregates of sericite, chlorite, epidote, actinolite, albite, potassium feldspar montmorillinite, kaolinite(?), and calcite. Commonly iron-stained from weathering of accessory iron-sulphide minerals. Locally contain disseminated sulfide minerals and sparse lenses of massive sulfide minerals. Major disseminated or massive sulfide minerals are pyrite, chalcopyrite, and sphalerite. Only larger bodies shown on geologic map

PIPs SLANA SPUR FORMATION (Middle Pennsylvanian to lower Permian) (Richter and Dutro, 1975).--A thick sequence of marine calcareous and noncalcareous volcaniclastic rocks with subordinate limestone, sandstone, conglomerate, tuff, and volcanic breccia. Brachiopods, corals, and foraminifers, locally abundant, indicate a Pennsylvanian and Permian age. Probably equivalent to upper part of the Skolai Group in the southern Wrangell Mountains (MacKevett, 1978). Thickness 700 to 1,400 m

PIPsu Upper calcareous volcaniclastic member.--Predominantly gray-green coarse clastic volcanic-rich limestone and gray-green coarse-grained calcareous volcanic sandstone, with minor volcanic conglomerate, massive bioclastic limestone, and light-gray-green lapilli tuff. Fine- to coarse-grained. Sedimentary rocks generally have angular to subangular clasts, show abundant graded bedding, abundant contorted stratification and slump structures, and poor sorting. Volcaniclastic, rocks contain abundant andesitic, dacitic and pumice rock fragments, with pyroclastic, pilotaxitic, trachytic, scoriaceous, and relict glassy textures (Bond, 1973, 1976). Major igneous minerals in volcaniclastic rocks are plagioclase, potassium feldspar, amphibole, and sparse quartz. Volcaniclastic rocks locally intensely hydrothermally altered to fine-grained aggregates of epidote, chlorite, actinolite, albite, potassium-feldspar, calcite, and sericite. Authigenic analcite replaces and cements clasts in some calcareous sandstone strata. Presence of graded bedding, poor sorting, and slump structures indicates sedimentary and volcaniclastic rocks deposited from turbidity currents in a low-energy environment below wave base located near active volcanic vents (Bond, 1973, 1976). Thickness 350 to 450 m

PPsl Lower volcaniclastic member.--Dark-gray, dark-green, and maroon volcaniclastic and volcanic rocks with interbedded lapilli tuff, volcanic breccia, argillite, and limestone. The volcaniclastic rocks range from massive volcanic conglomerate and volcanic sandstone to thin-bedded grit, sandstone, and siltstone that commonly exhibit graded bedding. Volcanic rocks consist of mainly andesite to dacite flows, with lesser basalt flows. Limestone lenses (l), as much as 25 m thick, consist of thin- to medium-bedded gray and light-gray locally volcanic-rich limestone. Volcanic flow textures range from hypautomorphic granular to microporphyritic. Major igneous minerals in volcanic and volcaniclastic rocks are plagioclase, amphibole, and biotite, with very sparse quartz and potassium feldspar. Volcaniclastic rocks contain abundant andesite and dactite rocks fragments, and pumice rock fragments, both with pyroclastic, trachytic, scoriaceous, and relict glassy textures. Volcanic and volcaniclastic rocks intensely hydrothermally altered to fine-grained aggregates of chlorite, epidote, actinolite, sericite, calcite, and kaolinite(?). Volcanic rocks locally contain disseminated sulfide minerals and pods of massive sulfide minerals. Major disseminated and massive sulfide minerals are pyrite, chalcopyrite, bornite, and sphalerite. Limestone layers locally recrystallized to skarn adjacent to dikes and sills of dacite and diabase. Local pods of massive sulfide minerals in skarn with abundant pyrite, and lesser chalcopyrite. Presence of graded bedding in volcaniclastic rocks, abundant pyroclastic rocks, and fossil fragments in volcanic breccias indicate volcaniclastic and volcanic rocks deposited on sea floor as blanket deposits around volcanic vents (Bond, 1973, 1976). Thickness 300 to 950 m

PPt TETELNA VOLCANICS (Pennsylvanian) (Mendenhall, 1905).--Chiefly dark-green, dark gray-green, and purplish-gray-green volcanic flows, volcanic mud and debris avalanches, and lapilli-pumice tuffs interbedded with fine- to coarse-grained volcaniclastic rocks. Flows generally massive porphyritic andesites; locally amygdaloidal. Volcaniclastic rocks range from mudstone to conglomerate and are locally graded. Occur in eastern part of geologic map. Apparently represents vestiges of a late Paleozoic volcanic arc that was built directly upon oceanic crust (Richter and others, 1977). Probably equivalent to the lower part of the Skolai Group in the southern Wrangell Mountains (MacKevett, 1978). Thickness greater than 1,000 m, but base nowhere exposed

TANGLE SUBTERRANE

SOUTH OF EUREKA CREEK FAULT

Rocks herein assigned to the Tangle subterrane were initially mapped by Rose (1966a), Rose and Saunders (1965), Smith (1974), and Stout (1976). The Tangle subterrane includes the Amphitheater Group of Smith (1974) and Stout (1976). Silberling and others (1981) also assign the Amphitheater Group to the Wrangellia terrane.

Ŧnf SUBAERIAL BASALT FLOWS OF NIKOLAI GREENSTONE (Upper Triassic).--Massive amygdaloidal basalt flows similar to Nikolai Greenstone in Slana River subterrane. See above description of same unit in Slana River subterrane. Former Boulder Creek Volcanics and Paxson Mountain Basalt of Stout (1976). Locally contains relict medium-grained clinopyroxene phenocrysts, partly to completely replaced by igneous hornblende, and metamorphic actinolite, in southern part of area east of Upper Tangle Lakes. Similar rocks from the Denali mine in eastern part of Healy quadrangle contain sparse lenses of black limestone with fragmentary impressions of <u>Halobia superba</u> of late Karnian (Late Triassic) age (N. J. Silberling, written commun., 1980). Thickness greater than 4,350 m; top not exposed

Ŧnfs SHALE, CHERT, AND SILTSTONE.--Small thin layers of dark gray shale, chert and siltstone within subaerial basalt flows of Nikolai Greenstone. Occur chiefly in central part of map area southeast of Summit Lake. Maximum thickness of a few tens of meters.

Ŧnp PILLOW BASALT FLOWS OF NIKOLAI GREENSTONE (Upper Triassic).--Interlayered pillow basalt flows, and minor basalt flow breccia, basaltic tuff, and argillite. Petrology of pillow basalt similar to subaerial basalt flows of Nikolai Greenstone. Formerly pillowed andesite flows at top of Tangle Lakes Formation of Stout (1976). Basalt flow breccia and basaltic tuff consist of fine- to coarse basalt fragments and fine-grained plagioclase and clinopyroxene crystals that are partly altered to very fine-grained epidote, chlorite, and actinolite. Argillite consists of very fine-grained schistose aggregates of plagioclase, calcite, graphite and sparse chlorite and sericite. Sparse lenses of argillite from small hill one mile east of VABM TANGLE, east of Tangle Lakes, contain fragmentary impressions of pelecypod tentatively identified as <u>Monotis subcircularis</u> by Stout (1976) but recollected and reidentified as <u>Daonella</u> or <u>Halobia</u> of Middle or Late Triassic age by N. J. Silberling (oral commun., 1979) Thickness about 1,020 m

Pzt AQUAGENE TUFF, ARGILLITE, LIMESTONE, CHERT, ANDESITE TUFF, AND GREENSTONE (Upper Paleozoic).--Interlayered basaltic aquagene tuff, dark-gray siliceous argillite, light-gray to white calcite limestone and marble, red and black chert, gray-green andesite tuff, and gray-green basalt. Former middle and lower portion of Tangle Lakes Formation of Stout (1976). Aquagene tuff is a hyaloclasite consisting of fine- to medium-grained fragments of basalt pillow rinds and basalt that are highly altered to very fine-grained aggregates of chlorite, epidote, and actinolite. Argillite is schistose and consists of very fine-grained aggregates of plagioclase, chlorite, graphite, and sericite. Limestone and marble consists of granoblastic to schistose aggregates of medium-grained calcite and sparse dolomite. Chert consists of granoblastic aggregates of very fine-grained quartz with sparse sericite and chlorite, and with very sparse highly recrystallized radiolaria. Andesite tuff consists of fine-grained granoblastic aggregates of plagioclase, chlorite, sericite, epidote, and actinolite with sparse relict broken crystal outlines of plagioclase. Greenstone is amygdaloidal and consists of fine-grained ophitic plagioclase and clinopyroxene that are partly recrystallized to granoblastic epidote, chlorite, actinolite, and sericite. Generally thick-bedded to massive. Unit is best exposed on east side of Maclaren River in canyons in foothills to north of East Fork of Eureka Creek, and on north side of Amphitheater Mountains, in narrow canyons cutting foothills to northwest of Wildhorse Creek. Unit contains extensive dikes of gabbro and large sills of diabase and gabbro grading downward into cumulate mafic and ultramafic rock. Sparse limestone lenses about 3.2 km east southeast of VABM Tangle contain fragments of upper Paleozoic bryozoa (N. J. Silberling, oral commun., 1979). Thickness greater than 875 m; base not exposed

Pzl Limestone

Pzb Metabasalt (greenstone)

TERRANE OF ULTRAMAFIC AND ASSOCIATED ROCK (Mesozoic?)

Unit descriptions revised from Richter and others (1977).

Mzq TONALITE AND QUARTZ MONZONITE.--Mottled light-gray to light-greenish-gray tonalite and quartz monzonite including high-soda and high-alumina variants of these types. Fine to medium-grained with a porphyritic to porphyroblastic texture. The mineral assemblage is partly metamorphic. Sodic plagioclase, occurring as large phenocrysts or porphroblasts, and commonly altered to white mica and clinozoisite, is the dominant constituent. Interstitial minerals are quartz, occurring as fine-grained clots, and minor pyroxene and amphibole, generally altered to chlorite. Form small elongate plutons intruding the amphibole-rich metamorphic rock of the terrane

ums SERPENTINITE.--Intensely deformed schistose serpentinite and talc schist derived from dunite, pyroxenite, and periodotite. Occurs as isolated, fault-bounded lenses and masses within or adjacent to major fault zones

ump PYROXENITE AND PERIDOTITE.--Forms crudely layered elongate bodies within amphibole-rich metamorphic rock (Mza). Pyroxenite occurs as discreet masses and as thin layers in peridotite. Peridotite, with minor dunite, is largely altered to serpentinite. Local masses of light-grayish-green to dark-greenish-gray gabbro forms a discontinuous outer zone to map unit. Remnant olivine in the peridotite ranges between Fo80-85. Local gabbroo dikes

umd DUNITE.--Forms two elongate masses separated from the pyroxenite-peridotite body by amphibole-rich metamorphic rock (Mza). Light-gray to greenish-gray, massive, and generally fine-grained (1-2 mm). Local cataclastic fabric with large olivine grains (†10 mm) surrounded by finer grained olivine. Local planar shattering of olivine grains. Commonly spotted unevenly with grains and crude crystals of chromite, locally arranged in short layers. Cracks throughout body generally filled with serpentine, talc, and iddingsite. Local gabbro dikes

Mza AMPHIBOLITE AND HORNBLENDE-PLAGIOCLASE GNEISS.--Chiefly fine- to medium-grained metamorphic rock with granoblastic textures ranging from massive dark-green amphibolite to finely banded gneissic rock. Banding thickness and amphibole-feldspar ratio extremely variable. Rare thin lenses of light-green and gray epidote-bearing marble and zones of dark-gray graphitic schist interlayered with gneiss. Local abundant amphibole-rich pegmatite. Metamorphic minerals include: green hornblende, calcic plagioclase, quartz, minor clinopyroxene, sulphides, and black oxides. FFeldspar generally altered to epidote-clinozoisite, carbonate occurs throughout the rock in granular masses and veinlets. Forms host of ultramafic rock and are intruded by tonalite and quartz monzonite bodies (Mzq)

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