DESCRIPTION OF MAP UNITS

[See pamphlet for references cited]

NON-GLACIAL DEPOSITS

Ql **Landslide deposits (Holocene)**—Diamictons composed of angular clasts of bedrock and surficial deposits derived from upslope. Arrows denote downslope direction of movement. Unit includes both transported material and unstable scarp area if present

Qbi **Incipient blockslides (Holocene)**—Large unrotated masses of bedrock crevassed or otherwise deformed as a result of slight movement toward nearby free face. Recognized primarily from air photos. Arrow shows direction of movement

Qmw **Mass-wastage deposits (Holocene and Pleistocene)**—Colluvium, soil, or landslide debris with indistinct morphology, mapped where sufficiently continuous and thick to obscure underlying material. Unit is gradational with units Qf and Ql

Qt **Talus deposits (Holocene)**—Non-sorted angular boulder gravel to boulder diamicton. At lower elevations gradational with unit Qf. At higher elevations includes small rock-avalanche deposits, as well as some Holocene moraines, rock glaciers, and protalus rampart deposits that lack characteristic morphology. Surfaces generally unvegetated

Qf **Alluvial-fan deposits (Holocene)**—Poorly sorted cobble to boulder gravel, deposited either as a discrete lobe at the intersection of a steep stream with a valley floor of lower gradient or as a broad apron on steep sideslopes

Qb **Bog deposits (Holocene)**—Peat and alluvium. Poorly drained and intermittently wet. Grades into unit Qyal

Qyal **Younger alluvium (Holocene)**—Moderately sorted deposits of cobble gravel to pebbly sand along rivers and streams. Generally unvegetated surfaces; gradational with units Qf and Qb

Qoal **Older alluvium (Holocene and Pleistocene)**—Deposits similar to unit Qyal, but standing above modern floodplain level and generally separated from it by a distinct topographic scarp. Age of deposits presumed younger than that of unit Qvr, but relations are ambiguous in some localities

Qa **Alluvium and mass-wastage deposits, undivided (Holocene and Pleistocene)**—Undivided deposits composed of units Qf, Qyal, Qmw, Qvt, and Qvr, intermixed on the sides and floors of upland stream valleys. Similar to unit Qag in heterogeneity but occurring where deposits of alpine glaciers have been later obscured or are absent

GLACIAL DEPOSITS

Qag **Alpine glacial deposits (Holocene and Pleistocene)**—Deposits ranging from boulder till in uplands and upvalley to gravel or sand outwash on broad valley floors. On valley sides and uplands, includes areas veneered with

drift, but also includes bedrock, alluvial fans, colluvium, or talus deposits. On valley floors, also includes small fans, bogs, and modern stream alluvium. Areas of thin, sparse drift not distinguished from bedrock. Includes indistinct moraines near outlets of Heather Lake and Lake Twentytwo [28]. (Numbers in brackets refer to figure 3, locations of obscure places). Miller (1969) has described neoglacial moraines below South Cascade and Le Conte Glaciers

Deposits of the Fraser glaciation of Armstrong and others (1965)

Vashon Drift (Pleistocene)—Divided into:

Qvr **Recessional outwash deposits**—Stratified sand and gravel, moderately sorted to well-sorted, and well-bedded silty sand to silty clay. This deposit formed predominantly in outwash plain and valley train environments in lowland areas. Locally includes:

Qvrs **Stillaguamish Sand Member**

Qvi **Ice-contact deposits**—Similar in texture to unit Qvr, but containing collapse features, abrupt grain-size changes, or till lenses that indicate deposition near stagnant or active ice

Qvt **Till**—Mainly compact diamicton with subangular to rounded clasts, glacially transported and deposited. In ice-marginal areas or where covered by a thin layer of recessional outwash, contact with units Qvi or Qvr is gradational. Mapped areas also include deposits of units Qf, Qmw, and Qyal that are poorly exposed or too small to show at this map scale

Qva **Advance outwash deposits**—Well-bedded gravelly sand, fine-grained sand, and bedded silt, generally firm and unoxidized; deposited by proglacial streams and in proglacial lakes

EARLY GLACIAL AND NON-GLACIAL DEPOSITS

Qtb **Transitional beds (Pleistocene)**—Laminated clayey silt to clay that either pre-date or were formed during the early part of the Vashon stade; rare dropstones present

Qpf **Non-glacial and glacial sedimentary deposits of pre-Fraser glaciation-age (Pleistocene)**—Moderately to deeply weathered, moderately sorted sand and gravel. Weathering rinds 1-3 mm thick on fine-grained volcanic clasts. Exposed only in the western part of quadrangle along north and south boundaries

ROCKS AND DEPOSITS OF THE CASCADE MAGMATIC ARC

Rocks of Glacier Peak volcano and associated volcanic rocks and deposits (Holocene and Pleistocene)—Divided into:

Qglh **Laharic deposits (Holocene and Pleistocene)**—Boulder diamicton to well-sorted sand and gravel with characteristic clasts of pumice and volcanic rocks from Glacier Peak; found along Suiattle, White Chuck, Sauk, and North Fork of the Stillaguamish Rivers. Includes deposits of unit Qyal where alluvium is too narrow to easily distinguish at this map scale

Qgp **Pumice deposits (Holocene)**—Mostly unconsolidated dacitic ash and pumice clast deposits as thick as 3 m

Qgwf **Deposits of the White Chuck fill (Holocene and Pleistocene)**—Well-bedded assemblage of lahars, pyroclastic flow deposits, alluvium, and reworked ash and silt. Parts of unit grade into unit Qglh downvalley. May also include some younger deposits. Includes

Qgwt An indurated, cliff-forming dacitic vitric tuff crops out in upper part of the White Chuck fill. The tuff is depicted on the map as forming a cap on the fill, but in reality, the tuff is overlain by at least one lahar (Beget, 1981, p. 59)

Qgsf **Deposits of the Suiattle fill (Holocene)**—Well-bedded assemblage of lahars, pyroclastic flows, air-fall ash, alluvium, and rare lava flows. Deposit grades downvalley into unit Qglh

Qgd **Dacite (Holocene and (or) Pleistocene)**—Mostly clinopyroxene-hypersthene dacite. Forms flows and volcanic rubble on Glacier Peak volcano.

Qgdp **Dacite of Disappointment Peak (Holocene and (or) Pleistocene)**—Oxyhornblende-hypersthene dacite forming massive, partly eroded dome

Qcc **Cinder cones (Holocene)**—White Chuck Cinder Cone [68] consisting of basalt lapilli and minor bombs with a few interbedded olivine basalt flows. Cinder cone remnant [71] just north of Indian Pass (just south of Sauk River quadrangle) is mostly composed of well-stratified tuff and breccia

Qaf **Andesite flow (Holocene and (or) Pleistocene)**—Eroded remnant of columnar-jointed olivine andesite flow at mouth of Lightning Creek [70]

Volcanic rocks of Gamma Ridge (Pliocene)—Divided into:

Tgrv **Volcanic rocks**—Altered tuff, volcanic breccia, volcanic sandstone, welded tuff, and minor flows of basalt. Variegated red, brown, green, and white; bedding obscure; altered to carbonate minerals, sericite, clays, and chlorite; siliceous kaolinite common near Gamma Peak; glassy rocks commonly spherulitic; common veins of zeolites, carbonate minerals, and quartz. Before alteration, composition ranged from rhyolite to basalt

Tgrc **Conglomerate**—White to dirty-gray tuffaceous conglomerate. Poorly bedded, composed of cobbles of granitoid rocks, quartzite, schist, and light-colored holocrystalline volcanic rocks in a fine-grained matrix of volcanic subquartzose sandstone that is much altered to greenish-yellow chlorite(?). Locally composed entirely of andesite cobbles

Tgrf **Altered andesite and dacite flows**—Red to black andesite and dacite, plagioclase-phyric, trachytic; much altered to calcite, chlorite, and zeolites

Intrusive rocks of the Cascade Pass family

Cool Glacier stock (Pliocene)—Divided into:

Tcgg **Granodiorite**—Pyroxene-biotite-hornblende granodiorite and quartz monzodiorite. Medium grained, hypidiomorphic granular

Tcgb **Breccia**—Clasts derived from Tenpeak pluton in a hydrothermally altered matrix of highly comminuted tonalite and altered volcanic material and some glass

Tdp **Dacite plugs and dikes (Pliocene)**—Gray, porphyritic biotite-hornblende-hypersthene dacite with locally resorbed quartz phenocrysts. Locally well-developed columnar jointing. Includes dacite breccia northwest of Glacier Peak. Locally includes andesite

Mount Buckindy pluton (Miocene)—Divided into:

Tmbt **Tonalite and granodiorite**—Mostly porphyritic biotite-hornblende tonalite to hornblende tonalite porphyry. Rocks are quartz-phyric with hypidiomorphic granular groundmass, but heterogeneous in grain size and texture.

Tmbb **Breccia**—Clasts of tonalite in a vuggy quartz and iron oxide (magnetite?) matrix

Cascade Pass dike (Miocene)—Divided into:

Tdt **Tonalite**—Medium-grained hornblende-biotite tonalite, hypidiomorphic granular with small glomeroporphyrocrysts of mafic minerals. Massive and coarsely jointed, with local areas of disseminated sulfide minerals. The dike has fine-grained, porphyritic, chilled margins; contact lit-par-lit complexes are common, and alteration is pervasive locally

Tdbx **Breccia**—Rotated fragments of altered hornblende schist with minor quartz and calcite or aplitic matrix grading downward into swarms of schist inclusions in a miarolitic tonalite matrix

Cloudy Pass batholith and associated rocks (Miocene)—Divided into:

Tcpl **Light-colored granite and granodiorite**—Hornblende-biotite granite and granodiorite, white to pink, medium-grained subhedral plagioclase in a finer grained matrix of xenomorphic granular to granophyric quartz and orthoclase; color index (CI)=5-15, massive, jointed, inclusions rare. Sharp contact with country rocks on west, grades into unit Tcpd on east

Tcpd **Dark-colored granodiorite, tonalite, gabbro, and quartz gabbro**—Light- to dark-gray, medium-grained hornblende-biotite granodiorite, gabbro, tonalite, and quartz gabbro, hypidiomorphic granular. CI=10-30. Massive, well-jointed, inclusions rare; locally altered and cataclastic, grades into unit Tcpl and in smaller bodies commonly contains pyroxene and locally abundant mafic inclusions. Varied in texture and composition, locally porphyritic. South of Lake Byrne [67] forms a complex of dikes, sills, and irregular small masses. At South Cascade Glacier, quartz with necklace inclusions suggests early-formed quartz phenocrysts

Tcpu **Granodiorite, tonalite, and gabbro, undivided**

Tcpb **Intrusive breccia**—Chips and large blocks of schist, gneiss, and aphanite in a matrix of dacite which is commonly highly cataclastic; dark aphanite fragments and dacitic matrix commonly trachytic; locally recrystallized by thermal metamorphism

Tcpc **Clustered light-colored dikes and irregular intrusive bodies**—White, variably fine grained to coarse grained xenomorphic or hypidiomorphic granular tonalite to granite alaskite in densely clustered dikes, sills, and irregular bodies, generally making up 80 percent or more of bedrock. Locally weakly to strongly foliated. Contacts of individual bodies are sharp. Contact of mapped concentration is gradational. Rocks rich in K-feldspar appear to be related to the batholith, but many light-colored rocks may be older associates of the metamorphic country rock

Tdm **Downey Mountain stock (Miocene)**—Hornblende-biotite tonalite, locally granodiorite. Similar to unit Tcpd

Intrusive rocks of the Snoqualmie family

Grotto batholith (Oligocene)—Divided into:

Tgm **Monte Cristo stock**—Hornblende-biotite granodiorite and tonalite. Locally contains augite and hypersthene. Commonly somewhat altered to chlorite, epidote, and sphene

Tgd **Dead Duck pluton**—Hornblende-biotite tonalite and granodiorite, with minor augite and hypersthene

Intrusive rocks of the Index family

Squire Creek stock and related intrusive rocks (Oligocene)—Divided into:

Tst **Tonalite**—Predominantly uniform hornblende-biotite tonalite and granodiorite, medium-grained and hypidiomorphic granular. Locally rich in small hornblende diorite inclusions. CI=12-18 as reported in Vance (1957a, p. 241-274). Locally in interior, pluton is fine-grained and with lower CI

Tsbt **Biotite tonalite**—On Vesper Peak mostly medium-grained hypidiomorphic inequigranular; rarely hornblende-biotite tonalite with rare hypersthene. CI=9-28, mostly about 12-20 (Baum, 1968, p. 20)

Tsh **Hornblende quartz diorite**—At Granite Lake [8] the rocks are a porphyritic hornblende-clinopyroxene quartz diorite with euhedral, highly corroded, pale-brown hornblende phenocrysts. Dikes of a similar but more porphyritic rock-type are common in the Mount Higgins area [9]

Tsst **Tonalite of the Shake Creek stock**—Biotite-hornblende tonalite, fine-grained, highly altered

Tsrd **Sauk ring dike (Oligocene and (or) middle Eocene)**—Gray dacite and andesite porphyry with abundant plagioclase and rare quartz phenocrysts; highly altered to epidote, chlorite, sericite, albite, and carbonate minerals. At northwest base of Sheep Mountain, rocks are a mixture of holocrystalline hornblende tonalite, dacite, and porphyry, as well as gradational types in between

Trl **Breccia of Round Lake (Miocene)**—Predominantly andesite to dacite breccia forming massive cliffs, locally weakly bedded. Rocks are plagioclase phyric, but phenocrysts are highly altered and mafic minerals are replaced by chlorite. Includes some probable hypabyssal holocrystalline pyroxene andesite porphyry

Tus **Unnamed sandstone (Oligocene)**—Moderately weathered to deeply weathered, sandy pebble conglomerate to very fine grained sandstone. Coarse beds contain a high percentage of quartzose pebbles; finer beds contain considerable mica and lignite. Deeply weathered exposures usually can be distinguished from old glacial outwash by manganese staining on joint planes, quartzose or pebble-rich lithology, and presence of organic matter

Barlow Pass Volcanics of Vance (1957a, b) (late and middle Eocene)—Divided into:

Tbv **Volcanic rocks**—Basaltic andesite, basalt and, rhyolite in flows, breccia, and tuff interbedded with tuffaceous to feldspathic sandstone, conglomerate, and minor argillite. Basalt in the upper part of the section forms dark brown columnar flows. Basaltic andesite occurring lower in section is generally dark-green to gray, aphyric, massive, and dense. Rhyolite occurs as thick flows, typically weathering light-green to white with flow laminations; commonly spherulitic. Volcanic rocks are mostly highly altered to a dense mat of chlorite, epidote, calcite, and sericite; porphyritic and trachytoid textures are relict. Bedding in volcanic rocks is obscure except in some water-laid tuffs

Tbg **Gabbro**—Medium-grained, ophitic with plagioclase and clinopyroxene. Intrusive into volcanic rocks (Tbv), but affinity uncertain

Tbb **Basalt—**Clinopyroxene-plagioclase microphyric basalt; in part, amygdaloidal. Cliff-forming columnar flows up to several tens of meters thick

Tbr **Rhyolite flows and rhyolite ash-flow tuff**—Commonly dark colored, green or black, weathering to light green, gray, white, or orange with sparse microphenocrysts of plagioclase and quartz. Commonly laminated and spherulitic, devitrified or highly altered to montmorillonoids

Tbs **Sandstone**—Mostly feldspathic subquartzose sandstone and pebble conglomerate with minor interbeds of argillite and siltstone, rarer tuffaceous sandstone, and tuff. Detrital mica and fossil leaves common. Well-bedded. In the area northwest of Darrington, bentonite interbeds are present (Kinder-Cruver, 1981, p. 29), and many sandstone beds are composed of quartz framework grains totally supported in a matrix rich in montmorillonoids probably derived from volcanic glass. Within 1 to 2 km of the Squire Creek stock and related plutons, sandstone and argillite are hornfelsic. Within the Darrington-Devils Mountain Fault Zone, conglomerate clasts are highly stretched

Tbsv **Sandstone and volcanic rocks**—Sandstone with conspicuous interbeds of basalt and rhyolite

Tgf **Granite Falls stock and associated plutons (middle Eocene)**—Biotite hornblende granodiorite, mostly fine grained hypidiomorphic granular, slightly porphyritic. Locally contains hypersthene and small amounts of elbaite (tourmaline). Commonly highly altered. Country rock strongly thermally metamorphosed

Mount Pilchuck stock (middle Eocene)—Divided into:

Tpg **Granite and granodiorite**—Mostly fine grained, slightly porphyritic, hypidiomorphic granular biotite granite with resorbed quartz phenocrysts. CI=4-8, locally as much as 40 percent K-feldspar, mostly perthite (Wiebe, 1963, p. 21). Wiebe (1963, p. 24-31) describes accessory cordierite and one occurrence of garnet. Zircon and tourmaline (elbaite) are also common accessories. Rock is massive, has chilled margins, and has thermally metamorphosed the country rock

Tpd **Dike swarm**—Concentration of granite and granite porphyry dikes making up as much as 50 percent of unit TKwg rock ground. May include numerous dikes and sills associated with the Bald Mountain pluton

Thl **Rhyolite of Hanson Lake (middle Eocene)**—Dark-colored, glassy to devitrified biotite rhyolite ash-flow tuff. Commonly perlitic, contains sanidine, plagioclase, quartz, and garnet phenocrysts. Poorly exposed near Hanson Lake [30] and to the west where the unit includes quartz- and clinopyroxene-bearing mafic tuff. Northwest of Bosworth Lake [29], mafic tuff and breccia are highly altered to epidote and smectites

Tfs **Feldspathic sandstone and conglomerate (middle Eocene)**—Dark-gray to green, locally red to purple, medium- to coarse-grained feldspathic sandstone, pebble to boulder conglomerate, and minor thin-bedded black argillite. Most coarse clasts are graywacke and greenstone

Tss **Sandstone associated with the Straight Creek Fault (middle and (or) early Eocene)**—Feldspathic sandstone and pebble conglomerate. Mostly highly sheared and locally altered

ROCKS WEST OF THE STRAIGHT CREEK FAULT

Rocks in the Darrington-Devils Mountain Fault Zone (DDMFZ)

Helena-Haystack mélange (middle Eocene to Late Cretaceous)—Divided into:

TKhm **Peridotite and serpentinite matrix**—Metamorphic peridotite and rare metamorphic dunite are orange- and black-weathering resistant rocks occurring mostly as steeply dipping tectonic lenses and sheets in Tertiary sandstone and as isolated blocks in serpentinite. Some relict pyroxene in serpentinite above Swede Heaven [10] suggests original cumulus textures. Serpentinite is generally flaky, gray to green in rare outcrops. On Helena Ridge, serpentinite is lizardite and chrysotile (Vance and Dungan, l977, p. 1498). In the Iron Mountain-Gee Point area [1,2], Brown and others (1982, p. 1089) describe serpentinite composed of antigorite, commonly with well-defined foliation, and relict aluminous chromite, rimmed by Fe-chromite suggesting an alpine peridotite protolith. Symbol (shown on map explanation)indicates outcrop of ultramafic rocks too small to show at this map scale

TKhg **Greenstone, foliated greenstone, and greenschist**—Greenstone including basalt with relict clinopyroxene and plagioclase to well-recrystallized actinolitic greenstone, and greenschist, commonly with pumpellyite, prehnite, stilpnomelane, and locally with aragonite in veins. Cruver (1983, p. 23) reports lawsonite in metagraywacke associated with greenstone of his Haystack Mountain unit on strike to the northwest. Outcrops are commonly

massive, but on Big and Little Deer Peaks, probable bedding is revealed by broad color bands and contrasting joint patterns when viewed from afar. See Cruver (1983) and Reller (1986) for detailed petrography and chemistry. Includes minor schistose dacite metaporphyry, graywacke, and argillite

TKhd **Diabase and gabbro**—Uralitic metadiabase and metagabbro, rarely with relict brown hornblende and saussuritic plagioclase, and very rare relict clinopyroxene. Partially to completely altered to actinolite and pumpellyite with pseudomorphous ophitic or subophitic textures. Commonly cut by mylonitic to cataclastic microshears. Commonly weathers out of serpentinite matrix as steepsided hillocks

TKhs **Sedimentary rocks**—Chert, graywacke, phyllitic argillite, and semischist

TKhf **Foliated metavolcanic rocks**—Silicic metaporphyry and micaceous quartz-feldspar schist, commonly with relict plagioclase phenoclasts. Foliated light-colored greenstone and greenstone. On Helena Ridge, includes considerable foliated greenstone, some with relict pillows. Northwest of Darrington, includes considerable metabasalt with relict plagioclase and clinopyroxene in an altered felty or trachytic matrix

TKha **Amphibolite**—Fine-grained amphibolite with well-crystallized green hornblende and plagioclase, partially altered to chlorite, epidote, and pumpellyite(?)

TKht **Tonalite**—Medium-grained hypidiomorphic hornblende tonalite altered to chlorite, prehnite, epidote, and pumpellyite(?). Rocks are locally gneissic and cataclastic, interlayered with amphibolite (TKha) at north contact of tonalite

Rocks southwest of the Darrington-Devils Mountain Fault Zone

Bald Mountain pluton (age uncertain)—Divided into:

bmg **Granodiorite and granite**—Medium- to coarse-grained hypidiomorphic biotite granodiorite and granite, in part gneissic near margins. Locally with coarse(1-2 cm) crystals of K-feldspar, accessory cordierite, mostly altered to pinite, and rare garnet. Rock is locally cataclastic. Clinopyroxene rimmed with hornblende; intergranular graphic intergrowths of quartz and K-feldspar

bms **Sill complex**—Multiple sills of granodiorite in hornfelsic argillite and graywacke. Sills, ranging from a few meters to hundreds of meters thick, makes up from 10 to 90 percent of this rock unit

Rocks of the western melange belt (middle Eocene to Late Cretaceous)—Divided into:

TKws **Semischist, slate, and phyllite**—Mostly pervasively foliated gray to black lithofeldspathic and volcanolithic subquartzose sandstone and semischist. Locally abundant fine- to medium-cobble conglomerate. Commonly interbedded with argillite or phyllite. Locally well developed rhythmite. Where foliation is less well developed, sedimentary features, including graded beds and load casts, are locally well preserved. Metamorphic minerals, which locally replace matrix and framework grains and also occur in veins, are carbonate minerals, prehnite, pumpellyite, chlorite, and sericite. Unit includes rare greenstone derived from mafic volcanic breccia, tuff, and flows. Also includes locally abundant chert

TKwph **Phyllite**—Gray, brown to black phyllite, less abundant semischist, locally abundant chert and rare greenstone. Includes subordinate thin beds of recrystallized sandstone and semischist and rare stretched-pebble conglomerate. Locally with well-developed pencil structures and rarer crinkle lineation . Metamorphic minerals are sericite, carbonate minerals, chlorite, prehnite, and pumpellyite(?). Metasandstone commonly forms small boudins as long as a few meters

TKwv **Volcanic rocks**—Greenstone and sheared greenstone including diabase and gabbro. Poorly exposed south of the Pilchuck River [31]

TKwm **Marble and limestone**—Mostly coarsely crystalline, dark-gray to white marble in small to moderate-size pods. Mostly massive but locally bedded with bioclastic layers. Star indicates outcrop of carbonate rocks too small to show at this map scale

TKwg **Gabbro and diorite**—Massive to foliated, fine- to medium-grained metagabbro and metadiorite. Outcrops sheared on all scales. In massive rocks, euhedral, mottled, locally crushed plagioclase, integranular to euhedral uralitized clinopyroxene and opaque minerals are common. Metamorphic minerals are albite(?), uralite, chlorite, sphene, and carbonate minerals

TKwu **Ultramafic rocks**—Serpentinized peridotite and dunite. Nearby Tertiary plutons have recrystallized ultramafic rocks to higher grade assemblages, locally with enstatite and talc. Symbol (shown on map explanation)indicates outcrop of ultramafic rocks o small to show at this map scale

TKt **Trafton terrane of Whetten and others (1988) (middle Eocene to Late Cretaceous)**—Predominantly greenstone and banded chert with subordinate graywacke and argillite. Commonly highly sheared and mixed on all scales. Greenstone has relict plagioclase and clinopyroxene, but is now mostly chlorite, carbonate minerals, and brownish pumpellyite(?); some rocks

with veins of green pumpellyite. Chert is red and black, locally highly recrystallized. Minor diabase. Argillite locally phyllitic. Locally includes:

TKtm **Marble and limestone**—Similar to unit TKwm. Locally highly fossiliferous bioclastic limestone such as at the abandoned Morcrop quarry on the north side of Porter Creek [15]. Star indicates outcrop of carbonate rocks too small to show at this map scale

TKtg **Metagranodiorite**—Medium-grained, hypidiomorphic hornblende-biotite metagranodiorite partially recrystallized to albite, chlorite, prehnite, and pumpellyite

Rocks of the eastern melange belt (middle Eocene to Late Cretaceous)—Divided into:

TKev **Mafic metavolcanic rocks with mostly subordinate graywacke and foliated graywacke, argillite and phyllitic argillite, chert, and marble**—Highly sheared and disrupted greenstone makes up from 20 to 50 percent of melange and contains relict clinopyroxene (some titaniferous) and plagioclase in an altered matrix of chlorite, carbonate minerals, and pumpellyite. Rare deformed pillows. Locally prehnite in veins. Volcanic subquartzose sandstone similar to sandstone in unit TKwg. Unit symbol in parenthesis (TKev) on map indicates block or inferred block in Helena-Haystack mélange

TKea **Argillite**—Black, locally foliate argillite with limy concretions. Poorly exposed south of the town of White Horse [12]. Locally cut by deformed and brecciated metadacite dikes

TKew **Volcanic rocks of Whitehorse Mountain**—Plagioclase-phyric pyroxene andesite and basaltic andesite ranging to dacite. Includes minor diabase and gabbro. Most rocks slightly metamorphosed and contain chlorite, pumpellyite, and prehnite. Forms massive cliffs. Amygdaloidal flow tops, breccia, tuff, and thin local sedimentary interbeds

TKec **Chert**—Mostly white-weathering, red or black ribbon chert and metachert making up to 20 to 80 percent of unit. Uniformly banded to complexly disrupted. Some chert as thin laminae in cherty argillite. Locally abundant greenstone, graywacke, and argillite. Vance (1957a, p. 221-222) reports considerable argillite and sandstone and several conglomerate beds on the west side of Three Fingers

TKem **Marble**—Gray to white, locally with chlorite; coarsely crystalline. Danner (1966, p. 326-329) describes the deposits south of White Horse; mostly in small pods. Star indicates outcrop of carbonate rocks too small to show at this map scale

TKegb **Gabbro**—On the South Fork of the Stillaguamish River, unit consists of gabbro, layered gabbro, and interlayered cumulate ultramafic rocks (wehrlite) (Dungan, 1974, p. 46-53). Includes some metatonalite and gneissic amphibolite. The large gabbro body mapped within the Helena-Haystack melange south of Darrington is medium grained and massive but laced with swarms of diabase dikes (Vance and others, 1980, p. 365). Gabbros are generally partially altered to albite, actinolite, epidote, and chlorite. Unit symbol in parenthesis (TKegb) on map indicates block or inferred block in Helena-Haystack mélange

TKet **Zone of tectonized meta-igneous pods**—Disrupted argillite, chert, and greenstone with abundant pods of tectonized metatonalite and metagabbro

TKeu **Ultramafic rocks**—Serpentinite, metaperidotite, and metaclinopyroxenite. Dungan (1974, p. 48-53, 94) describes some ultramafic blocks with primary cumulus textures and others as harzburgite and dunite tectonite. Metamorphic minerals, mostly confined to rocks north of the South Fork of the Stillaguamish River are tremolite, talc, and olivine. Symbol (shown on map explanation)indicates outcrop of ultramafic rocks too small to show at this map scale

Rocks northeast of the Darrington-Devils Mountain Fault Zone

Northwest Cascades System

MzPzg **Gabbroic intrusions (Mesozoic and Paleozoic)**—Mostly metagabbro and metadiabase. Fine- to medium-grained granular or ophitic saussuritized plagioclase in fibrous matrix of green amphibole, chlorite, and epidote

minerals. Grains are crushed, locally microbrecciated. Includes cataclastic tonalite northeast of Rockport

Easton Metamorphic Suite—Divided into:

Kes **Shuksan Greenschist (Early Cretaceous)**—Predominantly fine-grained greenschist, sodic actinolite-bearing greenschist, and (or) blueschist. Locally includes quartzitic greenschist, iron- and manganese-rich quartzite (metachert), greenstone, and graphitic phyllite. Rare relict clinopyroxene in some greenschist. Common also is leucogreenschist, generally with pumpellyite, characterized by a mosaic of albite porphyroblasts that have mineral inclusions aligned in the foliation. Common are epidote clots or balls, generally less than 1mm in diameter, and probably derived from vesicle fillings in the protolith basalt (Misch 1965; Haugerud, 1980, p. 39-44). Schists are commonly conspicuously layered on centimeter scale, and foliation and layering are tightly folded on outcrop scale. Locally interlayered with units Ked and Keds. Unit symbol in parenthesis (Kes) on map indicates block or inferred block in Helena-Haystack mélange

Keg **Garnet amphibolite (Early Cretaceous)**—Garnet amphibolite and muscovite-quartz schist, barroisite schist, hornblende-garnet rocks, and rare eclogite commonly surrounded by greenschist. Most of these rocks are coarser grained than typical Shuksan lithologies. The garnet amphibolite is overprinted by blueschist-facies metamorphism (Brown and others, 1982). Includes minor ultramafic rocks. Unit symbol in parenthesis (Keg) on map indicates block or inferred block in Helena-Haystack mélange

Ked **Darrington Phyllite (Early Cretaceous)**—Predominantly black, highly fissile sericite-graphite-albite-quartz phyllite, typically with abundant quartz veinlets; commonly complexly folded. Most phyllite has a strong crinkle lineation. Some well-foliated metasandstone. Locally interlayered wih unit Kes. Includes:

Keds **Silver-colored phyllite**—Predominantly fine-grained muscovite-rich phyllite or schist, commonly with lawsonite, locally with graphite and garnet. Some rocks with albite porphyroblasts. Dazzling bright in sunlight. Locally interlayered with unit Kes. Unit symbol in parenthesis (Keds) on map indicates block or inferred block in Helena-Haystack mélange

Kem **Mixed greenschist and phyllite (Early Cretaceous)**—Interlayered greenschist and black phyllite on a 1- to 10-m scale. Locally includes:

Kems **Mixed greenschist and silver-colored phyllite**

Keu **Ultramafic rocks (Early Cretaceous)**—Mostly serpentinite. Occurs in unit Keds and near faulted contacts with unit TKhm. Symbol (shown on map explanation)indicates outcrop of ultramafic rocks to small to show at this map scale

Krs **Slate of Rinker Ridge (Early Cretaceous and Late Jurassic)**—Predominantly gray to brown, little-recrystallized slate and phyllite with local foliated sandstone and semischist

KJb **Bell Pass melange (Early Cretaceous and Late Jurassic)**—Metagabbro, metadiorite, metatonalite, silicic gneiss, fine-grained epidote amphibolite gneiss, micaceous quartzite, amphibole schist, and ultramafic rocks. Lesser amounts of phyllitic argillite, cherty phyllite, chert, graywacke, semischist, metavolcanic rocks, and marble. Rocks highly variable, commonly mylonitic and (or) cataclastic. Locally includes:

Yellow Aster Complex of Misch (1966)—Medium- to coarse-grained silicic and feldspathic gneisses and associated weakly deformed plutonic rocks. See text for discussion of age. Divided into:

byan **Non-gneissic rocks**—Mostly metagabbro, metadiabase, and metatonalite with minor gneissic igneous rocks

byag **Gneissic rocks**—Siliceous gneiss, pyroxene gneiss, and associated metagabbro, metadiabase, and metatonalite. Includes areas lacking siliceous gneiss but including meta-igneous rocks with strongly mylonitic quartz bands

bu **Ultramafic rocks**—Commonly serpentinite; occurs along faults in the Prairie Mountain area. Symbol (shown on map explanation)indicates outcrop of ultramafic rocks to small to show at this map scale

bc **Chert**—Ribbon chert in large block north of White Chuck River

bv **Vedder Complex of Armstrong and others (1983)**—Amphibolite, blueschist, micaceous quartzite, and mica-quartz schist. See text for discussion of age. Diamond symbol indicates outcrop of ultramafic rocks to small to show at this map scale

Chilliwack Group of Cairnes (1944) (Permian to Devonian)—Divided into:

PDcs **Sedimentary rocks**—Well-bedded, gray to brown and black argillite and volcanic subquartzose sandstone with minor pebble conglomerate and rare chert. Includes some volcanic rocks locally. Graded beds, scour structures, and load casts locally prominent; some rhythmite. Locally, sandstone beds strongly disrupted in argillite matrix. Rocks grade rapidly from little deformed to phyllitic with a pronounced foliation generally subparallel to bedding

PDcv **Volcanic and metavolcanic rocks**—Mostly greenstone, with subordinate meta-andesite and rare metadacite or metarhyolite. Breccia and tuff predominate. Mafic metavolcanic rocks commonly with relict plagioclase and clinopyroxene in a chlorite-epidote matrix, commonly with carbonate minerals. Plagioclase is mostly recrystallized as albite. Includes some gabbro and diabase

PDcl **Limestone and marble**—Mostly coarsely crystalline, gray to black. Carbonate rocks in small isolated pods and blocks; locally fossiliferous. Star indicates outcrop of carbonate rocks too small to show at this map scale

ROCKS EAST OF THE STRAIGHT CREEK FAULT

Stitching units

Plutons of the tonalitic group

Kbl **Tonalitic gneiss of Bench Lake (Late Cretaceous)**—Mostly light colored, fine grained heterogeneous biotite tonalitic gneiss, locally with hornblende. Subhedral clinozoicite associated with mafic minerals. CI=3-19, mostly about 9-12. Layers and pods of finer grained biotite gneiss, garnet biotite-hornblende schist, and amphibolite locally making up 5-10 percent of rock. Mafic schlieren may be swirled. Cut by light-colored tonalite, pegmatite, and aplite dikes. Contact with unit Kblg is gradational. Includes:

Kblg **Banded tonalitic gneiss**—Strongly layered fine-grained biotite-hornblende gneiss and light-colored biotite tonalite to granodioritic gneiss , As mapped, commonly contains garnet and thin and thick layers and pods of Napeequa Schist (Kns), especially hornblende schist and schistose hornblendite as well as some ultramafic rocks (Knu). Layers pinch and swell. Rocks are cut by many irregular pegmatite and aplite dikes and have a migmatitic aspect. Gneiss layers are crystalloblastic gneissose to granoblastic with heterogeneous grain size. Some biotite gneiss layers have subidioblastic to porphyroblastic plagioclase with faint relict euhedral zoning suggesting an igneous origin

Kng **Nason Ridge Migmatitic Gneiss (Late Cretaceous)**—In south, mostly heterogeneous light-colored tonalite to granodioritic gneiss interlayered with mica schist and amphibolite similar to the Chiwaukum Schist. Predominantly crystalloblastic. Most common lithology is medium-grained biotite gneiss with a slightly porphyroblastic appearance due to anastomosing mica layers surrounding larger plagioclase crystals or aggregate grains. Contacts between gneiss and schist are both sharp and gradational along and across strike. Cross-cutting sills, dikes, and irregular bodies of light-colored fine-grained to pegmatitic tonalite and gneiss are also abundant in migmatitic phases. Most of unit has 50 percent

or more light-colored gneiss. Grades northward into more uniform, mostly medium grained garnet-biotite-quartz-oligoclase (or andesine) gneiss which is difficult to distinguish from Chiwaukum Schist. Rare rounded relict kyanite and sillimanite occur within sericite knots

Ksc **Sloan Creek plutons (Late Cretaceous)**—Biotite-hornblende tonalitic gneiss, flaser gneiss, and local gneissic metatonalite; medium grained, homogeneous, crystalloblastic gneissose to strongly flaseroid; locally strongly mylonitic. CI=0-37, but for most rocks CI=20-30 (Ford and others, 1988, p. 71). Locally contains garnet. Plagioclase normally zoned or unzoned and strongly stress twinned but with relict patchy zoning and faint oscillatory zoning and synneusis twins (Heath, 1971, p. 62). Retrogressive alteration is pronounced but somewhat sporadic; epidote minerals and sericite commonly fill plagioclase cores; mafic minerals are altered to chlorite, sphene, and prehnite. As mapped, includes some interlayered flaser gneiss and Nason Ridge Migmatitic Gneiss (Kng)

Tenpeak pluton (Late Cretaceous)—Divided into:

Ktc **Contact zone**—Dark-colored biotite-hornblende metatonalite and tonalitic gneiss, hornblende diorite, and hornblendite, locally with garnet; layers of garnet-hornblende-biotite schist increase to west. Pods of hornblendite and ultramafic rocks (R. A. Haugerud, written comm. 1993) suggest that much of of the country rock in this zone may be the Napeequa Schist. This description and others of the Tenpeak pluton adapted from Crowder and others (1966)

Ktd **Dark-colored metatonalite and tonalitic gneiss**—Medium-grained biotite-hornblende metadiorite and metatonalite. Xenoblastic to granoblastic with rare broken faintly oscillatory-zoned sodic andesine, commonly in a dark mesh of hornblende and biotite. CI=20-50. Rich in mafic lenses and streaks and hornblendite inclusions. Grades into unit Kti

Ktm **Metatonalite and tonalitic gneiss**—Light-colored medium-grained hornblende-biotite tonalite and tonalitic gneiss. Xenoblastic to hypidiomorphic, commonly with aligned euhedral hornblende prisms, locally as long as 1 cm. CI=15-20, locally as much as 40. Subhedral epidote and pseudomyrmekitic epidote common. Allanite and garnet occur on west margin of unit. Hornblende commonly zoned from brownish green to bluish green on rims. Sodic andesine crystals commonly broken and with faint euhedral oscillatory zoning

Kti **Interlayered rocks**—Light- and dark-colored biotite-hornblende dioritic gneiss, tonalitic gneiss and flaser gneiss, and subordinate hornblende schist

Ktf **Flaser gneiss**—Medium-grained hornblende and (or) biotite tonalite flaser gneiss; texures are xenoblastic, porphyroclastic, and mylonitic. CI=20-40

Chaval pluton (Late Cretaceous)—Divided into:

Kchb **Biotite-hornblende quartz diorite and diorite**—Mostly medium grained biotite-hornblende quartz diorite, locally diorite or tonalite, with clinopyroxene and hypersthene locally and accessory iron-titanium oxide, allanite, zircon, and apatite. Textures are mostly igneous but near the margins become subid-ioblastic with little or no relict igneous texture except for rare euhedral oscillatory-zoned plagioclase. Margins of main pluton are gneissic and minerals are mylonitized and recrystallized. Flaser gneiss common. Metamorphic minerals are epidote, blue-green hornblende (commonly with cores of brown igneous(?) hornblende, biotite, and

garnet). Some euhedrally zoned epidote. Descriptions modified from Boak (1977, p. 32-55)

Kchm **Mafic hornblende metadiorite, metaquartz diorite, and mafic amphibolite**—Heterogeneous, layered rocks with zones of unit Kchb and country rocks. Commonly rich in pegmatite and light-colored tonalite in sharply bounded dikes or irregular bodies with swirled, gradational contacts

Kchs **Sills and dikes**—Sills and dikes composed of mafic metadiorite and metaquartz diorite intrusive into the Chiwaukum Schist. Many layers of amphibolite. Sharply banded, tabular bodies of mafic rocks, similar to unit Kchm

Kgp **Grassy Point stock (Late Cretaceous)**—Light-colored, medium- to coarse-grained biotite metatonalite to rare metagranodiorite with CI=5-50. Mostly uniform granitoid rocks with gneissic margins and rare rhythmic mafic layering. Hypidiomorphic granular with highly strained crystals and strong cataclasis. Rare relict euhedral oscillatory zoned oligoclase-andesine

Kdm **Metadiorite (Late Cretaceous)**—West of Lake Byrne [67] fine- to medium-grained hornblende and biotite-hornblende metadiorite and dioritic gneiss with CI=20-30. Xenoblastic to granoblastic with epidote-filled andesine, epidote, allanite, and garnet. Description adapted from Crowder and others (1966)

Plutons of the granodioritic group

Eldorado Orthogneiss (middle Eocene to Late Cretaceous)—Divided into:

TKeb **Biotite-hornblende quartz monzodioritic gneiss**—Medium-grained subidioblastic to idioblastic sodic plagioclase with matrix of crystalloblastic to cataclastic quartz, K-feldspar, hornblende, biotite, and epidote; accessory sphene, apatite, zircon, and opaque oxides; commonly well aligned prismatic aggregates of hornblende and biotite, but in many rocks mafic minerals are aligned in a streaky planar fabric. Gradational over several hundred meters into unit TKef. Rock is granodiorite chemically, but $\delta^{18}O$ is less than 10 (Ford and others, 1988, p. 26; White and others, 1988, p. 30), a characteristic of the tonalitic group

TKef **Flaser gneiss**—Fine- to medium-grained biotite-hornblende metagranodiorite and meta-quartz monzodiorite flaser gneiss, with mosaic sodic plagioclase patches and rare simple crystals set in a finer grained mylonitic matrix of quartz, plagioclase, and mafic minerals

TKhl **Hidden Lake stock (middle Eocene to Late Cretaceous)**—Biotite metatonalite, based on modes, but rocks are granodiorite based on CIPW norms and d ^{18}O values greater than 10 (Ford and others, 1988, p. 26; White and others, 1988, p. 30). Relict hypidiomorphic granular texture with plagioclase mostly filled with well-crystallized epidote and muscovite; some crushed grain margins have recrystallized, and quartz is sutured. Some K-feldspar is microcline. Rocks are massive and sharply intrusive

Kcl **Cyclone Lake pluton (Late Cretaceous)**—Light-colored, fine- to medium-grained, muscovite-biotite metagranodiorite (meta-alaskite). Subhedral sodic plagioclase with relict euhedral oscillatory zoning in a matrix of quartz and microcline, locally blastomylonitic along foliation planes with sparse muscovite and biotite. Common myrmekite. Minor subhedral clinozoisite with rare allanite cores associated with micas. C.I. = 3-7 (Ford and others, 1988, p. 53). Faintly gneissic in outcrop. Rocks become coarser grained and more gneissic towards north margin of pluton where they grade abruptly into the Jordan Lakes pluton

Kjl **Jordan Lakes pluton (Late Cretaceous)**—Medium-grained hornblende-biotite tonalite and granodiorite. Hypidiomorphic granular with euhedral to subhedral plagioclase with relict euhedral oscillatory zoning and locally filled with clinozoisite and muscovite and in a mesostasis of microcline or perthite. Myrmekite common. CI=5-21, generally 10-17

Kdc **Downey Creek sill complex (Late Cretaceous)**—Mostly light colored muscovite-biotite metagranodiorite and granodioritic gneiss, locally metatonalite. CI=3-6 (Ford and others, 1988, p. 59). Crystalloblastic to porphyroblastic with insets of larger plagioclase in granofelsic, foliated matrix of quartz, oligoclase, K-feldspar including microcline, mica, garnet, epidote, and sphene. Ellipsoidal quartz mosaic aggregates suggest former quartz phenocrysts in some rocks. Some plagioclase with faint relict euhedral oscillatory zoning. Occurs mostly as sills and irregular masses into the Napeequa Schist (Kns) with intrusive contacts and metaporphyry apophyses. Schist inclusions in the pluton range from 10-70 percent. Includes small lenses in Milk Creek, along Canyon Creek, and a large sill in upper Sulphur Creek that have similar petrographic features

Sulphur Mountain pluton (Late Cretaceous)—Divided into:

Ksmm **Metagranodiorite and metatonalit**e—Medium-grained hornblende-biotite metagranodiorite and metatonalite characterized by large clinopyroxene prisms as long as 8 cm and quartz augen as large as 1.4 cm with accessory subhedral clinozoisite. Textures are xenoblastic to hypidiomorphic. Sphene and rare garnet and allanite. Calcic oligoclase commonly has faint euhedral oscillatory zoning but is also highly filled with epidote. CI=5-19, mostly about 10-13

Ksmf **Flaser gneiss**—On east side of pluton, flaser gneiss consists of medium-grained hornblende-biotite tonalite flaser gneiss with layers and inclusions of clinopyroxene-hornblende schist, hornblende gneiss, biotite gneiss, and quartzite. On west side, unit is hornblende-biotite metatonalite and tonalite flaser gneiss with layers of hornblendite and hornblende schist (Crowder and others, 1966)

Kfc **Foam Creek stock (Late Cretaceous)**—Medium-grained biotite metagranodiorite with distinctive decussate biotite books. CI=10-15, rarely 25 (Ford and others, 1988, p. 17). Hypidiomorphic granular with faint relict oscillatory zoned oligoclase-andesine. Commonly retrogressively altered. Margins are highly gneissic

Nason terrane

Chiwaukum Schist (Late Cretaceous)—Divided into:

Kca **Biotite schist and amphibolite**—Mostly fine grained to medium grained, well-laminated graphitic garnet-biotite-quartz-oligoclase (or andesine) schist, locally with cordierite, andalusite, staurolite, or kyanite and rarely with sillimanite. Abundant schistose amphibolite, fine-grained hornblende gneiss, hornblende-biotite schist, and less common calc-silicate schist and marble. Cut by dikes and sills of light-colored biotite tonalite and pegmatite. Grades into unit Kcgg

Kcm **Marble**—Thin to thick layers of coarsely crystalline white to gray marble, commonly with thin schist interbeds and associated calc-silicate schist. Star indicates outcrop of carbonate rocks too small to show at this map scale

Kch **Hornblende schist and amphibolite**—Black to light-green, fine- to medium-grained garnet-hornblende-quartz-plagioclase schist, gneiss, and amphibolite. Lepidoblastic to granofelsic, rarely garbenschiefer, with pods or layers rich in biotite, clinopyroxene, and (or) epidote

Kcgg **Garnet-graphite-mica schist**—Predominantly very fine grained garnet-graphite-biotite-oligoclase (or andesine)-quartz schist with kyanite and (or) staurolite

Kcu **Ultramafic rocks**—Symbol (shown on map explanation)indicates outcrop of ultramafic rocks too small to show at this map scale

Chelan Mountains terrane
Rocks southwest and northeast of the Entiat Fault

Cascade River Schist (Tertiary and Late Cretaceous)—Divided into:

TKcs, Kcs **Mica schist and amphibolite**—Mostly fine grained, highly fissile, green, brown, and black micaceous schist ranging from phyllitic sericite-quartz schist to granoblastic biotite- and muscovite-biotite-quartz-albite (or oligoclase) schist and fine-grained paragneiss. Many rocks have garnet; less commonly staurolite and kyanite. Rare chloritoid. Many rocks have

blue-green tourmaline. Hornblende-biotite-andesine schist, garbenschiefer, and fine-grained amphibolite common. Calcareous mica schist locally. Hornblende is commonly blue-green. Relict clastic textures common in metasandstone; unit includes small-pebble metaconglomerate. Most descriptions abstracted from Tabor (1961, p. 81-115). On Spider Mountain, unit includes phyllitic quartz-rich schist, calcareous mica schist, grading to impure marble, and silicic metaporphyry

TKcc, Kcc **Metaconglomerate and plagioclase-rich mica schist**—Gray to dark-green rocks ranging from boulder conglomerate with weak foliation to highly schistose rocks in which pebble clasts are so highly attenuated that they are only visible on surfaces cut perpendicular to lineation. Identifiable protoliths of clasts are quartzite, volcanic rocks, and granitoid rocks. Unmapped granule conglomerate rich in granitoid and metaquartzite clasts occurs elsewhere in the Cascade River Schist south of the North Fork of the Cascade River [34]

TKcma **Marble**—Coarsely crystalline gray to white marble with many impurities of quartz, plagioclase, and mica. Grades into calcareous mica schist. Symbol (shown on map explanation) indicates outcrop of carbonate rocks too small to show at this map scale

Kcmv **Metavolcanic rocks (Late Cretaceous)**—Fine-grained leucogreenschists, commonly with relict highly flattened phenocrysts of plagioclase or mafic minerals

Marblemount pluton (Tertiary and Late Cretaceous)—Divided into:

TKmd, Kmd **Meta-quartz diorite**—Hornblende meta-quartz diorite, metatonalite, and tonalitic gneiss; minor metadiorite, hornblendite, and schistose hornblendite. Light-colored metatonalite dikes. Most common rock type has CI =16-54 (Ford and others, 1988, p. 96). West of the Entiat Fault and in the South Fork of the Cascade River area, the rocks are medium grained, pale green, containing numerous anastomosing shears rich in chlorite, epidote, and actinolitic hornblende, and vary from massive with relict hypidiomorphic granular texture to highly foliate and mylonitic. Sodic plagioclase commonly unzoned, complexly twinned and filled with epidote and (or) white mica. East of the Cascade River South Fork, rocks are progressively more recrystallized to the southeast with pronounced metamorphic segregation, well-recrystallized blue-green hornblende, and local biotite

TKmf, Kmf **Flaser gneiss**—Dark-colored epidote-chlorite-muscovite-quartz- plagioclase flaser gneiss, locally with chlorite schist. Subhedral to subidioblastic sodic plagioclase in a foliate matrix, locally with biotite

TKmm **Magic Mountain Gneiss (Tertiary and Late Cretaceous)**—Light- colored chlorite-muscovite-epidote-plagioclase gneiss or flaser gneiss interlayered with chlorite-epidote-quartz-albite schist, locally with garnet and hornblende. Plagioclase, strikingly filled with epidote, is mostly albite and oligoclase; epidote is strongly zoned, mostly to iron-rich rims; chlorite is typically Mg rich. The gneiss layers range from flaseroid with epidote-filled plagioclase insets in a blastomylonitic quartz matrix to strongly layered quartz and albite rocks with numerous stringers of epidote and chlorite. Gneiss layers and greenschist layers are most commonly separated, but gradations occur. Scale of layering ranges from 5 cm to 6 m, but near the contact with the Cascade River Schist, greenschist layers increase in thickness and may be as thick as 60 m. Locally this contact is marked by a monolithologic breccia of equidimensional light-colored gneiss clasts, commonly augen shaped and as large as10 cm in a greenschist matrix. Descriptions abstracted from Tabor (1961, p. 38-72)

Napeequa Schist (Tertiary and Late Cretaceous)—Divided into:

TKns, Kns **Mica-quartz schist and hornblende schist**—Predominantly fine grained, mica-quartz schist, hornblende schist, amphibolite, hornblende-mica schist, garnet-biotite schist and minor hornblende-zoisite schist, hornblende garbenschiefer, calc-silicate schist, marble, and ultramafic rock. In the Cascade River area and in the Straight Creek Fault Zone, phyllitic muscovite-chlorite-quartz schist predominates. Rocks are mostly white, tan, brown to black, locally greenish with conspicuous compositional banding. Fine lamellar foliation, locally blastomylonitic. Evenly spaced quartz-rich layers, 1-10 cm thick, in mica-quartz schist suggest relict chert bedding, especially prominent north of Illabot Creek and locally along Downey Creek. On outcrop scale the schist is isoclinally folded, commonly crenulated or contorted; small crinkle folds on prominent S-surfaces

TKnm, Knm **Marble**—Coarsely crystalline white marble grading into calcareous schist and locally calc-silicate schist. Star indicates outcrop of carbonate rocks too small to show at this map scale

TKnu, Knu **Ultramafic rocks**—Thick, large layers along Downey Creek are mostly metadunite (Grant, 1966, p. 110). Other bodies are serpentinized metadunite and metaperidotite. Rocks are dark green to black on fresh surfaces, weathering rusty orange to brown with relics of olivine in a felted

mat of antigorite, talc, and tremolite (Crowder and others, 1966). The large body on Jordan Creek is mostly serpentinized peridotite (Bryant, 1955, p. 51-53). Many small pods of talc-tremolite schist are unmapped. Symbol (shown on map explanation)indicates outcrop of carbonate rocks too small to show at this map scale

Swakane terrane

Ksg **Swakane Biotite Gneiss (Late Cretaceous)**—Biotite-quartz-oligoclase gneiss, medium-grained, locally with garnet. Generally granofelsic to schistose but remarkably uniform and unlayered. Foliation folded on a small scale and swirled locally. Rare layers of hornblende schist. Cut by numerous sills and dikes of light-colored tonalite and tonalitic gneiss