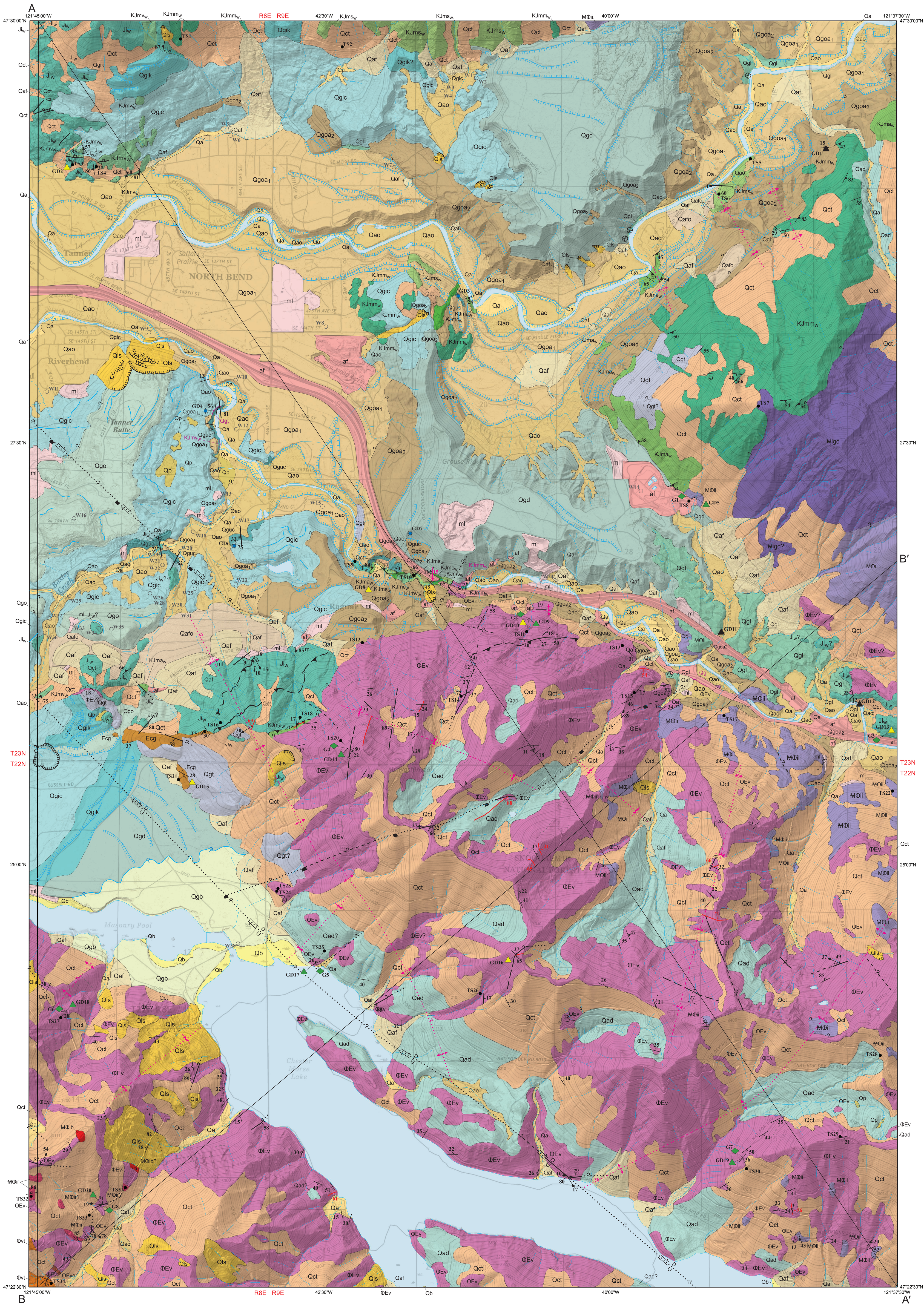
WASHINGTON GEOLOGICAL SURVEY
MAP SERIES 2022-04
Geologic Map of the Chester Morse Lake 7.5-minute Quadrangle

WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES
WASHINGTON GEOLOGICAL SURVEY

Geologic Map of the Chester Morse Lake 7.5-minute Quadrangle, King County, Washington

Alexander N. Steely, Megan L. Anderson, and Katherine A. Alexander

December 2022



ABSTRACT

We combine new geologic mapping, geochronology, geochemistry, thin-section analysis, a detailed gravity survey, and geophysical modeling to refine our understanding of the geology at the transition between the glaciated Puget Lowland and the volcanic and metamorphic Cascade Range in the Chester Morse Lake quadrangle.

Cretaceous to Jurassic rocks of the western mélange belt are the oldest in the area and consist of meta-sandstone (<86.5 Ma) and argillite interleaved with greenstone and meta-intrusive rocks (152–155 Ma). The contact with the overlying Tertiary rock is poorly exposed, but probably a faulted depositional surface above which a middle Eocene (<47.2 Ma) cherty conglomerate is locally present. The majority of Tertiary rock is a latest Eocene (~34.5 Ma) through Oligocene intermediate to silicic volcanic succession of thick crystal-vitric lapilli tuff and flows. Oligocene to Miocene mafic to felsic dikes and plutons, including the Snoqualmie batholith, are accompanied by a pronounced aureole of thermal metamorphism.

Late Quaternary units include abundant deposits from the last continental glaciation including thick accumulations of subglacial embankment deposits, which form the flat-topped surfaces near the mouths of major rivers and are mined for their aggregate. A now-incised series of fluvial deposits and terraces records the dynamic post-glacial adjustments as ice receded. There are isolated remnants of pre-glacial deposits and most are tilted and (or) faulted, though deformation associated with the advance of the Puget Lobe glacier in the most recent glaciation makes it difficult to deconvolve any older tectonic components. We find no compelling evidence for post-Vashon tectonic faulting.

DESCRIPTION OF MAP UNITS

Holocene Nonglacial Deposits

af — **Artificial fill (Holocene)**—Mixed earth materials of varied grain size and sorting placed to elevate the land or modify topography.

ml — **Modified land (Holocene)**—Mixed earth materials of varied grain size and sorting; mapped where humans have modified the underlying unconsolidated deposits.

Qa — **Alluvium (Holocene)**—Gravel, sand, silt, and clay, in varied abundance; locally contains scattered boulders, some greater than 5 m across; locally contains organic material and (or) soil; generally loose; mapped where there is at least some evidence of geologically recent fluvial deposition or erosion. Where unit Qao is present, unit Qa is topographically lower and (or) inset into it.

Qao — **Alluvium, older (Holocene)**—Gravel, sand, silt, and clay, in varied abundance; locally contains scattered boulders; well to poorly sorted; may be stratified or contain other sedimentary structures; locally contains organic material and (or) soil; generally loose. Unit is mapped adjacent to major perennial streams and rivers except where evidence for geologically recent fluvial deposition or reworking is absent.

Qb — **Beach and nearshore deposits (Holocene)**—Sand, locally interbedded with varying amounts of silt and clay; scattered pebbles to boulders are locally common. Mapped along the shores of Chester Morse Lake and Masonry Pool.

Qp — **Peat (Holocene)**—Organic-matter-rich silt to clay; locally sandy; typically loose and easily compacted; includes peat, muck, and gyttja; deposited in low-energy fluvial environments and closed depressions such as bogs, swamps, abandoned river channels, kettles, and lakes; commonly contains abundant fibrous or woody plant debris.

Qct — **Colluvium and talus (Holocene)**—Boulders, cobbles, pebbles, sand, silt, clay, soil, organic material, and semi-intact blocks of older deposits or bedrock, in varied abundance; clast to matrix supported; clasts range from angular to rounded, depending on source material; loose to compact. Includes deposits from small debris flows, topples, rock avalanches, talus, scree, and colluvium; may include deposits from small unmapped shallow landslides.

Qls — **Landslide (Holocene)**—Boulders, cobbles, pebbles, sand, silt, clay, soil, organic material, and semi-intact blocks of older deposits or bedrock, in varied abundance; typically matrix supported; generally unsorted; may include deposits from both shallow (depth less than that of tree roots) and deep-seated landslides, debris flows, topples, and rock avalanches. Absence of a mapped landslide does not indicate the absence of landslide hazard.

Qaf, Qafo — **Alluvial fan (Holocene)**—Pebble to boulder gravel and sand in varied abundance; moderately to poorly sorted; stratification varies from absent to weakly planar bedded; may contain organic material and (or) soil. Unit is mapped along and adjacent to streams where they emerge from confined channels into broader and flatter topography and is differentiated from other Holocene units on the basis of a fan-shaped morphology.

Late Pleistocene Glacial and Nonglacial Deposits

The most recent continental glaciation in the Puget Lowland occurred during the Vashon stade of the Fraser glaciation. This glaciation had a profound effect on the landscape, and was quite rapid; the glacier, known as the Puget Lobe, advanced and then retreated past the latitude of Seattle between about 15 and 13.5 ka (Booth and Goldstein, 1994). As the glacier advanced southward, it blocked rivers draining the Cascade Range, commonly forming ice-margin lakes and subglacial rivers (Porter, 1976; Booth, 1986). In much of the Puget Lowland, deposits from the Puget Lobe are lithologically distinctive because they contain rocks from the Canadian Cordillera and northernmost Washington. However, such clasts seem quite rare in clearly glacial deposits within the current map area, perhaps because they are overwhelmed by material carried by the ice-marginal river systems.

DEPOSITS OF LOCAL RIVERS DURING GLACIAL RECESSION

Booth (1990) and Tabor and others (2000) map a series of successively lower and younger 'recessional outwash' deposits near the map area that record lowering base level during recession of the Puget Lobe glacier. During this time, local rivers (which lack Puget Lobe glacial meltwater) interacted with the voluminous glacial meltwater from the Puget Lobe. Because discharge volume, sediment flux, and source area differ markedly between the two potential sources of sedimentary deposits, we use the terms 'old alluvium' for fluvial deposits of local rivers formed during glacial recession and 'outwash' for similar-age deposits resulting from glacial meltwater.

Qgoa$_1$ — **Old alluvium (Holocene to late Pleistocene)**—Cobble and boulder gravel to coarse sand with subordinate silt and, locally, minor lenses of diamicton; scattered outsized boulders are up to 5 m across; well to poorly sorted; typically crudely stratified or structureless; well-developed flat benches are locally common and their back edges are marked by a steep riser. Mapped below 930-ft elevation where smooth and flat surfaces lie adjacent to major rivers and into which units Qa and Qao are inset.

Qgoa$_2$ — **Old alluvium (Pleistocene)**—Cobble and boulder gravel to coarse sand with subordinate silt and, locally, minor lenses of diamicton; scattered outsized boulders are up to 5 m across; well to poorly sorted; typically crudely stratified or structureless; well-developed flat benches are locally common and their back edges are marked by a steep riser. Mapped above 930-ft elevation where sediment is inferred to have been deposited by local rivers and not glacial meltwater of the Puget Lobe.

DEPOSITS OF THE VASHON STADE OF THE FRASER GLACIATION

Qgb — **Beach and nearshore deposits (Pleistocene)**—Sand, silt, and minor gravel in varied abundance; poorly exposed and mapped predominantly on the basis of geomorphology, including a subtle shoreline at ~1,630 ft elevation north of Masonry Pool near the mouth of the Cedar River canyon.

Qgo — **Outwash, recessional (Pleistocene)**—Tan gravel, sand, and minor(?) silt in varied abundance; loose to consolidated; well bedded to structureless; sandy and silty intervals are generally well sorted; gravelly intervals are generally moderately to poorly sorted and typically clast supported. The two large expanses of this unit (south from Tanner Butte and north of Cedar Butte) have a smooth and subtly stepped surface that contrasts with the dimpled surface of unit Qgic (which typically lies adjacent to and below unit Qgo).

Qgd — **Glacial embankment deposits (Pleistocene)**—Light tan to gray sand and gravel in varied amounts, with sparse pebble to boulder diamicton (till) and minor interbedded clayey silt; organic-rich beds are rare; till and silt are compact and dense; sand and gravel are moderately to weakly consolidated and generally thinly to thickly bedded; clasts mostly subrounded to rounded, some are faceted, and there are many boulders >5 m across. Inset channels are found on the nearly flat but gently east-dipping surface of the three embankment deposits.

Qgic — **Ice-contact deposits (Pleistocene)**—Varied assortment of compact lenses of diamicton (till) and consolidated to loose beds of stratified to structureless sand to cobble and boulder gravel. The surface of unit Qgic is typically dimpled, without directional fabric, and locally has outsized boulders at the surface.

Qgt — **Lodgement till (Pleistocene)**—Compact gray diamicton and minor stratified sand or gravel; mild weathering of clasts and matrix; clasts are generally subrounded and some are faceted; typically lacks fabric, but locally there is weakly developed friable and subhorizontal layering.

Qgik — **Kame deposits (Pleistocene)**—Light tan to gray pebble to boulder gravel, pebbly sand, and minor compact diamicton; mildly weathered; typically loose to somewhat consolidated; typically stratified, mostly consisting of medium to thick planar bedding, but locally structureless.

Qgl — **Glaciolacustrine deposits (Pleistocene)**—Silt and sand with subordinate clay and rare diamicton; compact and firm; light to medium gray or tan, locally slightly bluish where found below about 1,000 ft elevation; typically thinly planar bedded to laminated, locally with rhythmic interbeds of sandy silt and silty clay. Fairhall and others (1966) obtained a 13,570 ^{14}C yr BP radiocarbon date on charcoal in lacustrine sediment from this unit (age site GD12).

DEPOSITS OLDER THAN THE FRASER GLACIATION

Qad — **Drift, alpine (Pleistocene)**—Tan to brown or gray unsorted compact mixture of boulders to pebbles in a matrix of coarse sand to clay; clasts angular to rounded, locally faceted, and similar to rocks exposed up-slope and (or) up-valley; typically mapped in alpine cirques, though exposures are not good. We did not find clear evidence of alpine glaciers interacting with ice from the Puget Lobe, in line with previous work (for example, Porter, 1976).

Qguc — **Glacial and nonglacial deposits, undivided (Pleistocene)**—Compact clay, silt, sand, minor gravel, and rare pebble to cobble diamicton; sand and silt are tan to light gray; clayey beds are gray to slightly blue; thin to medium planar bedding is typical; thick beds of clay are uncommon; charcoal is locally present in more-extensive sandy deposits; found beneath units Qgt, Qgic, or Qgd; presumably rests on bedrock; commonly tilted and locally faulted. New luminescence ages (age sites GD3–4 and GD6–7) indicate deposition prior to 20 ka. Includes advance deposits of the Vashon Stade and deposits of the Olympia non-glacial period; may include deposits from pre-Vashon glaciations.

Tertiary Intrusive, Volcanic, and Sedimentary Rocks

The map area contains a remnant of middle Eocene sandstone and conglomerate beneath a latest Eocene through Oligocene intermediate to silicic volcanic succession. Cretaceous to Jurassic rocks of the western mélange belt underlie the Tertiary rocks, though we are uncertain if the contact is depositional or faulted where best exposed along the northwest flank of Mount Washington. Low-grade zeolitic alteration of the volcanic succession occurred shortly after burial (Hammond, 1963). Oligocene to Miocene mafic to felsic dikes and plutons intrude these altered rocks and are accompanied by an aureole of thermal metamorphism that locally extends a kilometer or more from the main intrusion.

Migd — **Granodiorite (Miocene)**—White to light gray medium-grained equigranular to slightly porphyritic granodiorite and minor diorite; lacks notable chloritic alteration; intrudes rocks of units KJmm$_w$, KJma$_w$, and MΦii. This is the Snoqualmie Granodiorite of Smith and Calkins (1906) and the Snoqualmie batholith of Erikson (1969); nearby ages from Tabor and others (2000) range from ~17–20 Ma.

MΦii — **Intermediate intrusive rocks (Miocene to Oligocene)**—Gray medium- to fine-grained diorite, gabbro, monzonite, and minor granodiorite to tonalite; mostly equigranular, locally porphyritic; alteration is common and includes chloritic mafic minerals and sericitic feldspars; lacks ductile shearing, in contrast to some rocks of unit Ji$_w$. Considered a border phase of the Snoqualmie Batholith by Erikson (1969). An ^{40}Ar/^{39}Ar age on biotite from this unit is 24.8 Ma (age site GD5).

MΦir — **Rhyolite, intrusive (Miocene to Oligocene)**—Maroon, lavender, and gray fine-grained sparsely plagioclase-phyric rhyolite with uncommon irregular quartz phenocrysts. Near-vertical flow foliation and banding is prominent, distinctive, and divides the rock into 1–5-cm-thick plates.

MΦib — **Basalt dikes and sills (Miocene to Oligocene)**—Black to dark gray aphanitic to very sparsely plagioclase-phyric basalt dikes; 0.5 to 2-m or more in width; crude margin-perpendicular fractures or sub-horizontal columns. The rock of this unit is the least altered of any observed in the map area.

Φvt — **Tuff (Oligocene)**—Light green to greenish white crystal-vitric lapilli tuff; poorly welded to unwelded; mapped by Hammond (1963) as the Tuff of Stampede Pass.

ΦEiv — **Intrusive dikes and sills (Oligocene to Eocene)**—Gray to tan aphanitic to porphyritic basalt, andesite, and possibly dacite to rhyolite; typically found as 1–2-m-wide dikes and sills within unit ΦEv, where their similarity to flows of that unit make differentiation difficult. Shown as red lines (see legend at right) only.

ΦEvc — **Volcaniclastic rocks (Oligocene to Eocene)**—Gray, tan, and light green tuffaceous siltstone, pebbly diamictite, and interbedded coarse sandstone.

ΦEv — **Volcanic rocks, flows and tuffs (Oligocene to Eocene)**—Tan, blue, or grayish green tuff, lapilli tuff, and tuff breccia with varying proportions of crystal, lithic, and vitric components comprising most of the lower and upper portions of the unit; dark gray, black, or blue aphanitic to porphyritic flows with varying amounts of plagioclase, hornblende, and pyroxene seem to be more prevalent in the middle of the unit. The unit is geochemically diverse, ranging from basaltic andesite to dacitic rhyolite. Two zircon U-Pb ages near the base of the section are 34.5 and 34.7 Ma (age sites GD16 and GD10).

Ecg — **Conglomerate and sandstone (late to middle Eocene)**—Cherty pebble conglomerate with interbeds and lenses of lithic to arkosic and micaceous medium sandstone to pebbly sandstone; gray to tan; base of unit contains a poorly exposed vesicular and trachytic andesite flow that appears to rest on unit Ji$_w$. Detrital zircon U-Pb ages indicate deposition after ~47 Ma (age site GD15).

Mesozoic Low- and Medium-Grade Metamorphic Rocks of the Western Mélange Belt

The oldest rocks in the map area are Cretaceous to Jurassic marine metasediments, metavolcanics, and meta-intrusives that are mapped as part of the western mélange belt (WMB) by Tabor and others (2000). In thin section, chlorite, epidote, calcite, and quartz are common secondary minerals, and in combination with locally developed foliation, indicate metamorphism near greenschist facies as described in detail by Tabor and others (1993, 2000).

KJmm$_w$ — **Marine metasedimentary rocks, undivided (Cretaceous to Jurassic)**—Fine sandstone, argillite, and minor chert; dark blue, black, off-white, or tan; composed of any of the sedimentary facies described below. Unit KJmm$_w$ is locally subdivided into:

- KJma$_w$ — **Argillite-rich facies**—Dark blue to black argillite with subordinate shale, phyllite, slate, and fine sandstone; weakly developed cleavage to well-developed foliation common.
- KJms$_w$ — **Sandstone-rich facies**—Fine-grained dark gray to dark blue sandstone, subordinate argillite and chert, and minor conglomerate. Detrital zircon U-Pb ages indicate deposition after 86.5 Ma (age site GD8).
- KJmc$_w$ — **Chert-rich facies**—Rhythmic thin to thick beds of tan to off-white chert, subordinate medium gray to black argillite, and minor fine-grained dark blue to gray sandstone.

KJmv$_w$ — **Greenstone (Cretaceous to Jurassic)**—Dark gray to black or dark green aphanitic to rarely porphyritic rock; found as sheared blocks in a scaly argillite matrix; pyrite locally abundant.

Ji$_w$ — **Meta-intrusive rocks (Jurassic)**—Altered medium-grained gabbro and diorite, subordinate tonalite, and minor amphibolite; typically light greenish gray, with a range of metamorphic fabrics, from static alteration of mafic minerals to chlorite, through incipient foliation and development of local thin ductile shear zones; metamorphic minerals generally indicate sub-greenschist facies but locally include glaucophane; locally brecciated. Two zircon U-Pb ages indicate crystallization between ~153–156 Ma (age sites GD2 and GD13).

GEOLOGIC SYMBOLS

- Contact—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; grayed out where internal flow contacts are present
- Bedding formlines—Identity and existence certain; location inferred; In this map, symbol shows internal contacts between lava flows of the same unit
- Fault—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable
- Thrust fault—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; sawteeth on upper plate
- Reverse fault—Solid where location accurate; short-dashed where inferred; dotted where concealed; rectangles on upthrown block
- Oblique-slip fault, reverse right lateral offset—Short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; arrows show relative motion; rectangles on upthrown block
- Oblique-slip fault, high-angle right-lateral offset—Solid where location accurate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; relative motion shown by U and D
- Anticline—Long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable
- Syncline—Short-dashed where inferred; dotted where concealed; queried where identity or existence questionable
- Geologic unit too thin to show as a polygon—Identity and existence certain, location accurate
- Dike or Sill (ΦEiv)—Identity and existence certain; location accurate
- A — A′ Cross section line
- Fluvial terrace—Location accurate; hachures point down slope
- Landslide scarp—Hachures point down slope
- Perennial stream
- Intermittent stream
- Former shoreline or marine limit—Location accurate; queried where identity or existence questionable

- 43 Inclined bedding—showing strike and dip
- Horizontal bedding
- 57 Inclined metamorphic or tectonic foliation—showing strike and dip
- 28 Approximate orientation of inclined bedding in unconsolidated deposits or bedrock—showing approximate strike and dip
- 52 Small, minor inclined joint—showing strike and dip
- 81 Small, minor inclined fault—showing strike and dip
- 15 Inclined fold hinge of generic (type unspecified) small, minor fold—showing bearing and plunge
- 15 Inclined slickenline, groove, or striation on fault surface—showing bearing and plunge
- 16 Inclined bedding in unconsolidated sedimentary deposits or unconsolidated fragmental deposits of volcanic origin—showing strike and dip
- 69 Inclined fault—showing dip value and direction
- 72 Inclined dike—showing dip value and direction
- 18 Inclined flow banding, lamination, layering, or foliation in igneous rock—showing strike and dip
- GD16 Age site, U-Pb, uranium-lead
- GD1 Age site, ^{14}C, carbon-14
- GD19 Age site, 40Ar/39Ar, argon-argon
- GD4 Age site, optically-stimulated luminescence
- G3 Geochemistry sample location
- W37 Water well
- TS18 Thin section sample

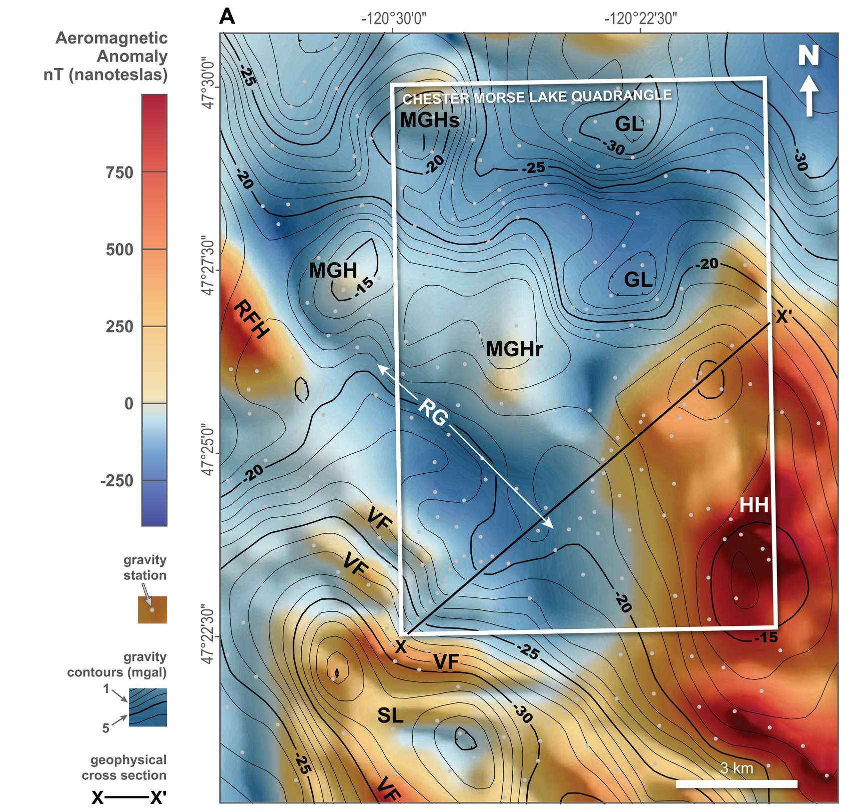
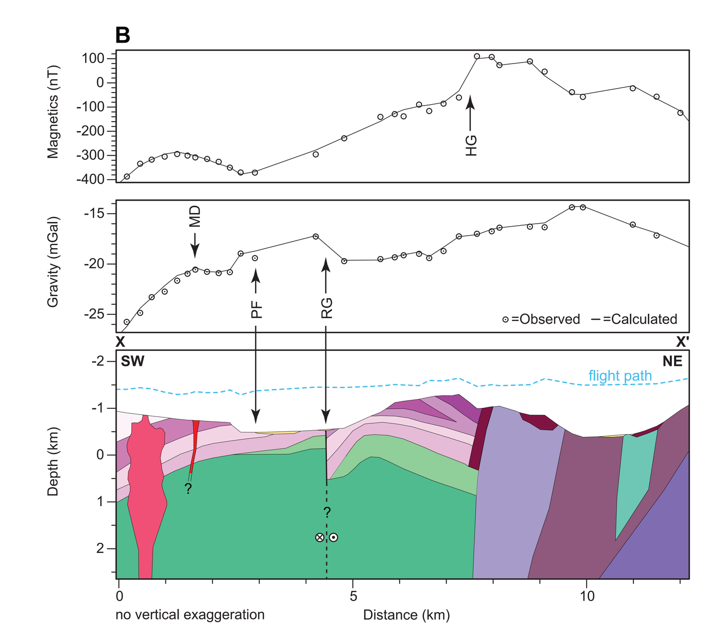


Figure M1. Geophysical interpretation for the map area. Geophysical feature acronyms referred to in the pamphlet—**GL**: Glacial gravity lows; **HG**: Hornfels gradient (magnetic gradient along the edge of the region containing hornfelsed rocks); **HH**: Hornfels magnetic high; **MD**: Mafic dike gravity high; **MGH** (and **MGHs/MGHr**): Metagabbro anomaly high; **PF**: Potential fault (unmodeled gravity low); **RFH**: Rattlesnake Mountain fault magnetic high; **RG**: Rattlesnake Mountain fault strand gravity gradient; **SL**: Syncline gravity low; **VF**: Volcanic flow magnetic high.

A. Combined isostatic gravity and hillshade aeromagnetic map (reduced-to-pole). Gravity contours are 1 mGal. Gravity stations are light gray dots. **X–X'** shows the end points of the geophysical model in **M1B**. White box marks the limits of the Chester Morse Lake quadrangle.

B. Two-dimensional potential-fields forward model of profile **X–X'**. Units and properties shown in the bottom panel predict gravitational and magnetic anomalies shown in the top two panels (ρ–saturated bulk density in kg/m^3; χ–magnetic susceptibility in SI x 10^3). Gravity data shown are no more than 900 m in map view from the model line. In our modeling, the diameters of the small dots inside the larger circles for the gravity and magnetic data points equal the data errors, but these errors are too small to show at print scale. "Flight path" shows the elevation of the airplane that flew the aeromagnetic survey. Several sub-units of the Eocene-Oligocene volcanics, though not separated on the geological map and cross section are geophysically distinct enough to model here; therefore we identify them only by their physical volcanology. It is likely that the edges of the areas with hornfelsed rocks are not hard boundaries as depicted, but are gradational; however, the width of the magnetic gradient HG suggests these zones do transition to unhornfelsed areas rather abruptly. The Rattlesnake Mountain fault zone strand (**RG**) has inferred right-lateral strike slip because of inferences northwest of the study area.



	Model Properties ρ	Model Properties χ	Average Measured Rock Properties ρ	Average Measured Rock Properties χ
Quaternary (undifferentiated)	2,000	0	—	—
Miocene–Oligocene intrusive–MΦir	2,630	12	2,630	12
Miocene–Oligocene intrusive–MΦib	2,800	22	—	—
Eocene-Oligocene volcanics–Oev: hornfels	2,700–2,830	55–144	2,750	76
Eocene-Oligocene volcanics–Oev: predominantly tuff and breccia	2,400	6	2,600	8
Eocene-Oligocene volcanics–Oev: predominantly flows	2,840	0	2,670	12
Eocene-Oligocene volcanics–Oev: predominantly tuff	2,770	8	2,620	9
Eocene-Oligocene volcanics–Oev: predominantly tuff	2,620	5	2,620	9
Eocene-Oligocene volcanics–Oev: predominantly flows	2,670	22	2,670	12
Eocene-Oligocene volcanics–Oev: predominantly tuff and breccia	2,300–2,500	17–22	2,600	8
Eocene-Oligocene volcanics–Oev: predominantly tuff and breccia	2,600	6	2,600	8
Snoqualmie batholith–Migd	2,706	1	—	—
Snoqualmie batholith–MΦii	2,845	33	2,790	28
Snoqualmie batholith–MΦii	2,735	15	2,710	15
Western mélange belt–Ji$_w$	2,850	57	—	—
Western mélange belt–KJmv$_w$	2,860	0–8	2,860	1
Western mélange belt–KJmm	2,730	3	2,730	3

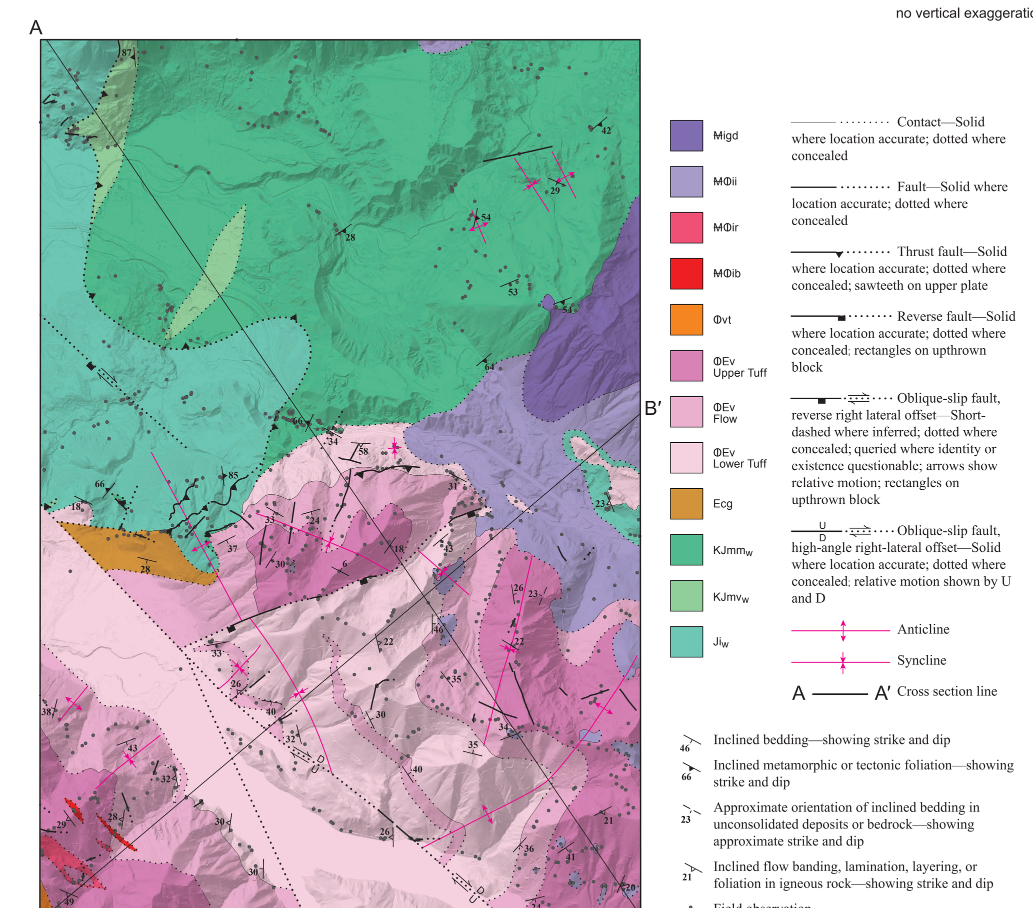
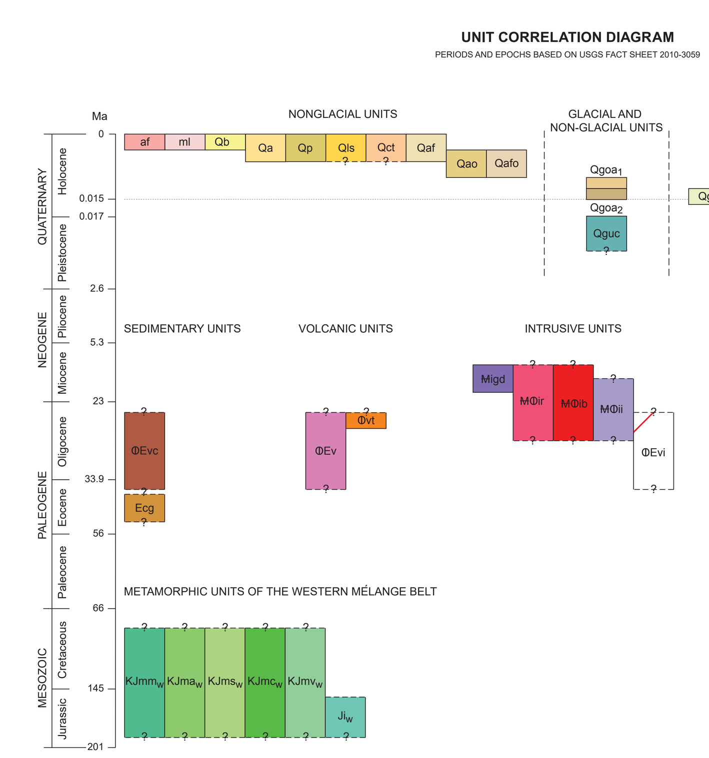
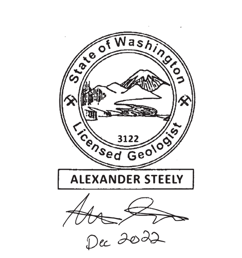


Figure M2. Inferred bedrock geology of the Chester Morse Lake quadrangle. This figure uses the mapped location of bedrock contacts and faults and infers their continuation beneath the cover of Quaternary units. The location of field observations is shown to indicate where we have constraints on the geology at the surface.



UNIT CORRELATION DIAGRAM



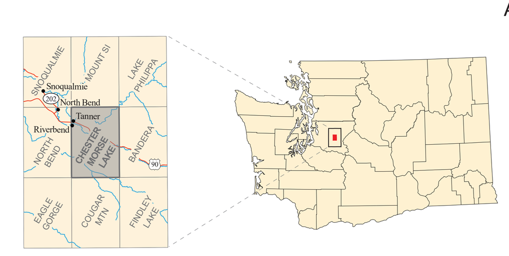
Lambert conformal conic projection
North American Datum of 1983
Base map from U.S. Geological Survey Chester Morse Lake 7.5-minute quadrangle, 2020; a portion of the North Bend quadrangle is also included along the left side of the map to account for datum shifts since previous mapping
Shaded relief generated from a lidar bare-earth digital elevation model (available from the Washington Geological Survey, https://lidarportal.dnr.wa.gov/)
GIS by Alexander N. Steely
Digital cartography by Daniel E. Coe
Editing and production by Susan R. Schnur and Maria A. Furtney

SCALE 1:24,000
contour interval 40 feet

APPROXIMATE MEAN DECLINATION, 2022

This geologic map was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program under USGS award number G21AC10798, 2021–2022.

Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G21AC10798. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.



CROSS SECTION EXPLANATION

Geologic units too thin to show as polygons at the scale of the cross section

Arrow point shows fault movement toward the viewer; arrow feathers show fault movement away from the viewer

Arrows show relative fault movement in the plane of the cross section