WASHINGTON STATE DEPARTMENT OF
Natural Resources
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Division of Geology and Earth Resources
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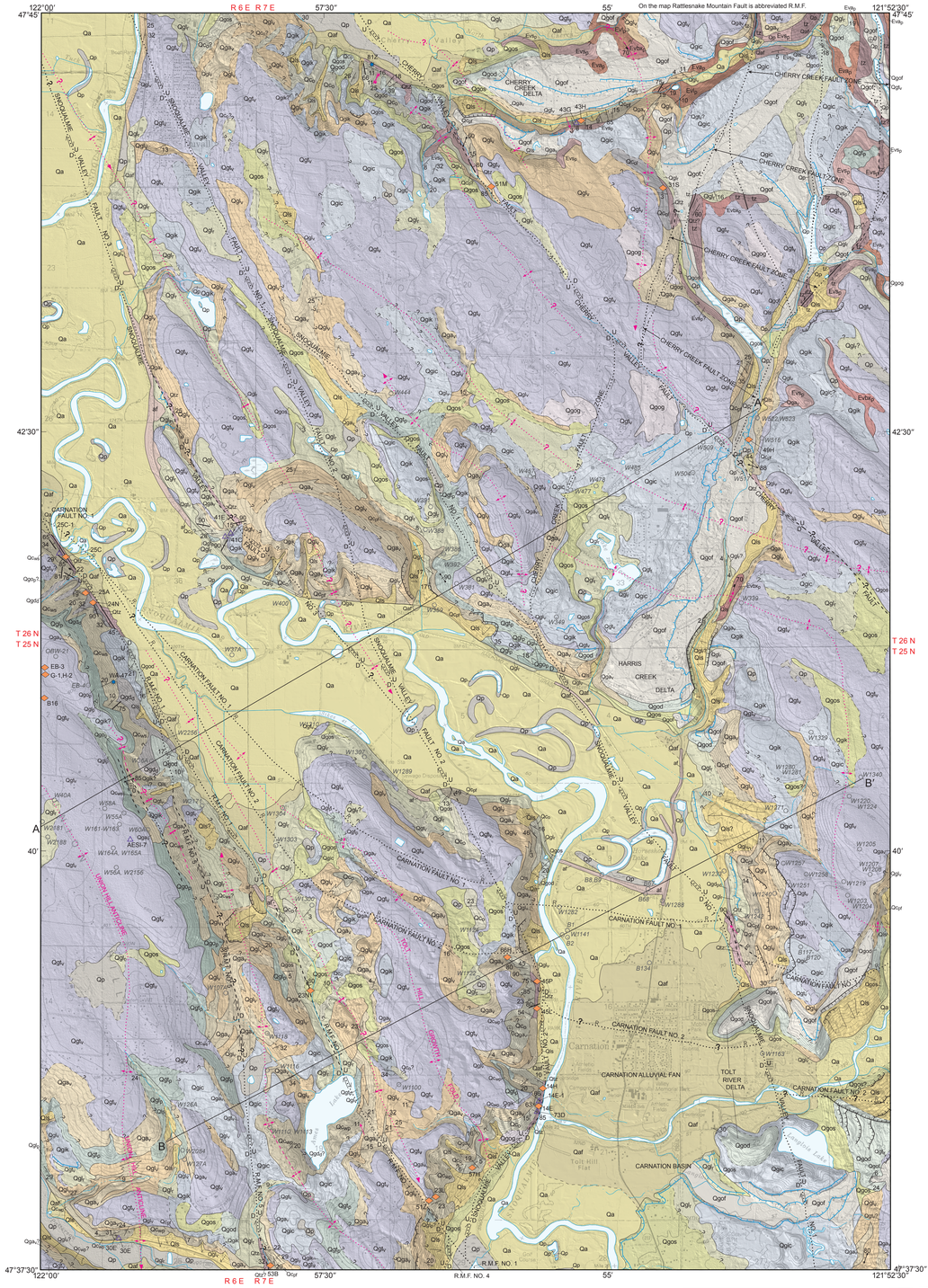
WASHINGTON DIVISION OF GEOLOGY AND EARTH RESOURCES
OPEN FILE REPORT 2010-1
Carnation 7.5-minute Quadrangle
June 2010
Pamphlet accompanies map



Lambert conformal conic projection
North American Datum of 1927; to place on North American Datum of 1983, move the projection lines approximately 20 meters north and 92 meters east as shown by crosshair corner ticks
Base map from scanned and rectified U.S. Geological Survey Carnation 7.5-minute quadrangle, 1993
Shaded relief generated from a lidar bare-earth digital elevation model (available from Puget Sound Lidar Consortium, http://pugetsoundlidar.ess.washington.edu/); sun azimuth 225°; sun angle 45°; vertical exaggeration 3x
Preliminary GIS by Joe D. Dragovich, Heather A. Littke, and Gregory R. Wessel
Final GIS and cartography by J. Eric Schuster
Editing and production by Karen D. Meyers

SCALE 1:24,000
1 MILE — 7000 FEET
1 KILOMETER
contour interval 20 feet
supplemental contour interval 10 feet

This geologic map was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program.

APPROXIMATE MEAN DECLINATION, 2010

Geologic Map of the Carnation 7.5-minute Quadrangle, King County, Washington

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June 2010

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LIST OF MAP UNITS

See pamphlet for complete descriptions of map units.

Quaternary Sedimentary Deposits

HOLOCENE NONGLACIAL DEPOSITS

af — **Artificial fill and modified land (Holocene)**—Mixed earth materials including sand and gravel fill

Qp — **Peat (Holocene)**—Peat, muck, and organic silt and clay, with local thin beds of tephra

Qa — **Alluvium (Holocene)**—Sand and silt with lesser gravelly sand, sandy pebble gravel, peat, and organic sediments

Qls — **Landslide deposits (Holocene to latest Pleistocene)**—Diamicton or boulder gravel

Qaf — **Alluvial fan deposits (Holocene to latest Pleistocene)**—Debris-flow diamicton and alluvial sand, gravel, and local boulder gravel

PLEISTOCENE GLACIAL AND NONGLACIAL DEPOSITS

Recessional Deposits of the Vashon Stade of the Fraser Glaciation

Qgl_r — **Recessional glaciolacustrine (glacial lake) deposits (Pleistocene)**—Silt, clayey or sandy silt, and silty sand, typically with scattered dropstones

Qgos — **Outwash sand (Pleistocene)**—Sand and pebbly sand, with some interbeds of silty sand, silt, or gravel

Qgod — **Deltaic outwash and kame deltas (Pleistocene)**—Sandy cobble gravel, gravel, pebbly sand, and minor sand

Qgof — **Fluvial outwash deposits (Pleistocene)**—Bouldery cobble gravel, gravel, pebbly sand, sand, and rare silt

Qgic — **Ice-contact deposits, undivided (Pleistocene)**—Bouldery cobble gravel, diamicton, silty pebbly gravel, and pebbly sand with lesser sand and silt. Locally divided into:

Qgik — **Ice-contact kames (Pleistocene)**—Sand and gravel, pebbly sand, sand, and cobble gravel, with scattered lenses of diamicton; may include some kame delta deposits

Qgog — **Outwash gravel deposits, undivided (Pleistocene)**—Poorly exposed bouldery pebble cobble gravel to pebbly sand

Advance Proglacial and Subglacial Deposits of the Vashon Stade of the Fraser Glaciation

Qgl_v — **Vashon lodgment till (Pleistocene)**—Mixture of clay, silt, sand, and gravel (diamicton)

Qga_v — **Vashon advance outwash (Pleistocene)**—Sandy (pebble) gravel, sand, and cobble gravel, with local silt interbeds

Qgl_v — **Advance glaciolacustrine deposits (Pleistocene)**—Silt, clayey silt, pebbly silt, and diamicton

Deposits of the Olympia Nonglacial Interval

Qc_o — **Olympia beds of Minard and Booth (1988), Snoqualmie River provenance (Pleistocene)**—Sand, sandy silt, silty sand, silt, clay with some organic silt-clay and minor peat, lesser sand and gravel, and rare cobble gravel. Locally divided into:

Qc_{of} — **Olympia beds of Minard and Booth (1988), local provenance (Pleistocene)**—Silt, sand, (pebble) gravel, and cobble gravel with some peat and organic sediments

Deposits of the Possession Glaciation

Qgl_p — **Lodgment till (Pleistocene)**—Nonstratified, unsorted mixture of clay, silt, sand, and gravel (diamicton), commonly with disseminated cobbles and boulders in a silt-sand matrix

Qgo_p — **Outwash (Pleistocene)**—Fluvial (cobble) gravel to pebble gravel and (pebbly) sand and minor silt

Qgl_p — **Glaciomarine and glaciolacustrine deposits (Pleistocene)**—Silt, silty clay, and silt ±clay with scattered gravel (dropstones) with lesser sand and diamicton

Whidbey Formation

Qc_{wp} — **Whidbey Formation, Puget Group provenance (Pleistocene)**—Andesitic cobble gravel, gravel, and pebble gravel with lesser sand and locally with silt, clay, peat, and rare thin beds of tephra

Qc_{ws} — **Whidbey Formation, Snoqualmie River provenance (Pleistocene)**—Mostly sand, silt, and silty sands with lesser pebbly sand, clay, gravel, and organic sediments including peat

Double Bluff Drift

Qgd_d — **Double Bluff Drift (Pleistocene)**—Pebbly silt and silty diamicton, with some silt, gravel, and gravelly sand, and locally with coarse sandy pebble gravel and sand

PRE-FRASER GLACIAL AND NONGLACIAL DEPOSITS, UNDIVIDED

Qc_{pf} — **Continental nonglacial deposits, pre-Fraser (Pleistocene)**—Snoqualmie River–provenance sand, silt, clay with some organic silt-clay and peat, lesser pebbly sand and gravel, and rare cobble gravel

Qgn_{pf} — **Glacial and nonglacial deposits, pre-Fraser, undivided (Pleistocene to Pliocene?) (cross sections only)**—Mostly (boulder) gravel, sand and gravel, sand, silt, clay, diamicton, and peat

Qgd_{pd} — **Glacial drift, pre–Double Bluff Drift (Pleistocene)**—Poorly exposed gravelly clayey silty gravel (diamicton)

Tertiary Volcanic and Sedimentary Rocks

Mvc — **Volcanic and sedimentary rocks (Miocene) (cross sections only)**—Nonmarine volcanic to tuffaceous sandstone, volcanic to polymictic conglomerate, tuff, claystone, siltstone, and lignite

ΦEn — **Blakeley Formation, nearshore to marine deposits (Oligocene to latest Eocene?) (cross sections only)**—Feldspathic to lithic (tuffaceous) sandstone, conglomerate, tuff, and minor siltstone and shale

ΦEc — **Blakeley Formation, fluvial-deltaic deposits (Oligocene to latest Eocene?) (cross sections only)**—Lithofeldspathic to lithic volcanic sandstone, pebbly sandstone, tuffaceous siltstone, siltstone, claystone, tuff, lapilli tuff, conglomerate and rare coal; may include the nonmarine (fluvial-deltaic) portion of the Blakeley Formation (Rau and Johnson, 1999) and (or) the rocks of Bulson Creek of Marcus (1981).

Evs_p — **Volcanic rocks of Mount Persis of Tabor and others (1993), volcaniclastic and volcanic rocks, undivided (Eocene)**—Volcanic lithic (tuffaceous) sandstone, tuffaceous siltstone, lahar and volcanic (boulder) conglomerate, porphyritic andesite flows, lithic to crystal lithic breccia, tuff breccia, and crystal lithic to lithic to vitric tuff, with minor silty shale, claystone, and coal. Locally divided into:

$Evlp_p$ — **Volcanic rocks of Mount Persis, andesite flows (Eocene)**—Andesite flows and rare flow breccia

$Evbx_p$ — **Volcanic rocks of Mount Persis, volcanic breccia (Eocene)**—Andesitic to dacitic lithic tuff breccia and lapilli tuff

$Evlp_p$ — **Volcanic rocks of Mount Persis, lahars (Eocene)**—Cohesive to noncohesive lahar and volcanic (boulder) conglomerate

Ev_{pgp} — **Puget Group, undivided (Eocene) (cross sections only)**—Continental feldspathic to volcanic lithic subquartzose sandstone, siltstone, claystone, andesitic flows, breccia, lapilli tuff, and tuff and lesser carbonaceous shale, pebble conglomerate, and coal

Mesozoic Low-Grade Metamorphic Rocks (Prehnite–Pumpellyite Facies)

KJm — **Western mélange belt of Tabor and others (1993) (Cretaceous to Jurassic) (cross sections only)**—Metamorphosed argillite, sandstone, greenstone, metagabbro, and diabase with minor metachert, metatonalite, slate, phyllite, marble, and rare ultramafite

Tertiary to Holocene Tectonic Zones

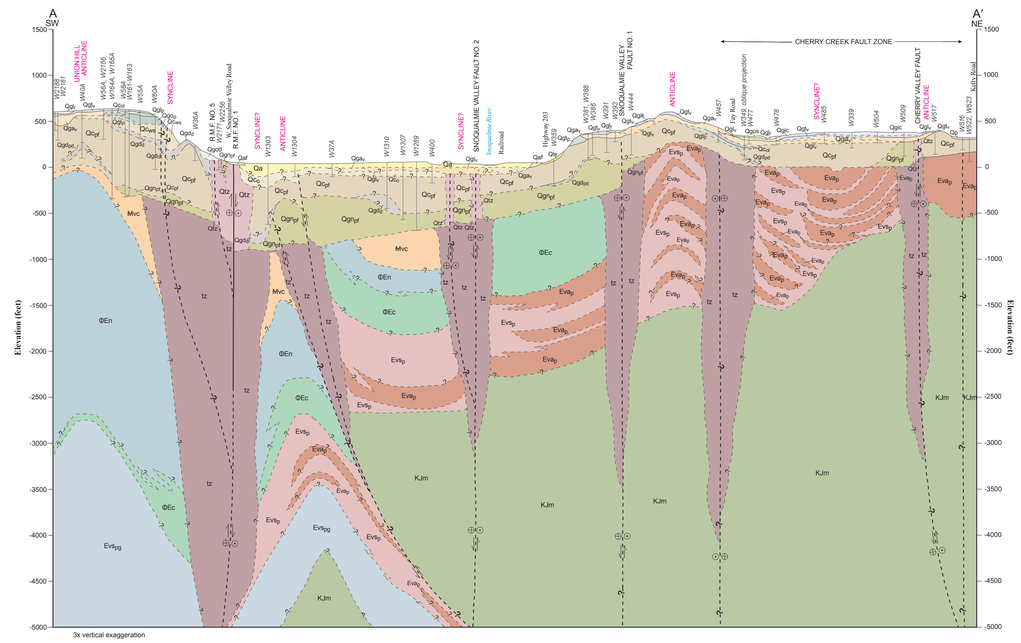
tz — **Tectonic zone (Tertiary to Holocene)**—Cataclasite, fault breccia, clay-rich fault gouge, protomylonite, and strongly slickensided and fractured rocks in fault zones. **Quaternary tectonic zones** (unit Qtz) are mapped in areas of prominent Quaternary deformation and (or) liquefaction.

MAJOR FINDINGS

- Snoqualmie River alluvium (unit Qa) is compositionally similar to quartz-rich sands in older deposits such as the Olympia beds and Whidbey Formation. These older deposits are considered "ancient Snoqualmie River alluvium", and (1) have a Snoqualmie batholith signature that dominates some older nonglacial strata (units Qc_o, Qc_{ws}, and Qc_{pf}), and (2) are preserved in structural basins, some inverted, between active faults.
- The Whidbey Formation has two distinct provenances: ancient Snoqualmie River alluvium (unit Qc_{ws}) and the Puget Group (unit Qc_{wp}). Unit Qc_{wp} was sourced from the Seattle uplift south-southwest of the map area.
- Quaternary deformation and liquefaction features are prominent in the study area and common along Rattlesnake Mountain fault no. 1 (RMF-1), Rattlesnake Mountain fault no. 5 (RMF-5), Snoqualmie Valley faults no. 1 and 2, and the Cherry Valley fault. The Cherry Creek fault forms a wide zone of deformation.
- The Duvall earthquake epicenters occur directly north of the Cherry Creek fault zone and may have originated from displacement along this fault zone.
- The Rattlesnake Mountain fault zone (RMFZ) is the southward extension of the Southern Whidbey Island fault zone (SWIF) of Sherrod and others (2008). RMF-1 is colinear with the active Cottage Lake lineament of Sherrod and others (2008) west-northwest of the study area. These major faults likely form the main strand of the RMFZ-SWIF south of Everett and within the Snoqualmie River valley.
- The SWIF forms the northeastern boundary of the Seattle basin in the map area.
- The compositional similarity of Snoqualmie River sediments (unit Qa) with the ancient fluvial sediments of the Olympia beds suggests uplift of the ancient river sediments between strands of the Rattlesnake Mountain fault zone.

GEOLOGIC SYMBOLS

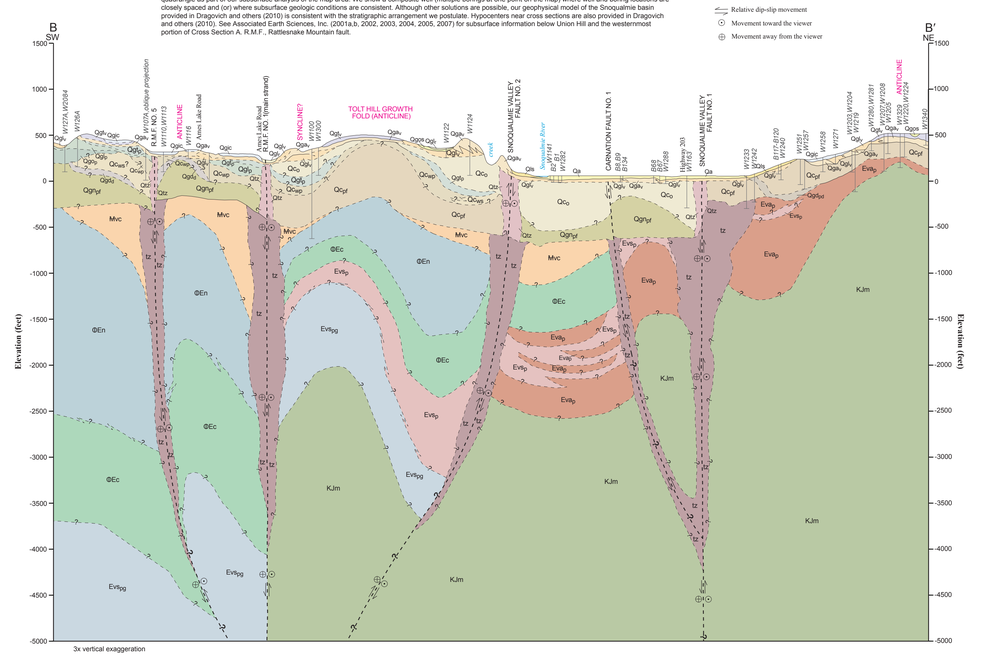
Contact—Identity and existence certain, location accurate
Contact—Identity and existence certain, location inferred
Contact—Identity or existence questionable, location inferred
Fault, unknown offset—Identity and existence certain, location accurate
Fault, unknown offset—Identity and existence certain, location inferred
Fault, unknown offset—Identity or existence questionable, location inferred
Fault, unknown offset—Identity and existence certain, location concealed
Reverse fault—Identity and existence certain, location inferred. R on upthrown block
Reverse fault—Identity and existence certain, location concealed. R on upthrown block
Reverse fault—Identity or existence questionable, location concealed. R on upthrown block
Left-lateral strike-slip fault—Identity and existence certain, location accurate. Arrows show relative motion
Left-lateral strike-slip fault—Identity and existence certain, location inferred. Arrows show relative motion
Left-lateral strike-slip fault—Identity or existence questionable, location inferred. Arrows show relative motion
Left-lateral strike-slip fault—Identity and existence certain, location concealed. Arrows show relative motion
Left-lateral strike-slip fault—Identity or existence questionable, location concealed. Arrows show relative motion
High-angle right-lateral, oblique-slip fault—Identity and existence certain, location accurate. Arrows show relative horizontal motion; U, upthrown block; D, downthrown block
High-angle right-lateral, oblique-slip fault—Identity and existence certain, location inferred. Arrows show relative horizontal motion; U, upthrown block; D, downthrown block
High-angle right-lateral, oblique-slip fault—Identity or existence questionable, location inferred. Arrows show relative horizontal motion; U, upthrown block; D, downthrown block
High-angle right-lateral, oblique-slip fault—Identity and existence certain, location concealed. Arrows show relative horizontal motion; U, upthrown block; D, downthrown block
High-angle right-lateral, oblique-slip fault—Identity or existence questionable, location concealed. Arrows show relative horizontal motion; U, upthrown block; D, downthrown block
Anticline—Identity and existence certain, location accurate
Anticline—Identity or existence questionable, location approximate
Anticline—Identity and existence certain, location inferred
Anticline—Identity and existence certain, location concealed. Arrowhead shows direction of plunge.
Anticline—Identity or existence questionable, location concealed
Syncline—Identity and existence certain, location inferred
Syncline—Identity or existence questionable, location concealed. Arrowhead shows direction of plunge.
Direction of downslope movement of landslide
Fluvial terrace scarp—Identity and existence certain, location accurate. Hachures point downscarp
Head or main scarp of landslide—Active, sharp, distinct, and accurately located. Hachures point downscarp
A A′ Cross section line
19 Bedding—showing strike and dip
0 Horizontal bedding
70 Joint—showing strike and dip
60 Minor fault—showing strike and dip
90 Minor vertical or near-vertical fault—showing strike
3 Minor fold—showing bearing and plunge
22 Slip lineation or slickensides on a fault or shear surface—showing bearing and plunge of offset
85 Slickensided surface—showing strike and dip
23 Bedding in unconsolidated sedimentary deposits or unconsolidated fragmental deposits of volcanic origin—showing strike and dip
19 Foreset bedding in unconsolidated sedimentary deposits or unconsolidated fragmental deposits of volcanic origin—showing strike and dip
90 Vertical slickensided surface—showing strike
730 Age-date sample locality, carbon-14 (^{14}C)
WA-47 Age-date sample locality, optically stimulated luminescence
30E Tephra age
B134 Water well
45P Significant site



Cross Sections A and B. We examined 1,258 wells, about 175 geotechnical borings, and about 310 test pit stratigraphic logs from various sources across the quadrangle as part of our subsurface analysis of the map area. We show a composite well (multiple borings at one point on the map) where well and boring locations are closely spaced and (or) where subsurface geologic conditions are consistent. Although other solutions are possible, our geophysical model of the Snoqualmie basin provided in Dragovich and others (2010) is consistent with the stratigraphic arrangement we postulate. Hypocenters near cross sections are also provided in Dragovich and others (2010). See Associated Earth Sciences, Inc. (2001a,b, 2002, 2003, 2004, 2005, 2007) for subsurface information below Union Hill and the westernmost portion of Cross Section A. R.M.F., Rattlesnake Mountain fault.

FAULT MOVEMENT SYMBOLS IN CROSS SECTIONS

Relative dip-slip movement
Movement toward the viewer
Movement away from the viewer



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