WASHINGTON STATE DEPARTMENT OF
Natural Resources
Doug Sutherland - Commissioner of Public Lands
Division of Geology and Earth Resources
Ron Teissere - State Geologist

Lambert conformal conic projection
North American Datum of 1927; to place on North American Datum of 1983, move the projection lines approximately 17.8 meters north and 92.4 meters east as shown by crosshair corner ticks
Base map from scanned and rectified U.S. Geological Survey Fall City 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 vertical; sun angle vertical; vertical exaggeration 6x
Digital cartography by Anne C. Heinitz, J. Eric Schuster, and Elizabeth E. Thompson
Editing and production by Jaretta M. Roloff

SCALE 1:24,000

contour interval 20 feet
supplemental contour at 70 feet

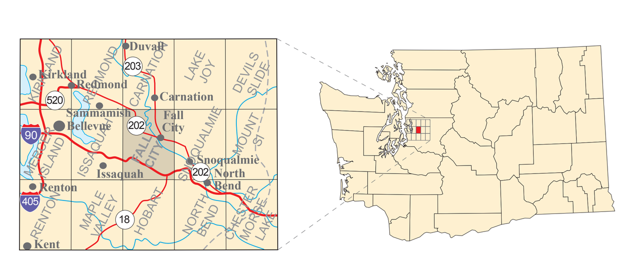
APPROXIMATE MEAN DECLINATION, 2007

MAJOR FINDINGS

- The area contains impressive Vashon recessional deposits, including small kame and glaciolacustrine deposits perched along mountainsides and deposited early in the ice recessional history.
- The compositional similarity of Snoqualmie River sediments with the ancient fluvial sediments of the Olympia beds suggests uplift of the ancient river sediments between strands of the Rattlesnake Mountain fault zone.
- The Tolt Hill growth fold is suggested by the top-of-bedrock contour map, stratigraphy, and the bedding orientations of the Olympia beds. We suspect that this anticline is one of several growth folds within the Rattlesnake Mountain fault zone, which we project across the study area and correlate with the Southern Whidbey Island fault zone.
- The Seattle fault zone may be active in the map area and is truncated by the Rattlesnake Mountain fault zone
- The proximity of the Renton Formation to the Seattle fault zone, combined with ancillary structural information, suggests that the Puget Group is thrust over younger Oligocene to Miocene rocks along Seattle fault no. 3.

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

Suggested citation: Dragovich, Joe D.; Anderson, Megan L.; Walsh, Timothy J.; Johnson, Brendon L.; Adams, Tamara L., 2007, Geologic map of the Fall City 7.5-minute quadrangle, King County, Washington: Washington Division of Geology and Earth Resources Geologic Map GM-67, 1 sheet, scale 1:24,000, with 16 p. text.



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

by Joe D. Dragovich, Megan L. Anderson, Timothy J. Walsh, Brendon L. Johnson, and Tamara L. Adams

November 2007

DESCRIPTION OF MAP UNITS*

QUATERNARY SEDIMENTARY DEPOSITS

Holocene Nonglacial Deposits

af — Artificial fill and modified land (Holocene)
Qa — Alluvium (Holocene)
Qp — Peat (Holocene)
Qls — Landslide deposits (Holocene to latest Pleistocene)
Qaf — Alluvial fan deposits (Holocene to latest Pleistocene)

Pleistocene Glacial and Nonglacial Deposits

DEPOSITS OF THE FRASER GLACIATION

Vashon Stade Recessional Deposits

Qgos — Outwash sand (Pleistocene)
Qgl_r — Recessional glaciolacustrine (lake) deposits (Pleistocene)
Qgic — Stratified ice-contact deposits, undivided (Pleistocene)
Locally divided into:
- Qgi — Ice-contact deposits, melt-out, ablation, or flow tills (Pleistocene)
- Qgie — Ice-contact deposits, eskers (Pleistocene)
- Qgik — Ice-contact deposits, kames (Pleistocene)

Qgof — Fluvial outwash deposits (Pleistocene)
Qgod — Deltaic outwash and kame deltas (Pleistocene)
Qgog — Outwash gravel deposits, undivided (Pleistocene)

Vashon Stade Proglacial and Subglacial Deposits

Qgt_v — Vashon lodgment till (Pleistocene)
Qga_v — Advance outwash deposits (Pleistocene)
Qgl_v — Advance glaciolacustrine deposits (Pleistocene)

DEPOSITS OF THE OLYMPIA NONGLACIAL INTERVAL

Qc_o — Olympia beds (Pleistocene)

DEPOSITS OF THE POSSESSION GLACIATION

Qgt_p — Till (Pleistocene)
Qgo_p — Outwash (Pleistocene)

PRE-FRASER GLACIAL AND NONGLACIAL DEPOSITS

Qgn_{pf} — Glacial and nonglacial deposits, pre-Fraser (Pleistocene to Pliocene?)
Locally divided into:
- Qc_w — Whidbey Formation (Pleistocene)
- oo — Older outwash (Pleistocene)(cross sections only)

ot, oot — Older tills (Pleistocene)(cross sections only)

TERTIARY VOLCANIC, SEDIMENTARY, AND INTRUSIVE ROCKS

Mvc — Volcanic and sedimentary rocks (Miocene) (cross sections only)
Φvc — Ohanapecosh Formation (Oligocene)(cross sections only)
ΦEn — Blakeley Formation (Oligocene to Eocene) (cross sections only)
Ev? — Volcanic rocks of Mount Persis (Eocene)(cross sections only)
Ei — Andesite porphyry dikes and sills (Eocene?)

PUGET GROUP

Ec_r — Renton Formation (middle? to late Eocene)
Evt_t — Tukwila Formation, tuff (middle Eocene)
Locally divided into:
- Evs_t — Tukwila Formation, volcanic and sedimentary rocks (middle Eocene)

Ec_t — Tiger Mountain Formation (middle Eocene)

RAGING RIVER FORMATION

Em_r — Raging River Formation (early? to middle Eocene)

TERTIARY TO RECENT TECTONIC ZONES

tz — Tectonic zones (Tertiary to Recent)

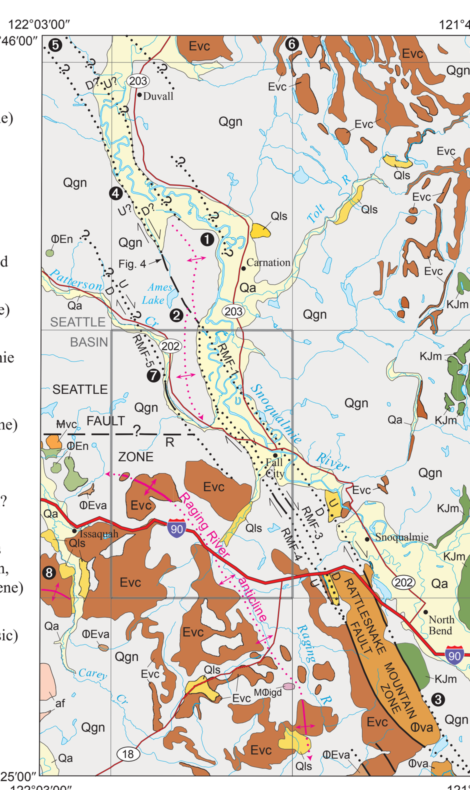
MESOZOIC LOW-GRADE METAMORPHIC ROCKS (PREHNITE–PUMPELLYITE FACIES)

KJm — Western mélange belt (Cretaceous to Jurassic) (cross sections only)

* *See accompanying pamphlet for complete description.*

GEOLOGIC SYMBOLS

- AES1 — Age-date sample site, radiocarbon (see Table 1)
- Geochemistry sample site
- Critical site (see pamphlet)
- Earthquake hypocenter (see pamphlet)
- EB2 — Geotechnical boring or water well (W indicates water well)
- Landslide scarp—hachures point downslope
- Terrace—hachures point downslope
- Late Pleistocene strandline
- Bedding—showing strike and dip
- Horizontal bedding
- Bedding in unconsolidated sediments or volcanic fragmental deposits—showing strike and dip
- Foreset bedding in unconsolidated sediments or volcanic fragmental deposits—showing strike and dip
- Minor fault—showing strike and dip
- Minor vertical or near vertical fault—showing strike and dip
- Minor fold—showing bearing and plunge
- Slip lineation or slickensides on a fault or shear surface—showing bearing and plunge of offset
- Slickensided fracture surface—showing strike and dip
- Vertical slickensided fracture surface—showing strike
- Contact—dashed where inferred
- Fault, unknown offset—dashed where inferred; dotted where concealed; queried where uncertain
- Thrust fault, sawteeth on upper plate—dotted where concealed; queried where uncertain
- Reverse fault, R on upthrown side—dashed where inferred; dotted where concealed; queried where uncertain
- Right-lateral strike-slip fault—dashed where inferred; dotted where concealed; queried where uncertain
- Reverse right-lateral strike-slip fault, R on upthrown side—dotted where concealed
- Reverse left-lateral strike-slip fault, R on upthrown side—dashed where inferred; dotted where concealed; queried where uncertain
- Anticline—dashed where inferred; dotted where concealed; queried where uncertain; large arrowhead shows direction of plunge
- Overturned anticline—dashed where inferred; dotted where concealed; queried where uncertain
- Syncline—dotted where concealed; queried where uncertain; large arrowhead shows direction of plunge
- Monocline (synclinal bend)—dotted where concealed
- MEib — Dike (unit MEib)(Miocene–Eocene?)—aphanitic basalt (~47% SiO_2)

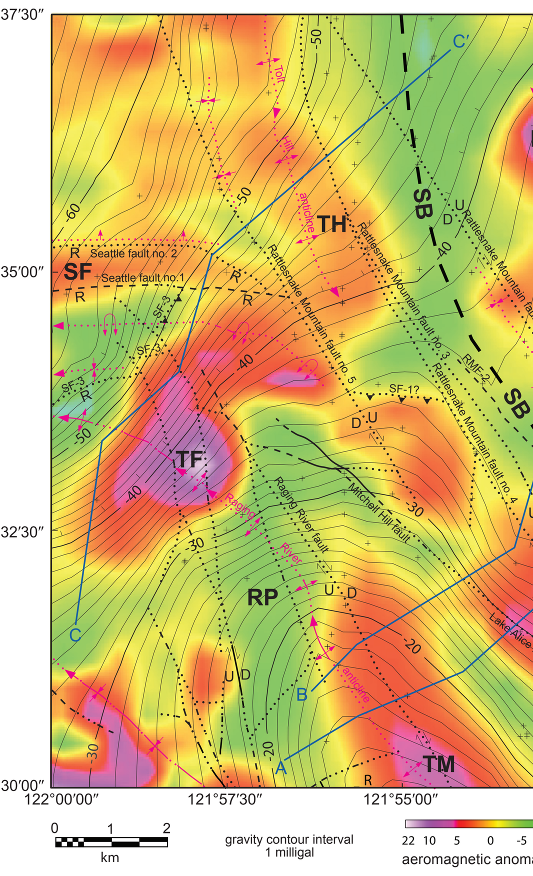


Description of Map Units (Figure 1)

af — Artificial fill and modified land (Holocene)
Qa — Alluvium (Holocene)
Qls — Landslide deposits (Holocene)
Qgn — Glacial and nonglacial deposits, undivided (Pleistocene)
Mvc — Volcanic and sedimentary rocks (Miocene)
MΦigd — Granodiorite and gabbro of the Snoqualmie batholith (Miocene–Oligocene)
Φva — Volcanic rocks of Rattlesnake Mountain and/or Ohanapecosh Formation (Oligocene)
ΦEn — Nearshore sedimentary rocks of the Blakeley Formation (Oligocene–Eocene)
ΦEva — Porphyritic andesite; Blakeley Formation? (Oligocene–Eocene)
Evc — Volcanic and sedimentary rocks; includes the Puget Group, Raging River Formation, and volcanic rocks of Mount Persis (Eocene)
KJm — Low-grade metamorphic rocks of the Western mélange belt (Cretaceous–Jurassic)

SCALE 1:235,000

Figure 1. Geologic map of the region (modified from Dragovich and others, 2002). Boxes are quadrangle boundaries shown on the index map; bold outline is Fall City quadrangle. Includes hypothetical geologic structures north of the study area, such as inferred extensions of the Rattlesnake Mountain fault zone. Our mapping suggests that the Snoqualmie valley is partially structurally controlled and contains northwest-trending half grabens and basins formed within this broad strike-slip fault zone. *Site 1*. Morphology of this uplands area suggests an en-echelon growth fold similar to the Tolt Hill anticline (Cross Section C). *Site 2*. Inferred northward extension of the Tolt Hill anticline; some volcanic sands in the Olympia beds (or perhaps Whidbey Formation) occur directly east of Rattlesnake Mountain fault no. 1 (RMF-1) here. These elevated old deposits may indicate folding and (or) uplift near an active fault(s). *Site 3*. Possible Holocene deformation along the RMF-1 occurs near here. *Site 4*. This linear slope break along the edge of the Snoqualmie River valley aligns with lineaments along Ames Lake and forms the inferred northward extension of RMF-1. Associated Earth Sciences (2004) mapped pre-Possession-age deposits up to 560 ft elevation, and Olympia beds are up to 650 ft in elevation above Snoqualmie valley here. We unearthed nonglacial volcanic sands of the Whidbey Formation(?) southeast of here (Dragovich, 2007). See Figure 4 for deformed recessional outwash along our projection of RMF-1 north of Ames Lake. *Site 5*. Active faults and lineaments defining the currently recognized southeastern limit of the active Southern Whidbey Island fault zone occur in a wide band a few miles northwest of here. We infer that the broad Rattlesnake Mountain fault zone (RMFZ) is the southern extension of the Southern Whidbey Island fault zone. *Site 6*. Location of the Duvall earthquake swarm (maximum magnitude 5.3) discussed in pamphlet. *Site 7*. Location of deformed Olympia beds along RMF-5 noted in the pamphlet (see critical sites 5 and 14 on Plate). *Site 8*. Newcastle Hills anticline in the Issaquah quadrangle. Note the 'younger section' (units Mvc and ΦEn) along the northern limb of this structure (discussed in the pamphlet). The Raging River anticline northwest of this fold is subparallel to both the RMFZ and the Seattle fault zone. Thrusting along the Seattle fault zone may place the Puget Group over the 'younger section' at depth. See 'Quaternary Faulting in the Study Area' in pamphlet.



Explanation (Figure 2)

MP — Mount Persis volcanics anomaly
RP — Raging River–Preston anomaly
SB — Snoqualmie Basin anomaly
SF — Seattle fault anomaly
TF — Tukwila Formation anomaly
TH — Tolt Hill anomaly
TM — Tiger Mountain anomaly
+ — Gravity measurement locations used to control gridding of gravity data
-60 — Gravity contours—hachures point in the direction of decreasing gravity values
A — Cross section lines

See 'Geologic Symbols' for faults and folds

Figure 2. Isostatic gravity anomaly contours (Anderson and others, 2006) superimposed on the aeromagnetic map of the Fall City quadrangle. The data come from an aeromagnetic survey contracted by the U.S. Geological Survey in 1997. Flight lines are oriented north–south with 250-m spacing (Blakely and others, 1999). Magnetic anomalies for the map area are subtle, therefore we present a reduced-to-pole aeromagnetic anomaly grid that is upward continued 50 m and differenced with the original grid according to standard procedures (Blakely, 1995). This combination of filters moves magnetic anomalies directly over the magnetic source units and enhances near-surface anomalies that are more appropriate for interpretation of shallow structures. New data constrain the gravity anomalies for this region (Anderson and others, 2006), and we used standard formulas and reduction procedures (Blakely, 1995), as well as a reduction density of 2670 kg/m³, to produce the isostatic gravity anomaly contours. Rock magnetic properties cited below are supported by hand sample and outcrop susceptibility measurements (Anderson and others, 2006; Megan Anderson, unpub. data, 2006). The center of anomaly TM is a strong, broad signal, both in the filtered and unfiltered data, indicating a deep source. We suggest that this anomaly overlies an intrusive body (perhaps unit Ei) because of the shape of the anomaly and its coincidence with a broad high in the gravity data. This body may be a subvolcanic intrusive equivalent to the Tukwila Formation (Cross Sections A, B). We also suspect that gabbros of the Snoqualmie batholith contribute to this magnetic high. Nonmagnetic rocks of the Raging River and Tiger Mountain Formations (anomaly RP) are coincident with an aeromagnetic low that wraps around anomaly TM. A zone of strong magnetic highs and lows (anomaly TF), in turn, wraps around anomaly RP and corresponds to the magnetically heterogeneous Tukwila Formation. This folded magnetic pattern is consistent with our mapping of the Raging River anticline. The strong magnetic high along the northeastern edge of the quadrangle (anomaly MP) is part of a broad magnetic high that extends to the north and is likely associated with the volcanic rocks of Mount Persis (unit Ev?; Fig. 1) shown on Cross Section C. Seattle fault no. 1 follows the sole east–west-striking linear magnetic anomaly (SF) in the map area. Anomaly TH is a relative magnetic high associated with Tolt Hill, and SB marks the position of the Snoqualmie valley basin, which is associated with the Snoqualmie valley. (See 'Quaternary Faulting in the Study Area'.)

Figure 4. Deformed recessional outwash in the Carnation quadrangle (Fig. 1, northwest of site 2 and Ames Lake) near Rattlesnake Mountain fault no. 1. Note blue pencil for scale. View is to the north-northwest, showing truncated subhorizontal bedding between gravel and sand outwash. The contact is offset by a high-angle fault discontinuity (arrow). We cannot discount landsliding or glacial shear as deformation mechanisms. A discontinuity east of the illustration has an opposite sense of fault offset and distinctly tilted bedding and may indicate that the recessional terrace has undergone extension during lateral spreading perhaps as a result of liquefaction. Site occurs ~100 ft west of the creek that defines the Rattlesnake Mountain no. 1 lineament north of Ames Lake (Fig. 1). This roadcut exposure is in the SW¼NW¼ sec. 18, T25N R7E (47°39.17′N, 121°57.62′W [NAD 27]). Quaternary deformation at this site and in the North Bend quadrangle, as well as other geophysical, geomorphic, and lithokogic anomalies suggest that Rattlesnake Mountain fault no. 1 is active.

Cross Section Legend

W41-43 — Well or composite well showing depth

Fault movement indicators:

- Strike-slip movement away from viewer
- Strike-slip movement toward viewer
- Relative dip-slip movement

Cross Sections. We examined 852 wells and ~550 geotechnical borings from private and public sources, as well as some test pits. To facilitate presentation, we do not show all of the boring and well locations used for cross section construction. We show composite wells in areas where well and boring locations are closely spaced and (or) in areas of consistent subsurface geologic conditions. The lower part of unit Qgl_v on the cross sections may locally contain some older deposits. Major sources of subsurface data include Turney and others, 1995; Jones, 1996; GeoEngineers, 1995; and Associated Earth Sciences, 1987, 2000a,b, 2003, 2005. See Table 1 in pamphlet for ^{14}C age information (for example, arrow with 14.5 ka label on Cross Section B refers to the 14,500 ±130 yr B.P. age date in Table 1.) and Figure 3 in pamphlet for bedrock top elevation.