WASHINGTON GEOLOGICAL SURVEY
MAP SERIES 2020-02
Geologic Map of the Oakville and Rainbow Falls 7.5-minute Quadrangles

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Geologic Map of the Oakville and Rainbow Falls 7.5-minute Quadrangles, Lewis, Thurston, and Grays Harbor Counties, Washington

Michael Polenz, Catherine Samson, Tabor Reedy, Wesley von Dassow, W. Cody Duckworth, Todd R. Lau, Megan L. Anderson, Elizabeth A. Nesbitt, Jeffrey H. Tepper, S. Andrew DuFrane, and Gabriel Legorreta Paulín

December 2020

ABSTRACT

The Oakville and Rainbow Falls quadrangles straddle Lewis, Thurston, and Grays Harbor Counties west of Washington's economically vital Interstate 5. This new map supports private and public resource management with insights into geologic deposits, structures, and hazards. Field- and lidar-informed mapping improves identification of landslides and other deposits. Fault architecture is interpreted from field observations, new gravity data, and, for most faults, modeling of magnetic and gravity anomalies. Abundant landslides in sedimentary rocks between the Doty and Scammon Creek faults mostly mask bedding orientations. New detrital zircon U-Pb analyses support stratigraphic revisions, notably including recognition of Miocene sedimentary rocks along the western map edge and the combination of the Eocene nearshore Skookumchuck and marine McIntosh Formations into a single marine-to-deltaic unit. New geochemical analyses support mapping basalt as Crescent Formation in the Black Hills and near the confluence of Independence Creek and the Chehalis River; basalt in the Rainbow Falls quadrangle is the Sentinel Bluffs Member of the Grande Ronde Basalt (Columbia River Basalt Group). Geochemical traits of volcaniclastic pebbles in Wilkes Formation near the western map edge and Astoria(?) Formation near the eastern map edge suggest derivation from a mix of Crescent Formation and younger alkaline forearc lavas, both exposed west of the map area. Glacial outwash from the Vashon Stade of the Fraser Glaciation, and at least one earlier Cordilleran ice incursion, raised the Chehalis River valley floor in the Oakville quadrangle and caused aggradation in tributary valleys. The outwash and younger alluvium provide ample gravel resources and a productive aquifer that is sensitive to contamination.

DESCRIPTION OF MAP UNITS

HOLOCENE TO PLEISTOCENE NONGLACIAL DEPOSITS

af **Artificial fill (Holocene)**—Cobbles, pebbles, sand, silt, clay, and boulders, all in various amounts, engineered and non-engineered.

ml **Modified land (Holocene)**—Locally derived soil, cobbles, pebbles, sand, silt, clay, and boulders, all in various amounts, reworked by excavation and (or) redistribution that modified topography.

Qls **Landslide deposits (Holocene to Pleistocene)**—Sand, silt, clay, pebbles, cobbles, and boulders, all in various amounts, derived by mass wasting from upslope; typically loose, unsorted, and jumbled; locally stratified in blocks; mostly mapped from landforms.

Qp **Peat (Holocene to Pleistocene)**—Peat, gyttja, muck, silt, clay, and sand in wetlands and other depressions; mostly mapped from landforms and wet conditions.

Qa, Qoa, Qoa$_{a1}$, Qoa$_{a2}$ **Alluvium (Holocene to Pleistocene)**—Floodplain sediments of sand, silt, clay, and peat, and channel sediments of pebbles, cobbles, boulders, sand, silt, clay, and peat, in varied amounts. Unit Qoa where relict. Mapped as unit Qoa$_{a1}$ where apparently aggraded due to Cordilleran ice advance northeast of map area. Unit Qoa$_{a2}$ is found on a set of more elevated benches on the south side of Independence Valley and contains clay soil with fragments <1 cm of locally derived sedimentary rock. It is older than unit Qoa$_{a1}$ and only speculatively alluvial.

Qaf, Qoaf **Alluvial fan (Holocene to Pleistocene)**—Silt, sand, and gravel, in varied amounts, in concentric lobes; gray to brown; loose; subangular to rounded; moderately to poorly sorted; stratified to unstratified. Unit Qoaf where relict; mostly mapped from landforms.

PLEISTOCENE GLACIAL SEDIMENTS

Late Pleistocene Continental Glacial Deposits

Qgo **Vashon proglacial outwash, undivided**—Pebble gravel, locally cobbly gravel, pebbly sand, or sand; in places with matrix and interbeds of silt and sand; loose; well- to sub-rounded; moderately to well-sorted; clast-supported and faintly bedded or unbedded; lithologically diverse.

Qpog **Pre-Vashon outwash gravel**—Pebble gravel and sand, in most exposures weathered to saprolite or clayey soil; loose to moderately compact; clasts rounded, sand matrix locally subangular; moderately to well-sorted; lithologically diverse; likely includes deposits from two or more pre-Vashon glaciations that are <1 Ma old.

Alpine Glacial Deposits

Qapo$_{lh}$ **Logan Hill Formation (Pleistocene)**—Sandy pebble gravel and sand, deeply weathered in all exposures to clay, fine sand, or silt, except for some quartz clasts; mildly to moderately compact, poorly indurated; clasts mostly well-rounded and equant to oblate; matrix rounded to subangular; interpreted as Cascade Range-sourced (alpine) glacial outwash.

QUATERNARY TO EOCENE CONTINENTAL DEPOSITS

QEcf, QEcf$_s$ **Terrestrial weathering clay**–Clay and silt in saprolite or soil of mostly basalt (where unit QEcf) or mostly siltstone (where unit QEcf$_s$); locally includes corestones; mostly orange brown to reddish brown and medium brown in unit QEcf, mostly pale yellowish brown to brown in unit QEcf$_s$; loose and soft near surface but stiff in some exposures; homogeneous except where saprolite preserves primary structure; mapped where unit fully conceals bedrock in the Black Hills.

TERTIARY VOLCANIC AND SEDIMENTARY BEDROCK

Mc$_w$ **Wilkes Formation (middle to late Miocene)**—Quartz-feldspathic siltstone, in places with thin sandstone interbeds, and at and near age site GD88 overlain by or interbedded with cobbly, basaltic pebble conglomerate; color white to pale yellow, pale gray, and pale brown, weathers pale yellow with orange to reddish brown iron staining; poorly lithified; siltstone well-sorted, planar-bedded and hackly.

Mv$_{gs}$ **Sentinel Bluffs Member of the Grande Ronde Basalt of the Columbia River Basalt Group (middle Miocene)**—Aphanitic, vesicular basaltic andesite with commonly zeolite-filled, equant vesicles <7 mm; dark to light gray; hard and crystalline; mostly structureless with rare platy zones, commonly blocky and columnar-jointed.

Mm$_a$ **Astoria(?) Formation (early to middle Miocene)**—Quartz-feldspathic marine siltstone, and very coarse to very fine grained sandstone; rare pebbles; locally with volcaniclastic conglomerate and detrital carbonized wood; moderately or heavily weathered in all observed exposures; mostly poorly lithified; poorly sorted in siltstone, moderately to well-sorted in sandstone; bedding faint or absent in Oakville quadrangle and thickly to very thickly bedded in Rainbow Falls quadrangle.

ΦEm$_{lc}$ **Lincoln Creek Formation (late Eocene to earliest Miocene)**—Marine siltstone and fine-grained sandstone; locally tuffaceous and (or) fossiliferous; moderately to poorly lithified except in well-lithified calcareous concretions; locally hackly and spheroidally weathered; sandstone grains subangular to subrounded and well-sorted; mostly lacks bedding.

En, En$_s$, En$_f$ **Nearshore to marine sedimentary rocks (middle to late Eocene)**—Quartz-feldspathic, micaceous siltstone and sandstone, commonly tuffaceous, locally with macrofossil shells, claystone, or coal seams; commonly friable, hackly, or spheroidally weathered; poorly to moderately lithified; mostly unbedded; undivided in unit En, mostly siltstone in subunit Enf, and mostly sandstone in subunit Ens. Includes deposits previously mapped as McIntosh Formation (mostly subunit Enf) and Skookumchuck Formation (mostly subunit Ens); correlated to Cowlitz Formation of Henriksen (1956) and Roberts (1958).

Em **Marine sedimentary rocks (Eocene)**—Basaltic lapilli tuff breccias interbedded with basaltic sandstone and siltstone; medium to dark gray and black; moderately compact, moderately to heavily indurated; locally well cemented; sandstone moderately to well-sorted, breccias poorly sorted; planar bedded.

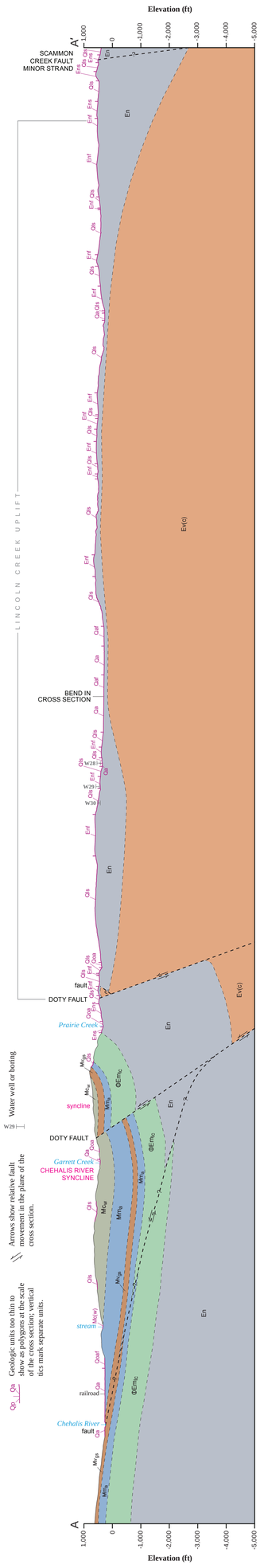
Ev$_c$ **Crescent Formation (early Eocene)**—Plagioclase-pyroxene tholeiitic basalt, locally with minor sedimentary interbeds; black to dark gray, commonly with greenish tint; aphanitic to fine-grained; locally brecciated; columns exposed in most quarries but rarely apparent elsewhere; pervasively chloritoid-altered; commonly contains amygdules filled with zeolite, chlorite, calcite, or quartz.

GEOLOGIC SYMBOLS

Mass-wasting landforms (overlay pattern)—Mapped where landforms that suggest mass movement on unstable slopes, but evidence for landslide deposits is inconclusive.

- Contact—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; queried where identity or existence questionable
- Fault—Identity or existence questionable; short-dashed where inferred; dotted where concealed
- Thrust fault—Long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; Sawteeth on upper plate
- High-angle dip-slip fault—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; relative vertical motion shown by U and D
- Oblique-slip fault, high-angle right-lateral offset—Short-dashed where inferred; dotted where concealed; relative horizontal motion shown by arrows, relative vertical motion shown by U and D
- Anticline—Solid where location accurate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable
- Syncline—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; arrow on line indicates plunge direction
- Mm$_a$ Geologic unit too thin to show as a polygon—Location accurate; Identity and existence certain
- A — A′ Cross section line
- Perennial stream
- Intermittent stream
- Fluvial terrace—Location accurate; hachures point down slope
- Direction of downslope movement of landslide
- 23 / 85 Inclined bedding—showing strike and dip; **black symbols** collected by Washington Geological Survey; **red symbols** compiled from Snavely and others (1958)
- 55 Overturned bedding—showing strike and dip
- 21 Approximate orientation of inclined bedding in unconsolidated deposits or bedrock—showing approximate strike and dip
- Horizontal bedding
- Approximate horizontal bedding
- 86 Small, minor inclined joint—showing strike and dip
- Small, minor vertical or near-vertical joint—showing strike
- 38 Inclined slickenline, groove, or striation on fault surface—showing bearing and plunge
- 86 Slickenside—showing strike and dip
- Vertical slickenside—showing strike
- 66 Small, minor inclined vein, veinlet, or mineralized stringer—showing strike and dip
- 19 Inclined contact—showing dip value and direction
- 77 Shear—showing strike and dip
- 18 Approximate orientation of inclined bedding, where top direction of beds is known from local features—showing approximate strike and dip
- GD9 Age site, fossil
- GD83 Age site, U-Pb, uranium-lead
- G6 Geochemistry sample location
- W11 Water well
- S2 Significant site
- M2 Paleomagnetic sample—normal magnetization
- M1 Paleomagnetic sample—reverse magnetization
- C1 Clast count sample

Elevation (ft)



CROSS SECTION EXPLANATION

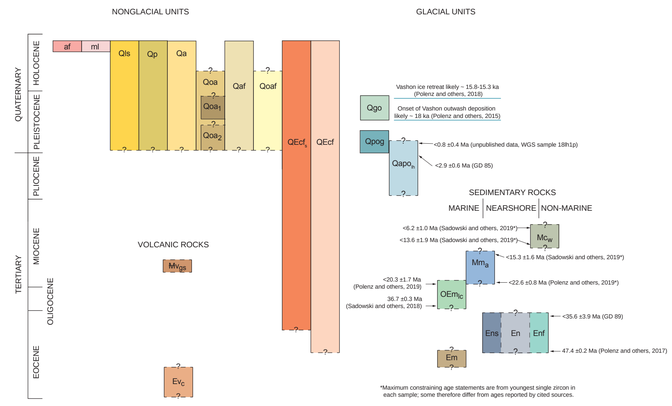
Arrows show relative fault movement in the plane of the cross section.

Geologic units too thin to show as polygons at the scale of the cross section; vertical tics mark separate units.

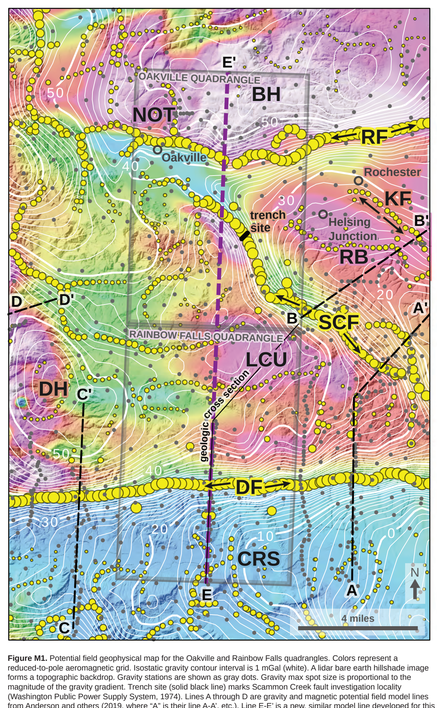
Water well or boring

CORRELATION OF MAP UNITS

PERIODS AND EPOCHS BASED ON USGS FACT SHEET 2010-3059



*Maximum constraining age statements are from youngest single zircon in each sample; some therefore differ from ages reported by cited sources.



aeromagnetic anomaly filtered reduced-to-pole (nanoteslas)

600
500
400
300
200
100
0
-100
-200
-300

gravity max spot
HIGH
LOW

- gravity station
- 10–ft gravity contour (mgal)
- 1–ft gravity contour (mgal)
- geologic cross section

WGS-MODELED PROFILES

- A — A′ Adna model (Sadowski and others, 2019)
- B — B′ Rochester model (Anderson and others, 2019)
- C — C′ Doty west fault model (Anderson and others, 2019; Reedy and others, 2019)
- D — D′ Fall River fault model (Anderson and others, 2019; Reedy and others, 2019)
- E — E′ Rainbow Falls–Oakville model (WGS, unpublished)

PHYSICAL FEATURES

BH–Black Hills
CRS–Chehalis River syncline
DF–Doty fault
DH–Doty Hills
KF–Kopiah fault
LCU–Lincoln Creek uplift
NOT–Northern Oakville trough
RB–Rochester basin
RF–Rochester fault
SCF–Scammon Creek fault

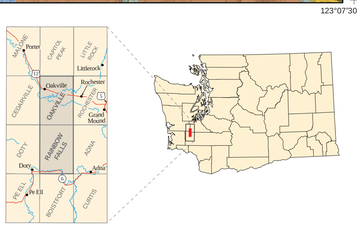
Figure M1. Potential field geophysical map for the Oakville and Rainbow Falls quadrangles. Colors represent a reduced-to-pole aeromagnetic grid. Isostatic gravity contour interval is 1 mGal (white). A lidar bare earth hillshade image forms a topographic backdrop. Gravity stations are shown as gray dots. Gravity max spot size is proportional to the magnitude of the gravity gradient. Trench site (solid black line) marks Scammon Creek fault investigation locality (Washington Public Power Supply System, 1974). Lines A through D are gravity and magnetic potential field model lines from Anderson and others (2019, where "A" is their line A-A', etc.). Line E-E' is a new, similar model line developed for this mapping. The geophysical model lines constrained subsurface inferences along cross-section A-A' and elsewhere in the map area.

Lambert conformal conic projection
North American Datum of 1927; to place on North American Datum of 1983, move the projection lines approximately 24 meters north and 95 meters east as shown by crosshair corner tics
Base map from scanned and rectified U.S. Geological Survey Oakville 7.5-minute quadrangle, provisional edition, 1986, and Rainbow Falls 7.5-minute quadrangle, provisional edition, 1986. revised 1994
Shaded relief generated from a lidar bare-earth digital elevation model (available from the Washington Geological Survey, http://lidarportal.dnr.wa.gov/)
GIS by Michael Polenz, Catherine Samson, Tabor Reedy, and Wesley von Dassow
Digital cartography by Daniel E. Coe
Editing and production by Susan R. Schnur and Maria A. Furtney

SCALE 1:24,000
1 0.5 0 1 MILE
1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 FEET
1 0.5 0 1 KILOMETER
contour interval 40 feet

APPROXIMATE MEAN DECLINATION, 2020

This geologic map was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program under USGS award number G19AC00220, 2019–2020.



Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G19AC00220. 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.

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Licensed Geologist
POLENZ, MICHAEL
Michael Polenz
December 2020