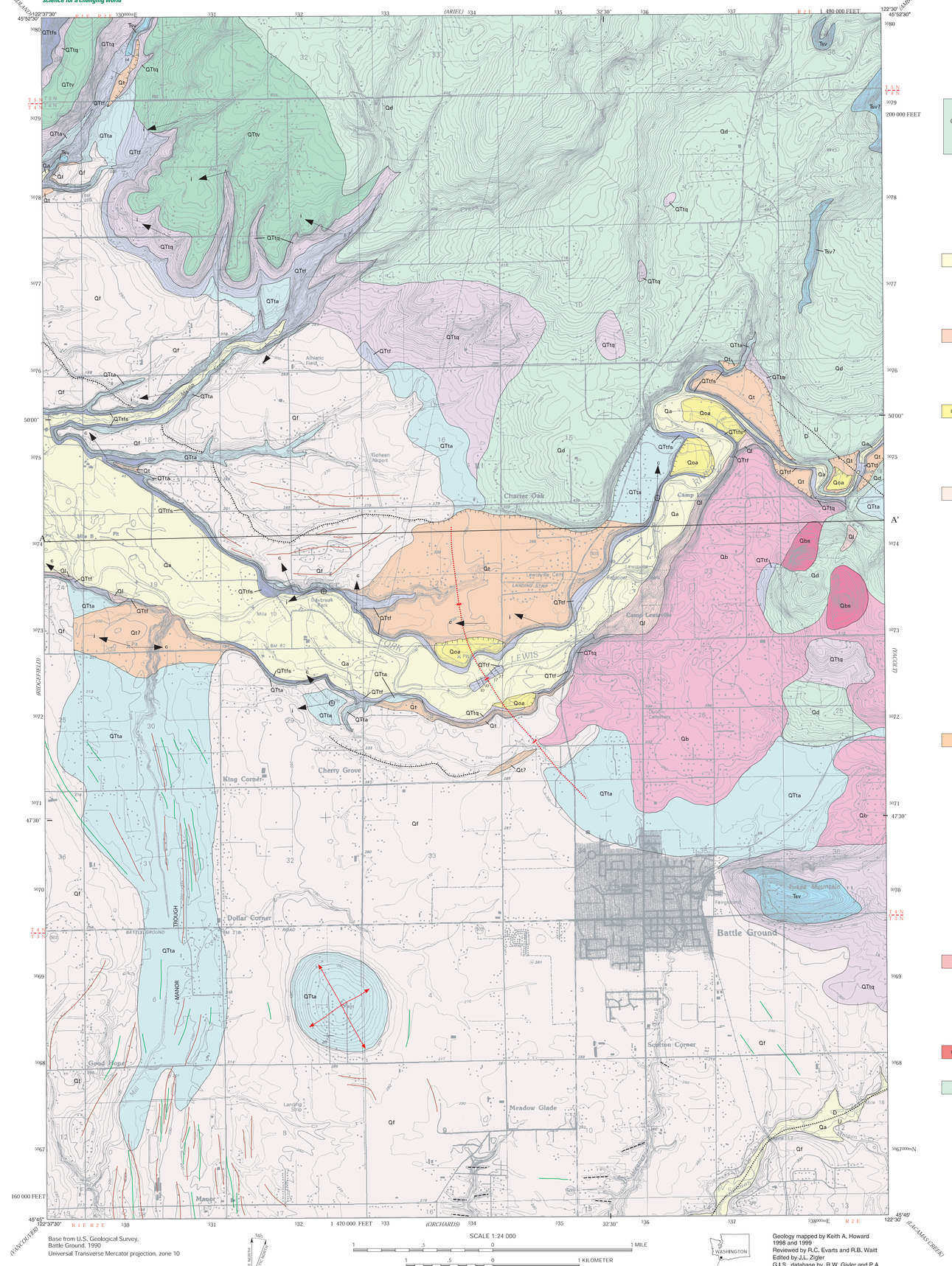
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES MF–2395
Pamphlet accompanies map



Base from U.S. Geological Survey, Battle Ground, 1990
Universal Transverse Mercator projection, zone 10

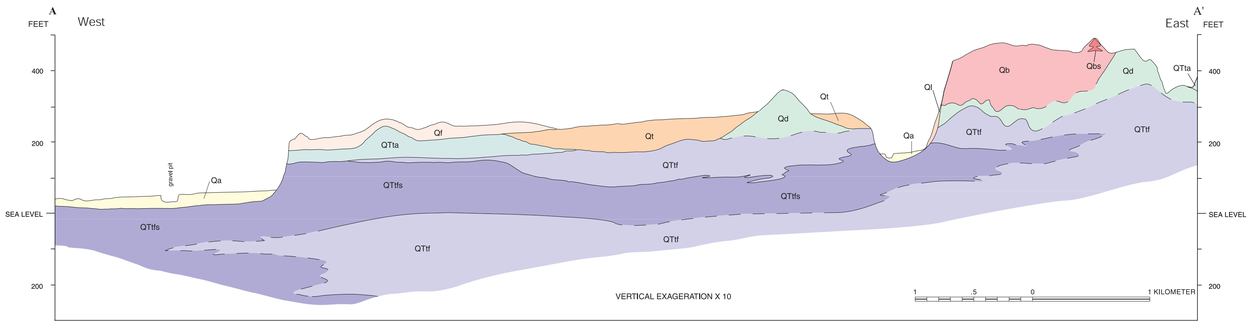
TRUE NORTH
MAGNETIC NORTH
18½°
APPROXIMATE MEAN DECLINATION, 1995

SCALE 1:24 000
1 .5 0 1 MILE
1 .5 0 1 KILOMETER

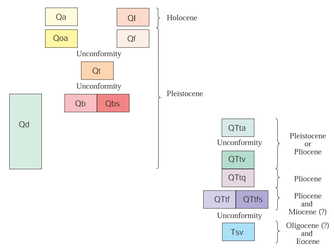
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC DATUM OF 1929

WASHINGTON
MAP LOCATION

Geology mapped by Keith A. Howard
1998 and 1999
Reviewed by R.C. Evarts and R.B. Waitt
Edited by J.L. Zigler
G.I.S. database by R.W. Givler and P.A. Dinterman
Manuscript approved for publication May 8, 2002



CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qa **Young alluvium (Holocene)**—Loose bouldery cobble gravel along present streams and floodplains. Underlies terraces as high as 6 m above East Fork Lewis River. Clasts mainly subrounded volcanic rocks derived from the Skamania Volcanics. Rarer clasts of olivine basalt, rounded quartzite pebbles, and granitoids. Exposed thickness ≥6 m in quarry on floodplain of East Fork Lewis River in west part of quadrangle (SW1/4 NE1/4 NW1/4 sec. 19, T. 4 N., R. 2 E.), where dark soil A horizon 0.3 m thick; maximum thickness of unit in water-well holes 9 m over fine-grained member of Troutdale Formation. In valleys of Mason Creek and Salmon Creek consists of sand, pebbles, and cobbles

Ql **Landslides and basalt talus (Holocene)**—Includes (1) active earthflow formed on glacial drift in east part of quadrangle (NW1/4 NE1/4 sec. 24, T. 4 N., R. 2 E); trees are tilted; (2) slump blocks along bluffs overlooking East Fork Lewis River in west part of quadrangle, where failure surfaces are in clay-rich fine-grained member of Troutdale Formation below resistant gravel assigned to unit **QTta**; and (3) talus of angular basalt blocks, and landforms inferred from mapped topographic contours as slumps, derived from resistant flows of Boring Lava where underlain by less resistant Troutdale Formation and glacial drift, in area of Camp Lewisville (also called Camp Juliana)

Qoa **Older alluvium (upper Pleistocene?)**—Fluvial deposits of sandy cobble gravel inside meander bends of East Fork Lewis River, standing in benches that slope down from 30 to 6 m above river toward the river's outer meander bends. Clasts dominated by volcanic rocks, subangular to subrounded. Locally contains small boulders. Overlies exposed Troutdale Formation fine-grained member at river mile 15.3 (0.8 km northeast of Camp Lewis, NE1/4 NW1/4 SE1/4 sec. 14, T. 4 N., R. 2 E.). Veneer of sand on the unit, recorded in water well logs, possibly correlates with the fine-grained catastrophic flood deposits (**Qfl**), which would indicate a pre-flood deposits age for the older alluvium unit. Thickness typically 3-10 m

Qf **Fine-grained catastrophic flood deposits (upper Pleistocene)**—Muscovite-bearing. Grain size fines northwestward from medium to fine sand in southeast corner of quadrangle through fine sand to silty very fine sand in northwest part of quadrangle. Medium sand also present on terrace near center of quadrangle at center of sec. 28, T. 4 N., R. 2 E. Basal zone locally includes pebbles and cobbles ripped up from underlying gravel of Troutdale Formation (unit **QTta**, exposed in gravel pit at SW1/4 NE1/4 sec. 29, T. 4 N., R. 2 E.). Rounded pebbles and cobbles of volcanic rock and quartzite locally present also on upper surface in west-central part of quadrangle at top of bluff north of Daybreak Park and near southeast corner of quadrangle from Morgan Creek to south of Meadow Glade. Sand mostly massive. Bedding features include (1) planar beds ~10-50 cm thick illustrated in Mundorff's (1964) figure 17 (NE1/4 SW1/4 sec. 18, T. 4 N., R. 2 E.); (2) lenticular beds 0.5 to 20 cm thick of silty very fine sand defined by slight grain size variations and etched in face of quarry (SW1/4 NE1/4 sec. 29, T. 4 N., R. 2 E.); and (3) rythmites consisting of at least seven wavy irregular graded beds averaging 10-20 cm thick and composed of well-sorted, loose, fine sand (pale greenish orange 10 YR 8/4, partly mottled to denser rusty hues) grading up to thinner (~4 cm), lighter-hued (10 YR 8/3), poorer sorted, more resistant, silty fine sand, exposed (in July, 1998) in ditch 1.6 km south of Dollar Corner (SW1/4 SW1/4 SW1/4 sec. 5, T. 3 N., R. 2 E.). Little weathered except for rust-colored spots and sparse 3-4-mm-thick, hard, round, ferruginous concretions locally present within 2 m of surface, and looser, darker (A horizon?, in part plowed) zone up to 1 m thick. Water-well logs typically record the unit as brown sand, silt, or clay. Thickness from well logs ranges up to 23 m, along western edge of quadrangle near Good Hope, and about 14-15 m in southern part of quadrangle between Manor and Meadow Glade and also near quadrangle center at dune overlooking Daybreak Park from the north. Highest elevation reached by deposit about 310 ft (95 m). Minimum age given by ^{14}C age of overlying peat in bog 0.6 km west of Manor, 13,080±300 yr B.P. (Mullineaux and others, 1978)

Qt **Terrace deposits (upper Pleistocene)**—Loosely consolidated, lenticular to massive, boulder-cobble gravel. Clasts chiefly derived from Skamania Volcanics; subangular to subrounded; rare rounded quartzite pebbles derived from Troutdale Formation; very rare subangular clasts derived from Boring Lava. Typified by 20-m-high exposure in active quarry 1 km southwest of Lewisville Cemetery; bouldery cobble gravel, locally cross bedded (7° west dip of cross beds), and about 5 percent lenses of nonmicaceous, grayish-orange, medium sand (SE1/4 sec. 21, T. 4 N., R. 2 E.). Unit distinguished tentatively from alluvial-fan deposits (**QTta**) by bouldery character, poor sorting, lensoid bedding, and poor consolidation. As contacts with that unit rarely exposed, located only roughly. Imbrication and crossbedding indicate mostly westward currents. Underlie part of fluvial terrace ~30 m above East Fork Lewis River; locally (1.5 km east of Cherry Grove) mapped where boulders lie on 3-m-high cut-bank overlooking this terrace. Inset into alluvial-fan deposits, glacial drift, and basalt of Battle Ground. Terrace graded to level higher than base of glacial drift and lower than top of alluvial-fan deposits. Includes unexposed deposits that form terrace remnants that are graded to a similar level along Lockwood Creek in the northwest corner of the quadrangle. Unit thickness 25-30 m above Troutdale Formation fine-grained member on main terrace near Lewisville Cemetery (secs. 21, 22, T. 4 N., R. 2 E.) where penetrated by numerous water wells. Local thickness as great as >40 m (and base deeper than current river grade) inferred 2 km northwest of King Corner, where unit tentatively mapped to include gravel deposit ≥35 m thick exposed on inaccessible river bluff (SW1/4 NW1/4 SE1/4 sec. 19, T. 4 N., R. 2 E.) and 5 m of higher, loose, imbricated, slightly micaceous sandy cobble gravel and crossbedded roundstone pebble gravel (volcanic clasts, rare quartzite pebbles) exposed in gravel pit (SE1/4 SW1/4 sec. 19, T. 4 N., R. 2 E.)

Qb **Basalt of Battle Ground (upper Pleistocene)**—Vesicular, gray to black, diktytaxitic, fresh olivine basalt, weathered to soil in upper part. Two flow units with massive centers and vesicular flow tops exposed on bluff above East Fork Lewis River. Correlated with Boring Lava of Treasher (1942). Thickness up to 40 m for flows and up to 60 m including basalt scoria subunit (**Qbs**) at cinder cones. Age 0.1 Ma based on preliminary ages using $^{40}Ar/^{39}Ar$ method (R. Fleck and R. Evarts, oral commun., 2000, 2001): about 107 ka at northernmost outcrop overlooking East Fork Lewis River (NE1/4 SE1/4 sec. 14, T. 4 N., R. 2 E.) and 99±57 ka where exposed in Battle Ground Lake maar crater 0.5 km east of quadrangle; that crater contains sediment at least 20 ka (Barnosky, 1985). Also includes:

Qbs **basalt scoria**—Red to gray; highly vesicular; includes agglutinate in SW1/4 NW1/4 sec. 24, T. 4 N., R. 2 E. Forms steep hills, evidently cinder cones. Locally described in well log as multicolored pumice. Buttresses against bouldery glacial drift (NE1/4 SW1/4 sec. 24, T. 4 N., R. 2 E.)

Qd **Glacial drift (Pleistocene)**—Amboy Drift of Mundorff (1984). Till and lesser stratified drift. Clasts largely intermediate and mafic volcanic rocks; rarer silicic volcanic rocks and rounded quartzite pebbles. Boulders 1-2 m across in places, such as in the north-central edge of the quadrangle (SE1/4 NW1/4 SW1/4 sec. 33, T. 5 N., R. 2 E.) and in the northeast part of the quadrangle west of Rock Creek (sec. 11, T. 4 N., R. 2 E). At east edge of this quadrangle along north bank of East Fork Lewis River, unit includes crossbedded sharpstone pebble gravel containing isolated blocks and boulders, gradationally overlain 3 m above river bed by angular boulders 1-3 m across, in turn overlain, on terrace 20 m higher, by boulder-cobble gravel. Thickness to at least 30 m (Mundorff, 1964, fig. 12; 1984) where lowest exposures reach down to about 210-230 ft (64-70 m) elevation along East Fork Lewis River near mouth of Rock Creek. Locally dissected by Mason Creek's middle fork, as indicated by till and boulder float present on interfluves, overlying Troutdale Formation. Diamict interpreted as drift exposed in valley of upper parts of Mason Creek's east fork suggests that drift coats the valley walls (SE1/4 SW1/4 sec. 4, T. 4 N., R. 2 E.; and SE1/4 SE1/4 sec. 34, T. 5 N., R. 2 E.). Southern part of drift underlies the basalt of Battle Ground, as identified where (1) poorly exposed bouldery and cobbly deposit (till?) is below basalt of Battle Ground outcrops along road 1 km northeast of Camp Lewis (NE1/4 SE1/4 sec. 14) and (2) float of subrounded to subangular boulders and cobbles derived from Skamania Volcanics veneer hills between mapped scoria and flows of basalt of Battle Ground and well logs show basalt is absent from subsurface (secs. 24, 25, T. 4 N., R. 2 E.). Overlies Troutdale Formation and Skamania Volcanics. Proposed by Mundorf (1984) to correlate with late Pleistocene Hayden Creek Drift based on average thickness (1-1.5 mm) of weathering rinds on volcanic clasts; Crandell (1987) suggested an older till also present based on greater thickness of weathering rinds (3 to 15 mm) on basalt clasts, as in till near Mason Creek (Crandell reported his outcrop as NW1/4 NE 1/4 sec. 9, T. 4 N., R. 2 E., but as exposure is lacking there, the location may be nearby roadcut exposure in NE1/4 SE1/4 SW1/4 sec. 4)

Troutdale Formation—Considered to be Pliocene and Miocene by Tolan and Beeson (1984), but here suspected to be in part Pleistocene. Subdivided into informal members:

QTta **Alluvial-fan member (Pleistocene(?) and (or) Pliocene)**—Moderately consolidated, massive, moderately well sorted, clast-supported, sandy cobble and pebble gravel. Clasts largely derived from the Skamania Volcanics, rounded to subrounded; some rounded quartzite pebbles. Local nonmicaceous sand lenses and micaceous clayey silt beds. Well expressed near Mason Creek (NE1/4 SE1/4 SW1/4 sec. 8, T. 4 N., R. 2 E.) where ~22 m of pebble and cobble gravel and minor sand lenses, unconformable on fine-grained member, is overlain gradationally by 1-m-thick bed of red silt, overlain unconformably by gravel 3 m thick gradational upward to semi-consolidated pebbly sandy red-brown silt 2 m thick grading up to higher pale gray silt 2 m thick underlying fan surface. Rare subtle clast imbrication and crossbeds indicate southwest-directed paleocurrents. Surface of unit outlines alluvial-fan shapes embayed in and graded upslope to base of hills eroded into Troutdale Formation quartzite-clast member and fine-grained member; also graded upslope to or above glacial drift limit. Distinguished from terrace deposits (**Qt**) by relative lack of boulders, better sorting, greater consolidation, and greater degree of weathering; the contact with terrace deposits was observed in an active quarry where 6 m of loose cobble gravel (assigned to terrace deposits, **Qt**) overlies quartzose-sand-matrix, pebble-cobble gravel 4 m thick (**QTta**), above sand unit of fine-grained member of Troutdale Formation (**QTtfs**) (NW1/4 SW1/4 sec. 18, T. 4 N., R. 2 E.). Distinguished from quartzite-clast member by (1) geomorphic fan surface that embays the quartzite-clast member, (2) low concentration of quartzite pebbles and of micaceous sand, and (3) southwest-directed paleocurrent indicators. Mapped to include material underlying dissected fan landform that embays the valley of Lockwood Creek. Mapped south of East Fork Lewis River to include volcanic clast-rich gravel poorly exposed in Manor flood channel west of Dollar Corner and King Corner, well sorted gravel exposed in gravel pit 0.8 km northwest of Cherry Grove, and rocks that cap large domal hill 1 km southeast of Dollar Corner, including poorly consolidated, micaceous, medium sandstone with south-dipping parting, questionably bedding, exposed in ditch on south side of hill. Thickness to at least 30 m. Overlies fine-grained member of Troutdale Formation. Weathering in member has turned a minority of volcanic pebbles and small cobbles rotten to as deep as 30 m below top of member, indicating age much older than Fraser glaciation (compare with Crandell, 1987). Includes some rocks previously mapped as alluvial fan deposits and as terrace gravel (Mundorff, 1964). Forms much of the Troutdale aquifer (Mundorff, 1964; Swanson and others, 1993)

QTtv **Volcanic-clast member (Pleistocene or Pliocene)**—Moderately consolidated pebble and cobble gravel. Subangular to subrounded intermediate to mafic volcanic clasts dominate; rare rhyolite clasts and petrified wood; some rounded quartzite pebbles. Interbedded sand and rip-up clasts of clay. Measured clast imbrication indicates west-southwest-directed paleocurrents. Includes diamict, at least 2 m thick, exposed in roadcut in SW1/4 NE1/4 SE1/4 sec. 36, T. 5 N., R. 1 E.; also exposed 1 km northwest of the quadrangle. Distinguished from Troutdale Formation quartzite-clast member on basis of greater cobble component, greater clast population derived from Skamania Volcanics relative to quartzite, and more westerly paleocurrent directions. Poorly exposed, but map relations indicate deeply dissected and overlies Troutdale Formation quartzite-clast member. Derived chiefly from Cascade Range; perhaps equivalent to Troutdale Formation Cascadian facies of Tolan and Beeson (1984). Thickness >30 m. May include outwash or other drift

QTtq **Quartzite-clast member (Pliocene)**—Clast-supported, well-sorted sandy pebble gravel and sand; cobble gravel less common. Deeply weathered to many meters such that volcanic pebbles can be cut with a shovel. Massive or poorly bedded. Gravel clasts about one-quarter to one-third, well-rounded pebbles of quartzite and lesser chert, schist, and gneiss; and dominant, well-rounded to subrounded pebbles to cobbles of volcanic rocks. Muscovite sand grains conspicuous. As mapped, includes micaceous medium sand in highlands 2 km northeast of Battle Ground containing pebbles derived from Skamania Volcanics. Thickness 30-45 m

QTtf **Fine-grained member (Pliocene and Miocene?)**—Lower member of Mundorff (1964). Clay, silt, sand, and rare gravel. Lignite and plant fragments common (for example along a fork of Mason Creek in NW1/4 NE1/4 NE1/4 sec. 8, T. 4 N., R. 2 E., at Lewisville Park, and noted in numerous well logs). Clay and clayey silt beds 1-3 m thick hard and resistant to erosion. Silt beds range in color from grayish-yellow-green to light-greenish-gray (5 GY 6/2 to 5 GY 7/1); commonly contain floating quartz sand or silt grains in clay-rich matrix that possibly derives from alteration of volcanic lithic or glass grains. Clay-rich basal part contains angular volcanic clasts as long as 0.5 m where above clay saprolite developed on the older volcanic rocks (**Tv**) along Lockwood Creek. Thickness from well logs >120 m. May correlate with Sandy River Mudstone. Includes:

QTtfs **Sand facies**—Medium, fine, and coarse micaceous, quartzose sand. Yellowish gray (5 Y 7/2). Muscovite grains conspicuous. Varies from loose to consolidated. Contains rip-up clasts of clay as large as 1 m diameter. Exhibits trough crossbedding indicating north- to northwest-directed paleocurrents. Locally contorted in soft-sediment deformation structures (SE1/4 NE1/4 SE1/4 sec. 20, T. 4 N., R. 2 E.). Thickness as great as 60 m determined from water-well records. Exposure near northwest corner of quadrangle directly underlies quartzite-clast member and likely is at higher stratigraphic level than rest of unit

Tsv **Skamania Volcanics (Eocene and Oligocene?)**—Called Skamania volcanic series by Trimble (1963). Intermediate to mafic flows. Low-grade metamorphosed, zeolitic. Two analysed samples contained 53.0 and 54.7 percent SiO_2 (R. Evarts, written commun., 2001). Typically contains sparse glassy plagioclase phenocrysts ~1 mm across in intergranular matrix. Massive flow rock; locally exhibits platy parting. Northeasternmost exposure sparsely phyric to aphyric; nearby mapped patches (secs. 1 and 12, T. 4 N., R. 2 E.) inferred where steep slopes suggest near-absence of overlying Amboy Drift. Exposure near northwest corner of quadrangle porphyritic, containing about 10 percent plagioclase phenocrysts 0.2 to 1.5 mm across; partly vesicular; deeply weathered to pale blue (5B 6/2) clay saprolite beneath Troutdale Formation fine-grained member; zeolite (clear platelike crystals) amygdules weathered in the saprolite to light-bluish-gray (5B 7/1) spots. Forms substrate for the other rocks

Terrace scarp—Dotted where concealed. Separates terraced alluvial units

Possible concealed fault—U indicates upthrown side, D downthrown side

Lineament—Identified as a series of parallel, barbed-tributary gullies

Strike and dip of bedding

Inclined

Horizontal

Current direction—Measured at tail of arrow. Determined from:

i Pebble imbrication—Direction opposite to preferred dip of pebbles

c Cross beds—Direction of dip of foreset beds

Syncline—Dotted where concealed and inferred from subsurface elevation of top of Troutdale Formation fine-grained member, sand facies, as interpreted from water-well logs

Structural dome—Rounded hill; well logs indicate updomed subsurface base of gravel above Troutdale Formation fine-grained member (Mundorff, 1964; Swanson and others, 1993)

Flood fluting—Topographic ridges and valleys in fine-grained catastrophic flood deposits and locally in underlying older gravel. Relief mostly 1 to 11 m from ridge crests to valleys. Fluvial dunes north of East Fork Lewis River. Valleys commonly bogs, and locally underlain by thin peat (Rigg, 1958)

Ridge

Valley

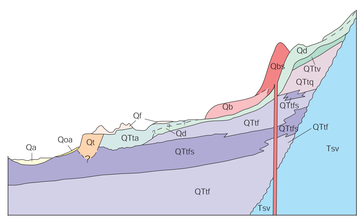


Figure 2. Sketch showing stratigraphic and geomorphic relations among units in the Battle Ground quadrangle.

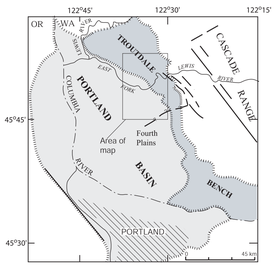


Figure 1. Map showing the area of the Battle Ground quadrangle within the Portland Basin of Washington and Oregon. Faults shown as heavy lines, dashed where inferred, base of hills shown as hachured lines, and patterned area designates city of Portland.

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GEOLOGIC MAP OF THE BATTLE GROUND 7.5-MINUTE QUADRANGLE, CLARK COUNTY, WASHINGTON

By
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2002