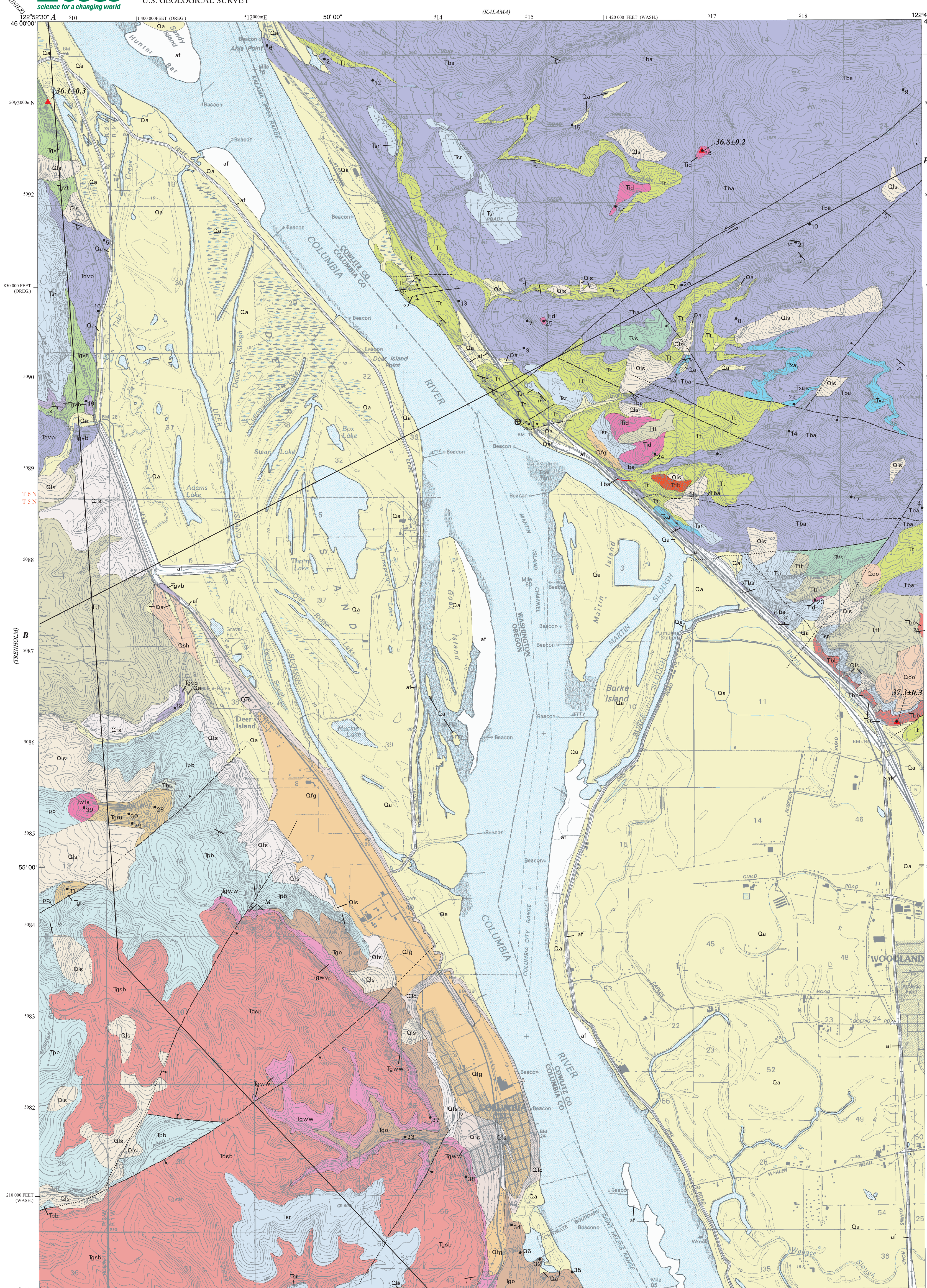


Base from U.S. Geological Survey, Deer Island, OR,WA, 1990.
Universal Transverse Mercator projection, zone 10

APPROXIMATE MEAN DECLINATION, 1995

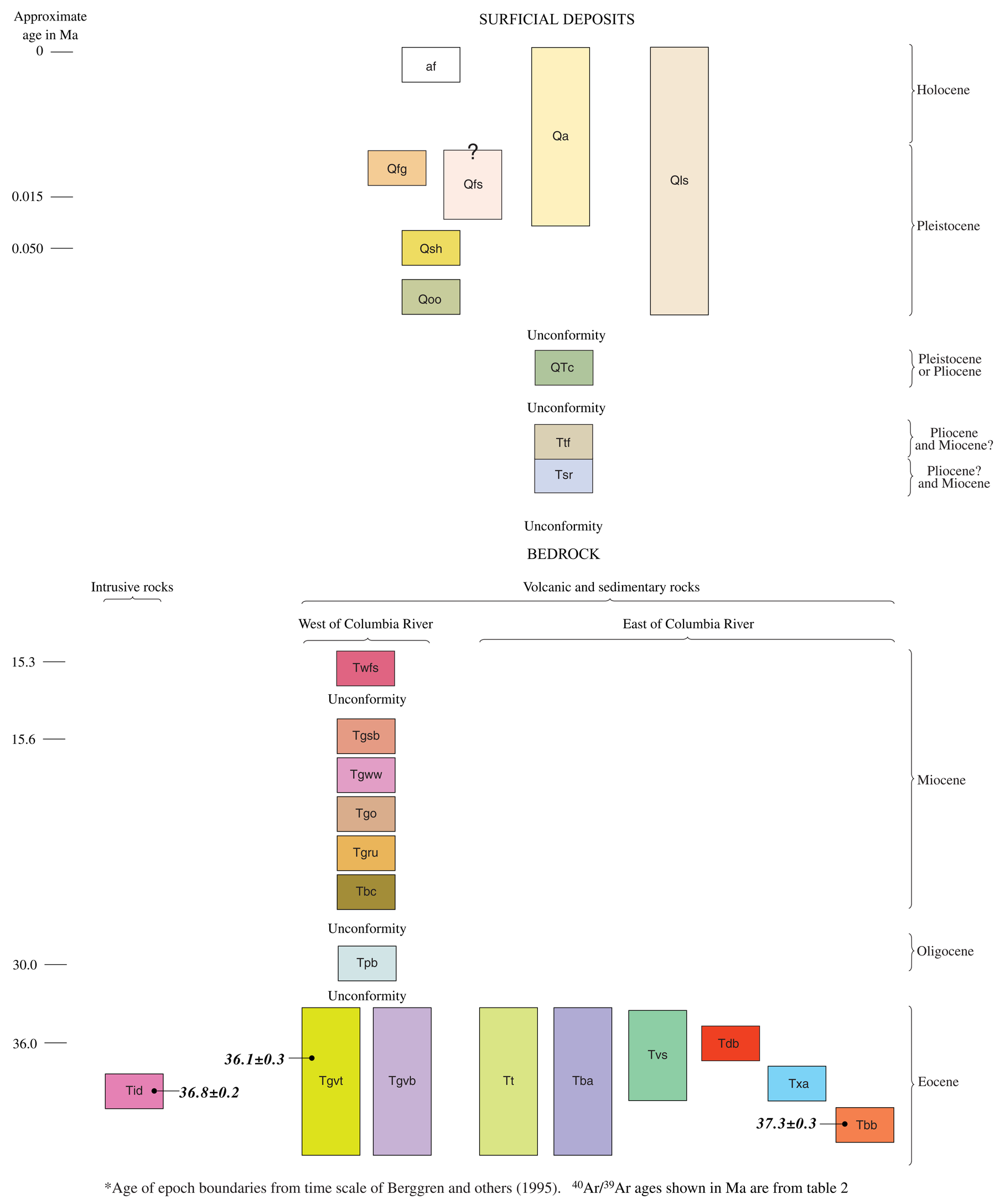
SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC DATUM OF 1929

MAP LOCATION

Geology mapped by R.C. Evarts, 1997-1999; assisted by K.S. Anderson, 1997; B.H. Reid, 1998
Digital database by R.W. Givler, L.A. Ray, and P.A. Dinterman
Edited by J.L.Zigler
Manuscript approved for publication March 22, 2002

CORRELATION OF MAP UNITS*



*Age of epoch boundaries from time scale of Berggren and others (1995). $^{40}Ar/^{39}Ar$ ages shown in Ma are from table 2

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

af — **Artificial fill (Holocene)**—Unconsolidated soil, sand, gravel, and rock used to construct elevated road and railroad beds and levees on Columbia River floodplain and sandy dredge spoils removed from Columbia River shipping channel

Qa — **Alluvium (Holocene and Pleistocene)**—Unconsolidated, poorly sorted to well-sorted, massive to laminated, commonly cross-stratified sand, silt, and minor gravel of Columbia River floodplain and local accumulations of poorly to moderately sorted, crudely stratified sand and gravel in valley bottoms of tributary streams. Locally includes fine-grained lacustrine, aeolian, and organic-rich marsh deposits as well as unmapped areas of artificial fill (af)

Qls — **Landslide deposits (Holocene and Pleistocene)**—Diamictons of bedrock and (or) surficial material transported downslope en masse. Mapped slides predominantly deep-seated failures ranging from more or less coherent slumps to internally disrupted rock-avalanche deposits; small unmapped debris-flow deposits are widespread in terrain characterized by thick soil horizons. Landslides particularly abundant in areas underlain by poorly consolidated sedimentary rocks of the Pittsburg Bluff Formation (Tpb) and clay-rich tuffaceous rocks (units Tvs and Tt). Small unmapped slides are also common along steep slopes of terraces composed of poorly consolidated, fine-grained flood deposits (unit Qfs) or beds of the Sandy River Mudstone and Troutdale Formation (units Tsr and Ttf)

Cataclysmic flood deposits (Pleistocene)—Sediments deposited by colossal glacier outburst floods or jökulhlaups initiated by repeated failures of ice dam at Pleistocene Lake Missoula in Montana, some of which released as much as 2184 km^3 of floodwater (Bretz, 1925, 1969; Allison, 1978; Baker and Bunker, 1985; Waitt, 1985, 1994, 1996; Allen and others, 1986; O'Connor and Baker, 1992). Many floods, hydraulically dammed by the relatively narrow constriction of Columbia River valley in northern part of quadrangle, temporarily ponded in Portland Basin, backed up into tributary valleys, and deposited suspended sediment load (Trimble, 1963). Radiocarbon ages and tephrochronologic data indicate most recent floods occurred between about 15.5 and 12.7 ka (Waitt, 1994) although there is evidence for older cataclysmic flooding events (Patton and Baker, 1978; McDonald and Busacca, 1988; Zuffa and others, 2000; Bjornstad and others, 2001). In this quadrangle divided into:

Qfg — **Gravel facies**—Unconsolidated deposits of massive, poorly sorted, pebbly to cobbly gravel. Forms 1-3-m-thick veneer on terrace surface between Columbia City and Deer Island and smaller deposit north of Martin Island. Diverse and variable clast population; well-rounded to subangular clasts, generally ≤30 cm diameter, include Columbia River Basalt Group, Tertiary and Quaternary volcanic rocks from the Cascade Range, pre-Tertiary granitic and metamorphic rocks, and quartzite. South of Columbia City, deposit rests on Grande Ronde Basalt and consists of subangular to angular basalt clasts with little matrix, presumably eroded from bedrock outcrops at Saint Helens immediately upstream. Deposit near Martin Bluff contains abundant rounded clasts probably reworked from older sedimentary units (Tsr, Ttf and Tc). Unconformably overlies bedded silt and sand along Smith Road west of Columbia City, suggesting deposition from a late flood on older eroded slackwater deposits

Qfs — **Silt and sand facies**—Unconsolidated deposits of rhythmically bedded silt and fine sand that form terraces with surface elevations of 200 to 250 ft (60 to 75 m) between Tide Creek and Columbia City. Locally exceeds 30 m in thickness. Bluish gray in fresh exposures but rapidly oxidizes to light brown. Composed largely of quartz, feldspar, and conspicuous muscovite, indicating deposition by Columbia River rather than by local streams. Thin unmapped deposits of similar character locally mantle topography to elevations as high as 400 ft (120 m). Interpreted as slackwater sediment that settled out of temporarily ponded floodwaters. Although silt and sand deposits near Columbia City are older than gravel facies (unit Qfg), those found elsewhere may be in part coeval with gravel, reflecting different hydraulic environments in a single flood

Qsh — **Mount St. Helens-derived alluvium (Pleistocene)**—Unconsolidated, moderately to poorly sorted, crudely bedded, coarse sand and sandy, clast-supported, pebble and cobble gravel that forms small dissected terrace remnant about 1.5 km northwest of community of Deer Island, Oregon. As much as 20 m thick. Deposit dominated by Tertiary volcanic rocks but larger clasts include distinctive weathered, white to light-gray, coarsely porphyritic, quartz- and biotite-phyric dacite of the kind produced during the earliest eruptions at Mount St. Helens volcano (Crandell, 1987; Mullineaux, 1996); grains of plagioclase, quartz, and biotite, similar to phenocrysts in the dacite, dominate the sandy fraction. Crossbedding indicates deposition from west-northwest-flowing currents. Terrace inferred to be distal remnant of large but ephemeral alluvial fan constructed at mouth of Lewis River following major eruption(s) during the Ape Canyon eruptive stage of Mount St. Helens, ca. 50? to 36 ka (Crandell, 1987; Scott, 1989) or possibly earlier (Berger and Busacca, 1995; Whitlock and others, 2000; M.A. Clynne, oral commun., 1999)

Qoo — **Old Outwash deposits (Pleistocene)**—Unconsolidated, moderately weathered, moderately sorted to well-sorted cobble gravel that unconformably overlies Neogene sediments (units Tsr and Ttf) on slope about 3 km north of Woodland. Contain well-rounded clasts of diverse volcanic rocks similar to Tertiary rocks of the Cascade Range but lacks quartzite and Columbia River Basalt Group clasts, indicating a Lewis River rather than Columbia River source. Clasts attributable to Mount St. Helens volcano or to Pleistocene basaltic centers in Lewis valley also absent. About 40 m thick. Interpreted as glaciofluvial deposits related to one or more periods of early or middle Pleistocene glaciation in Lewis River drainage (Mundorff, 1964; Crandell, 1987; R.C. Evarts, unpub. mapping)

QTc — **Conglomerate (Pleistocene? and Pliocene)**—Semi-consolidated, thick-bedded, poorly to moderately well sorted, clast-supported, commonly crossbedded, open-work and sand-matrix, pebbly to cobbly conglomerate that underlies virtually undissected terrace surface that slopes uniformly from 90 ft (27 m) at Columbia City to 60 ft (18 m) at Deer Island. Less intensely weathered than typical Troutdale Formation conglomerate. Well-rounded to subrounded clasts are chiefly Tertiary volcanic rocks derived from the Cascade Range and Columbia Plateau; scarce pebbles of coarse-grained granitic rocks, quartzite, and Pliocene olivine-basalt also present; typically weakly to moderately cemented by clay and limonite. Pronounced clast imbrication and foreset bedding indicate deposition from north-flowing currents. Deposit interpreted as erosional remnant preserved in lee of basalt outcrop at its south end

Ttf — **Troutdale Formation (Pliocene and Miocene?)**—Semi-consolidated, massive, poorly sorted to well-sorted pebbly and cobbly conglomerate and local subordinate friable sandstone. On Washington side of Columbia River, crops out in area about 2 to 4 km north of Woodland where as much as 80 m of conglomerate gradationally overlies sand and silt of Sandy River Mudstone. In Oregon, unit is mapped between Merrill and Tide Creeks based largely on water-well logs. Troutdale Formation underlies large area to the east and southeast of this quadrangle (Mundorff, 1964; Swanson and others, 1993; Howard, 2002; R.C. Evarts, unpub. mapping). Clast population dominated by well-rounded cobbles of the Columbia River Basalt Group; typically includes some light-colored granitic and quartzofeldspathic metamorphic rocks and conspicuous quartzite clasts stained yellow to brown by iron oxides; weakly to moderately cemented by clay and limonite produced by weathering of basaltic clasts. Sandstone interbeds and matrix of conglomerate generally composed of micaceous arkose compositionally similar to Sandy River Mudstone. These lithologies indicate primary source areas east of the Cascade Range and deposition from ancestral Columbia River. Upper several meters of unit thoroughly decomposed to red, structureless, clayey soil; in such areas, presence of scattered quartzite pebbles on surface is only evidence of parent material. Highest mapped exposures found at elevation of about 550 ft (170 m) but original top of unit was apparently much higher, as indicated by scattered quartzite pebbles in soil at elevations as high as 1200 ft (365 m)

Tsr — **Sandy River Mudstone (Pliocene? and Miocene)**—Variable but generally fine-grained and poorly indurated sedimentary rocks including thin-bedded claystone, mudstone, and siltstone, planar, lenticular, and crossbedded sandstone and siltstone, and lenses of pebbly sandstone and pebble to small-cobble basalt-clast conglomerate, commonly limonite cemented. Underlies extensive upland surface as high as 500 ft (150 m) west of Columbia River, where unit is as much as 100 m thick. Distribution east of river patchy; a sandstone-dominated section as much as 120 m thick overlies Paleogene bedrock adjacent to Interstate Highway 5 about 2 to 4 km north of Woodland and grades upward into conglomerate of Troutdale Formation. Typical sandstone is light to medium gray and moderately friable where fresh, weathers to orange-brown color, locally limonite-cemented; composed of subangular grains of quartz, plagioclase, orthoclase, a variety of volcanic and metamorphic rock fragments, muscovite, and minor biotite, tourmaline, magnetite, hornblende, and pyroxene. Lenticular conglomeratic interbeds lithologically similar to Troutdale Formation. Features such as crossbedding and cut and fill structures indicate fluvial depositional environment. Varicolored, clayey, tuffaceous beds with locally abundant carbonaceous woody fragments unconformably overlie member of Sentinel Bluffs of the Grande Ronde Basalt (unit Tgsb) southwest of Columbia City; observed only in quarry-wall exposure immediately south of this quadrangle, hence distribution of unit in this area is uncertain; at least 20 m and possibly as much as 50 m thick. Lithology and stratigraphic position of these deposits suggest correlation with Sandy River Mudstone of Trimble (1963), lower member of Troutdale Formation of Mundorff (1964), and Wilkes Formation of Roberts (1958); the strata overlying Grande Ronde Basalt near Columbia City may be equivalents of the Vantage interbeds (Beeson and others, 1985; 1989; Beeson and Tolan, 1990). Plant fossils from locality along route of Interstate Highway 5 near east edge of quadrangle are latest Miocene to early Pliocene in age (E.I. Sanborn, cited in Wilkinson and others, 1946)

BEDROCK

Intrusive rocks

Tid — **Intrusive dacite (Eocene)**—Tabular to irregular dikes and sills of black, sparsely to moderately porphyritic, vitric pyroxene dacite and silicic andesite intruding Eocene strata east of Columbia River. Commonly exhibits well-developed columnar jointing. Consists of phenocrysts of plagioclase (5-15 percent; 1-2 mm long; commonly contain abundant glass inclusions), augite (1-5 percent; 0.5-1 mm across), and hypersthene (0.5-4 percent; 0.5-1 mm across), and microphenocrysts of Fe-Ti oxide (<1 percent; 0.2-0.5 mm) in a hyalopilitic to pilotaxitic groundmass of plagioclase, pyroxene, and Fe-Ti oxide in abundant reddish, variably hydrated glass. $^{40}Ar/^{39}Ar$ incremental heating age of 36.8±0.2 Ma determined on plagioclase from intrusive body on west flank of Green Mountain (R.J. Fleck, written commun., 1999)

Volcanic and sedimentary rocks

West of Columbia River

Columbia River Basalt Group (Miocene)—Fresh, gray, variably vesicular, aphyric to sparsely plagioclase-phyric lava flows of tholeiitic basalt and basaltic andesite. Unaltered nature contrasts with pervasive zeolite-facies metamorphism of Paleogene rocks. Where best visible in quarry-wall exposures, flows typically exhibit well-developed colonnade and entablature jointing patterns and vesicular flow tops. Upper few meters commonly thoroughly weathered to red saprolite. In this quadrangle, consists of:

Wanapum Basalt

Frenchman Springs Member

Twfs — **Basalt of Sand Hollow**—Small erosional remnant of dark gray, microvesicular, nearly aphyric to microphyric, spheroidally weathered basalt exposed on western flank of Maple Hill. Contains widely scattered plagioclase phenocrysts and glomerocrysts as large as 1 cm and plagioclase and rare olivine microphenocrysts about 1 mm across in intersertal groundmass of plagioclase laths and augite and olivine granules in abundant virtually opaque glass with skeletal Fe-Ti oxides; microvesicles partly filled with calcite or green, yellow, or orange clay. Distinguished from Grande Ronde Basalt flows by a higher TiO_2 content of about 3.0 wt. percent (table 1). Chemistry, petrography, and magnetic polarity (J.T. Hagstrum, written commun., 2001) indicates correlation with informal basalt of Sand Hollow on Columbia Plateau (Beeson and others, 1985; 1989; Hooper, 2000) erupted about 15.3 Ma (Reidel and others, 1989). Position topographically below Grande Ronde Basalt flows suggests this flow occupied canyon eroded into the older flows

Grande Ronde Basalt—Light- to dark-gray, vesicular to microvesicular, aphyric to microphyric to sparsely plagioclase-phyric lava flows of tholeiitic basaltic andesite with relatively low TiO_2 contents (table 1), characteristic of the Grande Ronde Basalt of the Columbia River Basalt Group (Mangan and others, 1986; Beeson and others, 1989; Reidel and others, 1989). Typical samples are intersertal, containing lathlike plagioclase, granular clinopyroxene, and Fe-Ti oxide crystals in abundant dark glass. Textures resemble those described by Long and Wood (1986) for correlative flows on the Columbia Plateau. Aggregate thickness of Grande Ronde Basalt flows in Deer Island quadrangle approximately 200 m near Columbia City, thins northward. K-Ar and $^{40}Ar/^{39}Ar$ age determinations from the Columbia Plateau indicate that Grande Ronde Basalt flows were emplaced 16.5 to 15.6 Ma (Reidel and others, 1989). Based on field, chemical, and paleomagnetic properties, most Grande Ronde Basalt flows in this quadrangle can be assigned to informal members corresponding to those defined by Reidel and others (1989) on Columbia Plateau (terminology follows that of Reidel, 1998)

Tgsb — **Member of Sentinel Bluffs**—Flow or flows characterized by relatively high MgO content (4.5 to 4.7 wt. percent) and normal magnetic polarity. Contains scarce plagioclase phenocrysts as large as 5 mm across in a fine to medium-grained, intersertal to intergranular, microphyric groundmass with minor olivine; commonly diktytaxitic. As much as 90 m or more thick. Chemistry, petrography, and remanent magnetization (J.T. Hagstrum, written commun., 1999) indicate equivalence with Sentinel Bluffs unit of Reidel and others (1989; Beeson and others, 1989; Wells and others, 1989), which is within the N_2 magnetostratigraphic unit of Swanson and others (1979) and was erupted about 15.6 Ma

Tgww — **Member of Winter Water**—Sparsely plagioclase-phyric to glomerophyric basalt with relatively low MgO content (3.7 to 3.9 wt. percent) and normal magnetic polarity; plagioclase phenocrysts 1 to 3 mm across; groundmass aphyric to sparsely microphyric. Underlies member of Sentinel Bluffs (unit Tgsb); approximately 20 to 40 m thick. Chemical and paleomagnetic characteristics indicate probable correlation with Winter Water unit of Reidel and others (1989; Beeson and others, 1989; Wells and others, 1989), which is within the N_2 magnetostratigraphic unit of Swanson and others (1979)

Tgo — **Member of Ortley**—Aphyric, intersertal to intergranular basalt with relatively low MgO content (3.4 to 3.6 wt. percent) and normal magnetic polarity. Underlies member of Winter Water (unit Tgww). Approximately 20 to 60 m thick. Chemically and paleomagnetically equivalent to Ortley unit of Reidel and others (1989; Beeson and others, 1989; Wells and others, 1989), which is within the N_2 magnetostratigraphic unit of Swanson and others (1979)

Tgru — **Unassigned, reversely-magnetized, high-MgO basalt**—Two or more flows with generally intermediate MgO contents (4.1 to 4.2 wt. percent) and reversed magnetic polarity (J.T. Hagstrum, written commun., 1999, 2002). Forms bulk of Maple Hill. Locally contains rare plagioclase phenocrysts as large as 5 mm across in a microphyric, intersertal to intergranular groundmass. Relatively high CaO and Cr contents indicate affinity with high-MgO Grande Ronde basalts (M.T. Beeson and T.L. Tolan, oral commun., 2001). Does not correspond to any of the informal members described by Reidel and others (1989)

Tbc — **Basalt-cobble conglomerate (Miocene)**—Poorly lithified, poorly sorted, clast-supported conglomerate composed largely of weathered, rounded, pebbles and cobbles of Grande Ronde basalt, accompanied by smaller amounts of clasts similar to Eocene volcanic rocks of the area. Lensoid body approximately 40 m thick that occupies paleochannel incised into marine sandstone (unit Tpb) and directly underlies low-to-intermediate-MgO Grande Ronde Basalt flow (unit Tgru) on northeast flank of Maple Hill. Correlative with the Scappoose Formation of Van Atta and Kelty (1985)

Tpb — **Pittsburg Bluff Formation (Oligocene)**—Poorly exposed and deeply weathered, massive, friable, well-bedded, fine- to coarse-grained, tuffaceous, arkosic, and lithic sandstone, siltstone, mudstone, tuff, and rare granule and pebble conglomerate. Crops out only west of Columbia River. Approximately 200 m thick in this quadrangle but both base and top of unit are erosional unconformities. Thickness increases to the west (Wilkinson and others, 1946). Depositional environments predominantly shallow marine but unit contains rare lignite seams (Yancey and Geer, 1940; Wilkinson and others, 1946) indicating local subaerial, deltaic, or coastal plain settings. Sandstones consist of angular to subangular grains of porphyritic to aphyric, mafic to intermediate volcanic rocks, pumice, metamorphic rocks, monocrystalline quartz, plagioclase and alkali feldspar, muscovite, biotite, green and brown hornblende, pyroxene, epidote, titanite, apatite, zircon, and garnet. Exposures 3 to 5 km west of quadrangle contain a molluscan fauna similar to that of the Pittsburg Bluff Formation (Wilkinson and others, 1946), which is of latest Eocene to early Oligocene age; poorly preserved molds and casts of gastropods and pelecypods collected from roadcut about 1.5 km southeast of Maple Hill are consistent with an Oligocene age and probably reflect deposition in shallow continental shelf setting (E.J. Moore, written commun., 1999). As mapped, upper part may include beds correlative with the late Oligocene to middle Miocene Scappoose Formation (Warren and Norbisrath, 1946; Van Atta and Kelty, 1985)

Goble Volcanics (Eocene)—Dominantly mafic lava flows and interbedded volcaniclastic beds west of Columbia River. In this quadrangle consists of:

Tgvt — **Tuff**—Heterogeneous unit composed of andesitic to rhyolitic tuff, pumiceous lapilli tuff, pumiceous and lithic tuff breccia; very poorly sorted, matrix-supported, relatively coarse-grained deposits predominate; inferred to be mostly of pyroclastic-flow and lahar origin. Exposed in roadcuts along U.S. Route 30 north of Tide Creek. Generally light colored, ranging from white to light gray to green; weathers buff to yellowish brown. Most tuff beds exhibit minimal compaction, and some contain uncompacted pumice blocks as large as 30 cm across. Angular lithic blocks in lahar breccias as large as 1 m across. Carbonized woody debris present in some beds, especially near their base. Phenocrysts rarely constitute more than 10 percent of juvenile material in tuff and include plagioclase, augite, hypersthene, and Fe-Ti oxide but no quartz, hornblende, or biotite. Original glass is completely replaced by fine-grained smectites and (or) zeolites, of which clinoptilolite is the most common. $^{40}Ar/^{39}Ar$ age of plagioclase separated from a crystal-rich lapilli tuff in northwestern part of quadrangle is 36.1±0.3 Ma (R.J. Fleck, written commun., 1999)

Tgvb — **Basaltic andesite**—Flows and flow breccia of dark-gray to brown, porphyritic to seriate to (rarely) aphyric basaltic andesite. Flows generally 3 to 6 m thick, with reddish, vesicular, zeolitized tops; flow interiors blocky jointed to platy. Flows locally separated by thin (<0.5 m thick), massive, red-brown paleosols developed on fine-grained tuffaceous interbeds. Typical flows contain phenocrysts of plagioclase (10-35 percent; 1 to 5 mm long) and olivine (as much as 4 percent; 0.5 to 2 mm across; commonly partly resorbed and rimmed by fine-grained granular pyroxene ± magnetite; invariably replaced by smectite ± hematite, carbonate, serpentine, quartz; commonly contains minute inclusions of chromian spinel); many flows also contain phenocrysts of augite (as much as 2 percent; 0.5 to 1 mm across) and a few contain hypersthene (0.5 to 1 mm long); intergranular to trachytic groundmass of the same minerals plus Fe-Ti oxide and minor interstitial glass (mostly altered to smectitic clay ± quartz or calcite)

East of Columbia River

Tdb — **Dacite breccia (Eocene)**—Poorly sorted monolithologic breccia composed of angular clasts as large as 1 m across of black to red, locally flow-banded, dacite in matrix of comminuted dacite. Clasts contain sparse small (≤0.5 mm across) phenocrysts of plagioclase and augite in a felsic cryptocrystalline groundmass. Forms small ridge east of Interstate Highway 5 northeast of Martin Island. Most likely a block-and-ash deposit generated by collapse of a dacite dome

Tvs — **Volcaniclastic sedimentary rocks (Eocene)**—Diverse assemblage of continental volcaniclastic rocks of inferred epiclastic origin. Consists of generally well bedded, well-sorted to poorly sorted siltstone, sandstone, conglomerate, and breccia, all composed of volcanic debris. Typically light green to olive green or greenish gray but also white, tan, brown, or maroon. Texturally and compositionally immature; most abundant clasts are volcanic rocks petrographically similar to interbedded lava flows and tuffs; other components include plagioclase, Fe-Ti oxide, and pyroxene crystals, pumice, vitric ash, and carbonized plant remains. Interpreted as debris eroded from older and penecontemporaneous volcanoes and deposited in streams and lakes in medial to distal volcanic settings. Indurated, but easily eroded owing to pervasive replacement by soft clay minerals and zeolites, hence poorly exposed

Tt — **Tuff (Eocene)**—Andesitic to rhyolitic tuff, pumiceous lapilli tuff, and pumiceous and lithic tuff breccia lithologically similar to tuff of Goble Volcanics (unit Tgvt). Well-exposed in cliffs along east bank of Columbia River near Martin Bluff, in nearby railroad cuts, and along Interstate Highway 5 northeast of Martin Island

Tbb — **Basaltic andesite breccia (Eocene)**—Massive, unsorted, monolithologic diamictite composed of angular clasts as large as 1 m of dark-gray to reddish-gray, aphanitic to seriate, sparsely vesicular basaltic andesite in yellowish-gray matrix of comminuted basaltic andesite. Predominantly clast supported but lower part of unit shows inverse grading and higher proportion of matrix. At least 50 m thick; base not exposed; top locally weathered to limonite-stained and bleached saprolite and unconformably overlain by Sandy River Mudstone. Clasts consist of plagioclase, augite, and altered olivine ≤1 mm across in an intergranular to pilotaxitic groundmass of plagioclase, pyroxene, and Fe-Ti oxides poikilitically enclosed by equant oikocrysts (≤0.5 mm) of hypersthene. Textural characteristics suggest unit is a debris-avalanche deposit like the one formed in 1980 at Mount St. Helens. Wilkinson and others (1946) considered breccia to be interbedded with Troutdale Formation sediments, but an $^{40}Ar/^{39}Ar$ age of 37.3±0.3 Ma (R.J. Fleck, written commun., 1999) demonstrates it is a late Eocene bedrock unit

Tba — **Basaltic andesite (Eocene)**—Flows and flow breccia of dark gray to brown, porphyritic to seriate to aphyric basaltic andesite lithologically similar to flows of Goble Volcanics (unit Tgvb); unit locally includes minor andesite flows and volcaniclastic rocks too small or poorly exposed to map

Txa — **Xenolithic andesite (Eocene)**—Distinctive flow of platy, medium- to dark-gray, commonly microvesicular, sparsely porphyritic andesite containing scattered mafic xenoliths. Contains phenocrysts of plagioclase (1 to 2 percent; 0.5-1 mm long), augite (<0.5 percent; 0.5-1 mm across), and olivine (<0.5 percent; 0.5-1 mm across; altered to smectite ± hematite; with minute inclusions of chromian spinel) in a dark, Fe-Ti oxide-rich, commonly streaky, microgranular to cryptocrystalline groundmass. Subsequent, angular to ovoid xenoliths, ≤1 cm across, of coarse-grained, moderately recrystallized, porphyritic basaltic andesite constitute as much as 3 percent of flow

Contact—Dashed where approximately located; short-dashed where inferred; dotted where concealed

Fault—Dashed where inferred; dotted where concealed. Ball and bar on downthrown side. Arrows show relative horizontal movement

Basaltic andesite dike

Strike and dip of beds
Inclined
Horizontal

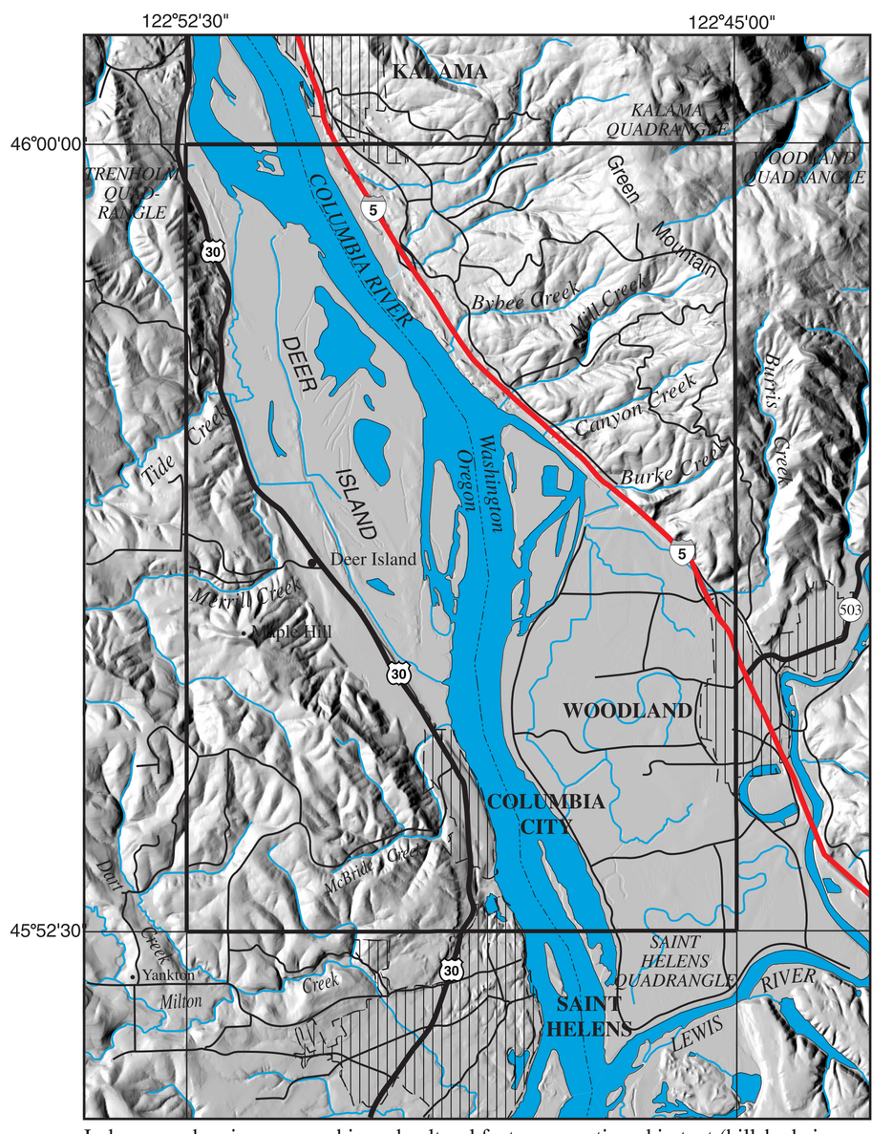
Strike and dip of compaction foliation in pumiceous lapilli tuff

Strike and dip of platy parting in lava flows

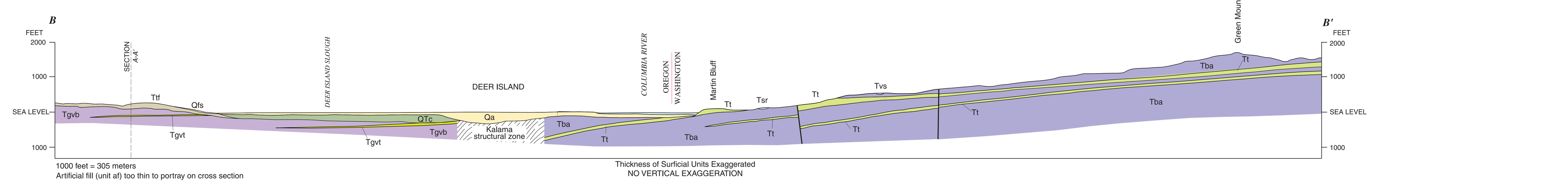
Sample locality for chemical analysis—See table 1

37.3±0.3 — **Sample locality for radiometric age determination and age in Ma (1-σ error)**

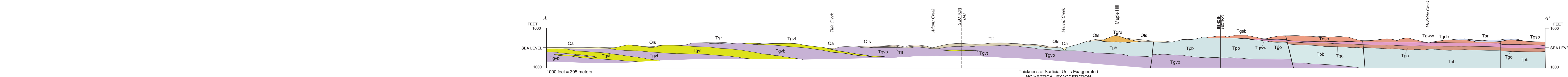
Megafossil locality



Index map showing geographic and cultural features mentioned in text (hillshade image derived from 10-m DEM of the Deer Island 7.5' quadrangle and vicinity)



1000 feet = 305 meters
Artificial fill (unit af) too thin to portray on cross section
Thickness of Surficial Units Exaggerated
NO VERTICAL EXAGGERATION



1000 feet = 305 meters
Thickness of Surficial Units Exaggerated
NO VERTICAL EXAGGERATION

This map was printed on an electronic plotter directly from digital files. Dimensional calibration may vary between electronic plotters and between X and Y directions on the same plotter, and paper may change size due to atmospheric conditions; therefore, scale and proportions may not be true on plots of this map.

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GEOLOGIC MAP OF THE DEER ISLAND QUADRANGLE, COLUMBIA COUNTY, OREGON AND COWLITZ COUNTY, WASHINGTON

By
Russell C. Evarts
2002