STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

GEOLOGIC MAP OF THE LAKE OSWEGO QUADRANGLE, CLACKAMAS, MULTNOMAH, AND WASHINGTON COUNTIES, OREGON

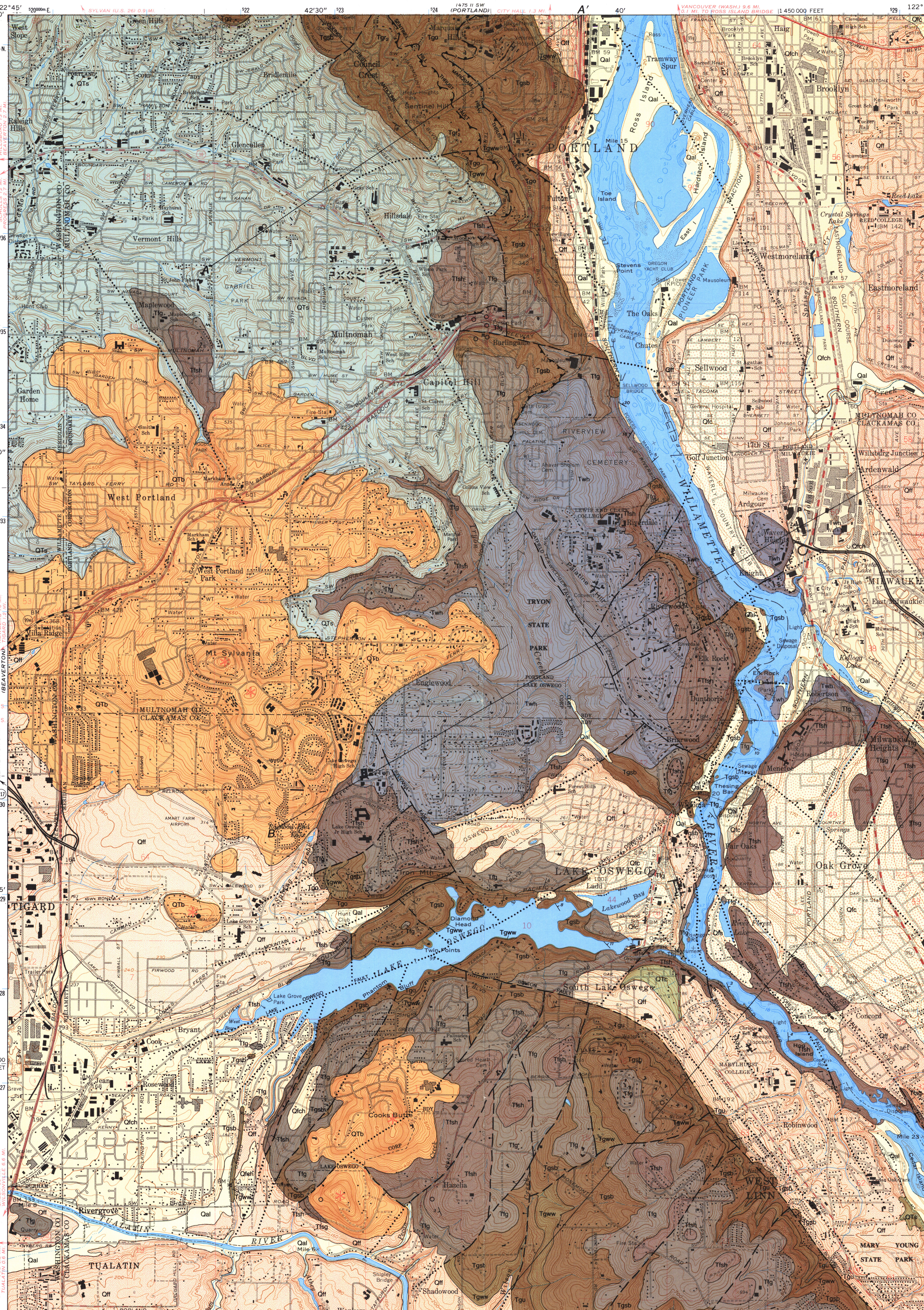
1989

GMS-59

Geologic Map of the Lake Oswego Quadrangle, Clackamas, Multnomah, and Washington Counties, Oregon

By M.H. Beeson and others

Funded by the U.S. Geological Survey and the National Earthquake Hazard Reduction Program under Cooperative Agreement 14-08-0001-A0512



Base map by U.S. Geological Survey

Control by USGS, NOS/NOAA, USCE, and State of Oregon

Topography from aerial photographs by photogrammetric methods. Aerial photographs taken 1952. Field checked 1954. Revised from aerial photographs taken 1960. Field checked 1961

Polyconic projection. 1927 North American datum. 10,000-foot grid based on Oregon coordinate system, north zone. 1000-meter Universal Transverse Mercator grid ticks, zone 10, shown in blue

UTM GRID AND 1984 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DEPTH CURVES AND SOUNDINGS IN FEET—COLUMBIA RIVER DATUM

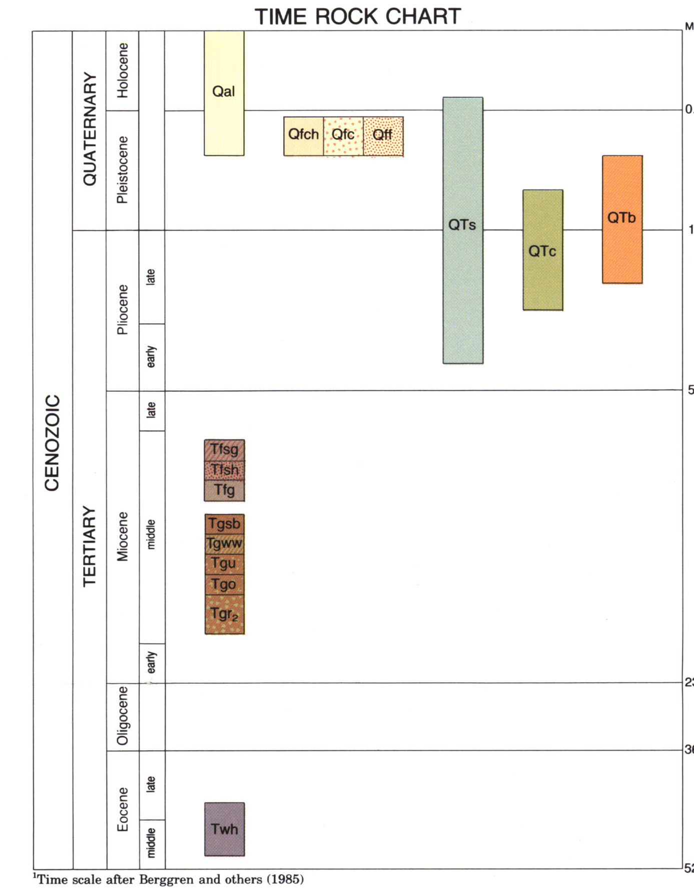
QUADRANGLE LOCATION

Bedrock geology by Marvin H. Beeson and Terry L. Tolan, Geology Department, Portland State University; surficial geology by Ian P. Madin, Oregon Department of Geology and Mineral Industries

Field work conducted during the summer of 1988

Cartography by Paul E. Staub

TIME ROCK CHART



[1]Time scale after Berggren and others (1985)

Table 1. Compositional averages of basaltic units in the Lake Oswego quadrangle.* Numbers in parentheses indicate number of samples averaged.

	Boring Lavas (4) Average	Std. dev.	Sentinel Gap (6) Average	Std. dev.	Sand Hollow (11) Average	Std. dev.	Ginkgo (6) Average	Std. dev.	Sentinel Bluffs (44) Average	Std. dev.	Winter Water (6) Average	Std. dev.	Ortley (4) Average	Std. dev.	Umtanum (3) Average	Std. dev.	R_2 (low TiO_2) (6) Average	Std. dev.	R_2 (high TiO_2) (3) Average	Std. dev.	Waverly Heights basalt (17) Average	Std. dev.
Major oxides in percent																						
SiO_2	52.46	1.43	52.66	1.21	52.41	0.68	51.91	1.00	54.26	0.57	56.21	0.41	56.84	0.91	56.13	0.66	57.25	0.71	56.07	0.38	49.66	0.71
Al_2O_3	16.79	0.11	13.93	0.64	13.97	0.74	13.71	0.64	14.47	0.40	14.05	0.34	14.19	0.32	14.60	0.34	14.74	0.25	14.57	0.24	14.74	0.62
TiO_2	1.03	0.16	3.12	0.13	2.93	0.04	3.16	0.15	1.95	0.06	2.05	0.02	2.02	0.06	2.17	0.07	2.03	0.03	2.20	0.06	2.53	0.23
FeO	7.85	0.48	12.71	1.96	13.00	0.99	13.73	1.66	11.42	0.95	11.62	0.69	10.99	0.67	9.32	0.53	9.81	0.86	9.20	0.40	13.20	0.67
MnO	0.13	0.005	0.22	0.03	0.21	0.01	0.24	0.06	0.20	0.02	0.19	0.02	0.18	0.02	0.14	0.02	0.17	0.02	0.17	0.03	0.26	0.06
CaO	8.64	0.28	8.19	0.22	8.51	0.17	8.38	0.29	8.65	0.16	7.15	0.36	7.11	0.39	6.80	0.32	7.11	0.13	6.90	0.13	10.74	0.63
MgO	7.39	0.66	3.63	0.34	4.25	0.19	3.76	0.51	4.53	0.26	3.52	0.23	3.46	0.14	2.95	0.21	3.51	0.11	3.18	0.08	5.40	0.53
K_2O	0.89	0.20	1.61	0.14	1.40	0.12	1.46	0.09	1.19	0.12	1.76	0.13	1.79	0.09	1.94	0.28	1.83	0.15	2.04	0.09	0.32	0.10
Na_2O	3.60	0.27	3.03	0.15	2.92	0.13	2.91	0.12	3.00	0.09	3.11	0.11	3.10	0.05	3.36	0.18	3.20	0.04	3.29	0.04	2.86	0.21
P_2O_5	0.23	0.07	0.71	0.03	0.58	0.02	0.71	0.04	0.33	0.01	0.35	0.01	0.33	0.02	0.37	0.02	0.35	0.02	0.39	0.007	0.29	0.03
Trace elements in ppm																						
Ni	164	34	8	3	10	4	5	1	9	5	0.2	0.4	3	2	3	1	6	3	2	0.5	33	13
Cr	221	110	29	4	35	4	26	2	43	3	17	3	16	3	19	2	20	3	16	5	76	36
Sc	29	4	33	1	35	3	34	1	34	2	31	2	31	2	30	3	31	2	31	1	39	2
V	179	12	409	21	422	11	404	14	317	11	341	13	330	26	350	30	333	16	342	13	394	29
Ba	300	77	625	80	537	18	591	69	475	38	625	44	758	92	907	182	818	141	835	135	68	17
Rb	12	3	40	4	33	4	35	2	27	3	47	4	50	6	54	7	51	4	53	3	4	3
Sr	775	298	331	16	321	9	334	19	318	13	322	9	351	10	350	9	342	12	[illegible]	[illegible]	219	14
Zr	126	25	203	11	180	4	183	9	159	4	176	2	190	4	186	6	175	7	188	3	170	15
Y	21	2	45	2	40	3	42	3	34	2	37	2	40	13	43	3	37	2	41	2	37	3
Nb	7.8	3.4	19.0	0	16	1	17.1	1	13	1	15	1	15	1	15.7	0.5	14.8	1.1	17	0.2	18.2	2.1
Cu	93	22	25	2	22	2	22	2	23	2	22	1	23	2	23	2	22	2	23	0.8	22	8
Zn	78	4	29	10	44	16	29	12	45	21	15	10	16	8	20	10	25	8	8	4	208	47
Pb	7	2	102	21	145	8	152	17	126	9	129	5	131	5	131	10	131	5	140	4	109	7
La	24	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ce	37	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Th	3	0.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

*XRF analyses by Peter R. Hooper, Geology Department, Washington State University, Pullman, Washington

EXPLANATION

Qal — **Alluvium (Quaternary)** — River and stream deposits of silt, sand, and gravel composed of mixed lithologies; largely confined to Willamette River channel and valley bottoms of tributary streams; may include local lacustrine, paludal, and eolian deposits

Catastrophic flood deposits (Pleistocene) — Boulders, gravels, sandy gravels, and sands containing high percentages of Columbia River basalt clasts and representing high-energy, subfluvial deposition during catastrophic floods caused by the repeated failure of the glacial ice dam that impounded glacial Lake Missoula (see Bretz and others, 1956; Baker and Nummedal, 1978; Waitt, 1985; Allen and others, 1986). Date of most recent catastrophic flood is estimated to be 15,500 to 13,000 years B.P. (Mullineaux and others, 1978; Waitt, 1987). Within map area, flood sediments are subdivided into three facies listed below

Qfch — **Channel facies (Pleistocene)** — Sediments are complexly interlayered and variable silts, sands, and gravels deposited in major floodways by flood events. The channels are cut in earlier and/or contemporaneous fine and coarse flood sediments (units **Qff** and **Qfc**). The irregular post-flood surfaces of these deposits have been locally filled by bog or pond sediments and by overbank alluvium from Johnson, Kellogg, and Crystal Springs Creeks

Qff — **Fine-grained facies (Pleistocene)** — Coarse sand to silt deposited by catastrophic floods. The finer sediments are predominantly quartz and feldspar and also contain white mica. The coarser sediments are predominantly Columbia River basalt fragments. Poorly defined beds of 1- to 3-ft thickness are observed in outcrop, and complex layering is recorded in boreholes. Soil development commonly introduces significant clay into the upper 6-15 ft of the deposits. The fine sediments are locally thick in the lower portions of the area and extend upslope as a mantle to an elevation between 300 and 350 ft

Qfc — **Coarse-grained facies (Pleistocene)** — Pebble to boulder gravel with silt and coarse sand matrix. The coarse sediments are poorly sorted and moderately to well rounded. The coarse deposits range from openwork gravel to gravel with considerable fine-grained matrix material. Clasts are largely basalt, but other lithologies may dominate downstream from bedrock exposures

QTs — **Undifferentiated sediments (Pliocene to Holocene)** — Commonly fine-grained, massive to finely bedded sediments that mantle bedrock units and are, in part, interfingered with Boring Lavas (unit **QTb**) flows. These sediments are rarely exposed except in manmade excavations. Thickness of sediments is highly variable, ranging from <15 to >200 ft (Trimble, 1963; Schlicker and Deacon, 1967; Lentz, 1981). Previous workers have generally divided these sediments into four separate units: (1) Portland Hills Silt (Quaternary loess often present above the 400-ft elevation) (Trimble, 1963; Lentz, 1981); (2) lacustrine deposits of Trimble (1963) (slackwater facies of catastrophic flood deposits found generally below the 400-ft elevation); (3) Troutdale Formation; and (4) Helvetia formation (Schlicker and Deacon, 1967). These units are not addressed in this study and are not differentiated on the map because of uncertainties with unit identification and positions of contacts

QTc — **Unnamed conglomerate (Pliocene to Pleistocene?)** — Well-rounded pebbles and cobbles of mainly andesite to dacite, with minor amounts of Columbia River basalt, in a poorly to moderately indurated lithic sandstone to sandy siltstone matrix. Andesite and dacite clasts often have weathering rinds, while Columbia River basalt clasts display little evidence of decomposition. Unit varies in thickness from ~30 to ~200 ft. Conglomerate of the same composition is exposed within the adjacent Gladstone quadrangle and represents part of a thick (~400-ft) channel fill. Clast and matrix lithologies of this unit differ from that of the Troutdale Formation (see Tolan and Beeson, 1984; Swanson, 1986) and probably represent deposits of Cascadian streams or an ancestral Clackamas River during late Troutdale time. Trimble (1963) previously mapped this unit as either the "sandy phase of lacustrine deposits" (catastrophic flood deposits) or "Gresham Formation"

QTb — **Boring Lavas (Pliocene to Pleistocene)** — Light-gray to gray, diktytaxitic, olivine- (less commonly plagioclase-) phyric basalt and basaltic andesite flows erupted from a series of local vents. Eruptive activity associated with Boring lavas built cones (e.g., Mount Sylvania and Cooks Butte) composed of interstratified cinders and lava. Boring lava flows are poorly exposed due to variable degrees of deep weathering and/or mantling by loess. Exceptions occur where catastrophic flood waters have eroded away overlying deposits or in excavations. Boring Lava flows typically display blocky to columnar jointing and, if preserved, vesicular flow tops. Thickness of unit **QTb** is highly variable, ranging from ~600 ft at a vent to ~50 ft for individual flows away from the vent. Age of unit **QTb** within the map area is poorly constrained; reversed magnetic polarity of all sampled flows within the map area (based on portable fluxgate magnetometer determinations) indicate an age of >700,000 years. Boring flows can be distinguished from older basalt units on the basis of physical appearance, stratigraphic position, lithology, and major oxide composition (Table 1)

Columbia River Basalt Group (middle Miocene) — Miocene tholeiitic flood-basalt flows that were erupted from linear fissure systems in northeastern Oregon, eastern Washington, and western Idaho from approximately 17 to 6 Ma (Swanson and others, 1979; Hooper, 1982). Many individual flows are known to be huge in size, often covering thousands to tens of thousands of square miles and ranging from hundreds to thousands of cubic miles in volume (Tolan and others, 1989). These flows entered western Oregon via a wide gap in the northern Oregon Miocene Cascade Range (Beeson and others, 1985; Beeson and Tolan, in press); some flows even reached the Pacific Ocean (Beeson and others, 1979). Significant differences and variations in the geochemical, paleomagnetic, and lithological properties of Columbia River Basalt Group flows allow this series of flood-basalt flows to be formally divided into five formations (Swanson and others, 1979) and also enable these formations to be further subdivided into a host of mappable members and units (Swanson and others, 1979; Beeson and others, 1985; Reidel and others, 1989). Members and units belonging to the Wanapum and Grande Ronde Basalts, two of the five Columbia River Basalt Group formations, are present within the map area and have a collective thickness ranging up to ~670 ft

Frenchman Springs Member, Wanapum Basalt (middle Miocene)

Tfsg — **Basalt of Sentinel Gap (middle Miocene)** — Consists of a single, blocky- to columnar-jointed flow within the map area. Fresh exposures are dark gray; weathered surfaces are typically brownish gray to dark gray. Fine- to medium-grained microphyric basalt, with acicular and equant plagioclase laths <0.1 cm in size; generally aphyric but can contain rare plagioclase phenocrysts ~1 cm in size. Thickness of unit is variable, ranging from 25 to 50 ft. Compositionally similar to older Ginkgo flows (Table 1) but can be differentiated on the basis of stratigraphic position, lithology (lack of abundant plagioclase phenocrysts), and normal paleomagnetic polarity (Beeson and others, 1985)

Tfsh — **Basalt of Sand Hollow (middle Miocene)** — Four flows are present within the map area. Flows typically are blocky to columnar jointed, but occasionally display entablature/colonnade jointing style. Fresh exposures are dark gray to black; weathered surfaces are typically greenish gray to black. The three oldest flows ("+3, +4, and +5" units of Beeson and others [1975]) are fine to coarse grained, occasionally diktytaxitic, and sparsely plagioclase phyric, with phenocrysts <2 cm in size. The youngest Sand Hollow flow is typically diktytaxitic, medium to coarse grained, and plagioclase phyric, with phenocrysts and glomerocrysts that commonly range from 2 to 5 cm in size. Unit thickness is variable, ranging from ~50 to ~200 ft. Sand Hollow flows can be distinguished from both the Sentinel Gap and Ginkgo flows on the combined basis of stratigraphic position, lithology, and composition (Table 1). Both low- to intermediate-P_2O_5 compositional types (Beeson and others, 1985) are present within the map area. Beeson and others (1985) report a K-Ar date of 15.3 Ma for this unit

Tfg — **Basalt of Ginkgo (middle Miocene)** — Two flows are present within the map area. Flows are commonly blocky to columnar jointed, often displaying well-formed prismatic colonnades. Fresh exposures are dark gray to black; weathered surfaces are commonly reddish brown to gray. Both flows are typically medium-grained, plagioclase-microphyric basalt, with laths <0.1 cm in size, and abundant plagioclase phyric, with phenocrysts and glomerocrysts ranging from 0.3 to 2 cm in size. The upper Ginkgo flow is commonly diktytaxitic. Thickness of this unit varies from 50 to ~200 ft within the map area. Ginkgo flows can be distinguished from the plagioclase-phyric Sand Hollow flow on the combined basis of stratigraphic position, composition (Table 1), and excursional paleomagnetic polarity (Beeson and others, 1985). This unit commonly overlies a thin (commonly approximately 1-ft-thick), discontinuous, sedimentary interbed that ranges from fluvial arkosic, micaceous sandstone to paleosol. This sediment is equivalent to the Vantage Member of the Ellensburg Formation (Swanson and others, 1979; Beeson and others, 1985) and is not shown here as a separate map unit because of its relative thinness

Grande Ronde Basalt (middle Miocene)

Tgsb — **Sentinel Bluffs unit (middle Miocene)** — Within the map area, two flows that were formerly designated as "-1 and -2 flows" of Beeson and Moran (1979) are present. Flows typically display blocky to columnar jointing and rarely display an entablature/colonnade jointing pattern. Fresh exposures are light to dark gray; weathered surfaces are greenish gray to dark gray. The lower flow is typically fine- to medium-grained sparsely plagioclase phyric, with small (<0.5 cm) tabular plagioclase phenocrysts. The upper flow is fine to medium grained, commonly diktytaxitic, and aphyric. Unit thickness ranges from 25 to 150 ft within the map area. Sentinel Bluffs flows are distinguished from the younger Frenchman Springs units and older Grande Ronde units on the basis of stratigraphic position, composition (Table 1), lithology, and normal paleomagnetic polarity (see Reidel and others, 1989; Beeson and others, 1989). Long and Duncan (1982) report a $^{40}Ar/^{39}Ar$ date of approximately 15.6 Ma for the youngest flows of this unit on the Columbia Plateau

Tgww — **Winter Water unit (middle Miocene)** — Within the map area, two flows that were formerly designated as the "-3 flow" of Beeson and others (1975) or "N_2 low-MgO flows" of Beeson and Moran (1979) are present. Winter Water flows display a wide range of jointing patterns, from columnar to entablature/colonnade. Fresh exposures are dark gray to black; weathered surfaces are greenish gray to grayish black. Both flows are typically glassy to fine grained and phyric to abundantly phyric, with small (<0.3 cm) plagioclase glomerocrysts that often display a distinctive radial or spoke-shaped habit. Distribution of glomerocrysts is often uneven and tends to be less abundant in the basal portion of the flow. Unit thickness ranges from 25 to 100 ft within the map area. Winter Water flows are distinguished from other Grande Ronde units on the basis of lithology, composition (Table 1), stratigraphic position, and normal paleomagnetic polarity (see Reidel and others, 1989; Beeson and others, 1989)

Tgu — **Umtanum unit (middle Miocene)** — Within the map area, two flows that were formerly designated as "N_2 low-MgO flows" of Beeson and Moran (1979) are present. Umtanum flows commonly display entablature/colonnade jointing style. Fresh surfaces are dark gray to black; weathered surfaces are gray green to dark gray. Flows are commonly glassy to very fine grained and abundantly plagioclase microphyric, with small (<0.2 cm) acicular microphenocrysts. Umtanum flows are known to interfinger with Ortley flows on the Columbia Plateau (Reidel and others, 1989) but can be distinguished from Ortley flows on the basis of higher TiO_2 concentrations (Table 1) and the presence of abundant plagioclase microphenocrysts

Tgo — **Ortley unit (middle Miocene)** — Within the map area, four flows formerly designated as "N_2 low-MgO flows" of Beeson and Moran (1979) are present. Ortley flows commonly display entablature/colonnade jointing style. Fresh exposures are gray to black; weathered surfaces are greenish gray to dark gray. Flows are commonly glassy to very fine grained and aphyric. Unit thickness ranges from 25 to >200 ft within the map area. Ortley flows are both compositionally (Table 1) and lithologically similar to the older Grouse Creek unit but can be distinguished on the basis of their normal paleomagnetic polarity (see Reidel and others, 1989; Beeson and others, 1989)

Tgr_2 — **R_2 Grande Ronde Basalt (middle Miocene)** — Consists of approximately six flows that are exposed only in the northern portion of the map area. Flows of this unit are similar to both the Ortley and Umtanum flows in physical, lithological, and compositional (Table 1) characteristics but can easily be distinguished on the basis of their reversed paleomagnetic polarity. (see Reidel and others, 1989; Beeson and others, 1989). Unit thickness varies, ranging from 150 to >400 ft within the map area. Although not differentiated here, this unit contains flows of both the Grouse Creek and Wapshilla Ridge units of Reidel and others (in press) on the Columbia Plateau

Twh — **Basalt of Waverly Heights and associated undifferentiated sedimentary rocks (Eocene)** — Consists of a sequence of subaerial basaltic lava flows and associated sediments that unconformably underlie flows of the Columbia River Basalt Group. The top of unit **Twh** is typically marked by a deeply weathered zone (probably >30 ft thick), except where it has been scoured away either by catastrophic flood waters or by normal river downcutting. Consequently, the best exposures of this unit are found adjacent to the Willamette River in the Waverly Heights area. Flows of unit **Twh** are typically blocky to columnar jointed and have well-developed vesicular flow tops and bottoms. Vesicles and vugs within flow tops, as well as some joints, are commonly filled with secondary minerals. Flow morphology and the absence of intraflow structures (pillow complexes and hyaloclastites) suggest that the lava flows were emplaced subaerially. Fresh flow surfaces are typically brownish gray to black; weathered surfaces are dark gray to brownish black. In hand sample, the flows are commonly fine to medium grained and range from sparsely to abundantly plagioclase phyric, with phenocrysts and glomerocrysts that are usually <0.5 cm in size. Unit **Twh** flows are basaltic in composition and are similar in composition to those of the Columbia River Basalt Group (Table 1). However, unit **Twh** flows can be distinguished from Columbia River Basalt Group flows because they do not precisely match any specific compositional type within the Columbia River Basalt Group. Two flows have yielded K-Ar dates of about 40 Ma (R.A. Duncan, personal communication, 1982). Sediments associated with unit **Twh** flows are not exposed, but borehole data suggest a marine environment of deposition and further suggest that these sediments underlie much of the Tryon Creek area. Thickness of this unit is not known, but it is assumed to extend to considerable depth in the map area. Unit **Twh** is believed to represent a portion of an oceanic island that was accreted to western Oregon

MAP SYMBOLS

Contact — Approximately located

Fault — Dashed where inferred; dotted where concealed; queried where doubtful; ball and bar on downthrown side. Slickensides found on local exposures of some northwest-trending faults show a component of strike-slip motion

Thrust fault — Sawteeth on upper plate; queried where doubtful

Anticline — Showing direction of plunge; dashed where approximately located; dotted where concealed

Strike and dip of bed

Geochemically analyzed sample

Volcanic vent

Engineering or water-well borehole

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GEOLOGIC CROSS SECTIONS