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GEOLOGIC MAP OF THE PORTLAND QUADRANGLE, MULTNOMAH AND WASHINGTON COUNTIES, OREGON, AND CLARK COUNTY, WASHINGTON

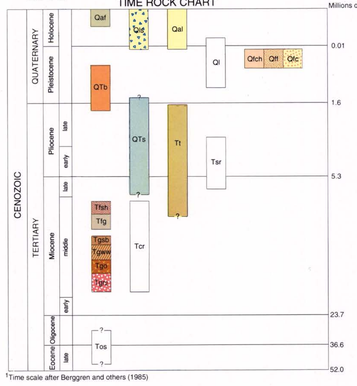
1991

Reconnaissance mapping of bedrock and structural geology in the Tualatin Mountains by Marvin H. Beeson and Terry L. Tolan, Geology Department, Portland State University.
Quaternary and subsurface geology in the remainder of the quadrangle by Ian P. Madin, Oregon Department of Geology and Mineral Industries

Field work completed in 1990

Cartography by Paul E. Staub

TIME ROCK CHART



† Time scale after Berggren and others (1985)

EXPLANATION

Qaf — **Artificial fill (Holocene)** — Sand, silt, and clay fills with subordinate amounts of gravel, debris, and local concentrations of sawdust and mill ends. Unit **Qaf** is mapped only where fill has eliminated lakes, sloughs, marshes, or gullies delineated during 1898 survey for earliest topographic map of Portland (U.S. Geological Survey, 1905). Fill areas mapped with queried contacts represent lakes and marshes that may have been drained rather than filled. Fill 1.5 to 5 m thick is common in developed areas of Columbia and Willamette floodplains, but thickness and distribution are highly variable, and it is not depicted on this map

Landslide deposits (Quaternary) — Major landslides inferred by topography or known to be historically active. Significant historical slides have been mapped at Washington Park Zoo and above reservoirs in northeast corner of Washington Park. Both may be part of larger prehistoric slides whose extent is controversial. Slide areas depicted at these sites are those for which there is wide agreement among investigators; extent of prehistoric slides may be greater. Map does not show all landslides present, particularly not all of those that are relatively small

Qal — **Alluvium (Quaternary)** — River and stream deposits of silt, sand, and organic-rich clay with subordinate gravel of mixed lithologies; largely confined to Columbia and Willamette River channels and valley bottoms of tributary streams; may include local lacustrine, paludal, and eolian deposits. Unit **Qal** reaches maximum thickness of 45 m

Ql — **Loess (Quaternary)** (shown on map in outline only) — Unit consists of quartzo-feldspathic silt (Lentz, 1977, 1981) that mantles Tualatin Mountains (Portland Hills) in southwestern corner of map area. Loess up to 12 m thick covers most slopes above 90 m to 105 m in elevation but is not shown in order to more clearly depict older units. Previous workers (Trimble, 1963; Schlicker and Deacon, 1967; Lentz, 1977; Madin, 1990) have mapped general distribution of loess; this study has not significantly improved on those early studies. Lentz (1981) suggested that loess was deposited between 34,000 and 700,000 years B.P., based on correlations of paleosols to regional glacial history and on inferred stratigraphic relations with Boring Lava and Pleistocene flood sediment.

Qfl — **Catastrophic flood deposits (Pleistocene)** — Gravel, sandy gravel, and sand containing high percentages of Columbia River basalt clasts and representing high-energy, subfluvial deposition during catastrophic floods caused by 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 estimated to be 15,500 to 13,000 years B.P., based on radiocarbon dating and tephrachronology (Mullineaux and others, 1978; Waitt, 1987). Flood sediments are subdivided into three facies listed below

Qfch — **Channel facies (Pleistocene)** — Complexly interlayered and variable silt, sand, and gravel deposited in major flood channel. Channel is cut in earlier and/or contemporaneous fine and coarse flood sediments (units **Qff** and **Qfc**) and retains much of original morphology. Irregular postflood surfaces of these deposits have been locally filled by bog or pond sediments and by overbank alluvium from minor streams. Channel deposits are typically 5 to 15 m thick

Qff — **Fine-grained facies (Pleistocene)** — Coarse sand to silt deposited by catastrophic floods. Silt and fine sand composed predominantly of quartz and feldspar with mica. Coarser sand composed predominantly of Columbia River basalt. Poorly defined beds of 30-cm to 1-m thickness are observed in outcrop. Locally, beds are separated by accumulations of clay and iron oxide 1 to 6 cm thick, which may be paleosols. Modern soil development commonly introduces abundant clay and iron oxides into upper 2 to 3 m of deposits. Fine sediments are locally thick in lower elevations of area and extend upslope as mantle to elevations between 90 and 105 m. Unit **Qff** reaches maximum thickness of 20 to 40 m. Unit **Qff** is equivalent to Willamette Silt of Allison (1953) and includes lacustrine sand, lacustrine silt and clay, and sand and silt deposits of Trimble (1963)

Qfc — **Coarse-grained facies (Pleistocene)** — Pebble to boulder gravel with silt and coarse sand matrix. Coarse sediments are poorly sorted and subangular to well rounded and range from openwork gravel to gravel with considerable fine-grained matrix. Clasts are largely Columbia River basalt, but other lithologies may dominate downstream from bedrock exposures. Unit **Qfc** reaches maximum thickness of 20 to 30 m. Coarse flood sediments are equivalent to Portland Delta deposits of Bretz (1919) and lacustrine gravels of Trimble (1963)

QTb — **Boring Lava (Pliocene to Pleistocene)** — Light-gray to gray, diktytaxitic, olivine-phyric (less commonly plagioclase-phyric) basalt and basaltic andesite flows erupted from a series of local vents. Eruptive activity associated with Boring Lava built cones (e.g., Elk Point) composed of interstratified cinders and lava. Boring Lava flows typically display blocky to columnar jointing and, if preserved, vesicular flow tops. Thickness of unit **QTb** is highly variable, ranging from >180 m near vents to <15 m for individual distal flows. Age of unit **QTb** within map area is probably Pleistocene, based on presence of normally magnetized flows overlying paleosol developed on reversely magnetized flows in boreholes near Sylvan. Boring Lava flows can be distinguished from older basalt units on the basis of physical appearance, stratigraphic position, lithology, and chemical composition (Beeson and others, 1989b)

QTs — **Neogene mudstones (Miocene to Pleistocene)** — Friable to weak, massive to thinly bedded siltstones and claystones. Unit **QTs** is known largely from well records and a few samples from boreholes. Mineralogy of borehole samples is quartzo-feldspathic. Neogene mudstones are locally interlayered with Boring Lava (unit **QTb**) flows. Maximum thickness of mudstones is 490 m (Trimble, 1963; Schlicker and Deacon, 1967; Lentz, 1981; Madin, 1990). Previous workers have mapped these rocks as Troutdale Formation (Trimble, 1963; Schlicker and Deacon, 1967), Sandy River Mudstone (Trimble, 1963), Sandy River Mudstone equivalent (Madin, 1990), and undifferentiated sediments (Beeson and others, 1989b)

Tt — **Troutdale Formation (Miocene to Pliocene)** — Friable to moderately strong conglomerates with minor interbeds of sandstone, siltstone, and claystone. In Tualatin Mountains, conglomerates consist of well-rounded pebbles and cobbles of Columbia River basalt and exotic volcanic, metamorphic, and plutonic rocks. Troutdale conglomerates exposed east of Willamette River consist of Boring Lava and High Cascade basalt, andesite, and dacite in addition to Columbia River basalt and exotic clasts. Conglomerate matrix and interbeds in both areas contain varying amounts of feldspathic, quartzo-micaceous, and volcanic lithic and vitric sediment. Lithology of sediments and ratio of conglomerate to sandstone and siltstone vary widely throughout area. Unit **Tt** reaches maximum thickness of 60 to 90 m in map area and is up to 275 m thick in other parts of Portland Basin (Swanson, 1986). Trimble (1963), Swanson (1986), and Tolan and Beeson (1984) have shown that rocks mapped as Troutdale Formation in many parts of Portland area are Miocene to late Pliocene. Age of unit **Tt** in Portland quadrangle is unknown

Tsr — **Sandy River Mudstone (Miocene to Pliocene)** (shown only in cross section) — Friable to moderately strong siltstone, sandstone, and claystone. Sandy River Mudstone is predominantly quartzo-feldspathic and typically contains white mica. Unit **Tsr** not exposed in Portland quadrangle but widely distributed and up to 275 m thick in subsurface. Trimble (1963) considered unit **Tsr** to be a lacustrine deposit, but sedimentary structures in unit **Tsr** east of map area along Clackamas River suggest fluvial origin (C.D. Peterson and A.R. Niem, personal communication, 1989). Unit **Tsr** contains early Pliocene fossil flora near its contact with Troutdale Formation (Trimble, 1963)

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). Individual flows cover thousands to tens of thousands of square kilometers and range from hundreds to thousands of cubic kilometers 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, 1990); some flows even reached the Pacific Ocean (Beeson and others, 1979, 1989a). Significant differences and variations in the geochemical, paleomagnetic, and lithologic properties of Columbia River Basalt Group flows allow them 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 >205 m. Geochemical data used to distinguish Columbia River Basalt Group formations and flows in this area are summarized in Beeson and others (1989b)

Tfsh — **Frenchman Springs Member, Wanapum Basalt (middle Miocene)**
Basalt of Sand Hollow (middle Miocene) — Two flows are present within map area. Flows are typically blocky to columnar jointed but occasionally display entablature/colonnade jointing style. Fresh exposures are dark gray to black, weathered surfaces typically greenish gray to black. These Sand Hollow flows (probably "+4" and "+5" units of Beeson and others, 1979) are fine to coarse grained, occasionally diktytaxitic, and sparsely plagioclase-phyric, with phenocrysts <2 cm in size. Unit thickness is variable, ranging to >60 m. Sand Hollow flows can be distinguished from Ginkgo flows on the basis of stratigraphic position, lithology, and composition (Beeson and others, 1989b). Only low-P_2O_5 compositional type (Beeson and others, 1985) is present within map area. Beeson and others (1985) report average K-Ar date of 15.3 Ma for this unit

Tfg — **Basalt of Ginkgo (middle Miocene)** — Two flows are probably present within map area, although only one is seen in outcrop. Flows are commonly blocky to columnar jointed, often displaying well-formed prismatic colonnades. Fresh exposures are dark gray to black, weathered surfaces commonly reddish brown to gray. Exposed flow is typically medium-grained, plagioclase-microphyric basalt, with laths <0.1 cm in size, and abundantly plagioclase-phyric, with phenocrysts and glomerocrysts ranging from 0.3 to 2 cm in size. Thickness of unit is only 15 m or less within map area. Ginkgo flows can be distinguished from plagioclase-phyric Sand Hollow flow on the combined basis of stratigraphic position, composition (Beeson and others, 1989b), and excursional paleomagnetic polarity (Beeson and others, 1985). Unit commonly overlies thin (commonly approximately 30 cm), discontinuous, sedimentary interbed ranging from fluvial arkosic, micaceous sandstone to paleosol. Interbed is exposed in sec. 31, T. 1 N., R. 1 E., where it contains locally derived volcanic debris, perhaps eroded from developing Tualatin Mountains. This sediment is equivalent to Vantage Member of Ellensburg Formation (Swanson and others, 1979; Beeson and others, 1985) and not shown here as separate map unit because of its thinness

Tgsb — **Grande Ronde Basalt (middle Miocene)**
Sentinel Bluffs unit (middle Miocene) — Within map area, two flows are present. These were formerly designated as "-1" and "-2" flows of Beeson and Moran (1979). Each, however, may consist of two or three flow units along east side of Tualatin Mountains in Washington Park. Flows typically display blocky to columnar jointing and rarely entablature/colonnade jointing pattern. Fresh exposures are light to dark gray, weathered surfaces greenish gray to dark gray. Lower flow is typically fine- to medium-grained basalt and sparsely plagioclase-phyric, with small (<0.5 cm), tabular plagioclase phenocrysts. Upper flow is fine to medium grained, commonly diktytaxitic, and aphyric. Unit is up to 50 m thick within map area. Sentinel Bluffs flows are distinguished from both younger Frenchman Springs units and older Grande Ronde units on the basis of stratigraphic position, composition (Beeson and others, 1989b), lithology, and normal paleomagnetic polarity (see Reidel and others, 1989; Beeson and others, 1989a). Long and Duncan (1982) report $^{40}Ar/^{39}Ar$ date of approximately 15.6 Ma for youngest flows of unit on Columbia Plateau

Tgww — **Winter Water unit (middle Miocene)** — Within map area, two flows are present, formerly designated as "-3 flow" of Beeson and others (1975) or "Ng low-MgO flows" of Beeson and Moran (1979). Winter Water flows display wide range of jointing patterns, from columnar to entablature/colonnade. Fresh exposures are dark gray to black, weathered surfaces 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 distinctive radial or spoke-shaped habit. Distribution of glomerocrysts is often uneven and tends to be less abundant in basal portion of flow. Unit thickness ranges from 7.5 to 30 m within map area. Winter Water flows are distinguished from other Grande Ronde units on the basis of lithology, composition (Beeson and others, 1989b), stratigraphic position, and normal paleomagnetic polarity (see Reidel and others, 1989; Beeson and others, 1989a)

Tgo — **Ortley unit (middle Miocene)** — Within map area, one or two flows are present, formerly designated as "Ng low-MgO flows" of Beeson and Moran (1979). Ortley flows commonly display entablature/colonnade jointing style. Fresh exposures are gray to black, weathered surfaces greenish gray to dark gray. Flows are commonly glassy to very fine grained and aphyric. Unit thickness ranges from 7.5 to >60 m within map area. Ortley flows are both compositionally (Beeson and others, 1989b) and lithologically similar to older Grouse Creek unit of Reidel and others (1989) but can be distinguished on the basis of their normal paleomagnetic polarity (see Reidel and others, 1989; Beeson and others, 1989a)

Tgz — **R_2 Grande Ronde Basalt (middle Miocene)** — Consists of approximately two flows poorly exposed in map area. Flows of this unit are similar to Ortley flow in physical, lithologic, and compositional (Beeson and others, 1989b) characteristics but can easily be distinguished on the basis of their reversed paleomagnetic polarity (see Reidel and others, 1989; Beeson and others, 1989a). Unit is up to 55 m thick within map area. Although not differentiated here, this unit contains flows of both Grouse Creek and Wapshilla Ridge units of Reidel and others (1989)

Tcr — **Undifferentiated Columbia River Basalt Group (middle Miocene)** (shown only in cross section) — Basalt encountered in deep wells northeast of Tualatin Mountains is inferred to be Columbia River basalt. Where no data are available to determine which flows are present, these basalts are shown as undifferentiated

Tos — **Undifferentiated older sedimentary rocks (upper Eocene to middle Oligocene)** (shown only in cross section) — Tuffaceous marine sedimentary rocks believed to underlie unit **Tcr** throughout Portland quadrangle. Not exposed but known from Richfield Barber well (Newton, 1969) drilled in sec. 23, T. 1 N., R. 1 W., about 1.7 km west of Portland quadrangle. Barber well penetrated 900 m of sandstone, shale, fossiliferous sandstone, tuffaceous sandstone and shale, and volcanic agglomerate beneath Columbia River basalt

MAP SYMBOLS

Contact — Approximately located

Fault — Dashed where inferred; dotted where concealed; queried where doubtful; ball and bar on downthrown side

Thrust fault — Dashed where inferred; dotted where concealed; queried where doubtful; sawteeth on upper plate

Strike and dip of bed

Volcanic vent

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GEOLOGIC CROSS SECTIONS

Unit Qaf not shown
Dip of high angle faults unknown

STRUCTURE OF THE TUALATIN MOUNTAINS

The upland in the southwest corner of the Portland quadrangle is part of the Tualatin Mountains (locally referred to as the Portland or West Hills). The interpretation of the structure of the Tualatin Mountains has ranged from a simple anticline (Treasher, 1942; Trimble, 1963) to a dextral wrench zone that is both folded and faulted (Beeson and others, 1975) and forms the western edge of a pull-apart basin (Beeson and others, 1985, 1989a; Yelin and Patton, 1991). The linear character of the east front of the hills has been interpreted by many workers as evidence for a "Portland Hills Fault" (Diller, 1915; Dehlinger and others, 1963; Schlicker and others, 1964; Newton, 1969; Balsillie and Benson, 1971; Beeson and others 1975). The present mapping has added little to the interpretation of the Portland Hills Fault except in the southern third of the quadrangle, where water-well logs are consistent with a northwest-trending fault parallel to the front of the hills. Gravity data (Beeson and others, 1975) and topography strongly suggest a continuation of this fault along the base of the Tualatin Mountains north of downtown Portland.

Our present interpretation is that the Tualatin Mountains are part of a larger northwest-trending, dextral wrench fault zone (Beeson and others, 1989a; Beeson and Tolan, 1990). The Tualatin Mountains mark the southwestern side of this zone that includes the Portland basin, which we have interpreted to be a fault-bounded pull-apart basin (Beeson and others, 1985, 1989a; Beeson and Tolan, 1990). The basic form of the Tualatin Mountains in the Portland quadrangle is that of an asymmetrical anticline that has been extensively modified by faulting. Several distinct sets of faults are present, with some sets having a transverse orientation to the overall northwest trend of the Tualatin Mountains. Field evidence suggests that these fault sets originated and developed at various stages during the growth of the Tualatin Mountains. For example, the transverse thrust faults appear to have begun as a series of relatively low-amplitude, transverse anticlines and synclines during middle Miocene time. Frenchman Springs Member flows inundated these lows in the Burlingame (Lake Oswego quadrangle), Canyon Road, and Balch Canyon areas but did not cover the adjacent highs. Continuing deformation in post-middle Miocene time eventually resulted in the development of thrust faults along the limbs of these transverse folds. The transverse thrust faults are in turn displaced by apparently younger sets of faults, which indicates continued structural evolution. This structural complexity may be in large part due to the influence of a volcanic high that is located south of the Portland quadrangle on the Lake Oswego quadrangle. The high is composed of late Eocene-age Waverly Heights basalt and is transected by this structural zone. To the south of the Waverly Heights high, in the Lake Oswego quadrangle, the dextral movement along the Portland Hills-Clackamas River structural zone tends to pull the Columbia River basalt away from the Waverly Heights high, creating a near-surface environment of extension that results in normal and oblique-slip faults. To the north of this high, from the Burlingame area on the Lake Oswego quadrangle through the Portland quadrangle, the Columbia River basalt tends to be compressed against the high, initially producing folds and thrust faults. Continued deformation has allowed through-going, northwest-trending faults to develop and overprint the preexisting transverse folds and faults.

Although considerable new data have allowed us to show the detailed stratigraphy of the Columbia River Basalt Group in this area, many details of the structure are uncertain and must yet be considered preliminary. Currently, no evidence is available to determine whether any of the mapped faults are still active.

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GMS-75

Geologic Map of the Portland Quadrangle,
Multnomah and Washington Counties, Oregon, and Clark County, Washington

By M. H. Beeson and others

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