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New Geologic Mapping of the Northwestern Willamette Valley, Oregon, and its American Viticultural Areas (AVAs)— A Foundation for Understanding Their Terroir

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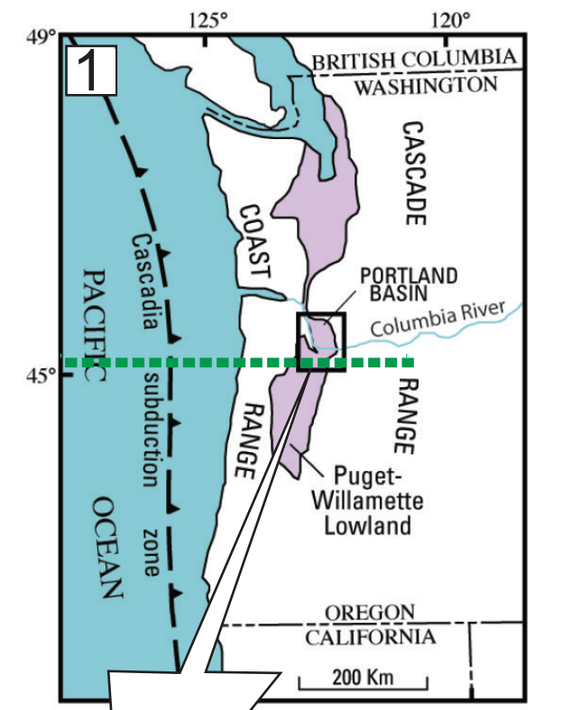
A new geologic map of the greater Portland, Oregon, metropolitan area is planned that will document the region's complex geology. The geology contributes to the varied terroir of four American Viticultural Areas (AVAs) in the northwestern Willamette Valley: the Yamhill-Carlton, Dundee Hills, Chehalem Mountains, and Ribbon Ridge AVAs. Terroir is defined as the environmental conditions, especially climate and soils, that influence the quality and character of a region's crops—in this case, grapes for wine.

The new geologic map will consist of 51 7.5′ quadrangles covering more than 2,500 square miles, and it will represent more than 100 person-years of geologic mapping and studies. The map (currently in review: "Geologic map of the greater Portland metropolitan area and surrounding region, Oregon and Washington" by Wells, R.E., Haugerud, R.A., Niem, A., Niem, W., Ma, L., Evarts, R., Madin, I., and others) is planned to be published as a U.S. Geological Survey Scientific Investigations Map. The region was mapped at the relatively detailed scale of 1:24,000 to improve understanding of its geology and its earthquake hazards. More than 100 geologic map units will record the 50-million-year history of volcanism, sedimentation, folding, and faulting above the Cascadia Subduction Zone.

On this poster we present the map (Map A) at a reduced scale (about 1:175,000) to show the general distribution of geologic map units, and we highlight, discuss, and illustrate six major geologic events that helped shape the region and form its terrior. We also discuss the geologic elements that contribute to the character of each of the four AVAs in the northwestern Willamette Valley.



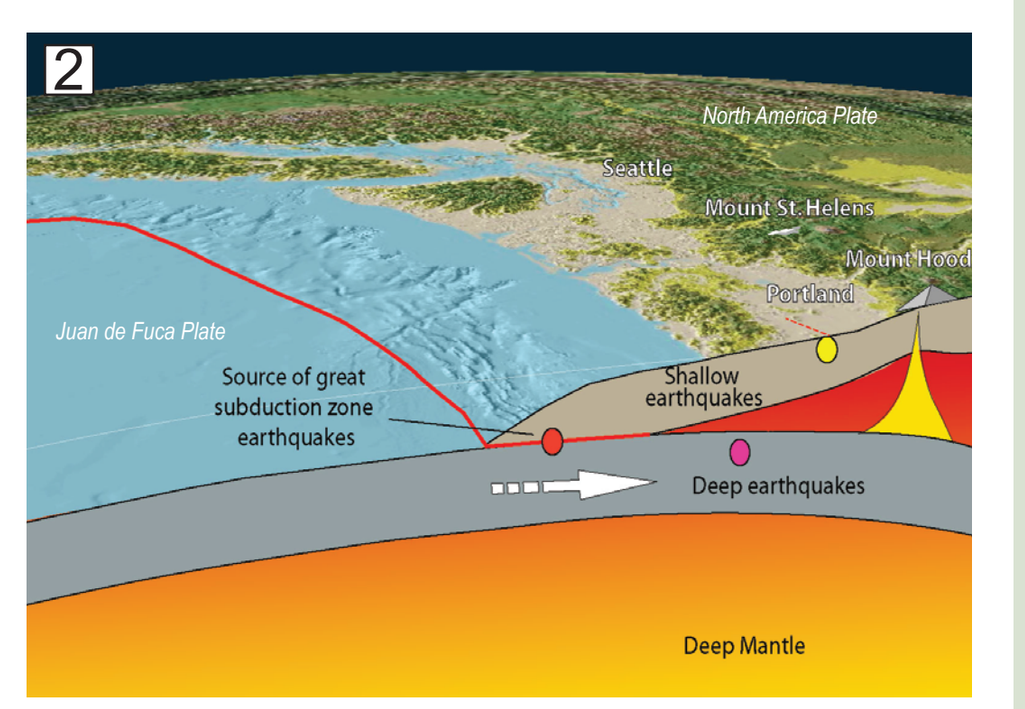
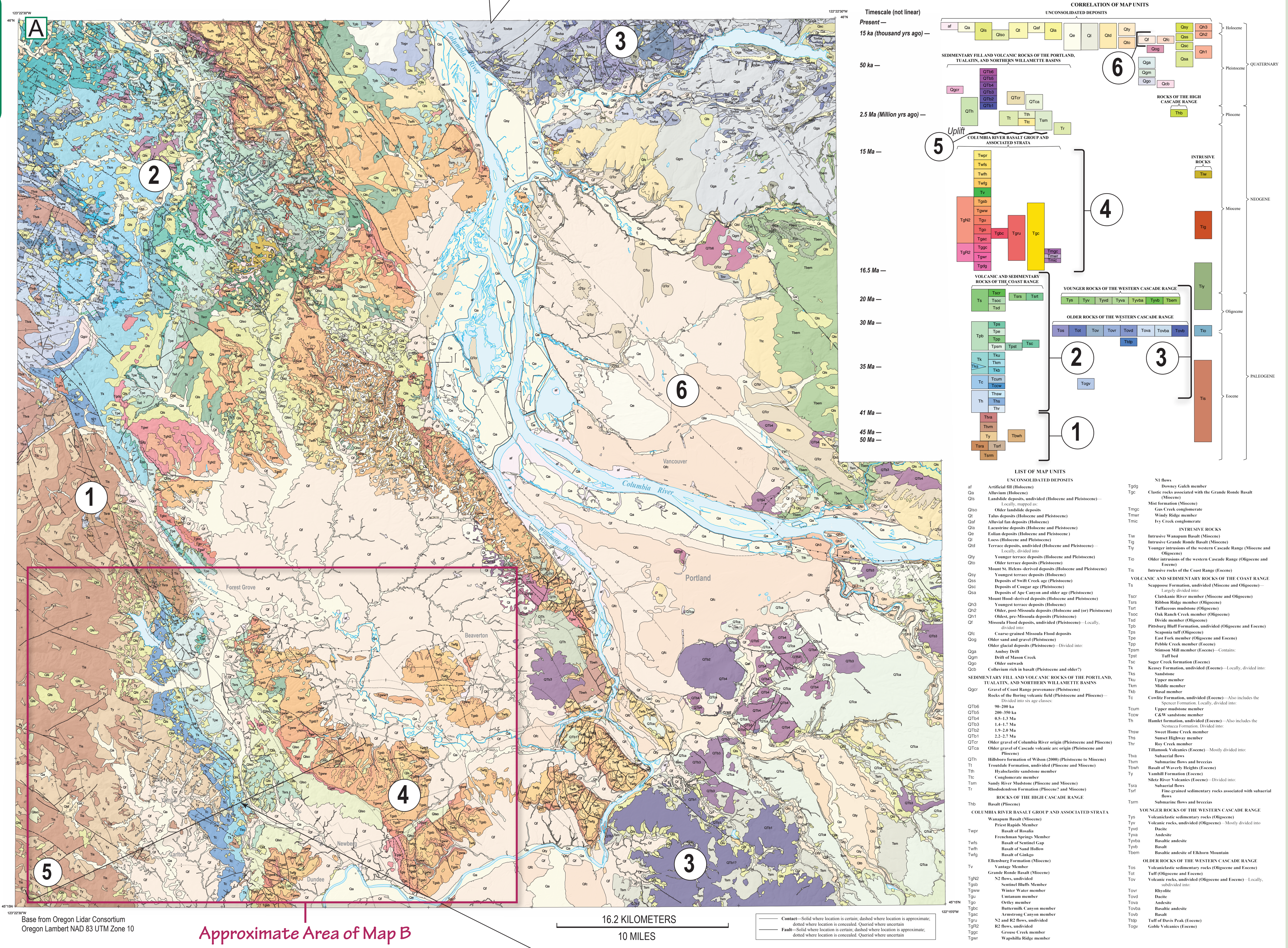


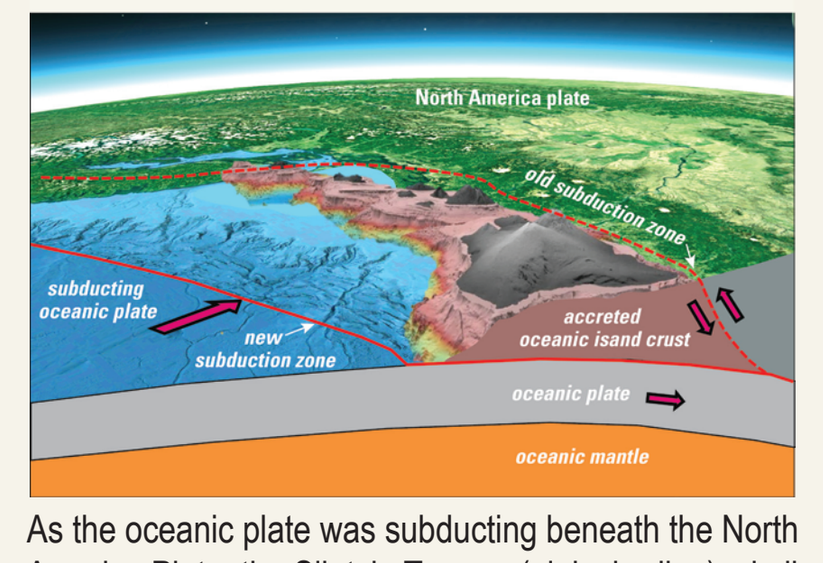
Figure 1. Map showing the location of the geologic map (Map A, below) in the Pacific Northwest region. The green dashed line shows the general location of the schematic cross section shown in figure 2.

Figure 2. Schematic cross section through the Cascadia Subduction Zone (red line), showing how the Juan de Fuca Plate dives beneath the North America Plate along the subduction zone. As the Juan de Fuca Plate sinks into the Earth's deep mantle, it causes earthquakes (depicted by colored dots), and it also produces the magma (depicted by a yellow triangle) that forms the chain of volcanoes known as the Cascade Volcanic Arc, in today's Cascade Range. It is this tectonic activity that is the source of the region's rocks, landscape, and geologic hazards, as well as its terroir. Base from Google Earth.

Map A. The geologic map (to right) records evidence of six major geologic events that have shaped the northwestern Willamette Valley. The circled numbers on Map A show the general areas where the evidence for these events can be found. In the Correlation of Map Units, the numbers indicate which map units show such evidence. The numbers in the boxes below correlate to the circled numbers on the map:



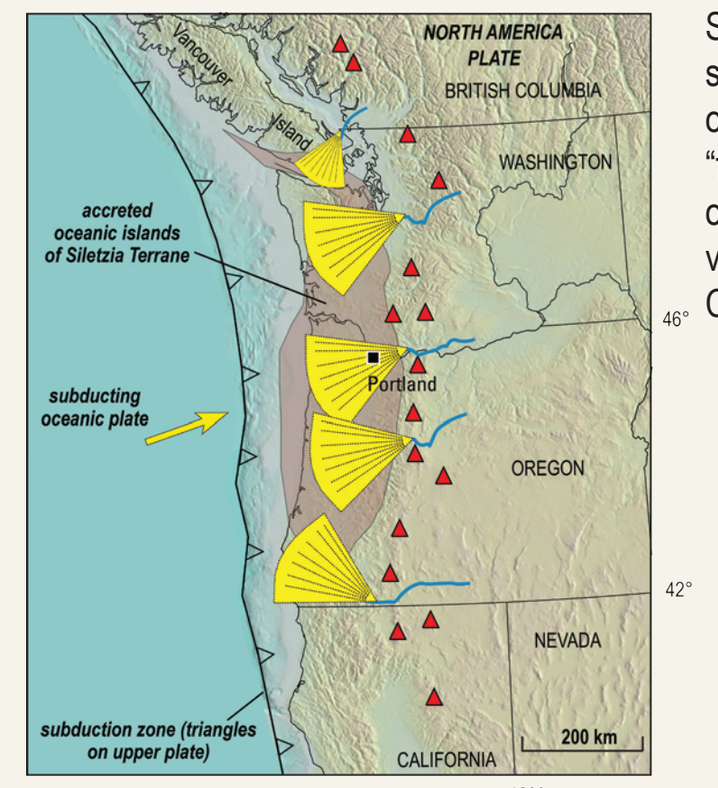
1 About 50 million years ago, an ancient basaltic ocean-island chain collided with North America



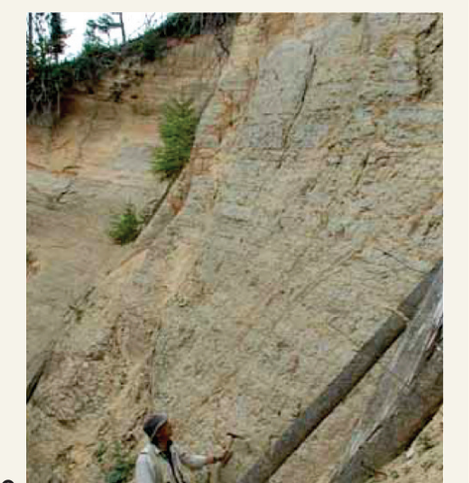
As the oceanic plate was subducting beneath the North America Plate, the Siletzia Terrane (pink shading), similar to today's Hawaiian Islands (shown in gray shaded relief, for scale reference), collided with the North America Plate and was accreted (welded) to it. Base from Google Earth

Photograph of an outcrop of 52-million-year-old pillow basalt, located near the Trask River, in Oregon. The rounded forms of pillow basalt result when lava is erupted beneath the ocean

2 Between about 50 and 15 million years ago, oceanic sediments were deposited on the accreted Siletzia Terrane, in what is now western Oregon and Washington

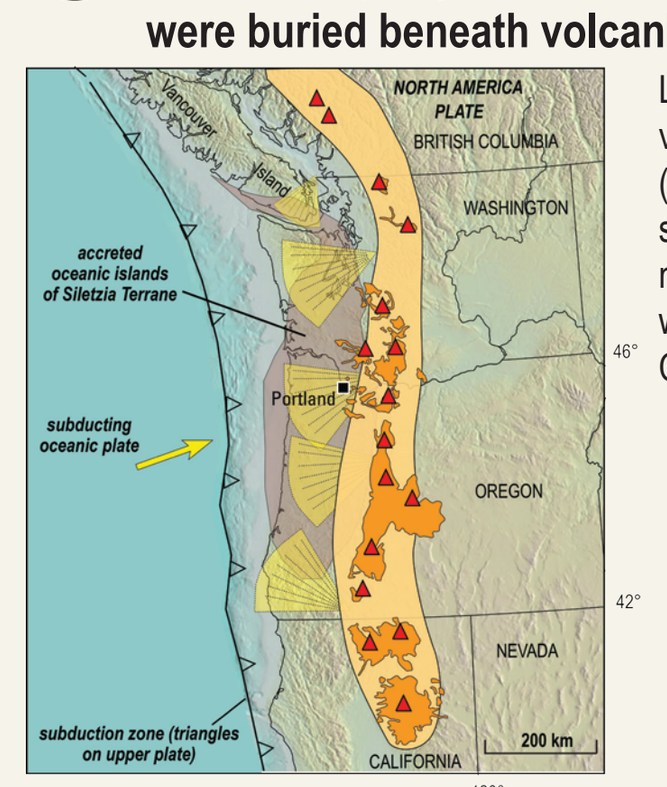


Sediment from rivers built deltas, shoreline deposits, and submarine fans of sand and mud (depicted by yellow "fan" shapes) in the fore-arc basin offshore of the string of burgeoning volcanoes (red triangles), the future Cascade Volcanic Arc



Photograph of an outcrop of 40-million-year-old sandstone of the Cowlitz Formation, located near Timber, Oregon

3 Between about 40 million years ago and the present, the sedimentary deposits and the accreted Siletzia Terrane were buried beneath volcanic rocks and deposits

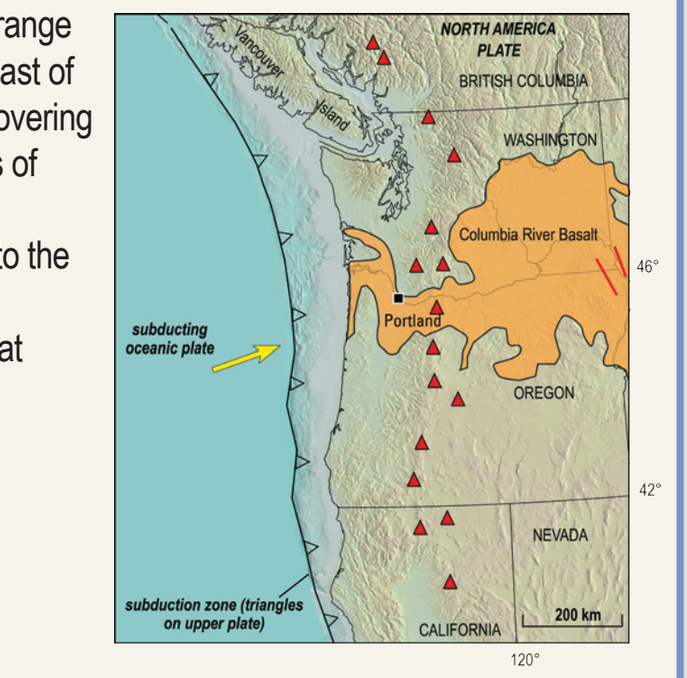


Lava flows were erupted from ancient volcanoes in the Cascade Volcanic Arc (2–40 million years old; light-orange shading). Younger volcanic rocks (0–2 million years old; dark-orange shading) were erupted from vents near the modern Cascade Arc volcanoes (red triangles)

Recent oblique aerial photograph of Mount St. Helens shows that volcanic activity continues to the present day

4 Between about 17 and 6 million years ago, stretching of the continental crust caused it to crack, releasing a flood of basaltic lava flows that blanketed the region

Lava flows of the Columbia River Basalt (orange shading) erupted from fissures (red lines) east of the Cascade Volcanic Arc (red triangles), covering much of Oregon and Washington and parts of Idaho and Nevada. Some flows traveled westward 440 miles (about 700 kilometers) to the Willamette Valley and the Pacific Ocean. A remnant of one such flow is Haystack Rock at Cannon Beach, Oregon

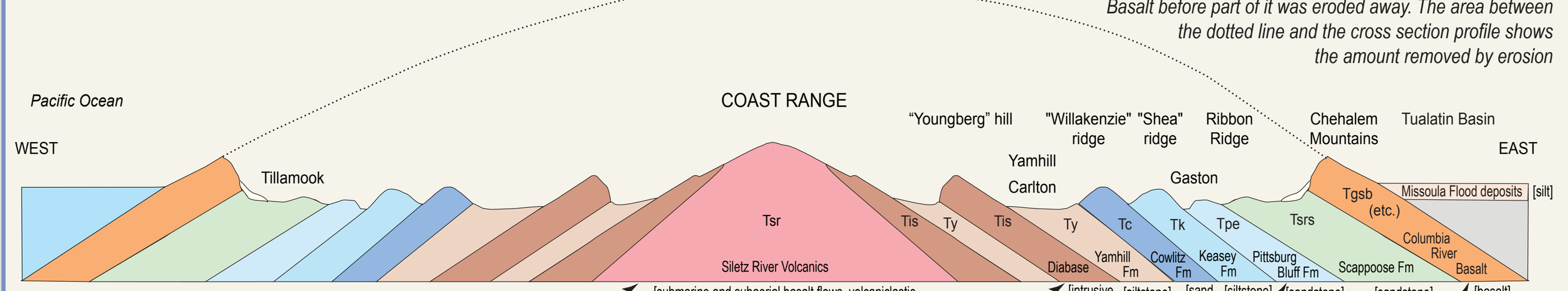


Photograph of the Columbia River Basalt at Haystack Rock, Cannon Beach, Oregon

5 Starting about 20 million years ago, strata in the Coast Range were folded into a broad arch

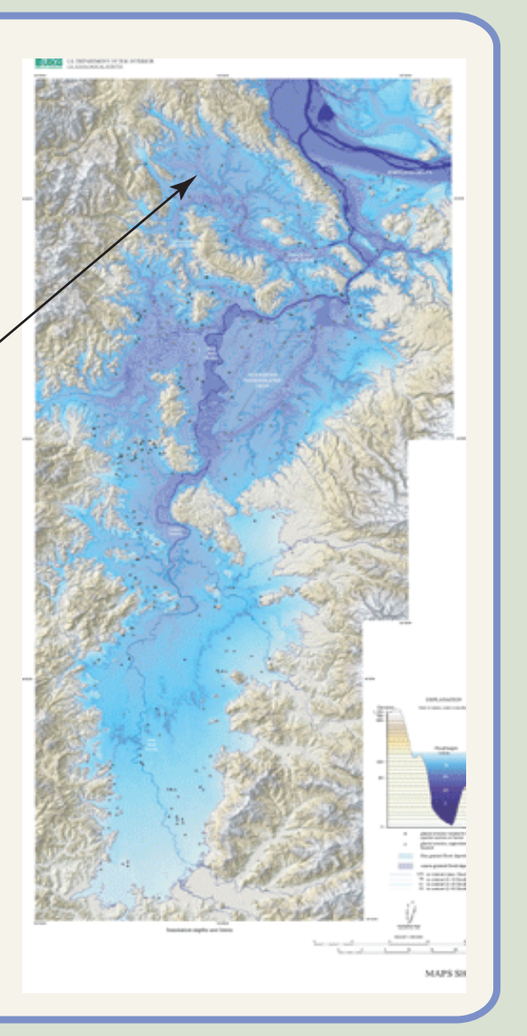
Below is a schematic cross section across a section of the Coast Range. The oldest rocks in the center (the formerly flat-lying Siletz River Volcanics), which were once buried beneath younger flat-lying strata, were folded and uplifted into an arch. Then they were exposed after the overlying strata were eroded away. The dotted line shows the original extent of the section, which is topped by the Columbia River Basalt (CRB). See the List of Map Units (in Map A above) for an explanation of the map-unit symbols, names, and ages

Bracket in Map A above shows where on the map the right side of the cross section below is located; the strata on the right side are tilted to the east (right)



6 Between about 20 and 15 thousand years ago, much of the region was covered by deposits from glacial-outburst floods

Waters from glacial lakes that had ponded behind glaciers north of the region were released in glacial-outburst floods as the glacier "dams" failed catastrophically at least 40 times, filling the Tualatin, Willamette, and Lower Columbia Basins with floodwaters (blue shading) and leaving a thick blanket of silt to an elevation as high as about 400 feet (120 meters). Map by Minervini and others (2003; https://pubs.usgs.gov/of/2003/of03-408/)



Photograph of an outcrop of rhythmically bedded flood deposits (silt), which record 26 catastrophic floods from ancient Glacial Lake Missoula. The outcrop, which had been exposed by construction activities, is located on Highway 26 at Cornell Road, near Beaverton, Oregon

Yamhill-Carlton AVA

West of Yamhill, Oregon, upland areas consist of siltstone and sandstone of the Yamhill Formation, which underlies soils such as the Goodin-Dupee-Chehulpum and Melbourne soil complexes. Basaltic sills (sheetlike intrusions) that intruded the sediments about 45 million years ago form the higher hills and are the parent material for the Saum-Parrett and Jory-Bellpine soil complexes.

East of Yamhill, feldspathic, micaceous sandstone of the Cowlitz Formation (about 40 million years old) forms the hills that are capped by the Wellsdale-Willakenzie-Dupee soil complex. East of the Willakenzie Estate winery, outside of Yamhill, lies tuffaceous, volcaniclastic mudstone and sandstone of the overlying Keasey and Pittsburg Bluff Formations (about 35 to 29 million years old). These rocks also underlie soils such as the Goodin-Melbourne soil complex near the Elk Cove Vineyards winery, in Gaston, Oregon.



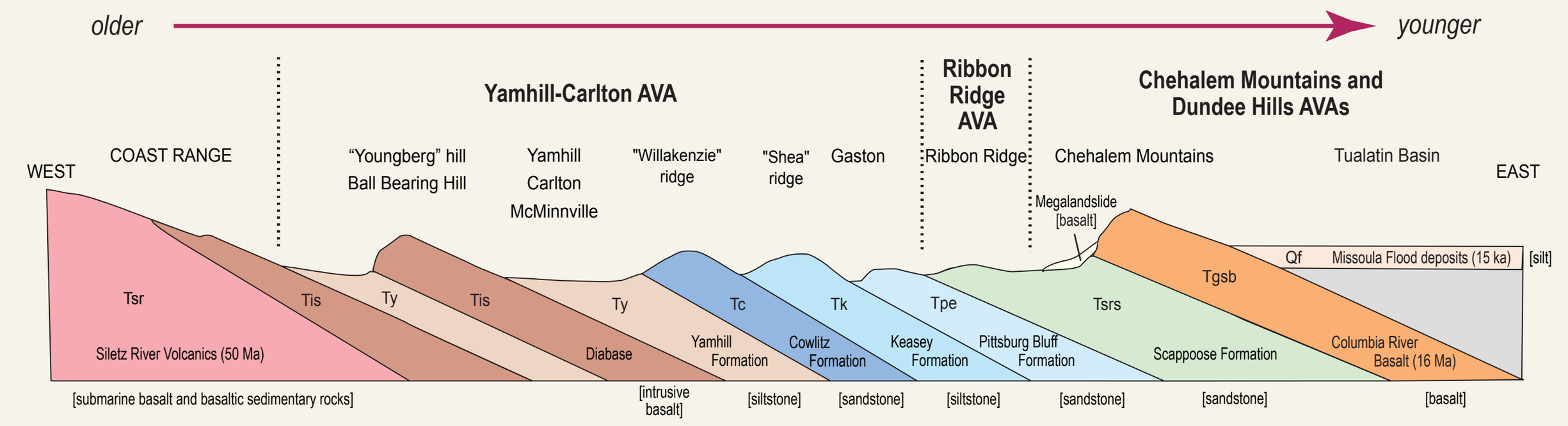


EXPLANATION

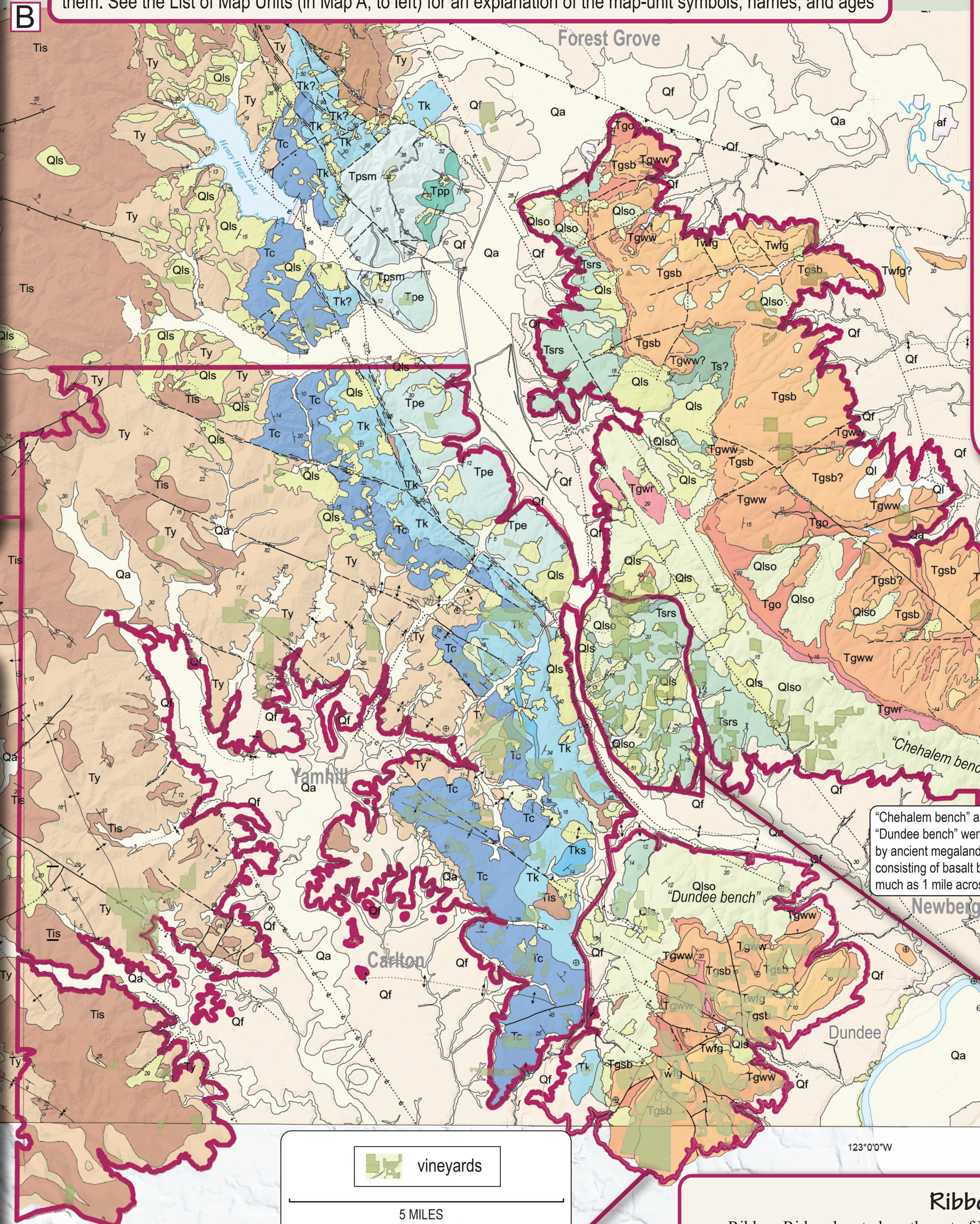
Tpe	**East Fork member of the Pittsburg Bluff Formation (29 million years old)**—Tuffaceous, massive siltstone and fine-grained sandstone; fossiliferous
Tk	**Keasey Formation, undivided (35 million years old)**—Tuffaceous, fossil-rich mudstone and sandstone. Locally, divided into:
Tks	**Sandstone**—Clean, micaceous sandstone
Tc	**Cowlitz Formation (40 million years old)**—Fossiliferous, medium-grained, very micaceous, gray to buff, oceanic sandstone; underlies "Willakenzie ridge" and Scoggins Dam
Tis	**Intrusive rocks of the Coast Range (45 million years old)**—Thick, columnar-jointed, blackish-brown basalt or diabase (that is, coarse-grained intrusive basalt) intrusions; underlies many Yamhill-Carlton-McMinnville hills
Ty	**Siltstone of the Yamhill Formation (46 million years old)**—Thin-bedded, deep-oceanic siltstone and fine-grained sandstone; here, rocks are tightly folded in a fault zone

Traveling eastward though the AVAs is like taking a trip through geologic time

This schematic cross section across the eastern part of a section of folded and uplifted Coast Range strata (also depicted in box 5, below left) shows the approximate boundaries of the AVAs (dotted lines). Note that the rocks decrease in age from west to east. See the List of Map Units (in Map A, to left) for an explanation of the map-unit symbols, names, and ages



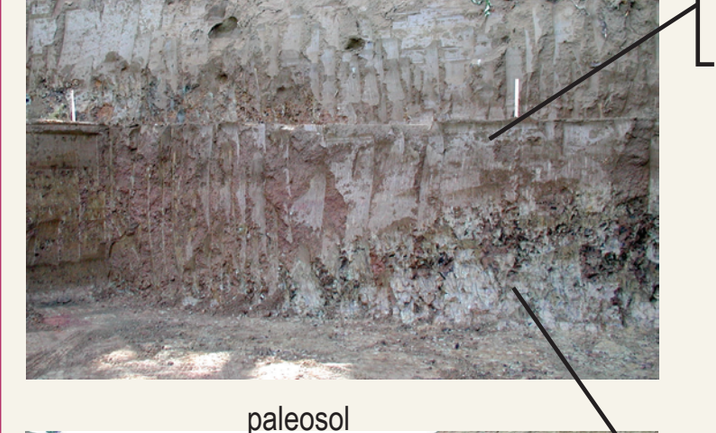
Map B. Below is part of Map A, enlarged to highlight the AVAs (outlined in red) and the map units that underlie them. See the List of Map Units (in Map A, to left) for an explanation of the map-unit symbols, names, and ages



Chehalem Mountains AVA

The Chehalem Mountains, located north of Newberg, Oregon, are underlain by lava flows of the Columbia River Basalt, which were erupted between 16 and 15 million years ago. Several geological formations and their members are recognized in the Chehalem Mountains.

Thick red Ultisols such as the Jory soil complex, derived from the deep weathering of basalt, are overlain by a cap of glacial loess (wind-blown silt) of variable thickness, producing the Laurelwood soil complex and related soils (as shown below in the upper photograph). The "Chehalem bench" is made up of basalt blocks, as large as 1 mile across, deposited by an ancient megalandslide.



EXPLANATION

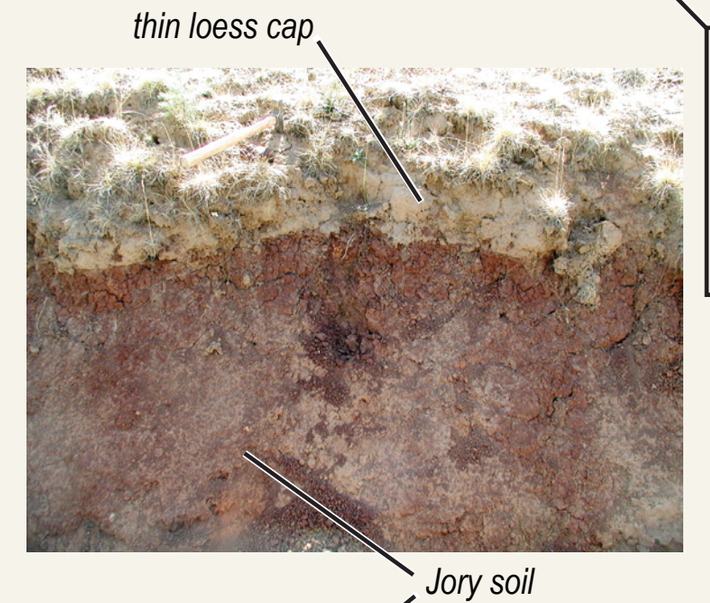
Ql	**Loess** — *younger loess (eolian silt)*; *older loess*
	Columbia River Basalt Group—Divided into:
	Wanapum Basalt—Here, consists of:
	Frenchman Springs Member—Mapped as the following subunits:
Twfh	**Basalt of Sand Hollow**
Twfg	**Basalt of Ginkgo**
	Grande Ronde Basalt—Here, divided into:
Tgsb	**Sentinel Bluffs Member**
Tgww	**Winter Water member**
Tgo	**Ortley member**
Tgac	**Armstrong Canyon member**
Tggc	**Grouse Creek member**
Tgwr	**Wapshilla Ridge member**
Tsrs	**Scappoose Formation**—Here, consists of: **Ribbon Ridge member**—Fine sandstone

Dundee Hills AVA

The Red Hills of Dundee, here referred to as the "Dundee Hills," are located southwest of Newberg, Oregon. The Dundee Hills are mostly underlain by 16- to 15-million-year-old lava flows of the Columbia River Basalt. The lava flows typically form thick red Ultisols such as the Jory soil complex, which is derived from deep weathering of the basalt. The "Dundee bench" is made up of basalt blocks, as much as 1 mile across, deposited by an ancient megalandslide.

Several formations and members of the Columbia River Basalt Group are recognized in the Dundee Hills, mainly by the presence or absence of plagioclase phenocrysts (some as large as 1") in the lava flows, as well as by the chemistry and paleomagnetic directions of the flows.

Photographs taken at the Maresh Red Hills Vineyard winery, in Dundee, Oregon. Top: In the foreground is the upper vineyard, underlain by the Frenchman Springs Member of the Wanapum Basalt; in the distance is a quarry that exposes the Winter Water member of the Grande Ronde Basalt. Middle and bottom: Close-ups of the interface between soil and rock



EXPLANATION

	Columbia River Basalt Group—Divided into:
	Wanapum Basalt—Here, consists of:
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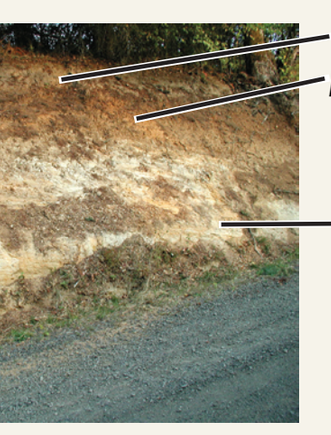
Tgac	**Armstrong Canyon member**
Tggc	**Grouse Creek member**
Tgwr	**Wapshilla Ridge member**
Tsrs	**Scappoose Formation**—Here, divided into: **Ribbon Ridge member**—Fine sandstone

Photograph of a hand sample of the basalt of Ginkgo (a subunit of the Frenchman Springs Member of the Wanapum Basalt), showing a large (2–3 cm) phenocryst of plagioclase (the light-colored inclusion) in the basalt. The presence of such distinctive plagioclase phenocrysts in the basalt flows helps to identify them as belonging to the basalt of Ginkgo subunit

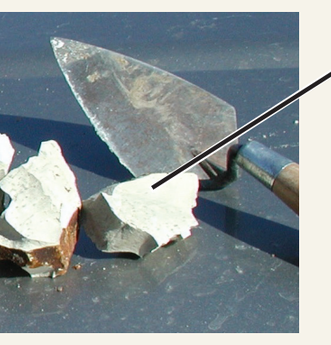
Ribbon Ridge AVA

Ribbon Ridge, located northwest of Newberg, Oregon, east of Chehalem Creek, is largely underlain by fine-grained oceanic sandstone, siltstone, and tuff of the Scappoose Formation (29 to 16 million years old), which is the parent material for the Wellsdale loam soils. Lag deposits consisting of basalt cobbles (from the Columbia River Basalt) are found on some ridgetops.

Photograph taken near Ridgecrest of an outcrop of the Ribbon Ridge member of the Scappoose Formation



Photograph of hand samples of the silicic tuffaceous mudstone subunit of the Scappoose Formation



EXPLANATION

	Scappoose Formation—Here, consists of:
Tsrs	**Ribbon Ridge member**—Cross-laminated, fine-grained, oceanic sandstone and siltstone; contains leaf fossils
Tsrt	**Tuffaceous mudstone**—Poorly exposed, silicic volcanic tuff from the Cascade Volcanic Arc, deposited in an oceanic basin. Forms lower slopes on north and west sides of Ribbon Ridge

Photograph of an outcrop on Ribbon Ridge, showing a deep red paleosol (that is, an old, buried soil layer) overlain by a younger, tan loess deposit

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Aerial photograph in Event 3 box is from U.S. Geological Survey's Cascade Volcano Observatory website (https://volcanoes.usgs.gov/observatories/cvo/). All other photographs and illustrations, unless otherwise noted, are by the authors

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