LEG J: APPROACH TO THE CARBON RIVER AREA

Through Orting and South Prairie Creek valley via State Route 162

This 17-mi (27 km) scenic route takes you upstream in the broad Puyallup River valley past its confluence with the Carbon River, and it then continues up the valley of South Prairie Creek (Fig. J-1). This leg begins near Sumner (elev. ~75 ft or 23 m), follows State Route (SR) 162 south through the city of Orting, and then curves east-northeast to the junction with SR 165 (elev. 692 ft or 211 m) via the town of South Prairie. SR 165 is the gateway to the northwest entrances of Mount Rainier National Park (see Legs K and L). This area is close to where the thick Puget lobe glacial ice flowed against the resistant rocks of the Cascade Range near the end of the Ice Age (~16 ka).

A nexus of glacial meltwater channels cuts the landscape near here. Some of these channels were likely carved by floods when large ice-marginal lakes burst their ice dams. Later, after the ice had receded farther north, rivers of glacial meltwater flowed southward into a deep ice-dammed lake, called glacial Lake Puyallup, at the location of the modern Puyallup Valley, filling the whole valley to the brim with water. Crandell (1963b) characterized this lake by carefully mapping a delta complex that formed where sediment-laden outwash streams emptied into it. He noted three different elevations for the tops of those deltas, at 460, 400, and 360 ft (140, 122, and 110 m, respectively). Because the delta tops are close to the level of the lake into which they are built, he inferred that those surfaces mark three levels of glacial Lake Puyallup, each controlled by the lowest available spillway at a given time. The surface of the oldest of these lakes was more than 400 ft (122 m) above that of the modern Puyallup River valley at Orting.

Troost (2007) has suggested that the intensive scouring of meltwater channels that cut across the glacially fluted landscape to the west, flood deposit gravels that lap onto drumlins truncated by those channels, and kettles left by blocks of stagnant ice and multiple terrace levels along those channels all indicate a sequence of glacial outburst floods or jökulhlaups from glacial Lake Puyallup. The lake eventually emptied to the north when the Puget Lobe had melted far enough back.

About 5600 years ago, prior to the Osceola Mudflow, the postglacial (and post-Lake Puyallup) Puyallup River terminated in Puget Sound between the cities of Sumner and Puyallup (see Fig. 36, p. 38). It was tributary to the White River, which flowed through the valley of South Prairie Creek until the enormous Osceola Mudflow from Mount Rainier aggraded its channel and cut a new "shortcut" channel for the White River farther north between Enumclaw and Auburn.

The Puyallup River valley has a long agricultural history—the fertile silty, sandy soils are rich in Mount Rainier Andesite fragments and crystals. There is a diversity in agriculture—berries, vegetables, and nursery stock—that thrives on the sandy loam of the lowermost (more northern) valley near Puyallup, Sumner, and Alderton (Fig. J-2). However, as the highway goes south past McMillin, the clay-rich, rocky, and extensive Electron Mudflow deposit crops out at the surface. The mudflow is more difficult to till than the sandy loam, and so vegetables give way to pasturelands. This great lahar flowed into place about A.D. 1500, burying the old valley floor by as much as 16 ft (5 m) at the present site of Orting, probably within one hour after it began on the

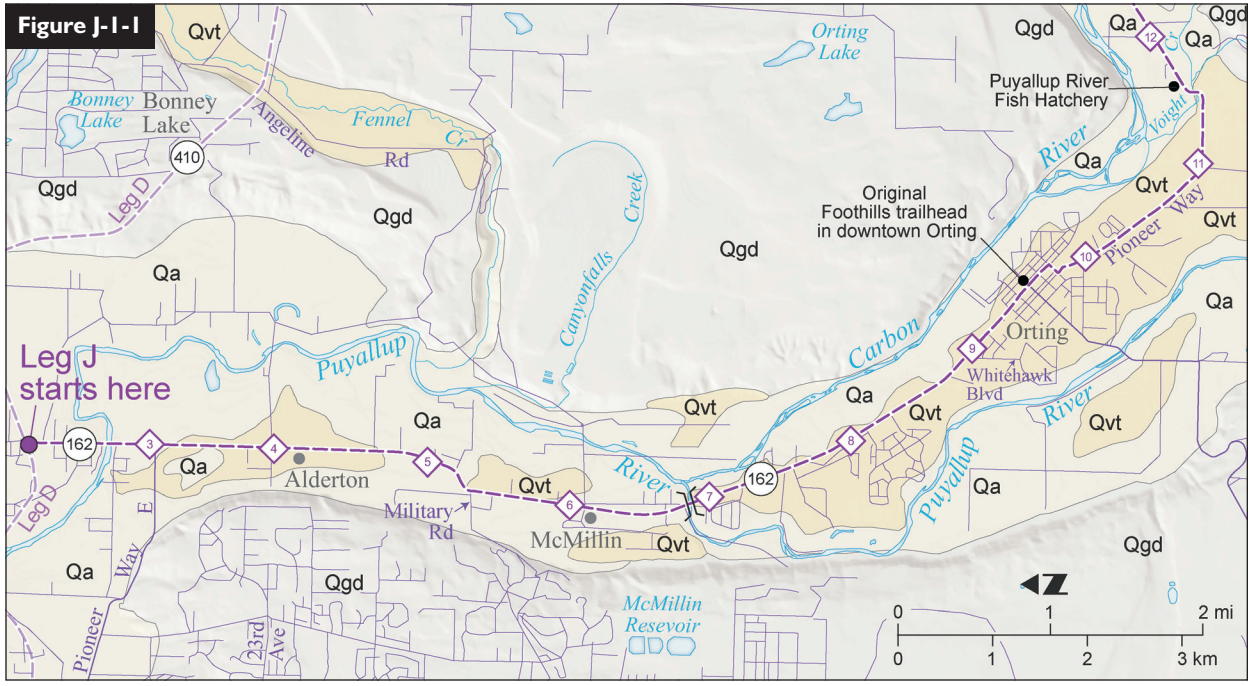

Figure J-1. Geologic map for Leg J (two consecutive panels). The geology was adapted from 1:100,000- and 1:500,000-scale digital versions of Walsh (1987), Tabor and others (2000), and Schuster (2005) and has been draped over a shaded relief image generated from 10-m elevation data. The leg maps were constructed using source-map data whose scale is smaller than the leg map scale, thus minor exposures may not appear on leg maps. The numbers in diamonds indicate mileposts. Check the north arrows for map orientation. The map explanation is on the inside back cover.

Figure J-2. This produce exhibit by the McMillin Grange at the Western Washington State Fair in Puyallup in the early 1990s demonstrates the fertility of the soils in the Puyallup River valley. At McMillin and points downstream of Orting, a silty sandy loam commonly overlies the Electron Mudflow deposit. Upstream (south) of McMillen, the clay-rich Electron Mudflow is commonly exposed at the surface, and there, dairy farms prevail.

upper west flank of Mount Rainier. The lahar flowed at least as far as the east outskirts of Puyallup. Planning for future use of the valley bottom, including residential and commercial development in the valley and associated infrastructure, includes discussions of the potential for lahars, flooding, liquefaction during earthquakes, and preservation of farmlands, as well as other issues. The population density of the valley bottom has already made efficient evacuation to higher ground via automobile a near-impossibility, so these issues will no doubt continue to appear in local headlines!

Distances along the route are given in miles, followed by kilometers in italics. If you take any side trips, you'll have to keep track of and add those miles to all the remaining mileages in the leg. Having a pencil and paper handy, and even a calculator will be helpful.

Mileage

0.0 *0.0* Junction of SR 410 and SR 162. Go right (south) on SR 162.

0.5 *0.8* Bridge across the Puyallup River. The farthest downstream outcrops of the Electron Mudflow (channel-fill deposit) and the Osceola Mudflow are here. The top of the Osceola deposit is about 22 ft (7 m) lower than this bridge. Studies of drilling logs of the Osceola mudflow by Dragovich and others (1994) have shown that the topography of the southern Puget Lowland has changed significantly within the past 5600 years. At the time of the Osceola Mudflow, the highland area now occupied by the modern cities of Federal Way, Milton, Edgewood, and Des Moines was nearly a large island in Puget Sound except for being attached by a narrow neck of land to the Puget Lowland near Sumner (see Fig. 36, p. 38). The delta of the Puyallup River at Puget Sound was located near the present City of Puyallup, and the delta of the ancestral White River in Puget Sound was located about halfway between Sumner and Auburn.

During the magnitude 7.1 earthquake of 1949, many eyewitness accounts of 'sand volcanoes' documented spectacular liquefaction in this area (Chleborad and Schuster, 1998). Black sands composing the sand volcanoes had originated in lahar-derived deposits from Mount Rainier (Palmer and others, 1991; Pringle and Palmer, 1992).

0.7 *1.1* Milepost (MP) 3. Pioneer Way.

1.2 *1.9* Enter Alderton. Lower(?) Pleistocene laharic deposits of the Alderton and Puyallup Formations of Crandell and others (1958) are exposed in the valley walls near Alderton. The two units are separated by the Stuck Drift of Crandell and others (1958); all are reversely magnetized (Easterbrook, 1994) and thus were deposited during a time when the Earth's magnetic field had reversed; this period is called the "Matuyama reversed magnetic polarity chron" (0.8–2.6 Ma). (See the "Paleomagnetism" sidebar on p. 104.)

2.9 *4.7* Military Road.

3.6 *5.8* MP 6, McMillin. There are scattered dark gray to black boulders along the roadside (Fig. J-3). Many of these are volcanic bombs that were erupted about 2,450 yr B.P. and deposited in a thick fan of pyroclastic debris on the west flank of Mount Rainier. They were picked up by the Electron Mudflow, about A.D. 1500, and carried to this location.

Danner (1966) described tufa interbedded with gravel on a steep bluff near where Canyon-falls Creek intersects McCutcheon Road, slightly northeast of McMillin. Tufa is a spongy, porous deposit of calcium carbonate deposited by a spring or seep.

Figure J-3. Andesite volcanic bombs near McMillin and Orting commonly display a 'breadcrust' texture. These rocks were probably erupted about 2,450 yr B.P. during Mount Rainier's Summerland eruptive period and deposited in pyroclastic flow deposits in the upper South Puyallup River. They were then picked up by the Electron Mudflow in about A.D. 1500 and carried to this location. The bomb in the foreground is about 18 in. (0.45 m) wide. (See Fig. A-11, p. 60.)

4.4 *7.1* Another Puyallup River bridge. The Carbon River enters the Puyallup River about 0.2 mi (0.3 km) downstream of this bridge.

4.5 *7.2* Trailhead for the Foothills Trail, a 'rail trail' built on an abandoned railroad bed that parallels the highway.

5.7 *9.2* Enter Orting.

5.8 *9.3* Village Green subdivision. Many tens of buried trees were exhumed during the excavations for

Figure J-4. A aerial view to the southeast of the Puyallup River valley near Orting, some 30 mi (50 km) flow distance from Mount Rainier. The valley is underlain by a thick stack of lahar deposits from Mount Rainier. The youngest lahar is the Electron Mudflow of about A.D. 1500. It originated on the upper west flank (right side) of Mount Rainier and flowed down the Puyallup River valley. At Orting, it covers the entire valley floor to a maximum depth of about 16 ft (5 m). The buried stump shown in Figure J-5 was found during excavations located in the lower left corner of this photo. Photo by Steve Brantley, U.S. Geological Survey, 1992.

this subdivision. The trees were buried in place or carried to this location from Mount Rainier by the Electron Mudflow. The oldest tree found had 457 annual growth rings (counted about 6 ft (~2 m) above the roots), thus it had begun to grow some time before about A.D. 1045.

6.1
9.8 Small turnout on the west. In good weather, Mount Rainier can be seen straight ahead to the southeast.

6.4
10.3 Ptarmigan Middle School. The tree stumps on the lawn were exhumed during construction of the school and are members of the buried forest mentioned above. The inevitability of future lahars in the Puyallup River valley and the installation of acoustic flow monitors in the upper Carbon and Puyallup River valleys by the U.S. Geological Survey (USGS) in cooperation with Pierce County have changed the emergency preparedness practices of citizens in this valley, including that of the schools. Students now learn about the history of lahars and how they are monitored, and they practice evacuations via bus and walking to high ground. A project called "Bridge for Kids" initiated by local citizens has acquired preliminary funding for planning and development of a pedestrian bridge that would allow citizens of Orting to walk to higher ground on the east side of the Carbon River if a lahar is detected. (See http://www.bridge4kids.com.)

Figure J-5. One of the many large subfossil trees unearthed in 1993 during excavations for a sewer line at a new subdivision in Orting. This Douglas-fir was rooted about 16 ft (5 m) below the present land surface. Its average breast-height diameter was more than 9 ft (2.8 m). Tree-ring matching tells us that it was about 360 years old when it was buried by the Electron Mudflow from Mount Rainier at about A.D. 1500. The Electron began when a massive part of the upper west flank of Mount Rainier collapsed and began to flow as a wet, thick slurry at high velocities down the Puyallup River. While the average speed of the flow was about 30 mi (48 km) per hour, in the upper reaches of the river it flowed significantly faster. The lahar likely reached this area about one hour (or less) after it had been initiated at Mount Rainier. It was probably more than 100 ft (30 m) deep when it exited the Cascade Mountains near the present town of Electron, and likely flowed through the site of Orting as a surge about 30 ft (9 m) deep.

6.5
10.5 White Hawk residential subdivision. This area was inundated by the Electron Mudflow in about A.D. 1500 (Fig. J-4). Beginning in 1993, excava-

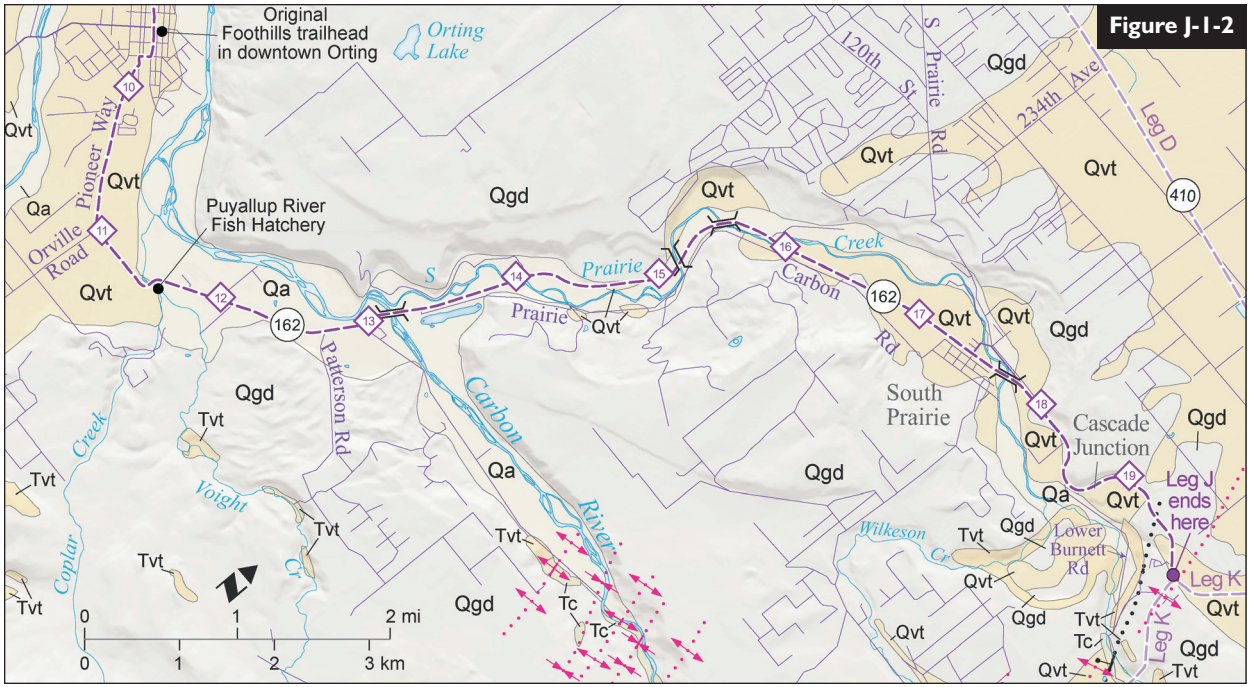

Figure J-1-2

tions on the west side of the highway have exposed remnants of a buried old-growth forest (mostly Douglas-fir) that was preserved within the clay-rich mudflow (Fig. J-5). Some of the excavated snags are lying on the surface, and several in-place stumps stick up in the storm-water retention pond north of the subdivision entrance (now mostly obscured by vegetation in the pond). The 16-ft (5 m)-long chunk of andesitic volcanic breccia, on the left (southeast) side of White Hawk Boulevard (up 0.1 mi [0.1 km]), was excavated here.

7.1 *11.4* Downtown Orting (Calistoga Street).

7.6 *12.2* MP 10.

8.1 *13.0* The warning siren slightly east of the highway is part of the lahar warning system that uses acoustic flow monitors to detect the approach of a lahar from Mount Rainier. The USGS installed the monitors in upper reaches of the Puyallup and Carbon Rivers in 1998 in a cooperative arrangement with Pierce County and the Washington Emergency Management Division of the Washington Military Department (Lahusen, 1996).

The west flank of Mount Rainier, the source of the Puyallup River, has been identified as being particularly susceptible to failure because of the concentrations of altered rock composing its upper flanks. (See "Stewing in Its Own Juices", p. 39.)

8.5 *13.7* MP 11. Orville Road. About 0.8 mi (1.3 km) south of here, USGS geologist Dwight "Rocky" Crandell described another huge boulder 32 ft (10 m) in diameter that had been rafted from Mount Rainier by the Electron Mudflow.

9.1 *14.6* Puyallup River Fish Hatchery at Voight Creek.

9.5 *15.3* MP 12.

10.3 *16.6* Patterson Road. Note the lahar evacuation sign. This road leads out of the lahar inundation zone.

10.5 *16.9* MP 13. Railroad bridge. The new Carbon River bridge replaces the old trestle bridge that was partly undermined and made unsafe by flood erosion in 1990.

10.6 *17.0* You have reached the Carbon River, which heads at Carbon Glacier and drains part of the north flank of Mount Rainier. This is where South Prairie Creek enters the Carbon River. Despite its present size, South Prairie Creek valley is a remnant of the much larger ancestral White River valley that drained the north slope of Mount Rainier. The canyon is wider than that of the Carbon River and is eroded through the bedrock of the Puget Group (Eocene), here formally subdivided into the Carbonado (oldest), Northcraft, and Spiketon Formations.

Both river beds contain abundant rocks from Mount Rainier, but they also include Tertiary igneous bedrock of the Cascades and sandstones, shales, and coal fragments from coal seams of the Puget Group. Along bars and shores of the lower Carbon River, one can find abundant black, gray, and tan petrified wood from the Northcraft Formation. Pieces as large as 1.5 ft (0.5 m) in diameter and 3 ft (0.9 m) long have been found. Farther downstream in the Orting area, the fragments of petrified wood are generally smaller.

11.4 *18.3* MP 14. Bridge over South Prairie Creek.

12.6 *20.2* Another bridge over South Prairie Creek.

13.4 *21.6* An Osceola Mudflow deposit, a massive, poorly sorted, concrete-like layer, is exposed in the left bank of South Prairie Creek under vegetation on the downstream side of this bridge.

15.0 *24.1* Fire station in the town of South Prairie.

15.1 *24.3* Yet another bridge over South Prairie Creek.

15.4 *24.8* The road ascends a terrace.

15.9 *25.6* Lower Burnett Road. Glacial outwash is exposed slightly east of here in a roadcut and continues for half a mile (0.8 km).

17.2 *27.7* End of SR 162 at the intersection of SR 165. Here you can join Leg K (at mile 1.6 of that leg) to the Mowich Lake area. Leg L, the Fairfax Forest Reserve Road to the Carbon River Entrance to Mount Rainier National Park, can be reached from SR 165.

Remember to reset your odometer when you start another leg. ■