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THE COLUMBIA RIVER GORGE
THE STORY OF THE RIVER AND THE ROCKS

Ron Suchanek*

Introduction

The Columbia River Gorge is a most spectacular and beautiful sight. Although it is not the deepest canyon in North America, its primitive beauty makes us wonder what tremendous forces of nature interacted to bring about its creation. The most obvious force of nature is the erosive power of the Columbia River itself as it cuts its way through the Cascade Mountains.

But, what about those steep cliffs, how did they form? Why are there more waterfalls on the south side of the river than on the north? Were the Cascade Mountains always there, or were they formed by some particular force? As we wonder about it, more and more questions arise.

In order to seek answers to our many questions, let us travel the 65-mile length of the Columbia River Gorge for a closer look at the rock formations and geology of the area. We will supplement our observations with information from the literature on the geology of the Gorge (see references at end of report) and try to put together a picture of how the Gorge came to be as we see it today. Particularly helpful in this regard is the article by A. C. Waters, "The Columbia River Gorge: Basalt stratigraphy, ancient lava dams, and landslide dams," published in Bulletin 77 of the Oregon Department of Geology and Mineral Industries.

Our Field Trip

Our route east will take us up the Columbia Gorge on Interstate Highway 80N to the Bridge of the Gods at Cascade Locks, where we will cross the Columbia River and continue on the Washington side as far as the bridge to Hood River. Here we will cross back to the Oregon side, going east nearly

* Ron Suchanek, a graduate student in Secondary Education at Portland State University, designed this non-technical account of the Columbia River Gorge for use by his students. The report was a term paper submitted in May 1974 for a course in Geology of Oregon taught at PSU by R. E. Corcoran.

to The Dalles. Our return trip to Portland will be on the Oregon side of the Columbia River via Interstate 80N and the old Scenic Highway (see accompanying map).

Starting from Portland State University, we will drive south on Broadway, enter the Freeway, and follow the signs for I-80N east toward The Dalles. Once on I-80N, continue east. Near Troutdale we will cross over the Sandy River. From this point on, start observing the rock formations on both sides of the river.

Take the Rooster Rock State Park exit, cross over I-80N, turn left, and follow the road to the west end of the parking lot.

STOP 1: Crown Point and Rooster Rock

Looking up, we see a great vertical bluff of resistant rock, named Crown Point, rising about 700 feet above the river. It is composed of columnar basalt. (Basalt is a dark-colored rock that has formed from molten lava flows.) It is believed that the bluff is a remnant of a great lava flow that filled an ancestral canyon of the Columbia River (Waters, 1973). Because this type of basalt is so common in this area, it was named Columbia River Basalt (nicknamed "Coriba" by E. T. Hodge, 1931). Some geologists have found that this same type of basalt extends farther north in eastern Washington and have called it Yakima Basalt (Waters, 1961). In this paper, we shall call it "Coriba" (Columbia River Basalt).

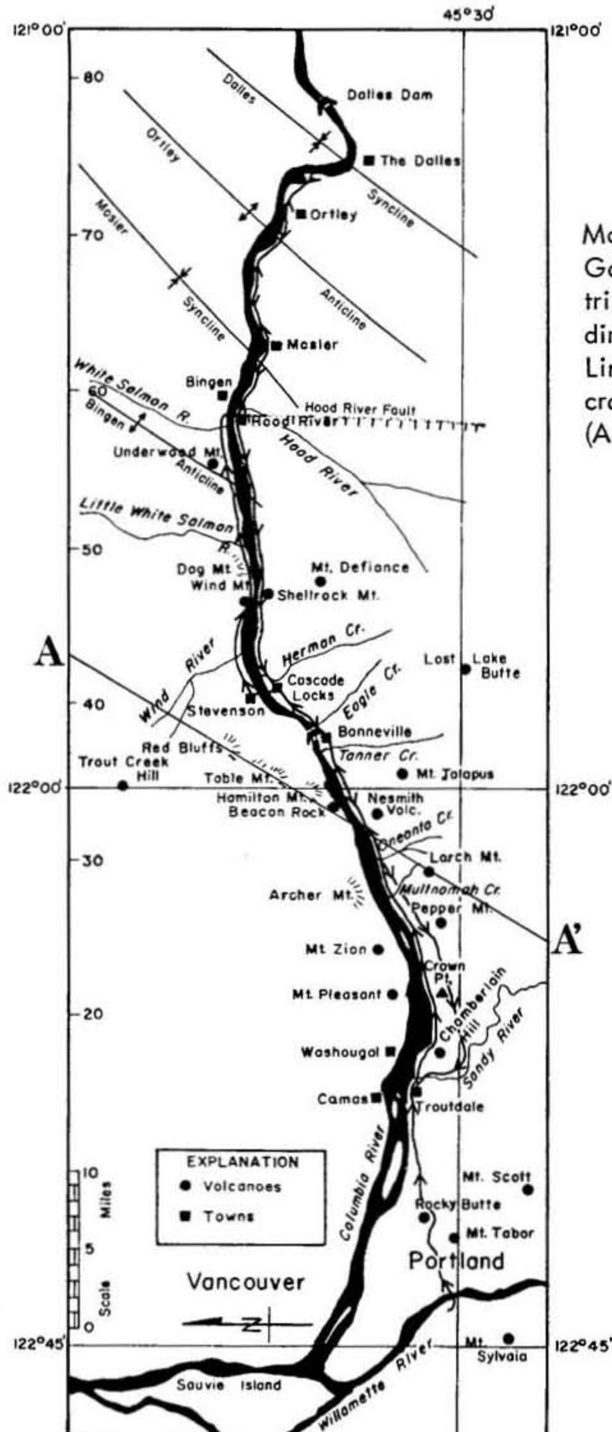
One characteristic of Coriba is its vertical or columnar jointing. (A joint is a fracture or break in the rock.) Because of the vertical jointing, weathered pieces of Coriba break away parallel to the face of the bluff and fall to the base of the bluff, forming a slope of fragments and scattered blocks known as talus.

Looking toward the river, we see a pinnacle of rock known as Rooster Rock, which is a huge piece of columnar-jointed basalt. What is this rock doing at the edge of the river? How did it get there? If we look just west of Crown Point, we see a recessed area in the cliff. It is thought that this is the scar of a landslide which, among other debris, deposited the huge piece of basalt upright at the river's edge (Williams, 1916; Waters, 1973). Because the rock is very hard and resistant to weathering and erosion, it still stands today.

Let us return to I-80N and continue east. Note the high bluffs of basalt on the right. Also note that there is another formation on top of the basalt, which we will examine later on our return trip to Portland.

About $6\frac{1}{2}$ miles farther, we pass Multnomah Falls and Larch Mountain on the right. We will also visit this area on our return trip.

As we proceed east, we get occasional glimpses of a huge rock at the river's edge on the Washington side. This rock, named Beacon Rock, rises about 800 feet above river level. As we drive, we can see that its sides are perpendicular for hundreds of feet. Is this another basalt pinnacle like



Map of Columbia River Gorge showing route of trip (arrows indicate direction of tour). Line A-A' is position of cross section on p. 207. (Adapted from Allen, 1957)

Rooster Rock? No, geologists believe that it is part of a volcanic plug. At one time it was an active volcano, which later plugged its own vent. The river eroded away the sides of the volcano and left the more resistant rock that formed the plug; hence Beacon Rock as we see it today (Williams, 1916; Waters, 1973).

On the Oregon side, we can see the basalt (Coriba) cliffs rising higher and higher above the river, in some places over 2,000 feet (Williams, 1916). Notice the many layers. Obviously they are the result of many huge lava flows and much volcanic activity in the geologic past.

About 14 miles beyond Crown Point we reach McCord Creek. Stop at the roadside outcrop of rock just before crossing the bridge.

STOP 2: McCord Creek - Eagle Creek Formation

Here a very different type of rock is exposed beneath the Coriba, rising to a height of about 250 feet above the river. Instead of solid dark rock like the basalt, we see a mixture of different sized light-grey rocks (from pebbles to boulders) held together by finer material. This rock formation is known as the Eagle Creek Formation, so named because of its discovery along Eagle Creek, a tributary of the Columbia River on the Oregon side (Williams, 1916). Since this formation is found beneath the Coriba, it must have been formed before the basalt flows. The obvious question, "How did it form?" comes to mind.

A study of the rocks in the Eagle Creek Formation show they are mostly volcanic fragments. The finer material appears to be composed of ashy silt and sand. All of this seems to indicate that the material was deposited as mudflows and slurry floods from nearby active volcanoes (Waters, 1973).

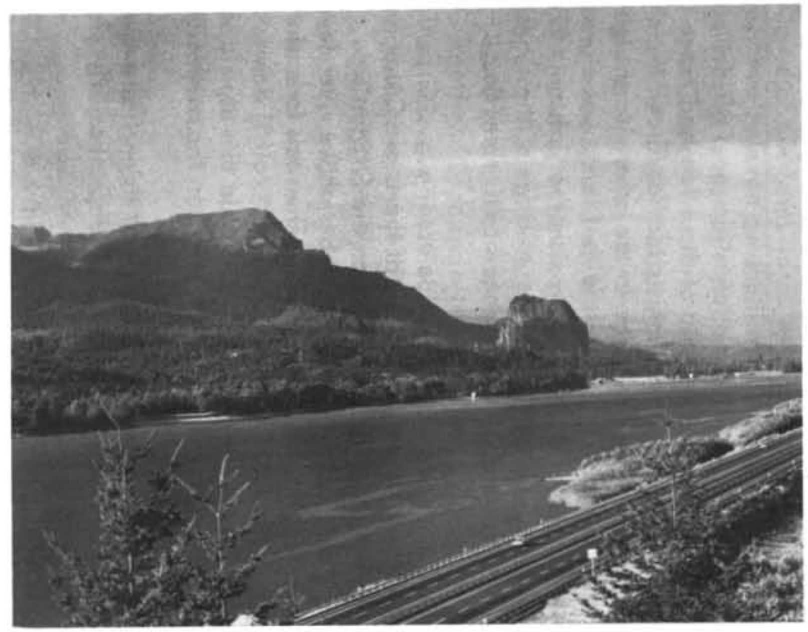
Closer study of the rock formation will reveal dark bands containing plant fragments. Chaney (1918) found wood and leaves of many plant species that are now extinct and determined that they grew here in early Miocene time, 14 to 16 million years ago (Chaney, 1959).

Two and a half miles farther east on I-80N, we will pass Eagle Creek, the type locality of the formation. Continue east.

Take the Cascade Locks exit and cross the Columbia River on the toll bridge. On the Washington side, turn right onto Washington Highway 14 (US 830). We are now skirting the lower portion (or toe) of the Bonneville Landslide. Note the hummocky ground and the jumble of rocks in the slide. As we pass Ash Lake, we have a good view of the cliffs forming the scarp, or break, at the head of the landslide.

STOP 3: Eagle Creek Formation

About 1.8 miles beyond the toll bridge we come upon a large block of Eagle Creek Formation perched on edge near the railroad track. Similar rock occurs in the roadcut (Waters, 1973). Stop here. Examine the Formation and compare it with what we saw on the Oregon side.



Above: Beacon Rock, the plug of an old volcano, rises from the Washington side of the Columbia River. (Hwy. Div. photo)

Left: Rooster Rock is a piece of an ancient landslide that slid from the recessed cliff to the south. (Hwy. Div. photo)

STOP 4: Overview of Bonneville Landslide Area

About 0.3 miles farther, stop again. From here we have an overview of the Bonneville Landslide area. Rockfalls and landslides peel off the cliffs of Eagle Creek and Coriba Formations at the head of the slide and move slowly toward the river. The forward motion of this slide has forced the river to the southern bank, causing a big rounded bulge in the otherwise straight course of the river. In the recent past, it is possible that there was a great downslope movement of material so as to temporarily dam the Columbia River and give rise to the local Indian legend of the ancient Bridge of the Gods. The rapids at Cascade Locks may be all that remained of this river dam (Waters, 1973).

Look again at the cliffs at the head of the slide area (e.g., Greenleaf Peak, Red Bluffs) and compare the relative positions of the Eagle Creek and Coriba Formations with the corresponding formations on the Oregon side. The formations on this side of the river seem to rise higher above river level than the corresponding formations on the Oregon side. The rock formations are lower on the Oregon side because they slope gently (2° to 8°) downward from north to south across the Gorge (Waters, 1973). Could this dip slope from north to south explain why more landslides are found on the north side of the gorge?

Before we answer this question, let us continue east through the town of Stevenson. At the east edge of town, notice the outcrops of a different kind of rock. It looks bluish green.

STOP 5: Ohanapecosh Formation Equivalent

Continue on for approximately 2.7 miles until you come to a good outcrop of the bluish-green rock. Stop and examine it closely. Note that in some places there appears a purplish-brown to red-brown clay material. This material, called "saprolite" by geologists, results from long weathering and alteration of rock. Saprolite layers 10 to 100 feet thick have been found within this bluish-green rock formation (Waters, 1973).

Recent studies of this rock formation along the Columbia River Gorge showed that it contains altered volcanic rocks which are considered to be equivalent in age and origin to the upper Eocene (45 to 37 million years ago) Ohanapecosh Formation (Fiske and others, 1963) of Mount Rainier National Park. Since the evidence for this classification is inconclusive, the formation along this portion of the Columbia River Gorge is called the Ohanapecosh Formation equivalent. The base of the Ohanapecosh Formation equivalent has not been found in the Columbia River Gorge area. It is believed that its total thickness may exceed 10,000 feet. The formation itself appears to be composed of volcanic rock fragments from underwater eruptions and mudflow and slurry flood deposits from eruptions on land (Waters, 1973).

The top layer of the Ohanapecosh Formation equivalent is also deeply weathered and converted to a purplish-brown to red-brown clay saprolite. On top of the Ohanapecosh we find rocks of the Eagle Creek and Coriba Formations.

Cause of the Landslides:

Rainwater penetrates the permeable Coriba along its numerous vertical joints and is transmitted deeper by other vertical joints in the rocks of the Eagle Creek Formation. The water cannot enter the Ohanapecosh Formation equivalent at most places because all joints and other openings have been sealed by the alteration of the rocks, so water collects at the saprolite boundary and converts the saprolite to slippery clay. Then the vertically jointed formations above begin to break away, tilt, and slide downslope on this unstable and well-greased skidboard (Waters, 1973).

This situation exists all along the north side of the Columbia River Gorge from Cape Horn (which is nearly opposite Crown Point) to about two miles east of Wind Mountain. The largest and most typical of these landslides is the Bonneville Landslide, which we have already observed.

The Ohanapecosh Formation equivalent underlies extensive areas between Rock Creek and Little White Salmon River on the north side of the river and can be seen in outcrops along the highway. On the south side of the river it is covered by overlying formations, except in a few small patches near the river bank. A few outcrops occur in the area immediately around Cascade Locks (Waters, 1973).

Let us continue along Highway 14, past Carson and Wind River, and about a mile farther on, stop to see a different kind of rock.

STOP 6: Wind and Shellrock Mountains

Wind Mountain on the Washington side and Shellrock Mountain across the Columbia on the Oregon side are two volcanic stocks. These rock masses are part of a north-south chain of quartz diorite intrusions which pushed up through older rocks in late Miocene to Pliocene times (Waters, 1973). The rocks are lighter in color than basalt and have a platy jointing. Note the ring of platy talus around the base of Wind Mountain. We will pass Shellrock Mountain on our return trip.

Continue about one mile farther and turn left onto Bergen Road, which crosses the active Wind Mountain Landslide. (The landslide material is not from Wind Mountain itself but from the formations overlying the slippery Ohanapecosh Formation equivalent.) Note the bumps and displacements on the road, and the "drunken forest" on either side.

STOP 7: Wind Mountain Active Landslide

Stop at junction of Bergen and Girl Scouts Road. Note the effects of the landslide on the former pavement, on the forest, and on the house. Note the large piece of red saprolitized Ohanapecosh among the jumble of different rock types in the roadcut.

Return to Highway 14, turn east. Notice the Coriba on both sides of the river. We will pass through two tunnels in thick Coriba.

In the area of Underwood Mountain, we find lava beds of more recent origin over the Coriba. The lower portions of the Underwood lavas, as they are called, are marked by pillow lavas. (Pillow lavas are rounded structures produced by molten lava flowing into water.) This would seem to indicate that the Underwood lavas poured into an ancestral Columbia River (Waters, 1973).

Just after we pass the Underwood lavas we see an upfold in the rock formations. This upfold or anticline is known as the Bingen anticline, named after the nearby town of Bingen, Washington. The Bingen anticline can also be seen in the rock formations on the Oregon side of the river.

Cross over the bridge to the town of Hood River on the Oregon side of the Columbia River Gorge. Hood River Valley was formed by a downdrop along a fault which runs from north to south through the valley. Over 1,000 feet of fall on the east side of the valley is marked by a fault scarp. Several small cinder cones and shield volcanoes are on the line of the fault.

Continue upriver along the Oregon side of the Columbia River on I-80N. Soon, on the north side of the river, we can see the Coriba dipping toward the river. This downfold, which continues across the river and onto the Oregon side, is known as the Mosier syncline, named after the town of Mosier, through which the syncline passes.

Farther on, we see the Coriba folding upward again in the vicinity of Ortley, Oregon. Appropriately, it is called the Ortley anticline. Each of these anticlines and synclines follows a northeast-southwest orientation across the Gorge (see map).

Continue on and take the Rowena exit to the right. Follow the Rowena Loop Road to the top of the Coriba flows and turn left to the viewpoint.

STOP 8: Rowena view - East end of Columbia River Gorge

From here we can see the Columbia River Gorge giving way to a flat flood-swept area of basalt of the Columbia Plateau. Around the bend of the river to the right is The Dalles, Oregon. This town is located on a downfold called Dalles syncline. In The Dalles area, sedimentary beds of rock known as Dalles Formation lie on top of the basalt.

This stop marks the farthest point east we will travel through the Gorge. Return to I-80N and head west through the town of Hood River.

Twelve miles west of Hood River, we pass round the huge talus piles crowding the highway at the base of Shellrock Mountain. At times, some rocks actually land on the highway itself. On the opposite side of the river is Wind Mountain.

About a mile beyond, between Shellrock Mountain and the town of Dodson, the highway is heaving upward. The Highway Department has encountered much difficulty in this area and has unsuccessfully tried to

Oneonta Gorge, a narrow slit in Coriba has a waterfall at its end. (Hwy. Div. photo)

Multnomah Falls drops in two falls, each held up by harder layers of basalt. (Hwy. Div. photo) relieve the problem by removing many thousands of cubic feet of material from the slopes above the highway. Just east of the town of Wyeth, red mud boils up and spreads over the ground near the highway each spring (Waters, 1973). What is the cause of all this?

The culprit, as explained by Waters (1973), is the thick clay saprolite of the Ohanapecosh Formation equivalent discussed earlier. Although the Ohanapecosh can be seen on the Oregon side in only a few places near the river level, it is nevertheless underlying the Eagle Creek Formation and the Coriba. We must also remember that the rock formations slope downward from north to south across the Gorge. Because of this southerly dip away from the river, the slick saprolite cannot cause landslides as it does on the north side of the Gorge. However, the great weight of the overlying rock formations can squeeze the saprolite mud upward toward the north, thus forcing it up through the ground just south of the river. This is probably what is causing the highway to heave upward and red mud to ooze out each spring.

Continue west on I-80N. After passing the town of Cascade Locks, look again across the river at the Bonneville Landslide area.

About 3 miles farther, we pass Bonneville Dam on the right. On the left, there are good exposures of the Eagle Creek Formation in the roadcuts. Across the river, we can again see Beacon Rock.

About $5\frac{1}{2}$ miles farther, take the exit to the Scenic Highway. High up on the left rises Saint Peters Dome, a 2,000-foot cliff composed of basalt.

The first waterfall we pass is Horsetail Falls. Continue on to Oneonta Gorge.

STOP 9: Oneonta Gorge

Here a waterfall has eroded through a possible structural weakness in the lava flow to form a narrow box canyon with a waterfall at its end. Molds of trees that were buried in the base of a lava flow are visible in the walls (Allen, 1957, p. 14; Waters, 1973).

Continue on to Multnomah Falls.

STOP 10: Multnomah Falls

Multnomah Falls is the most beautiful falls along the Columbia River Gorge. It is also the second highest falls in the United States. The upper main falls drops 541 feet. It should be obvious by now that the exposed cliff of the falls is composed of basalt. At least four layers representing four lava flows can be identified.

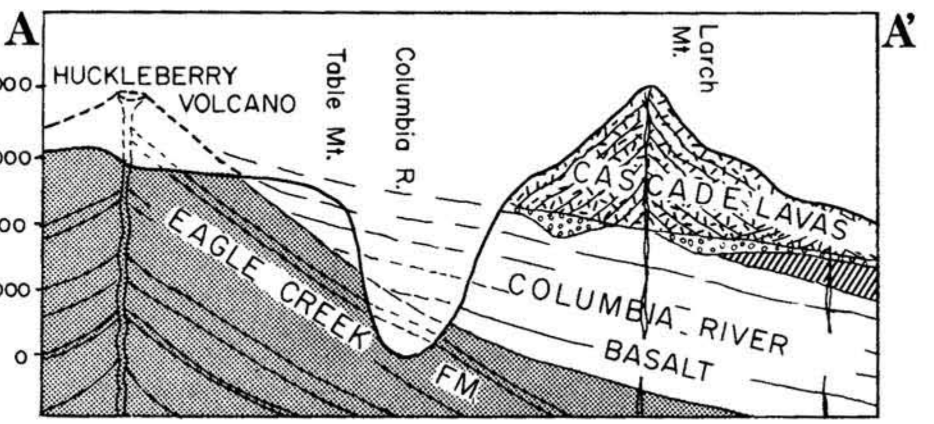
Why is the cliff of the falls so steep? Think back to the type of jointing found in this basalt for the answer. Such basalt breaks in vertical fragments. As the water of the falls wears away the basalt of the cliff, the basalt weakens at the jointing and eventually falls to the base, where it is eroded further by the falling water.

Why is there a lower falls as well as an upper falls? Why does not the upper falls drop directly to the lowest stream level? It is believed that the rock at the base of the upper falls is much harder and therefore more resistant to water erosion, hence the two falls.

Continue west on the Scenic Highway. About half a mile farther, we pass Wahkeena Falls on the left, then Latourell Falls. At this point we might ask: "Why are there so many waterfalls on the Oregon side of the Gorge?" For the answer, think back to the previous discussion about the numerous landslides along the north side of the river and the fact that all the rock formations dip from north to south across the Gorge (see cross section). Since Coriba forms the steep walls on the south side, it is not as prone to landsliding; hence high basalt cliffs and waterfalls.

West of Latourell Falls, the Scenic Highway begins to ascend to Crowr Point in a series of loops. Look at the rock outcrops as we ascend. They are composed of Coriba. Continue on past Vista House. Again, look closely at the rock outcrops. Soon we will see a change. The basalt is overlain by gravels similar to what we saw in the Eagle Creek Formation. Can Eagle Creek Formation be on top of, as well as under, the Coriba? It is unfortunate there is no stopping place along the road because we have come upon a new rock formation, the Troutdale Formation, but we will see more of it later.

As we continue to ascend, we soon see a red band in the outcrops and a different material on top of the red band. This is yet another new formatio



Diagrammatic cross section of Columbia River Gorge from ancient Huckleberry Volcano (source of Eagle Creek Formation) to Larch Mountain. Tilt of rock layers toward southwest produces high cliffs of Columbia River Basalt on Oregon side (adapted from Allen, 1957).

known as Boring Lava. The red line was caused by the red-hot flowing lava baking the top layer of rock, the way bricks are burnt in a kiln (Williams, 1916).

Continue on around the top of the crescent-shaped cliff; stop at the Viewpoint on Chanticleer Point.

STOP 11: View of Gorge From Chanticleer Point

If the day is clear, we can get an exceptional view of the Columbia River Gorge. Across the river, to the northeast, is Cape Horn, composed of thick flows of Coriba. On top is Troutdale Formation similar to that seen in the roadside outcrops west of Vista House. Farther up the Gorge on the Washington side are the Bonneville and other slide areas and Beacon Rock.

On the Oregon side we can see Crown Point, itself composed of hundreds of feet of Coriba flows. Beyond is Larch Mountain sloping down toward the steep cliffs of the Gorge where we passed so many waterfalls. At the river's edge below Crown Point is Rooster Rock. To our right is the recessed cliff from which Rooster Rock presumably broke during a gigantic landslide. Heavy growth of trees on the debris slope indicates that this is mainly an old slide; however, slumped pavement on the Scenic Highway we just passed over tells us that slight movement is still going on.

Return to the Scenic Highway and continue west. At Corbett Junction, keep left. At Bell Road Junction, take Bell Road to the right (this is a short-cut). About 1 mile farther, rejoin the Scenic Highway. Along the road, we can see numerous roadcuts of the same gravel formation we found above the Coriba and beneath the Boring Lava just west of Crown Point.

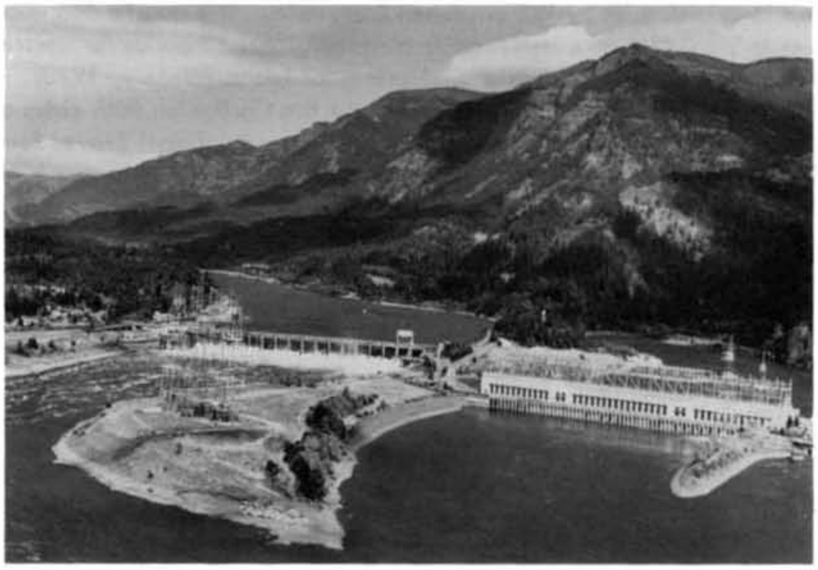
Continue on to the vicinity of the bridge across the Sandy River leading to the town of Troutdale. Stop somewhere near the bridge.

STOP 12: Troutdale Formation

Superficial examination of the outcrop on the right would lead us to believe that we are observing more of the Eagle Creek Formation. However, closer scrutiny will show marked differences. There are no large boulders as in the Eagle Creek, the rocks show less size variation and appear to be better sorted, and the particles are more rounded.

A study of the type of rocks found in the Troutdale Formation show that they are mostly Coriba fragments, with the finer material being volcanic debris. The formation also contains some reddish quartzite and quartz pebbles not found in the Eagle Creek Formation. The upper layers of the Troutdale Formation also contain beds of sandstone.

All geologists who have studied this formation agree that it is a huge gravel deposition made by the ancestral Columbia River as it flowed into the Willamette basin (Waters, 1973). Because the pebbles are more rounded and better sorted, we are lead to believe that these rock fragments have been



View of Bonneville Dam. On upper right Gorge walls are composed of flow upon flow of Coriba overlying Eagle Creek Formation. On left is toe of Bonneville landslide. (Hwy. Div. photo)

View looking up Columbia River Gorge from Chanticleer Point. Crown Point and Vista House on right, Cape Horn on left, and Beacon Rock in distance. (Hwy. Div. photo) carried long distances by the ancestral Columbia. The quartz and quartzite pebbles in particular are believed to have originated from as far upstream as northeastern Washington, British Columbia, or Idaho (Waters, 1973).

Since these Troutdale deposits overlie the Coriba on both sides of the Gorge, they formed after the period of basalt flows. Fossil leaves found in the Troutdale Formation have been dated as being Pliocene in age (Chaney, 1944).

This ends our journey through the Columbia River Gorge. To return to Portland, follow the highway along the Sandy River, through the State Park, to Interstate 80N.

Putting it all Together

Now that we have traveled through the Columbia River Gorge, let us put all that we have seen and learned into a complete picture, starting with the sequence of rock formations. Assuming that the younger formations are laid on top of the older formations, we find the following pattern appearing in the Columbia River Gorge:

Relative age	Name of formation	Geologic time (m.y.=million years ago)
Youngest formation	Recent alluvial deposits (at river level)	Holocene (Recent) (<0.01 m.y.)
↑	Cascade Andesite and Boring Lava	Plio-Pleistocene (5 - 0.01 m.y.)
	Troutdale Formation and Dalles Formation	Pliocene (12 - 3 m.y.)
	Columbia River Basalt (Coriba)	Miocene (26 - 12 m.y.)
↓	Eagle Creek Formation	Early Miocene (26 - 20 m.y.) Oligocene (37 - 26 m.y.)
Oldest formation	Ohanapecosh Formation equivalent	Upper Eocene (45 - 37 m.y.)

The Geologic Story

During Eocene time, the present position of the Cascade Range was probably a rolling land surface dotted with volcanoes, while a shallow arm of the ocean lay to the west. Over a span of millions of years, lavas and explosive volcanic fragments, together with mudflows and flood debris, formed the thick Ohanapecosh Formation. Between eruptions, weathering of the rock produced layers of red, clayey saprolite. After volcanism ceased, a thick layer of saprolite formed on the surface of the Ohanapecosh. Later, in Oligocene to Miocene time, a new episode of volcanic eruptions spread debris of the Eagle Creek Formation over the Ohanapecosh. Between eruptions, the Eagle Creek Formation weathered enough to form a soil on which plants grew, as evidenced by the fossil leaves and wood found in this formation.

A new period of great volcanic activity occurred during the Miocene. From fissures in the earth came many successive flows of Columbia River Basalt. Total thickness ranges from several hundred to several thousand feet along the present Gorge. Before the time of these lava flows, the Columbia River had already come into existence, as evidenced by the pillow lavas found in the Coriba. The Coriba buried the mudflows and flood deposits of the Eagle Creek Formation and compressed and solidified them into a more or less firm rock (Williams, 1916).

The active volcano, which later became Beacon Rock, is believed to have erupted through the sediments of the Eagle Creek Formation before the forming of the Gorge. Much later, the river eroded away the less resistant sides of the volcano and left the more resistant plug.

After the great lava flows of Coriba had ceased, pressures within the earth's crust began causing the rock layers to fold into anticlines and synclines and to break along faults.

During this same geologic time period (Pliocene), the Columbia River continued to flow and wear away at the rock formations as they were uplifted. This erosion resulted in the deepening of what was to become a gorge, and the depositing of sediments to the west to form the Troutdale Formation. Continued uplift raised some of the early Troutdale sediments above the river level to heights such as Crown Point (about 700 feet above the present river level), forcing the Columbia to cut deeper to reach ocean level.

During later Pliocene time, new volcanic eruptions occurred in a north-south band along the crest of the Cascade Range. These volcanoes (e.g., Larch Mountain, Mount Defiance) produced what is known as the Cascade Andesite and Boring Lava, which covered the Coriba and the Troutdale Formation (Lowry and Baldwin, 1952). Also during this period, stocks (large masses of molten rock) intruded older rocks and cooled to form Wind and Shellrock Mountains, which, like Beacon Rock, were exhumed by the Columbia River at a later time.

In Pleistocene time, large volcanoes erupted along the crest of the Cascades, forming the snow-capped peaks we know today. Two of these, Mount Hood and Mount Adams, sit on either side of the Columbia River Gorge.

During the millions of years of its history, neither erupting volcanoes nor folding rock layers could stop the mighty Columbia in its journey to the sea. Its erosive power kept pace with these obstacles. There is evidence that in fairly recent times large landslides and tongues of lava dammed the river at various places in the Gorge, but the river carved its way through.

The growth of the Cascade Range and the corresponding deepening of the Gorge appear to have lessened in recent times. Although man-made dams now control the waters of the Columbia, the river still erodes where the current is swift and deposits alluvium elsewhere, as evidenced by the numerous sandbars.

Now we know the probable origin of the Columbia River Gorge as it exists today. The rock formations have told us their story. Man can only stand in awe of the tremendous forces of nature which made the Gorge a most spectacular and beautiful sight.

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SELF-RESCUE MINE EMERGENCY COURSE MANDATORY

Anyone going underground in a mine must have completed a mine emergency safety training course on the use of self-rescue units. This is now a Federal law under the Department of Interior's MESA (Mines Emergency Safety Administration). A card certificate will be issued at the end of the course. This card and a self-rescue unit must be carried by each person at all times while underground. The mandatory 2-hour course will be given by John English, MESA, Health and Safety Training Center, Bldg. 2, Albany Metallurgy Research Center, Albany, Oregon on January 29, 1975, between 8:00 a.m. and 3:00 p.m. To arrange for attendance write or call the Oregon Dept. of Geology and Mineral Industries in Portland (phone 229-5580) or the Bureau of Mines Liaison Office in Salem (phone 399-5755).

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NEW ENERGY ADMINISTRATION AGENCY CREATED

Bill H.R. 11510, "Energy Research and Development Administration," signed by the President October 11, establishes a new executive agency to consolidate the Federal energy research and development efforts of four existing agencies: The Atomic Energy Commission, the Interior Department, the National Science Foundation, and the Environmental Protection Agency. The new agency will have a broad charter to develop new and improved energy source and utilization technologies covering a broad range of energy sources including fossil, nuclear, solar, and geothermal. Responsibilities, transfer of functions, funding, and administrative programs are summarized in the American Mining Congress Legislative Bulletin, November 13, 1974.

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EOCENE STRATIGRAPHY OF SOUTHWESTERN OREGON PUBLISHED

"Eocene Stratigraphy of Southwestern Oregon," by Ewart M. Baldwin, Department of Geology, University of Oregon, has been published as Bulletin 83 by the State Department of Geology and Mineral Industries. The bulletin represents the culmination of many years of detailed mapping by Dr. Baldwin and his graduate students in a region that extends from the Oregon Coast to the Western Cascades and includes most of Coos County and parts of Curry and Douglas Counties. In coordinating the results of these investigations and those of other workers in southwestern Oregon, Dr. Baldwin has worked out the Eocene history of this large region and has recognized and defined many new stratigraphic units.

(continued next page)

The 40-page bulletin is illustrated by paleogeographic maps, photographs, a multicolored geologic map at a scale of 1:250,000. The bulletin is for sale by the Oregon Department of Geology and Mineral Industries at its Portland, Baker, and Grants Pass offices. The price is $3.50.

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INTERNATIONAL GEOTHERMAL CONFERENCE AT KLAMATH FALLS

More than 200 persons participated in the International Conference on Geothermal Energy (the first such conference in the United States) held in Klamath Falls October 7-9, 1974. Sponsors were the Oregon Institute of Technology, Oregon Department of Economic Development, Oregon Department of Geology and Mineral Industries, the city of Klamath Falls, and Klamath County Chamber of Commerce. The conference focused on industrial, agricultural, and commercial-residential uses of geothermal energy and included field trips to see a number of installations in the Klamath Falls area. Governor Tom McCall, luncheon speaker on the first day of the seminar, urged development of geothermal energy and cited examples of cost advantages already experienced by users of geothermal energy in Oregon. Featured speakers on the conference program represented four widely divergent regions: Budapest, Hungary; Reykjavik, Iceland; Rotorua, New Zealand; and Klamath Falls, Oregon.

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GEOTHERMAL LEASE SALES SCHEDULE ANNOUNCED

The following tentative schedule for competitive leasing of geothermal steam resources in KGRA areas has been announced by Archie Craft, State director, Bureau of Land Management:

<u>Fiscal year 1975</u>

- April 23 -- Vale Hot Spring addition
- May 22 -- Mickey Hot Springs (Alvord Desert KGRA)
- May 29 -- Alvord Hot Springs (Alvord Desert KGRA)
- June 5 -- Borax Lake Hot Springs (Alvord Desert KGRA)

<u>Fiscal year 1976</u>

- July 1975 -- Warner Valley
- February 1976 -- Klamath County

Craft states that the announced schedule is subject to stipulations of the Environmental Protection Act and other possible considerations. Leases are granted to qualified persons or corporations offering the highest bid at a public sale.

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INDEX TO THE ORE BIN
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AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. Upon request, a complete list of Department publications, including out-of-print, will be mailed)

BULLETINS

8.	Feasibility of steel plant in lower Columbia River area, rev. 1940: Miller	$0.40
26.	Soil: Its origin, destruction, preservation, 1944: Twenhofel	0.45
33.	Bibliography (1st suppl.) geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1963: Baldwin	3.00
36.	Papers on Tertiary foraminifera: Cushman, Stewart & Stewart. vol. 1 $1.00; vol. 2	1.25
39.	Geology and mineralization of Morning mine region, 1948: Allen and Thayer	1.00
46.	Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch	1.00
52.	Chromite in southwestern Oregon, 1961: Ramp	3.50
57.	Lunar Geological Field Conf. guidebook, 1965: Peterson and Groh, editors	3.50
58.	Geology of the Suplee-Izee area, Oregon, 1965: Dickinson and Vigrass	5.00
60.	Engineering geology of Tualatin Valley region, 1967: Schlicker and Deacon	5.00
61.	Gold and silver in Oregon, 1968: Brooks and Ramp	5.00
62.	Andesite Conference Guidebook, 1968: Dole	3.50
64.	Geology, mineral, and water resources of Oregon, 1969	1.50
66.	Geology, mineral resources of Klamath & Lake counties, 1970: Peterson & McIntyre	3.75
67.	Bibliography (4th suppl.) geology and mineral industries, 1970: Roberts	2.00
68.	The Seventeenth Biennial Report of the State Geologist, 1968-1970	1.00
69.	Geology of the Southwestern Oregon Coast, 1971: Dott	3.75
70.	Geologic formations of Western Oregon, 1971: Beaulieu	2.00
71.	Geology of selected lava tubes in the Bend area, 1971: Greeley	2.50
72.	Geology of Mitchell Quadrangle, Wheeler County, 1972: Oles and Enlows	3.00
73.	Geologic formations of Eastern Oregon, 1972: Beaulieu	2.00
74.	Geology of coastal region, Tillamook Clatsop Counties, 1972: Schlicker & others	7.50
75.	Geology, mineral resources of Douglas County, 1972: Ramp	3.00
76.	Eighteenth Biennial Report of the Department, 1970-1972	1.00
77.	Geologic field trips in northern Oregon and southern Washington, 1973	5.00
78.	Bibliography (5th suppl.) geology and mineral industries, 1973: Roberts and others	3.00
79.	Environmental geology inland Tillamook Clatsop Counties, 1973: Beaulieu	6.00
80.	Geology and mineral resources of Coos County, 1973: Baldwin and others	5.00
81.	Environmental geology of Lincoln County, 1973: Schlicker and others	7.50
82.	Geol. hazards of Bull Run Watershed, Mult. Clackamas Cos., 1974: Beaulieu	5.00
83.	Eocene stratigraphy of southwestern Oregon, 1974: Baldwin	in press
84.	Environmental geology of western Linn Co., 1974: Beaulieu and others	8.00
85.	Environmental geology of coastal Lane Co., 1974: Schlicker and others	7.50

GEOLOGIC MAPS

Geologic map of Oregon west of 121st meridian, 1961: Wells and Peck	2.15
Geologic map of Oregon (12" x 9"), 1969: Walker and King	0.25
Geologic map of Albany quadrangle, Oregon, 1953: Allison (also in Bulletin 37)	0.50
Geologic map of Galice quadrangle, Oregon, 1953: Wells and Walker	1.00
Geologic map of Lebanon quadrangle, Oregon, 1956: Allison and Felts	0.75
Geologic map of Bend quadrangle, and portion of High Cascade Mtns., 1957: Williams	1.00
GMS-1: Geologic map of the Sparta quadrangle, Oregon, 1962: Prostka	1.50
GMS-2: Geologic map, Mitchell Butte quad., Oregon: 1962, Corcoran and others	1.50
GMS-3: Preliminary geologic map, Durkee quadrangle, Oregon, 1967: Prostka	1.50
GMS-4: Gravity maps of Oregon, onshore & offshore, 1967: Berg and others [sold only in set] flat $2.00; folded in envelope	2.25
GMS-5: Geology of the Powers quadrangle, 1971: Baldwin and Hess	1.50
GMS-6: Prelim. report, geology of part of Snake River Canyon, 1974: Vallier	in prep.

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18.	Radioactive minerals prospectors should know, 1955: White and Schafer	$0.30
19.	Brick and tile industry in Oregon, 1949: Allen and Mason	0.20
21.	Lightweight aggregate industry in Oregon, 1951: Mason	0.25
24.	The Almeda mine, Josephine County, Oregon, 1967: Libbey	2.00

MISCELLANEOUS PAPERS

1.	Description of some Oregon rocks and minerals, 1950: Dole	0.40
2.	Oregon mineral deposits map (22 x 34 inches) and key (reprinted 1973): Mason	0.75
4.	Rules and regulations for conservation of oil and natural gas (rev. 1962)	1.00
5.	Oregon's gold placers (reprints), 1954	0.25
6.	Oil and gas exploration in Oregon, rev. 1965: Stewart and Newton	1.50
7.	Bibliography of theses on Oregon geology, 1959: Schlicker	0.50
7.	(Supplement) Bibliography of theses, 1959 to Dec. 31, 1965: Roberts	0.50
8.	Available well records of oil and gas exploration in Oregon, rev. 1963: Newton	0.50
11.	A collection of articles on meteorites, 1968 (reprints from The ORE BIN)	1.00
12.	Index to published geologic mapping in Oregon, 1968: Corcoran	0.25
13.	Index to The ORE BIN, 1950-1969, 1970: Lewis	0.30
14.	Thermal springs and wells, 1970: Bowen and Peterson	1.00
15.	Quicksilver deposits in Oregon, 1971: Brooks	1.00
16.	Mosaic of Oregon from ERTS-1 imagery, 1973:	2.00

OIL AND GAS INVESTIGATIONS SERIES

1.	Petroleum geology, western Snake River basin, 1963: Newton and Corcoran	2.50
2.	Subsurface geology, lower Columbia and Willamette basins, 1969: Newton	2.50
3.	Prelim. identifications of foraminifera, General Petroleum Long Bell no. 1 well	1.00
4.	Prelim. identifications of foraminifera, E. M. Warren Coos Co. 1-7 well: Rau	1.00

MISCELLANEOUS PUBLICATIONS

Landforms of Oregon: a physiographic sketch (17" x 22"), 1941	0.25
Geologic time chart for Oregon, 1961	free
Postcard - geology of Oregon, in color . . . 10¢ each; 3 - 25¢; 7 - 50¢; 15 -	1.00
Oregon base map (22 x 30 inches)	0.50
Mining claims (State laws governing quartz and placer claims)	0.50
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