Field Trip Workbook **NAME:**_____
G200 Field Studies—Sec 002 (Columbia Gorge)
Spring, 2025
Instructor: Alex Ruzicka
TA: Benjamin Agyemang

Use this workbook to answer the following questions about the geology at the stops we will be making. If you need extra space, add answers to the back of the pages.

Stop 1- cliffs along Sandy River (along Historic Highway)
Stop 2- Women's Forum (along Historic Highway)
Stop 3- Cascade Locks, Marine Park
Stop 4- Starvation Creek State Park (Exit 55 on I-84) LUNCH
Stop 5- Memaloose Overlook (along Historic Highway) OPTIONAL
Stop 6- Rowena Viewpoint (along Historic Highway)
Stop 7- East Mayer State Park (Rowena River Road east)
Stop 8- brown-yellow outcrop (milepost 61.0 on pullout of I-84)

Note: the 55-passenger bus has bathrooms in the back. Other bathroom opportunities are at Starvation Creek I-84 Exit 55 (eastbound), Cascade Locks Marine Park, Starvation Creek State Park, East Mayer State Park, and Memaloose State Park I-84 exit before milepost 73 (westbound), and elsewhere.

Figure 1. Shaded topographic map of the Columbia Gorge showing our planned stops (red dots). [Modified after O'Connor and Burns, 2009]

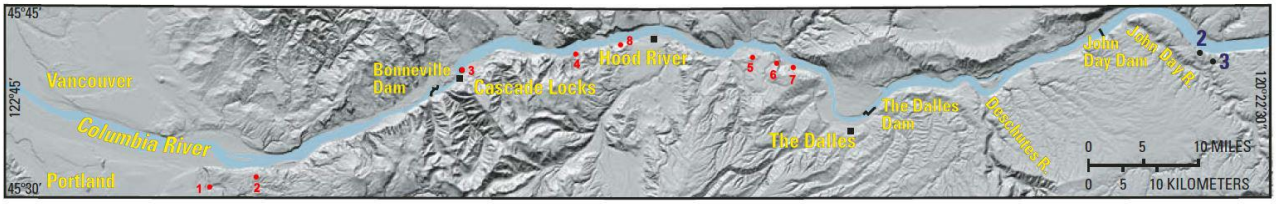


Figure 2. Schematic geologic cross section of the Columbia Gorge. [After O'Connor and Burns, 2009]

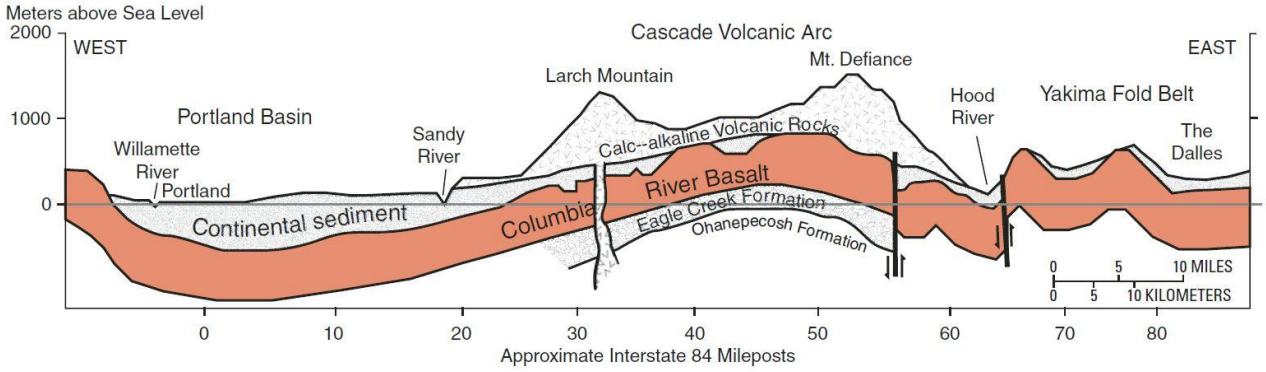


Figure 2. Schematic geologic cross section for south of the Columbia River corridor through the Portland Basin and Columbia River Gorge. Horizontal scale approximate. After Allen (1984, p. 78).

Head east on I-84, past views of Rocky Butte and Prune Hill to Exit 18.

[set 0.0 mi at US 30] After the turnoff, proceed south (left) on the Historic Columbia River Highway US 30, paralleling the Sandy River.

We will soon see cliffs on the left side of the highway. These contain gravels and are part of the Troutdale Formation (part of the “continental sediment” in Fig. 2), which we will be examining in Stop 1. A closer view of these gravels is seen in Fig. 3.

Figure 3. Close-up of conglomerate in the Troutdale Formation from mile 1.7. Notice the alignment of flattened gravels. [Image: A. Ruzicka]

[2.7 mi] STOP 1- Troutdale Formation. *Immediately after a sign indicating Stark Street Bridge ¼ mile, there is a long pullout on the right (southeast) side of the highway. Students should stay on the side of the highway where the pullout is located and where a better view of the outcrop is obtained.*

The Troutdale Formation (17-7 Myr old, where Myr = millions of years) is considered to represent streambed deposits of the ancestral Columbia River. Inspection reveals that the cliff is composed of conglomerate and sandstone layers and lenses.

Q1. What type of remediation efforts have occurred on the cliff to prevent the downslope movement of material (mass wasting)?

Q2. (a) Provide definitions of conglomerate and sandstone. (b) What causes the rounding of conglomerate gravels?

Q3. What two types of paleocurrent indicators are visible in these rocks? (Note: a paleocurrent is an old current.) Name them, and make a sketch of these showing which way the current is moving in each. HINT: to answer this question, consider what you are seeing at Stop 1 and in Fig. 3.

Q4. What is the apparent geographic direction (mostly northward, eastward, southward or westward) of current for these paleocurrent indicators? The cliffs we see at Stop 1 face southeast; those in Fig. 3 face west.

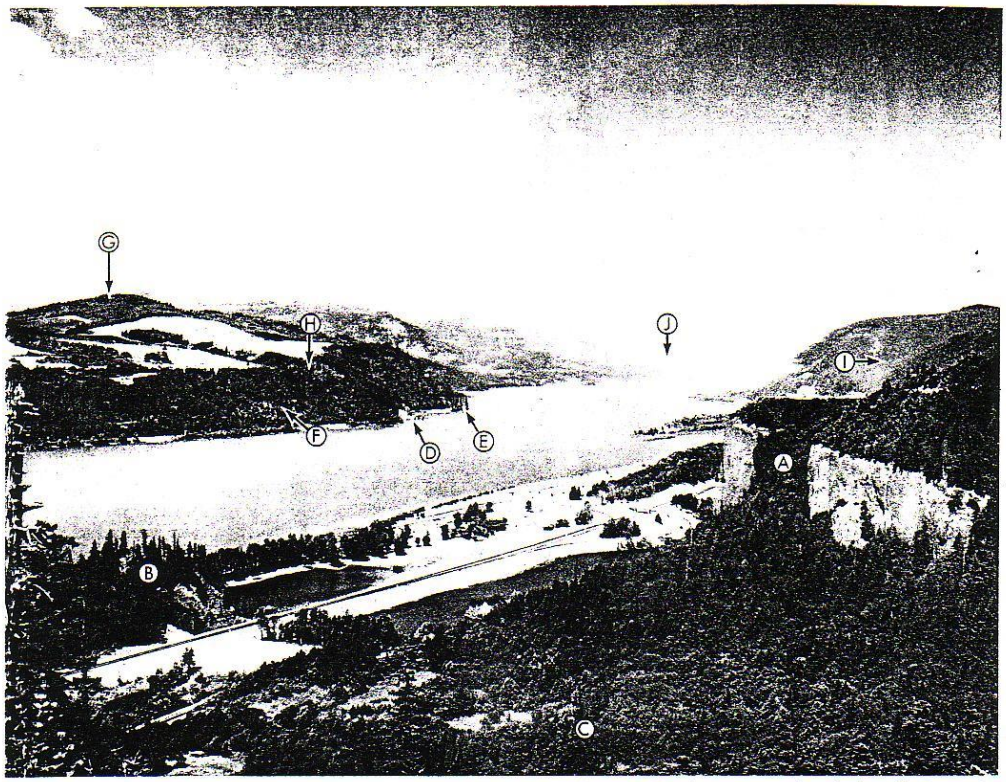
Q5. If the paleocurrent directions in Q4 differ, what could account for this?

After Stop 1, continue driving on US 30 past the Stark Street Bridge [2.9 mi], through Dabney State Park [3.3 mi], ignoring Nielsen Road to the left, and enter Springdale [4.3 mi]. Pass East Bell Road on the left (a slight short cut we will avoid) [4.7 mi].

[4.9 mi] Angle left, following sign for US 30 to Corbett. Ignore subsequent turnoff to left for I-84 and pass by Corbett Highschool [7.0 mi].

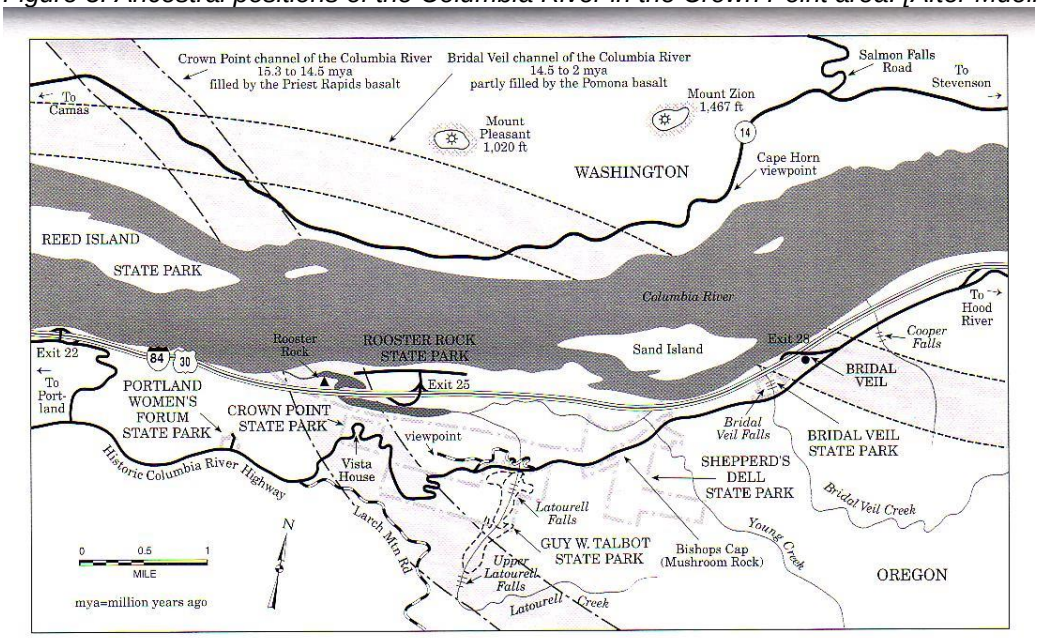
[8.9 mi] STOP 2 – Chanticleer Point, Women's Forum State Park. *Here there is a large parking area with a great view of the western Columbia Gorge and Crown Point. Start at the first (southern) viewpoint near the parking lot entrance. Fig. 4 gives an image feature locator and Fig. 5 a map.*

Figure 4. View from Chanticleer Point looking northeast. [After Tolan and Beeson, 1984]



View from Womens Forum State Park (Stop 2). A=Crown Point, a portion of the Priest Rapids intracanyon flow which totally destroyed a former course of the ancestral Columbia River approximately 14 m.y. ago. B=Rooster Rock landslide block. C=Crown Point landslide. Slide plane is probably the contact between the Columbia River basalt and older "Skamania Volcanics." D=remnant of the Pomona Member intracanyon flow located on the north side of the westerly trending Bridal Veil channel. Directly north of Womens Forum State Park is the point where the projections of the Priest Rapids and Bridal Veil channels intersect with the modern-day river (see Part I, Figure 6). E=Grande Ronde Basalt flows near Cape Horn which formed the northern canyon wall of the Bridal Veil channel. The southern portion of the Bridal Veil channel was destroyed by the modern-day river. F=lower member sandstones and conglomerates of the Troutdale Formation that were deposited within the confines of the Bridal Veil channel. G=Mount Zion, a Boring Lavas volcano that postdates the Troutdale Formation. H=small basaltic-andesite intracanyon flow from Mount Zion. I=location of the Bridal Veil channel on the Oregon side. J=Beacon Rock, a volcanic neck.

Figure 5. Ancestral positions of the Columbia River in the Crown Point area. [After Mueller and Mueller, 1997].



Q6. What is an intracanyon flow, and how does this relate to what you see at this stop?

Q7. Name and describe the different volcanic landforms you can or should be able to see from this location.

Q8. What is the origin of the valley between Chanticleer Point and Crown Point, and how does it relate to Rooster Rock?

Move to the second (northern) viewpoint at the end of the parking lot and look at the helpful sign ('Chanticleer Point Crafted by Cataclysms').

Q9. What kind of rock makes up most of Crown Point and how old is it?

Q10. The sign at the second viewpoint shows the following stratigraphy from bottom to top: “gravels” (Eagle Creek Formation), Columbia River Basalt lavas, more “gravels” (the Troutdale Formation we saw at Stop 1), and andesitic lavas. What accounts for the Troutdale Formation being at higher elevation here (about 220 m above sea level) than at Stop 1 (about 15 m ASL)?

Chanticleer Point is also a good place to start thinking about the Missoula (aka Bretz) Floods that came through the Columbia Gorge. The helpful sign at the second viewpoint also gives a flood map. We will see evidence for flood erosion and deposition later in the field trip, but Fig. 6 shows estimates of maximum flood levels as well as the level of the Columbia River pre-dam impoundment. In Fig. 6, Chanticleer and Crown Points are, respectively, 27-28 km from Portland and 215-223 m above sea level. A symbol corresponding to Crown Point is shown on the figure.

Figure 6. Estimated flood heights along the Columbia River (West-left, East-right) based on a model (thick solid line), compared to geological evidence for flooding or not flooding (symbols) and the pre-dam (pre-impoundment) height of the Columbia River (medium solid line). [After O’Connor & Burns]

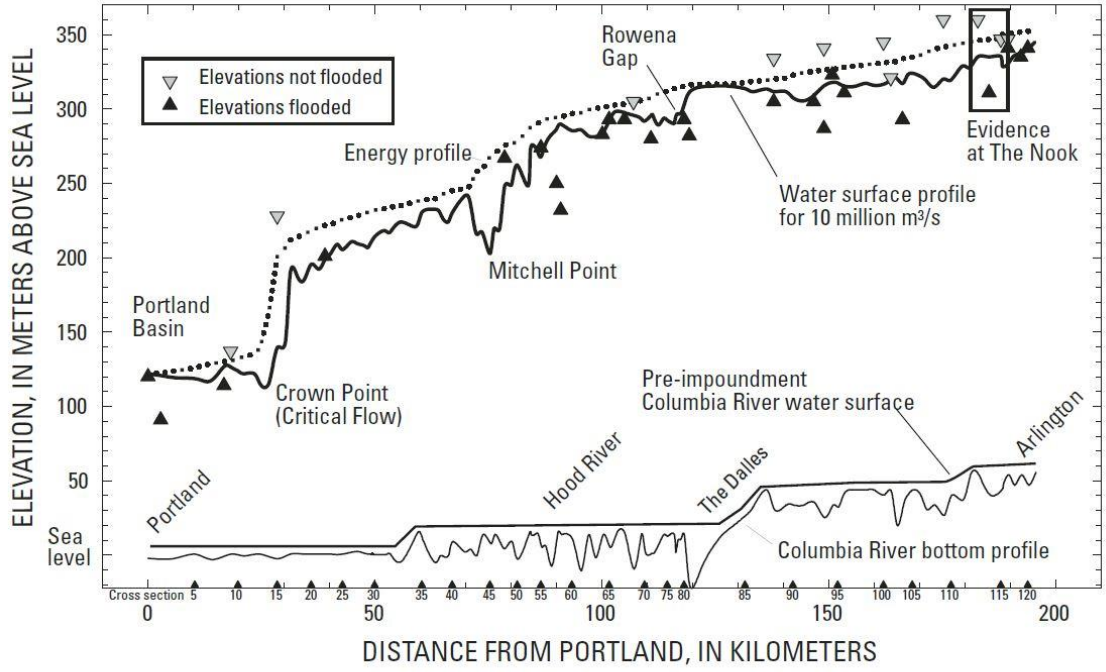


Figure 6. Evidence for maximum Missoula flood stages in lower Columbia River valley and step-backwater flow calculation results for a discharge of 10 million m^3/s. Modified from Benito and O’Connor (2003).

Q11. Based on Fig. 6, were Chanticleer and Crown Points (roughly 220 m above sea level) overtopped by floods?

Q12. Based on Fig. 6, to what approximate depth relative to the pre-impoundment surface was the Gorge here filled with water during flooding?

After Stop 2, we will drive back on US 30 about 1.6 mi to the west.

[10.5 mi]. Turn right on Northeast Corbett Hill Road down to I-84 [12.0 mi], then eastbound on I-84.

Notice as we drive that the Columbia Gorge has steep cliffs and a roughly flat bottom, kind of a U-shape profile. This type of profile differs from what is typical for streams, which is a V-shaped profile. U-shaped profiles are typical of glacial erosion. Tall waterfalls falling from side valleys (like at Multnomah Falls) are also characteristic of glaciated topography. Yet the gorge probably wasn't created by glacial erosion!

Q13. What geologic event created the steep cliffs and flat bottom profile of the Columbia Gorge?

[33.4 mi] Take Exit 44 to Cascade Locks. Drive through town, on Wa Na Pa Street. Our route goes left on SW Portage Road [34.4 mi] into Marine Park.

A large bus will not be able to go through the tunnel, so the bus will park on the main street and students will have to disembark on Wa Na Pa and walk through the tunnel, then proceed right (east) to the marina area.

[34.4] STOP 3- Cascade Locks Marine Park. *The port of Cascade Locks is named for shipping locks that were once required to lift boats past the Great Cascades of the Columbia, prior to the construction of the Bonneville and other dams.*

Fig. 8 shows a view from Cascade Locks, Fig. 9 shows a map view, and Fig. 10 shows evidence for a one-time drowned forest extending upriver. We will talk about the geologic and historic story from the shore of the Columbia River east of the marina.

Figure 8. Greenleaf Peak as seen from Cascade Locks. Strata visible in the cliff are Western Cascade-aged rocks of the Ohanapecosh and Eagle Creek Formations (Fig. 2), with rock layers that dip towards the Columbia River. These formations consist of >20 Myr-old lahars, tuffs, basaltic, andesitic, and rhyolitic lavas, conglomerates, and sandstones. [Image: A. Ruzicka]

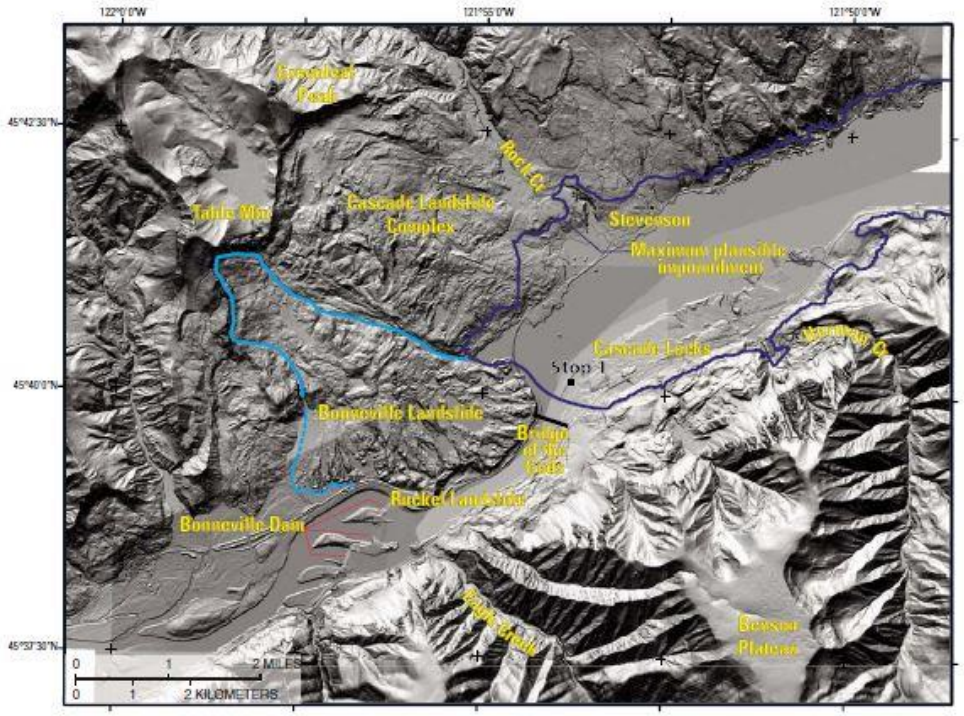


Figure 8. Shaded relief map from lidar topographic data in vicinity of the Bonneville landslide. Topographic data from Washington Department of Natural Resources, U.S. Geological Survey, and Oregon Lidar Consortium. Maximum plausible ponding level drawn at 90 m (300 ft) asl.

Figure 9. Shaded relief map around Cascade Locks. Our STOP 3 is where "Stop 1" is marked in the figure. Greenleaf Peak is near the top. [After O'Connor and Burns, 2009]

Q14. Look across the river. What evidence do you see for a large landslide?

Q15. What caused this landslide? Mention contributing factors.

Q18. Why was this area given the name, “Bridge of the Gods”? Your answer should mention Indian legends.

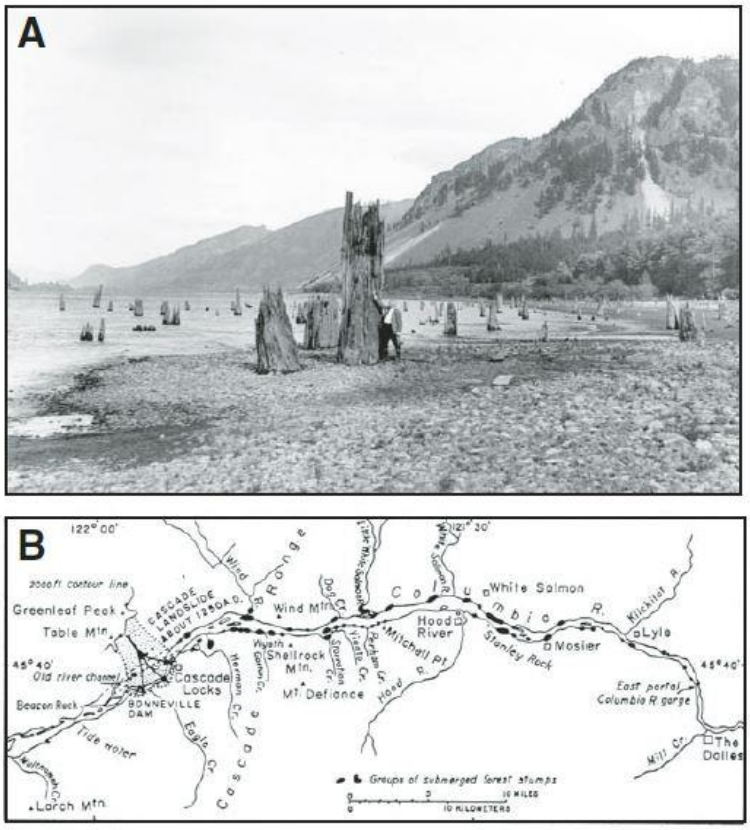


Figure 10. Evidence for drowned forests (pre-dam) of the Columbia. [After O'Connor and Burns, 2009]

Original caption:

Figure 10. Submerged forest of the Columbia. (A) D.H. Lawrence photo, 1933, courtesy of the Oregon Historical Society (#3931). (B) Distribution of submerged forest snags; modified from Lawrence and Lawrence (1958).

After Stop 3, we will continue east on Wa Na Pa street and get back on I-84 eastbound [35.3 mi], with views of Wind Mountain and Dog Mountain [mileposts 50-52].

[45.2] STOP 4 - Exit 55 Starvation Creek State Park (Lunch stop). *This newly renovated pullout has bathrooms, a viewpoint of cliffs with a convenient wall for sitting, 2 picnic tables, and individual basalt columns that have been decoratively placed at the edge of the parking lot and viewing area. From here one can access hiking trails and a portion of the historic highway that has been closed to cars. Starvation Creek Falls can be seen with a short walk to the east on the historic highway.*

This stop gives us a close look at the rocks that make up the cliffs of the gorge. The most prominent cliffs in the Gorge are made of successive lava flows (Columbia River Basalt) that have distinctive jointing (fracture) patterns. Two types of jointing are often observed, blocky/columnar and entablature/colonnade, as shown in Fig. 7. We can identify flow tops because they often have gas bubbles (vesicles).

Q19. What forms such jointing in basalt flows?

Q20. Which type of jointing pattern in Fig. 7 do you see in the outcrop here and what does it imply?

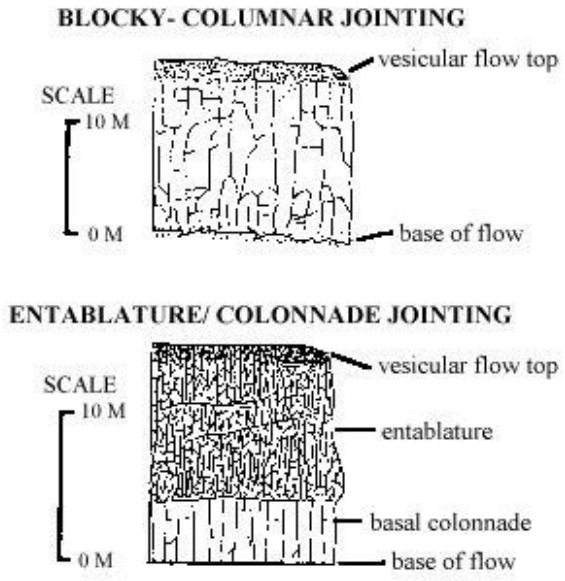


Figure 7. Jointing patterns for Columbia River Basalts. [From http://www.fs.fed.us/r6/columbia/forest/geology/index.shtml]

Q21. Look at the 13 decorative columns that were removed from the basalt cliffs. The shapes were produced naturally by jointing; note they have flat sides. Do a census and count the number of flat sides on each column. (a) How many sides are the most common? (b) What is the name of the polygon that corresponds to this? (c) Make a sketch of what a typical column looks in cross section viewing along the long axis of a column.

Once done with lunch, we will continue eastbound on I-84, past Viento State Park, Mitchell Point [Exit 55], and then will travel through Hood River [Exit 62-64]. The prominent cliff across the river known as Coyote Wall becomes visible at around milepost 68.

[60.0 mi] Take Exit 69 to Mosier, following signs for US 30 and climbing out of town. As we climb, we will pass views across the river of the Coyote Wall and the Labyrinth.

[63.3 mi] STOP 5- Memaloose Viewpoint [OPTIONAL]. Just pass milepost 60 on US 30 there is a *pullout to the left (north), with a short trail to a viewpoint. We are just west of Rowena Gap. Missoula floods inundated the valley in front of you. Scabland knobs are visible below you and across the river in the area known as The Labyrinth.*

Q22. (a) What clues do you see for how high floodwaters reached in the Columbia Gorge at this location? (b) To what approximate depth was the canyon flooded? (c) Was the viewpoint itself overtopped with flood waters?

Q23. What evidence is there for tectonism (large scale earth movements) in this area?

After Stop 4 continue eastbound on US 30.

[66.8 mi] STOP 6- Rowena Crest Viewpoint*. Pullout to right. Here we get a great view of Rowena Gap to the east, Columbia River Basalt on both sides of the river, and the town of Lyle across the river in Washington.*

Looking towards Rowena Gap in the far distance to the east on the north side of the river are layers of Grande Ronde basalt (~16 Myr old) that are not flat, and closer to you are layers of Priest Rapids (~14.5 Myr old) and Pamona basalts (~12 Myr old) that are flatter

(Fig. 11). The sudden change of orientation and age marks a major thrust fault, which caused the Grande Ronde basalt to be moved up and over rocks to the west.

Figure 11. Columbia River Basalt cliffs in Rowena Gap. Image from about one mile to the east of the Rowena Crest Viewpoint. [Image: A. Ruzicka]

Q24. Draw a sketch showing the orientations of basaltic rock layers on the opposite side of the canyon in Rowena Gap towards the east, extending past the edges of Fig. 11. Schematically show the thrust fault in your sketch and how it relates to the rock layers. (Note: we will see the same rock layers at our next stop.)

Around the town of Lyle there are two types of deposits, a delta deposit associated with the Klickitat River where it meets the Columbia River, and a gravel deposit under the town of Lyle just to the east.

Q25. How were the delta and gravel deposits around Lyle formed?

Q26. Rowena Crest Viewpoint is at an elevation of 203 m above sea level and is just west of Rowena Gap. Was this area overtopped by Bretz floodwaters, according to Fig. 6?

After Stop 6, continue eastbound on US 30 where we will wind down from the plateau on nicely graded curves. In short order we will turn left at a sign for I-84 [69.6 mi], pass underneath I-84 at Exit 76, go across some train tracks, and turn right onto Rowena River Road East. At the end of the road [70.4 mi] we will enter into East Mayer State Park.

[70.4 mi] STOP 7- East Mayer State Park. *We will aim to park in the central parking area surrounded by a ring road. A path to the river goes near some restrooms. Here we are at our most distant point from Portland. We will walk over the rock outcrop here and talk about it. We will also get another view across the river of the cliffs we saw in the last stop.*

Q27. Geologist J. Harlan Bretz (of Missoula floods fame) described scablands in eastern Washington and near the Columbia River as lowlands and valleys underlain by eroded basalt outcrop. What is the relationship of the rock outcrop here to the scablands, and how did it form?

Q28. Stop 7 is only slightly lower in elevation (about 100 ft ASL) than the town of Lyle (100-300 ft ASL) just a couple miles to the west that we looked down on from Stop 6. Lyle is underlain by gravel deposits. But such gravels are largely absent here. What explains this difference, and how does it relate to the floods that passed through this area? Fig. 12 shows a map of the area.

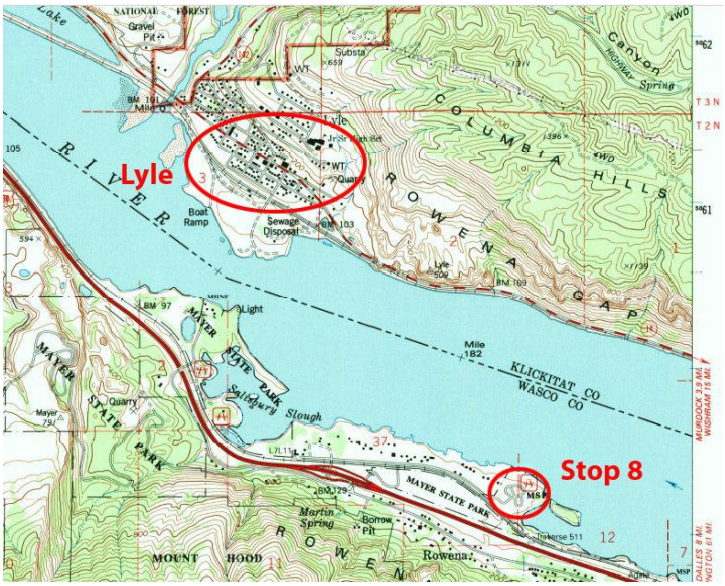


Figure 12. Topographic map of the Stop 8 area. North is towards the top, thicker contour intervals are 100 feet, and the distance between Stop 8 and the center of Lyle is about 1.7 miles. [Map: USGS.]

Return to I-84 and take the westbound entrance to head back to Portland. Back on I-84 westbound, we will pass the Memaloose State Park rest area just before milepost 73, pass Exit 69 Mosier, and pass Exit 64-62 Hood River.

[87.8 mi, at milepost 61.0] STOP 8- highway pullout for distinctive yellow-brown deposit. *Here we are on a wide pullout from the interstate. We will walk a little down a road where we get further from the freeway and still have a good view. Students should stay on the pullout or the side road as traffic on the freeway moves fast.*

The deposit of interest is visible on both sides of the highway and contains blocks and fragments of basalt in sediment; some of the basalt forms crude layers (Fig. 13). A cliff of massive Columbia River Basalt occurs over the deposit across the freeway.

Figure 13. Blocks and cobbles of rounded to angular basalt within yellow-brown sediment at Stop 8. The largest block at lower left is about 1 ½ feet long and occurs at the base of a cliff slope. Fragments have eroded from the slope and have collected at the base of the slope at bottom. Note the basalt fragments near the middle of the image which form a crude layer that dips to the right (west). [Image: A. Ruzicka]

Q29. What is the yellow-brown deposit, and what evidence is there that it formed by the interaction of magma (magma is molten rock) with water?

Q30. (a) Make a sketch of the cliff on the other side of the deposit from the side road, labelling the yellow-brown deposit and the Columbia River Basalt layers above. Show textural features within the two units. (b) What evidence is there for erosion following the formation of the distinctive colored deposit? (c) What is the name of this erosional feature, and what does it represent? Label this feature in your sketch.

RETURN TO PORTLAND VIA I-84 WESTBOUND.

MAKE SURE YOU TURN IN YOUR NOTEBOOK TO THE TA BY THE DEADLINE (5 PM June 6). YOU CAN TURN IT IN EITHER: (A) ON THE BUS RIDE BACK, (B) WHEN WE RETURN TO PORTLAND, (C) BY E-MAIL TO THE TA, OR (D) AS HARDCOPY IN THE TA's MAILBOX (Agyemang) IN CH17.

References

Mueller M. and Mueller T. (1997) *Fire, Faults & Floods—A Road and Trail Guide Exploring the Origins of the Columbia River Basin.* Univ. Idaho Press, Moscow, Idaho. 288 pp.

O'Connor J.E. and Burns S.F. (2009) Cataclysms and controversy—Aspects of the geomorphology of the Columbia River Gorge. *Field Guides* **15**, 237-251. doi: 10.1130/2009.ffdo15(12)

Tolan T.L and Beeson M.H. (1984) Exploring the Neogene History of the Columbia River: Discussion and geologic field trip guide to the Columbia River Gorge, Part II. Road log and comments. *Oregon Geology* **46**, 103-112.