

Road Guide to the Columbia River Basalt Group of the Lewiston, Kendrick, Deary, Moscow Area, Idaho.

James R. Cash
Dean L. Garwood

Staff Report S-10-6
June 2010

Idaho Geological Survey
Morrill Hall, Third Floor
University of Idaho
Moscow, Idaho 83844-3014

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public distribution. This publication may not
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Road Guide to the Columbia River Basalts of the Lewiston, Kendrick, Deary, Moscow Area, Idaho.

James R. Cash ¹ and Dean L. Garwood ²

BRIEF HISTORY OF THE COLUMBIA RIVER BASALT GROUP

Flows of the Columbia River Basalt Group erupted from a series of fissures located in eastern Washington, eastern Oregon, and west-central Idaho (Figure 1). Eruptions began just over 17 million years ago and ended about 6 million years ago and covered an area of about 200,000 km² (Digital Geology of Idaho, Columbia River Basalts). The area includes much of western Idaho, eastern Oregon, and eastern Washington. The lava followed the current path of the Columbia River from the Tri-cities area of Washington to the Pacific Ocean. Over 234,000 km³ of lava (including the more recently included Steens Mountain Basalts) erupted and deposited basalt 4-5 km thick in central Washington (Figure 1; Reidel and others, 2005). Individual flows range in thickness from several meters to tens of meters.

A number of models have been generated to explain how such a vast area can be covered in lava without it first cooling and solidifying. One of the latest models (Digital Geology of Idaho website, Columbia River Basalts) postulates that the lava followed lava tubes from its source to ponds of lava with crusted tops. As the ponds inflated, lava built up pressure ultimately ending in breaching the outer part of the lobe and creating a new lobe. The lava within these ponds remained hot because it was insulated from above by a developing crust. This process was thought to have repeated again and again allowing the lava to flow great distances.

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Geologists have subdivided the Columbia River Basalt Group into 7 different formations (Figure 2). Camp and Ross (2004) have included the Steens Mountain basalt flows. From oldest to youngest they are: Lower Steens Mountain Basalt, Upper Steens Mountain Basalt and Imnaha Basalt (these overlap in time), Picture Gorge Basalt and Grande Ronde Basalt (these overlap in time), Wanapum Basalt, and Saddle Mountains Basalt. Each formation has been subdivided into members based upon the chemistry, magnetic properties, and mineralogy. About 60% of the erupted material comprises the Grande Ronde Basalt (Camp and Ross, 2004). The lava making up the Grande Ronde probably did not reside long in the crust and thus did not develop distinct chemical signatures to separate this formation into members. However, there were several reversals in Earth's magnetic field during the period of eruption of the Grande Ronde Basalt that helps field geologists subdivide the formation. Geologists have mapped the Grande Ronde Basalt using magnetostratigraphic units based upon the orientation of the Earth's magnetic field as preserved in the basalt flows rather than members based on distinct chemistry or mineralogy. They are designated as reversed or normal and numbered from oldest (R_1) to youngest (N_2).

ABOUT THIS ROAD LOG

The road guide that follows was developed for high school/middle school teachers. The route begins and ends in Moscow (Figure 3). From Moscow, travel south to Lewiston, then east to Juliaetta and Kendrick, then north to Deary, and then back to Moscow. Mileages given in the guide may vary slightly due to minor differences in car odometers. This guide attempts to accommodate by adding clues to help the driver recognize upcoming stopping points. It would be advisable to those following the route to read ahead at each stopping point to familiarize the driver with the next site. It would be extremely helpful to have the two geologic maps covering the trip area: Geologic Map of the Idaho Parts of the Orofino and Clarkston 30 X 60 Minute Quadrangles (Kauffman and others, 2009) and Geologic Map of the Potlatch 30 X 60 Minute Quadrangle, Idaho (Lewis and others, 2005). Maps are available digitally from the Idaho Geological Survey website: www.idahogeology.org. Go to Maps -> Search for Geologic Maps and find the map and click on it. Select the map that comes up and click on it. Click on the map image. Once it comes up, save it to the hard drive or to a flash drive (more efficient once downloaded). The maps can either be viewed on a laptop computer or print segments of each map that coincide with the route to follow. Figure 3 is a route map as shown on Google Maps.



Figure 1. Diagram depicting the extent of the Columbia River Basalt Group. The dark lines inside the flow area represent locations of feeder dikes. Not all formations are represented over the entire area and some flows, especially the more recent ones, were restricted by lower volume eruptions (Reidel and others, 2005).

Series	Group	Formation	Member	Mag.	Age
Miocene	Upper	Saddle Mountains Basalt	Lower Monumental Member	Black	6 Ma
			Ice Harbor Member	White	
			Buford Member	Black	
			Elephant Mountain Member	White	
			Pomona Member	Black	
			Esquatzel Member	White	
			Weissenfels Ridge Member	Black	
			Asotin Member	White	
			Wilbur Creek Member	Black	
			Umatilla Member	White	
	Middle	Wanapum Basalt	Priest Rapids Member	Black	14.5 Ma
			Roza Member	White	
			Shumaker Creek Member	Black	
			Frenchman Springs Member	White	
			Eckler Mountain Member	Black	
				White	
	Lower	Grande Ronde Basalt	N2	Black	15 ma*
			R2	White	
			N1	Black	
			R1	White	
Picture Gorge Basalt	Imnaha Basalt		Black	16.6 Ma*	
			White		
			Black		
			White		
Upper Steens Mountain Basalt	NO		Black	16.6 Ma*	
			White		
Lower Steens Mountain Basalt	RO		Black	16.6 Ma*	

Figure 2. Columbia River Basalt Group classification of Camp and Ross (2004). Black and white bands under Mag. column indicate Normal (black) or Reverse (white) polarity intervals.



Figure 3. Generalized map of field trip route.

ROAD LOG

In Moscow, drive south on US Highway 95. At the top of the hill on the south end of town, stop at the A & W restaurant (corner of Lauder and US Highway 95; there is a gas station there as well). Set odometer to 0.

Travel south towards Lewiston. Between Moscow and the top of the Lewiston grade, there are loess deposits of fine grained silt and clayey silt deposited during both the Pleistocene and Holocene. The loess was deposited in many layers sometimes with long periods of exposure between layers. During this exposure time, mature soils would develop. The loess covers predominantly a Miocene/Pliocene landscape of Columbia River basalts. On areas of higher elevation, or step toes, the loess covers older Cretaceous intrusive granitic rocks and Precambrian Belt Supergroup metasedimentary rocks.

Look for a sign labeled Kluss Rd. before the turn off to Genesee. About 0.4 mi. south of the road, there is a right turn lane. Pull into this lane then off on to the shoulder of the road. This will afford some protection from traffic along a very busy highway, view outcrop from the shoulder.

Stop 1 – Mile 11.8



Figure 4. Outcrop of Basalt of Lewiston Orchards north of Genesee.

Across the highway is an outcrop of basalt of Lewiston Orchards, Weissenfels Ridge Member, Saddle Mountains Basalt.

The Saddle Mountains Basalt flows are the youngest of the Columbia River Basalt Group. The Weissenfels Ridge Member has 4 distinct flows in the Lewiston basin but only the basalt of Lewiston Orchards has been mapped in this area. Saddle Mountains Basalt did not cover the entire Columbia Plateau. They are often localized and tended to fill low lying areas. There is an exposure of one dike along the Lewiston Grade above Lewiston where some of the lava from this flow erupted.

Group	Formation	Member
Columbia River Basalt Group	Saddle Mountains Basalt	Lower Monumental Member
		Ice Harbor Member
		Buford Member
		Elephant Mountain Member
		Pomona Member
		Esquatzel Member
		Weissenfels Ridge Member
		Asotin Member
		Wilbur Creek Member
		Umatilla Member
	Wanapum Basalt	Priest Rapids Member
		Roza Member
		Shumaker Creek Member
		Frenchman Springs Member
		Eckler Mountain Member
	Grande Ronde Basalt	N2
		R2
Picture Gorge Basalt	N1	
	R1	
Imnaha Basalt		
Upper Steens Mountain Basalt	N0	
Lower Steens Mountain Basalt	R0	

Continue along US Highway 95 south.

Stop 2 – Mile 13.0



Figure 5. Outcrop of Priest Rapids Member, north of Genesee.

Across the road is an outcrop of a basalt flow much older than at the previous stop.

Group	Formation	Member
Columbia River Basalt Group	Saddle Mountains Basalt	Lower Monumental Member
		Ice Harbor Member
		Buford Member
		Elephant Mountain Member
		Pomona Member
		Esquatzel Member
		Weissenfels Ridge Member
		Asotin Member
		Wilbur Creek Member
		Umatilla Member
	Wanapum Basalt	Priest Rapids Member
		Roza Member
		Shumaker Creek Member
		Frenchman Springs Member
		Eckler Mountain Member
	Grande Ronde Basalt	N2
		R2
Picture Gorge Basalt	N1	
	R1	
Innaha Basalt		
Upper Steens Mountain Basalt	N0	
Lower Steens Mountain Basalt	R0	

The surface of this flow has weathered into gray clay called saprolite. During the Miocene, the climate was much warmer and wetter than today. The minerals in the basalt weathered to form the gray clay above the basalt. Close to the surface of the basalt are chunks of less weathered basalt. The Priest Rapids Member underlies much of the surface covering of loess in the field trip area.

Continue along US 95 south. Near the junction of Leon Rd. (near the intersection

of US 95 and US 195), there are several outcrops of basalt between **miles 21 and 21.5**.



Figures 6 & 7. Outcrops of Asotin/Wilbur Creek unit of Saddle Mountains Basalt at Leon Rd.

Stop 3 – Mile 24.5



Figure 8. Outcrop of Asotin/Wilbur Creek unit of Saddle Mountains Basalt near the top of Lewiston Grade.

Pull into to the turnout on the right. The basalts exposed in the road cut are the same as those near Leon Rd.

Group	Formation	Member
Columbia River Basalt Group	Saddle Mountains Basalt	Lower Monumental Member
		Ice Harbor Member
		Buford Member
		Elephant Mountain Member
		Pomona Member
		Esquatzel Member
		Weissenfels Ridge Member
		Asotin Member
		Wilbur Creek Member
		Umatilla Member
	Wanapum Basalt	Priest Rapids Member
		Roza Member
		Shumaker Creek Member
		Frenchman Springs Member
		Eckler Mountain Member
	Grande Ronde Basalt	N2
		R2
Picture Gorge Basalt	N1	
Imnaha Basalt	R1	
Upper Steens Mountain Basalt	NO	
Lower Steens Mountain Basalt	RO	

Flows from these members lie above Wanapum and Grande Ronde basalts. Flows of these two members mixed in the Lewiston basin. They are mapped as one unit because they have variable chemistry. In the road cut, there is a contact between 2 flows of this unit. With an age of 13 Ma, this is one of the oldest of the Saddle Mountains Basalt in the area.

Continue along US 95 south. Pull into the turnout on the right marked Scenic Overlook/Nez Perce National Historic Site.

Stop 4 – Mile 25.1



Figure 9. View of CRB's looking upriver from the Lewiston grade. Grande Ronde Basalt at river level, Priest Rapids Member near rim, Asotin/Wilbur Creek Member forms rim.

Directly across the road at the top of the road cut is the Asotin/Wilbur Creek unit of the Saddle Mountains Basalt. Looking down along the ridge line there is a dipping unit. This is the Priest Rapids Member of the Wanapum Basalt. Under the Priest Rapids basalt is the weathered surface of the Grande Ronde Basalt like that near Genesee. Looking down hill also at road level, there is a red layer which contains a small scale reverse fault that formed to accommodate folding in the Lewiston Hill. The basalts containing this red layer are also part of the Grande Ronde basalts.

Group	Formation	Member
Columbia River Basalt Group	Saddle Mountains Basalt	Lower Monumental Member
		Ice Harbor Member
		Buford Member
		Elephant Mountain Member
		Pomona Member
		Esquatzel Member
		Weissenfels Ridge Member
		Asotin Member
		Wilbur Creek Member
		Umatilla Member
	Wanapum Basalt	Priest Rapids Member
		Roza Member
		Shumaker Creek Member
		Frenchman Springs Member
		Eckler Mountain Member
	Grande Ronde Basalt	N2
		R2
Picture Gorge Basalt	N1	
Imnaha Basalt	R1	
Upper Steens Mountain Basalt	NO	
Lower Steens Mountain Basalt	RO	



Figure 10. Small reverse fault in Grande Ronde Basalt, Lewiston Hill.

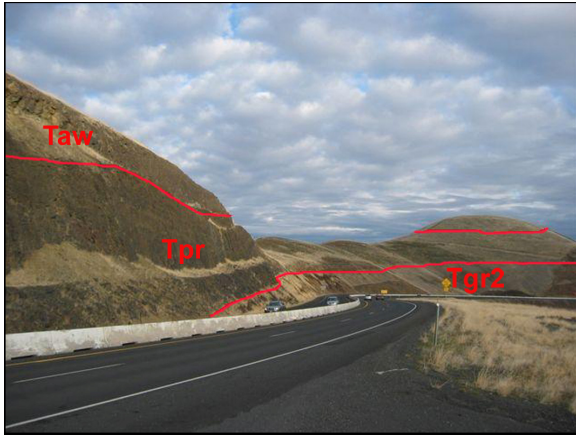


Figure 11. **Top**-Asotin Member and Wilbur Creek Member, undivided, (Taw; Saddle Mountains Formation; **Middle**-Priest Rapids Member (Tpr; Wanapum Formation); **Bottom**-Grande Ronde R₂ magnetostratigraphic unit (Tgr2; Grande Ronde Formation).

About 60 % of the total volume of Columbia River basalts consists of Grande Ronde Basalt. The basalts making up this formation have been dated between 16.5 -15.4 Ma. For convenience, this formation was subdivided according to the magnetic polarity preserved in the basalt. Chemical analysis normally used to separate members of other formations would generate more data than would be feasible to collect with the map project. A geologist field mapping Grande Ronde basalts checks the polarity of the rock using a portable instrument called a fluxgate magnetometer. Sometimes the rocks are drilled for magnetic properties and analyzed in the lab on a spinner magnetometer. Given the massiveness of the Grande Ronde basalts, it is easiest to locate your position in the stack by checking the polarity. There were two magnetic reversals during the Grande Ronde basalt eruptions so two sections of the stack have reversed polarity and two have normal polarity. They appear on the map as (from oldest to youngest) R₁, N₁, R₂, and N₂. Near the stratigraphic boundary of a reversal, the magnetic signature in the basalt becomes inconsistent. At this stop, the R₂ magnetostratigraphic unit is exposed below.



Figure 12. View looking down at Lewiston. Basalts of Asotin/Wilbur Creek and Lewiston Orchards form plateau, Grande Ronde and Priest Rapids basalts at river level.

Looking south into the Lewiston basin, the basalt units appear in the same order as they do here. Beyond the Potlatch paper mill, most of the basalt that underlies the surface of the plateau are the Asotin/Wilbur Creek unit. Some of the higher spots in the basin are the basalt of Lewiston Orchards which overlies the Asotin/Wilbur Creek unit. Along the Clearwater River, the Asotin/Wilbur Creek basalts form the rim, with Priest Rapids and Grande Ronde R₂ basalts below. Structurally, the arrangement of basalt units suggests that the Lewiston basin has been down warped into its current location. The Lewiston basin is a complex syncline bounded to the north by the Lewiston hill structure (the hill you are on) and to the south by the Waha escarpment which extends southwest of Peck, just south of Culdesac and along a meandering line to the Snake River (use following photo to aid in interpreting this site).

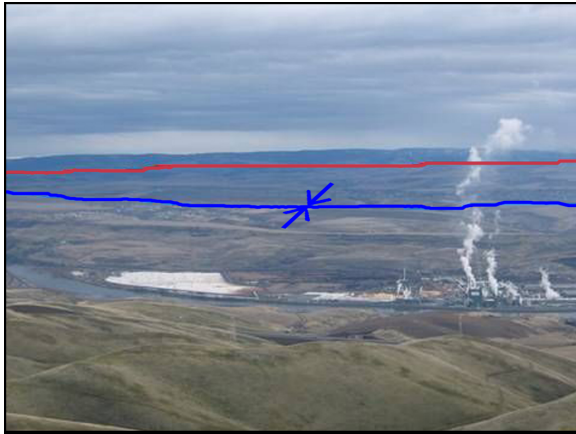


Figure 13. Red line-Approximate location of Waha Escarpment/Limekiln fault; Blue line-Approximate axial trace of Lewiston syncline.

The structural deformation of the basin was ongoing during the time of deposition but was most rapid during the time Asotin/Wilbur Creek basalts were being extruded. The Asotin/Wilbur Creek basalts thin over older warps in the basalt surface. Additionally, an anticline (the Lewiston anticline) and number of smaller folds have been mapped in the area. The Lewiston anticline axial trace lies below us and trends in a more or less east-west line.

Continue along US 95 south. Pull in to the next turnout on the right.

Stop 5 – Mile 25.9



Figure 14. Outcrop of Grande Ronde R₂ showing multiple flows.

Group	Formation	Member
Columbia River Basalt Group	Saddle Mountains Basalt	Lower Monumental Member
		Ice Harbor Member
		Buford Member
		Elephant Mountain Member
		Pomona Member
		Esquatzel Member
		Weissenfels Ridge Member
		Asotin Member
		Wilbur Creek Member
		Umatilla Member
	Wanapum Basalt	Priest Rapids Member
		Roza Member
		Shumaker Creek Member
		Frenchman Springs Member
	Grande Ronde Basalt	Eckler Mountain Member
		N2
	Picture Gorge Basalt	R2
		N1
	Imnaha Basalt	R1
Upper Steens Mountain Basalt		
	NO	
Lower Steens Mountain Basalt	RO	

On the way down the rest of the grade, turnouts are scarce and the traffic can be heavy at times. For safety reasons, the next stop will be at the bottom of the grade. On the way down, several features are worth glancing at:

At **mile 26.3**, there is an abrupt change in the basalts revealed in the road cut to your left. The more massive basalt above is Grande Ronde R₂ while the more rubblely basalt below represents the top of a flow in the Grande Ronde N₁.



Figure 15. Outcrop of Grande Ronde R₂, Lewiston Hill.

Group	Formation	Member
Columbia River Basalt Group	Saddle Mountains Basalt	Lower Monumental Member
		Ice Harbor Member
		Buford Member
		Elephant Mountain Member
		Pomona Member
		Esquatzel Member
		Weissenfels Ridge Member
		Asotin Member
		Wilbur Creek Member
		Umatilla Member
	Wanapum Basalt	Priest Rapids Member
		Roza Member
		Shumaker Creek Member
		Frenchman Springs Member
		Eckler Mountain Member
	Grande Ronde Basalt	N2
		R2
	Picture Gorge Basalt	N1
	Imnaha Basalt	R1
Upper Steens Mountain Basalt	N0	
Lower Steens Mountain Basalt	R0	

Travelling through the “dog leg” of the grade, the highway crosses the axial trace of the Lewiston anticline. At **mile 26.9**, on the east side of the road is a dike of Lewiston Orchards basalt that possibly fed the flow at the top of the grade (next photo). The lava probably followed a fractured plane created by the folding of the older basalts. The dike is contained within Grande Ronde R₂ basalts.

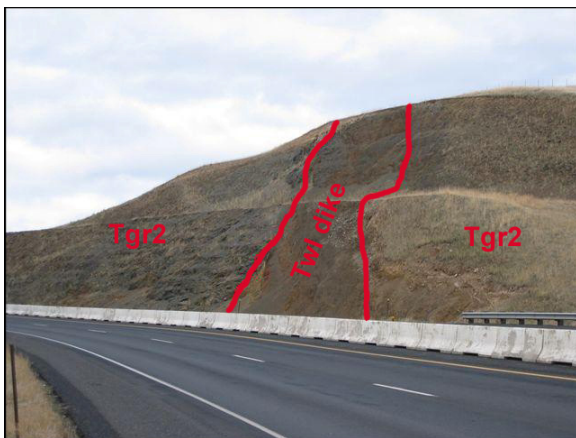


Figure 16. Dike of Basalt of Lewiston Orchards (Twl; outlined in red) within Grande Ronde R₂ basalt.

Continue along US Highway 95 south. Near the bottom of the grade, move into the right

hand lane. Take the US Highway 12 West exit at **mile 29.3** (Lewiston/ Walla Walla exit). Upon entering US Highway 12, remain in the right hand lane. Take the first exit to the right marked Idaho 128, Port Districts (**mile 30.1**). Stop at the stop sign (**mile 30.2**) then turn right. To your immediate right there is a parking area across from a gas station.

Stop 6 – Mile 30.3



Figure 17. Outcrop of Lower Monumental Member of Saddle Mountains Basalt.

This is the youngest Saddle Mountains Basalt flow exposed in this area. The basalt is very dark and very fine grained. This basalt rests on gravel which can be observed around the corner.

Group	Formation	Member
Columbia River Basalt Group	Saddle Mountains Basalt	Lower Monumental Member
		Ice Harbor Member
		Buford Member
		Elephant Mountain Member
		Pomona Member
		Esquatzel Member
		Weissenfels Ridge Member
		Asotin Member
		Wilbur Creek Member
		Umatilla Member
	Wanapum Basalt	Priest Rapids Member
		Roza Member
		Shumaker Creek Member
		Frenchman Springs Member
		Eckler Mountain Member
	Grande Ronde Basalt	N2
		R2
	Picture Gorge Basalt	N1
	Imnaha Basalt	R1
Upper Steens Mountain Basalt	N0	
Lower Steens Mountain Basalt	R0	



Figure 18. Outcrop of Lower Monumental Member, Saddle Mountain Basalt in contact with underlying gravel.

This basalt is a good example of fine-grained basalt. Basalt in this unit has been dated at 6 Ma. At the northwest end of the parking area, the basalt in contact with gravel suggesting that this lava flow filled into an existing river channel of rounded cobbles and boulders.

Return to US Highway 12. This road can be very busy with both auto and truck traffic. Continue on this route a short distance west to the first intersection (20th Street N, also labeled Port of Lewiston; **mile 30.4**). Turn around and return to the stop sign (**mile 30.5**) turn left. At the intersection with US Highway 12 (**mile 30.6**), turn east and head towards Missoula. Once on US Highway 12, take the first right onto Frontage Rd. at **mile 31.5**. Take the first left off of Frontage Rd. into the Flying J service station (**mile 31.8**). This might be a good bathroom stop or chance to refuel.

Return to US Highway 12 and head east toward Missoula, Montana. At the truck weigh station in the highway median, move to the left hand lane. Continue along US Highway 12 to the Caterpillar Tractor (CAT) dealer on the north side of the road. Turn left at **mile 35** and travel the short

distance to a “T” in the road (**mile 35.1**). Turn left and travel a short distance on this road. Pull out to the right just below the electrical substation (Spalding Substation). This is a large turn out with plenty of parking.

Stop 7 – Mile 35.3



Figure 19. Outcrop of Priest Rapids Member. Just down river from CAT dealer.

The basalt exposed here is the Priest Rapids Member. The basalt is fine grained but unlike that at the previous stop, individual grains are visible. Basalt columns typically form as the lava cools and shrinks. Often the coarser grained basalts at the bottom of flows form thicker columns while finer grained basalts toward the top of the flow form thinner columns. The Priest Rapids Member has been dated at 14.5 Ma.

Turn around here and return to US Highway 12. Turn left (east) at **mile 35.6** toward Missoula, Montana. Get in the right hand lane. Pull into the turn out labeled Historic Site/Scenic Byway Information.

Stop 8 – Mile 37.6



Figure 20. View of CRB's upriver from Lewiston. Grande Ronde R_2 below with Priest Rapids Member and Asotin/Wilbur Creek basalt above.

This stop gives an opportunity to look at the CRB's from the bottom up rather than from the top down as previously examined on the Lewiston grade. Looking across the Clearwater River to the south, the stack of basalts begins at river level with Grande Ronde R_2 . Priest Rapids basalt lies above it with Asotin/Wilbur Creek basalt forming the rim. The bench before the rim represents landslide activity associated with the location of an interbed (a layer of sediment that accumulated on top of one lava flow and covered by another). We will deal with interbeds in more detail later in the trip.



Figure 21. View of CRB's looking upriver. Shows Mostly Grande Ronde R_2 with Priest Rapids Member and Asotin/Wilbur Creek basalt on top. Note dip.

Look east (upriver). Notice that the basalt layers dip toward the south on the north side of the river. Several folds with varying orientations exist in this area.

Return to US Highway 12 and continue east. US Highway 95 and US Highway 12 split at **mile 39.4**. Remain in the right hand lane to stay on US Highway 12 toward Missoula, Montana. At **mile 44.2** turn left on ID Highway 3. Pull into the first turnout to your right which will be at the confluence of the Potlatch and Clearwater rivers.

Stop 9 – Mile 44.5

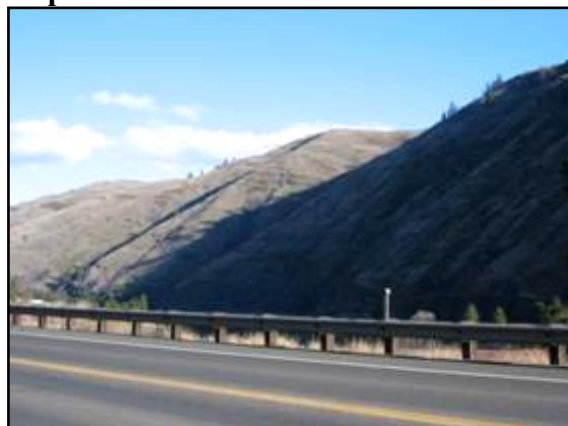


Figure 22. View of CRB's looking upstream. Grande Ronde (N_1 , R_2) below, Priest Rapids and Asotin/Wilbur Creek above. Note dip in flows.

Walk back toward the highway intersection to the outcrop closest to the turnout. ID Highway 3 is used by chip trucks and logging trucks taking wood products to the Lewiston/Clarkston area. Walk along the Clearwater River side of the guard rail to view the outcrop. The basalt exposed here contains large crystals of plagioclase feldspar. This is the Imnaha Basalt.

Group	Formation	Member
Columbia River Basalt Group	Saddle Mountains Basalt	Lower Monumental Member
		Ice Harbor Member
		Buford Member
		Elephant Mountain Member
		Pomona Member
		Esquatzel Member
		Weissenfels Ridge Member
		Asotin Member
		Wilbur Creek Member
		Umatilla Member
	Wanapum Basalt	Priest Rapids Member
		Roza Member
		Shumaker Creek Member
		Frenchman Springs Member
	Grande Ronde Basalt	N2
		R2
	Picture Gorge Basalt	N1
R1		
Imnaha Basalt	NO	
	Upper Steens Mountain Basalt	
Lower Steens Mountain Basalt	RO	



Figure 23. Outcrop of Imnaha Basalt at confluence of Clearwater and Potlatch rivers.

This is the oldest of the Columbia River basalts found in this area. Because of the large crystals of feldspar, this basalt tends to weather into more rounded shapes. The presence of these large crystals of plagioclase feldspar and the lower position in the stack help to easily distinguish the Imnaha basalts from other CRB's. Looking up at the outcrop, the columnar nature of the basalts is apparent. Some column pieces can be found in the rubble along the road.

Walk back to the turnout. Look upstream along the Clearwater River at the basalt on the south side of the river. From river level

up are: Grande Ronde R₁, Grande Ronde N₁, Grande Ronde R₂, Priest Rapids, and Asotin/Wilbur Creek basalts. Note that the layers of basalt are tilted to the south. The axial trace of the Lewiston Anticline follows the ridge separating the Potlatch and Clearwater rivers.

Return to ID Highway 3 and continue east toward Kendrick. Ahead there is a sign indicating a Weigh Station. Turn right into the weigh station area and park.

Stop 10 – Mile 45.9



Figure 24. Outcrop of Grande Ronde Basalt (R₁) in contact with interbed of Latah Formation. Across from weigh station along Potlatch River south of Juliaetta

Exposed here is an interbed between Grande Ronde and Imnaha basalts (not shown at this stop). Sedimentary deposits within the basalts are included in the Latah Formation. It is a mixture of sand, silt, and clay with minor amounts of gravel. Outcrops of interbedded material are limited and often difficult to trace. Some interbeds have been individually named because they are unique but most are included under the more general heading of Latah Formation Interbeds. Above this interbed is Grande Ronde R₁ basalt. This basalt is fine grained and highly fractured. Water has seeped into the cracks weathering the surfaces. This lava flowed over the interbed and baked the top layer of interbedded material. The grain size of interbedded material indicates moderate

rates of water flow. Here the interbedded material was once an actively eroding surface on top of Imnaha basalts.



Figure 25. Closeup of interbed of Latah Formation. Note coarse-grained texture.

Continue east on ID Highway 3. Just past mile marker 2, there is another interbed in a large road cut at a right hand bend of the road. Park at the downstream end of the guard rail and walk up to the outcrop along the river side of the guard rail.

Stop 11 – Mile 46.9



Figure 26. Contact of Latah Formation with Grande Ronde R_1 basalt (above) and Imnaha Basalt (below).

Exposed here is interbedded material sandwiched between Imnaha Basalt below and Grande Ronde R_1 basalt above. Notice how the Imnaha Basalt is weathering into more rounded shapes and the Grande Ronde R_1 into more angular shapes. The interbed contains mostly coarse-grained material but the top is fine-grained. It appears that above

the Imnaha Basalt was an actively eroding landscape which included both moving and stationary bodies of water.

Continue east on ID Highway 3. About 2 miles ahead, there is a major bend in the road (and river). There is a turnout on the left. Be careful as this turnout will likely contain lots of fallen rock.

Stop 12 – Mile 48.2



Figure 27. Outcrop of Grande Ronde R_1 with spring. Latah Formation interbed to left.

The basalt that outcrops here is Grande Ronde R_1 . The sedimentary material is an interbed of the Latah Formation. A number of springs also appear here. Next to the largest spring are some fine-grained sediments that contain numerous plant fossils.



Figure 28. Closeup of Latah Formation interbed fragments.

At the downstream end of this outcrop, there is a primitive road spur. Part of the way up, the spur will cross a small creek. To the right is found more sandy material which contains many wood fragments and leaf pieces. The grain size of the sediment varies here which suggests that there were changes in water movement on the original weathered surface.



Figure 29. Outcrop of Latah Formation interbedded with Grande Ronde R_1 above.

The fact that there is a major shift in the river direction here is significant. The Cottonwood Creek fault cuts across the Potlatch River here. Just up the road, we will cross the Little Potlatch River which follows the Cottonwood Creek fault.

Continue east along ID Highway 3. Just before crossing the Little Potlatch River is Sunbright Rd. on the north side of the highway. Pull in here to get off of the highway.

Stop 13 – Mile 49.2



Figure 30. View of CRB's looking upriver from the confluence of the Little Potlatch and Potlatch rivers.

Looking up the Potlatch River, there is a thick stack of basalt on the south side. Starting from river level the units are: Grande Ronde R_1 , Grande Ronde N_1 , Grande Ronde R_2 , Priest Rapids Member, and the Asotin/Wilbur Creek basalt. The Priest Rapids Member has reverse polarity, and the Asotin/Wilbur Creek basalt has normal polarity. There are 5 magnetic reversals represented in the stack. Driving from the last stop, the highway crossed the Cottonwood Creek fault. The fault displaced the northeast side down and to the southeast compared to the southwest side.



Figure 31. View of Little Potlatch River canyon, Cottonwood Creek fault.

Continue east along ID Highway 3 through the towns of Juliaetta and Kendrick. Stop at the intersection of ID Highway 3 and Cedar Ridge Rd. There is a large triangular parking area at the intersection.

Stop 14 – Mile 58.4



Figure 32. Outcrop of Grande Ronde R_1 at intersection of Highway 3 and Cedar Ridge Rd.

This spectacular outcrop of basalt columns occurs in the Grande Ronde R_1 magnetostratigraphic unit. These unusually large columns may be the result of unusual cooling conditions. This may have been a subsiding valley at the time this basalt was being deposited. On the route up ID Highway 3, there are repeated exposures of interbeds likely deposited by active streams.



Figure 33. Outcrop of columnar Grande Ronde Basalt R_1 .

This is an exceptionally thick lava flow. This flow has very distinct columns that formed due to slow cooling conditions associated with a thick flow.

Continue northeast up ID Highway 3. Please be careful at all stops along the Kendrick/Deary grade as it is frequently used by both chip and logging trucks. At milepost 15 pull into the turnout and stop.

Stop 15 – Mile 59.4

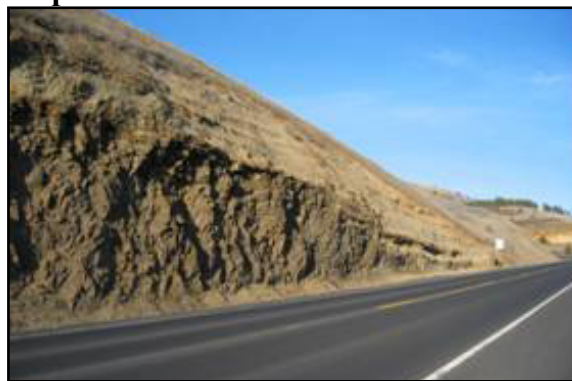


Figure 34. Outcrop of Latah formation interbed with invasive sill of Grande Ronde R_1 .

The basalt at this stop is a sill that invaded into the Latah Formation interbed. The basalt that lies up section from here is Grande Ronde N_1 . The basalt down section is Grande Ronde R_1 . The sill is also Grande Ronde N_1 . Looking closely at the sedimentary layers, they have been disturbed by the intrusion of the sill. The bottom of the sediment is also baked which can be most easily explained by invasion.

Continue northeast up ID Highway 3. Turn into the next large pull out.

Stop 16 – Mile 59.9



Figure 35. Outcrop of Latah formation with Grande Ronde N_1 above.

This large sand deposit is another Latah Formation interbed. The sand sized grains and the cross-bedding suggest moving water. The top surface has been baked by the overlying lava flow. The basalt is part of the Grande Ronde N_1 .

Walk up to the road cut just above the turnout. The basalt here (Grande Ronde N_1) likely flowed into a body of water. Large pillow structures appear in the cut on both sides of the road indicating such a history. There are also some spectacularly large vesicles as well.



Figure 36. Outcrop of pillow basalts, Grande Ronde N_1 .

Continue northeast up ID Highway 3 to what appears to be another interbed. There is a pull out across from the outcrop. Stop here.

Stop 17 – Mile 61.3



Figure 37. Outcrop of weathered surface of Grande Ronde N_1 below with Priest Rapids Member of Wanapum Basalt above.

Observe the outcrop from the pullout. Large truck traffic can make crossing the highway here hazardous. Look closely at what appears to be an interbed, it looks much different than others observed on this trip. Exposed here is a weathered surface, called saprolite, of Grande Ronde N_1 basalt. Imbedded in the loose material are a number of gray clasts which represent the weathered remains of the top of the Grande Ronde N_1 . Above this is the Priest Rapids Member of the Wanapum Basalt. This portion of the Grande Ronde N_1 likely was exposed for

some time before being buried by the Priest Rapids basalt. The Priest Rapids basalt is exposed the rest of the way up the grade.



Figure 38. Saprolite developed on the surface of the Grande Ronde.

Continue north along ID Highway 3. The terrain remains relatively flat for some time. As the road begins a short, twisting climb, watch for Fern Hill Rd. on your right. Stop at the intersection.

Stop 18 – Mile 68.6

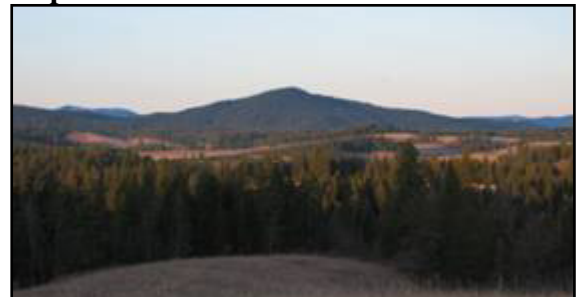


Figure 39. View of Cherry Butte looking north from intersection of ID Highway 3 and Fern Hill Rd.

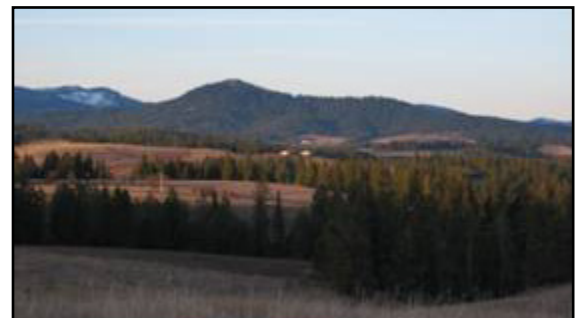


Figure 40. View of Potato Hill looking north from intersection of ID Highway 3 and Fern Hill Rd.

Looking to the north northeast there are two mountains beyond the town of Deary. Potato Hill is the mountain on the left and Cherry Butte is on the right. These are unrelated to the CRB's but are interesting volcanic landforms. Both produced lava flows richer in silica than the CRB's. The flows are relatively dark yet, because of their silica content, classify as an andesite or rhyolite. What makes them even more unique is that at least one flow from Potato Hill contains angular rock fragments from older rocks. This makes these a volcanic breccia. These rocks are much older (Eocene) than the CRB's (Miocene). These rocks may be related to dikes exposed several miles to the south that have been dated at 51 Ma.

Continue north on ID Highway 3 until the intersection with ID Highway 8 at Deary (**mile 73.5**). Turn right (east) toward Helmer/Bovill. About a mile east of Deary there is a house on the right and a road cut on the left. Park along the side of the road.

Stop 19 -Mile 74.5



Figure 41. Outcrop of rhyolite-dacite flow from Potato Hill (Eocene- Potato Hill volcanics).

The rocks found in the road cut are rhyolite and dacite from Potato Hill. They are probably of Eocene age and are likely contemporary with the Challis Volcanics found in south-central Idaho. This particular flow contains clasts of rock found below the volcano. The clasts consist of both volcanic and granitic fragments which range in size from under a millimeter to several meters.

Turn around here and head west on ID Highway 8 toward Troy and Moscow. At the base of the grade just before Troy, there is a road leading to a sewage treatment plant on the south side of the highway. Pull on to this road and find a place to park.

Stop 20 – Mile 87.0



Figure 42. Outcrop of Onaway Member, Potlatch Volcanics (Oligocene) just east of Troy.

Walk out to the intersection of the road to the sewage plant with ID Highway 8. On the way down the grade into Troy, exposed first is the Priest Rapids basalt and then into Grande Ronde N₁ basalts. To your right on the south side of the highway is an outcrop of Grande Ronde N₁ basalt. Across the highway and to your left (towards Troy) is another road cut. The basalt that crops out in the road cut here is neither Grande Ronde Basalt nor is it associated with Potato Hill volcanics. This is an outcrop of the Onaway Member of the Potlatch Volcanics. Two samples of basalt from this formation found near Harvard (north of Deary) were dated using ⁴⁰Ar/³⁹Ar at 25.6 ± 0.2 Ma and 26.2 ± 0.2 Ma placing them in the Oligocene epoch. One small dike of basalt of this age has been identified south of Deary along Big Bear Creek.

Return to ID Highway 8. Turn west and continue on to Moscow to complete the trip. Odometer should be about **mile 99** at the Eastside Marketplace at the eastern end of Moscow.

GLOSSARY OF TERMS

Anticline – A fold in rock layers, generally convex upward. The core of the fold usually contains the stratigraphically oldest rocks.

$^{40}\text{Ar}/^{39}\text{Ar}$ dating – The sample is generally crushed and single crystals of a mineral hand-selected for analysis. These are then irradiated to produce ^{39}Ar from ^{39}K . The sample is then degassed in a high-vacuum mass spectrometer via a laser or resistance furnace. Dating relies on the conversion of K to Ar, and accurate measurement of this conversion. The sample is heated in an increment (step heating) which releases argon from different reservoirs within the crystal grain. Each step produces argon with a certain $^{40}\text{Ar}/^{39}\text{Ar}$ ratio, and only when 80% or more of these steps are within acceptable error is the crystal's age known. Dating via $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology is generally accurate to within 1-2% for properly collected and irradiated and treated samples. (<http://en.wikipedia.org>)

Axial trace – The intersection of the axial plane of a fold with a specified surface (here the surface of the Earth).

Basalt – A fine-grained, dark igneous rock rich in calcium feldspar and iron-rich minerals.

Clast – An individual constituent, grain, or fragment of a detrital sediment or sedimentary rock, produced by the physical disintegration of a larger rock mass.

Cross bedding – Inclined sedimentary structures in a horizontal rock unit. The original deposition was in tilted layers and not due to post depositional deformation.

Dacite – An extrusive igneous rock having a similar composition to andesite except that it has more quartz and less calcium rich

plagioclase feldspar. The rough extrusive equivalent to granodiorite.

Dike – A sheet intrusion that cuts across existing rock layers or through massive rock structures such as batholiths.

Fissure – An extensive crack, break, or fracture in the Earth's crust.

Fluxgate magnetometer – A portable instrument used to measure the orientation of Earth's magnetic field preserved in the rock.

Interbed – A bed or rock material found between layers of a different rock type.

Loess – Any sediment, dominated by silt, of wind borne origin.

Magnetic reversal – A change in the direction of Earth's magnetic field between normal and reversed.

Magnetostratigraphic unit – A rock unit described in part by the direction magnetic polarity preserved in the rock.

Metasedimentary – A sedimentary rock that has been changed by metamorphism.

Pillow structure – Pillow-shaped structures formed as lava is extruded into water.

Plagioclase feldspar – A type of feldspar rich in calcium and/or sodium.

Reverse fault – A type of fault resulting from compressional stress. The hanging wall moves up relative to the foot wall.

Rhyolite – A fine-grained igneous rock with a composition similar to granite.

Saprolite – A soft clay-rich material formed from decomposed rock. It forms in place from an igneous or metamorphic rock.

Spinner magnetometer – A lab instrument used to determine the orientation of Earth's magnetic field preserved in a rock sample.

Steptoe – An isolated protrusion of bedrock, such as the summit of a hill or mountain, in a lava flow.

Syncline – A fold in rock layers, generally concave upward. The core of the fold

usually contains the stratigraphically youngest rocks.

Vesicles – A small cavity in an extrusive rock formed by the expansion of gas or steam during the solidification of the rock.

Volcanic breccia – A rock composed of rock fragments in a volcanic matrix.

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