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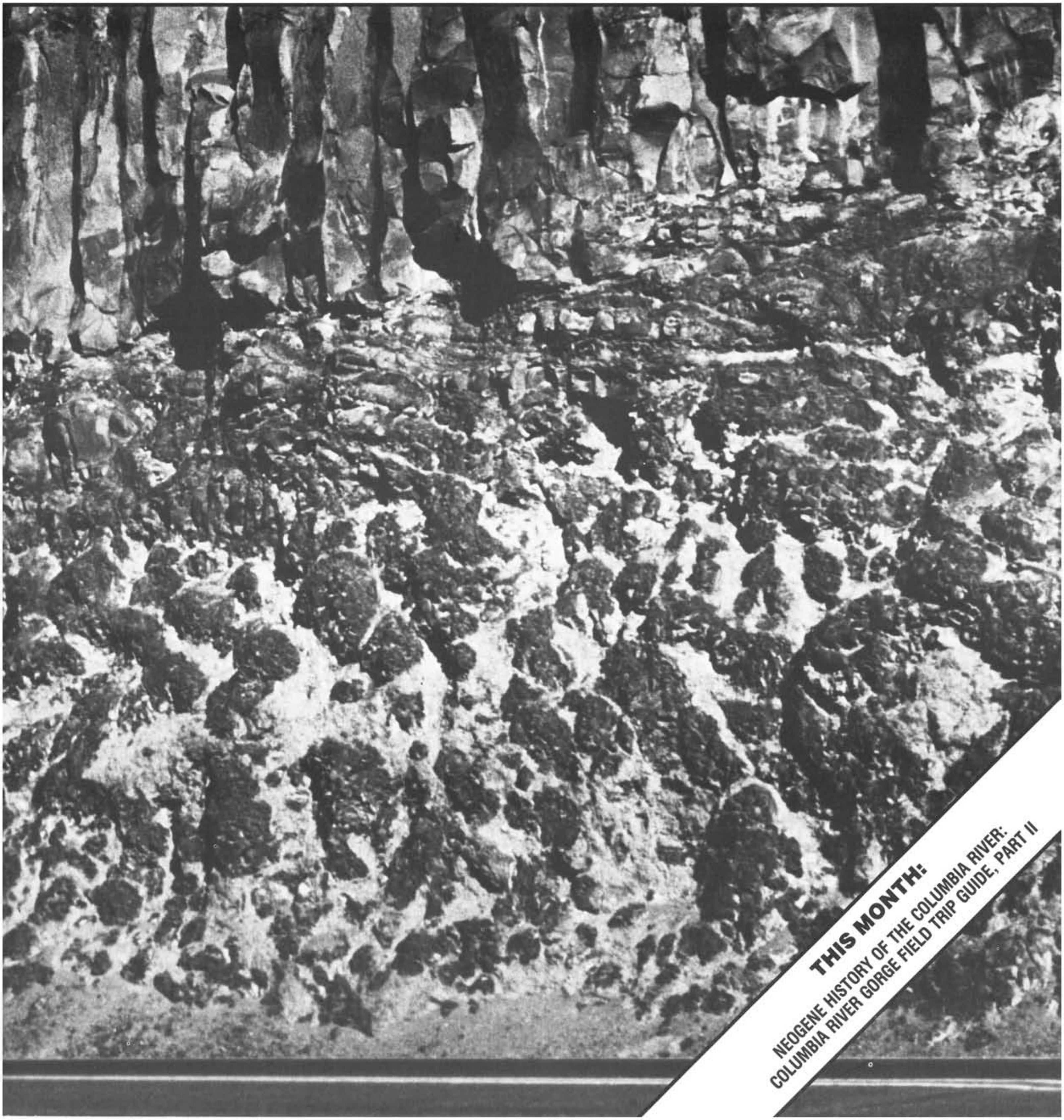

THIS MONTH:
NEOGENE HISTORY OF THE COLUMBIA RIVER:
COLUMBIA RIVER GORGE FIELD TRIP GUIDE, PART II

OREGON GEOLOGY

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Oregon Geology is designed to reach a wide spectrum of readers interested in the geology and mineral industry of Oregon. Manuscript contributions are invited on both technical and general-interest subjects relating to Oregon geology. Two copies of the manuscript should be submitted, typed double-spaced throughout (including references) and on one side of the paper only. Graphic illustrations should be camera-ready; photographs should be black-and-white glossies. All figures should be clearly marked, and all figure captions should be typed together on a separate sheet of paper.

The style to be followed is generally that of U.S. Geological Survey publications (see the USGS manual *Suggestions to Authors*, 6th ed., 1978). The bibliography should be limited to "References Cited." Authors are responsible for the accuracy of their bibliographic references. Names of reviewers should be included in the "Acknowledgments."

Authors will receive 20 complimentary copies of the issue containing their contribution. Manuscripts, news, notices, and meeting announcements should be sent to Beverly F. Vogt, Publications Manager, at the Portland office of DOGAMI.

COVER PHOTO

Westwardly dipping, foreset-bedded pillow complex at The Dalles, on U.S. Highways 197 and 30, just south of the I-84 interchange. This exposure of pillow basalt provides evidence for the history of the Columbia River Gorge at Columbia River basalt time. See discussion in last month's issue and field trip stop 13 in road log beginning on next page.

OIL AND GAS NEWS

Columbia County

Champlin Petroleum's Puckett 13-36, located in sec. 36, T. 8 N., R. 5 W., was spudded June 24. The well was drilled to total depth and was plugged and abandoned August 15. No report on findings has been released.

Mist Gas Field

Reichhold Energy Corporation has added another producing gas well, the 14th, to the Mist Gas Field. The well, Busch 14-15, located in sec. 15, T. 6 N., R. 5 W., was spudded August 2. It was drilled to a total depth of 2,258 ft and was completed August 11, flowing at a rate of 3 MMcfd. The Busch well is ½ mi north of Columbia County 23-22, a new producer since May.

Douglas County

Hutchins and Marrs started drilling Great Discovery 2 on July 5. The well, located in sec. 20, T. 30 S., R. 9 W., has a proposed total depth of 3,500 ft. A.M. Jannsen Well Drilling Company is the contractor.

Lane County

Drilling continues on Leavitt Exploration and Drilling well Maurice Brooks 1, located in sec. 34, T. 19 S., R. 3 W.

Recent permits

Permit no.	Operator, well, API number	Location	Status, proposed total depth (ft)
266	Reichhold Energy Corp. Columbia County 23-4 009-00130	SW¼ sec. 4 T.6 N., R.5 W. Columbia County	Location; 3,000.
267	Amoco Production Co. Weyerhaeuser 1-6 019-00026	SW¼ sec. 6 T.25 S., R.8 W. Douglas County	Application; 13,500.
268	Amoco Production Co. Weyerhaeuser 1-13 019-00027	SW¼ sec. 13 T.25 S., R.9 W. Douglas County	Application; 13,500.
269	Reichhold Energy Corp. Longview Fibre 13-23 009-00131	SW¼ sec. 23 T.6 N., R.5 W. Columbia County	Application; 2,600.
270	Hutchins & Marrs Great Discovery 3 019-00028	SW¼ sec. 20 T.30 S., R.9 W. Douglas County	Application; 3,500.
271	Hutchins & Marrs Great Discovery 4 019-00029	SW¼ sec. 20 T.30 S., R.9 W. Douglas County	Application; 3,500.
272	Hutchins & Marrs Great Discovery 5 019-00030	SW¼ sec. 20 T.30 S., R.9 W. Douglas County	Application; 3,500.

□

Former Washington State Geologist dies

Vaughn Edward (Ted) Livingston, State Geologist and head of the Division of Geology and Earth Resources in the Washington Department of Natural Resources from 1971 to 1982, died on July 9, 1984, at the age of 56 years.

Livingston was born in 1928 in Hayward, California. He studied at Brigham Young University, where he received his bachelor of science degree in geology in 1954 and his master of science degree in geology in 1955. He served the Washington State geologic division for nearly 26 years. Following his service as State Geologist, Livingston worked briefly for the Lands Division of the Washington Department of Natural Resources before his retirement in 1982. □

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

by Terry L. Tolan and Marvin H. Beeson, Portland State University, Portland, Oregon 97207, and Beverly F. Vogt, Oregon Department of Geology and Mineral Industries, Portland, Oregon 97201*

The following field trip guide is designed to let you see many of the geologic features related to the courses of the ancestral Columbia River discussed in last month's issue of *Oregon Geology*. The trip is long, covering more than 155 mi, and will take a long day to complete. You may choose instead to spend two days on the trip. Included are several optional side trips that direct you to points of geologic interest away from the main highways. The mileage for these optional side trips is not added into the mileage for the main portion of the road log. References used either in Part I (last month's issue) or in Part II (this issue) appear at the end of Part I.

The field trip route, which is shown on pages 106-107, starts in Portland and follows along the Oregon (southern) side of the Columbia River to The Dalles. It returns to Portland via the Washington (northern) side of the river. The starting point is Lewis and Clark State Park, which is located approximately 18 mi east of downtown Portland. The park is reached by going east on I-84 from Portland, taking exit 18, turning left from the off ramp, and following the road under a railroad bridge to the parking area at the entrance to the park.

We wish to remind you to be careful of traffic and to exercise caution at field trip stops along the main highways. *—Editor*

Total miles	Road log and comments
0.0	**Lewis and Clark State Park parking area.** *Begin the trip by turning left on the Old Scenic Highway (also called Crown Point Highway on some signs) and driving upstream along the Sandy River. At the Sandy River bridge intersection, turn left and continue on the Old Scenic Highway toward Corbett.* Note the outcrops of upper member Troutdale Formation exposed along the left side of the road.
2.7	Pull over and park on the right side of the road just before the bridge. **STOP 1. Upper member sands and gravels of the ancestral Columbia River facies of the Troutdale Formation at Stark Street Bridge.** Note the lithic and vitric sandstone beds and the high-alumina basalt clasts related to Boring-High Cascade Lavas volcanism along the ancestral Columbia River that are characteristic of the upper member of the Troutdale Formation. The lithic sandstone is gray, whereas the vitric sandstone is usually reddish due to alteration of the basaltic glass shards. Note also the occasional quartzite and other exotic pebbles in the conglomerate beds, the lens-shaped beds of sandstone and conglomerate, and the presence of cross-bedding that together indicate fluvial deposition by a stream carrying exotic clasts from distant sources. Note the large subangular boulders near the top of the outcrop; these are mostly high-alumina basalt from a nearby Boring Lavas vent. *Proceed along Old Scenic Highway.*
3.1	Dabney State Park, right side of road.
3.3	Intersection. *Stay right.*
4.4	Intersection. *Stay right.*
4.5	Intersection. *Turn left toward Corbett.*
5.4	Intersection. *Stay left.*
6.6	Corbett.
6.9	Intersection. *Turn left here toward Corbett Station and I-84 for Optional Side Trip A or continue along Old Scenic Highway for main trip.*

*Current address: Geosciences Group, Rockwell International, Richland, Washington 99352

OPTIONAL SIDE TRIP A

Base of Crown Point via Corbett Station. Opportunity to examine Frenchman Springs Member flows and bedded Priest Rapids hyaloclastite.

[0.0] *Turn left from Old Scenic Highway (mile point 6.9 of main trip). Proceed north toward Corbett Station.*

[0.7] Frenchman Springs flows are exposed from here to the quarry at Corbett Station. The uppermost flow is an aphyric, Wallula Gap flow displaying hackly jointing (entablature). The lower flows are massive to blocky-jointed, sparsely plagioclase-phyric Sand Hollow flows.

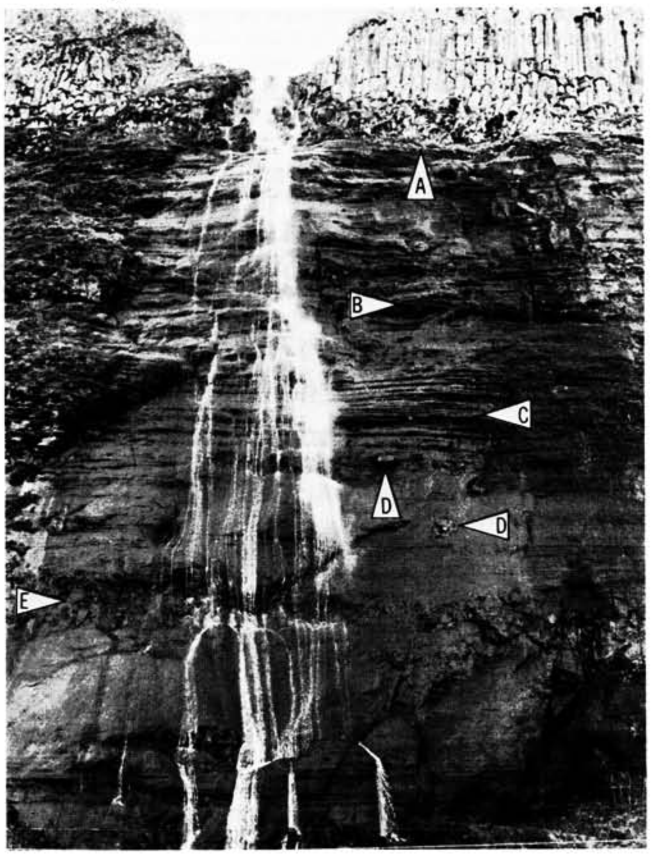
MEMBER	UNIT	MAGNETIC POLARITY
FRENCHMAN SPRINGS	Basalt of Lyons Ferry	N
	Basalt of Wallula Gap	N
	Basalt of Oregon City	N
	Basalt of Sand Hollow	N
	Basalt of Silver Falls	E? N
	Basalt of Ginkgo	E

Informal stratigraphy of the Frenchman Springs Member in western Oregon. These units have been defined on the basis of major-oxide and trace-element chemistry, paleomagnetic polarity, lithology, and stratigraphic position. N=normal polarity; E=excursional polarity.

[1.3] **Corbett Station Quarry.** This is the westernmost exposure of Columbia River basalt on the Oregon side of the Gorge and is a sparsely plagioclase-phyric Frenchman Springs flow of the Oregon City type. This flow contains amber to reddish-orange plagioclase glomerocrysts which range from 0.5 to 2 cm in size. You may want to collect a small, fresh piece of this flow (with a glomerocryst if you can) to compare to other Columbia River basalt flows you will see on this trip. Based on surface exposure and subsurface data from an Oregon Department of Geology and Mineral Industries (DOGAMI) heat-flow well drilled in this quarry, this flow is approximately 50 m thick. The great thickness of this flow and the presence of scattered pillowed zones throughout the exposure suggest that it may be an intracanyon flow.

[1.4] *Turn onto I-84 eastbound toward Hood River.* N_2 high MgO Grande Ronde flows are exposed along the railroad track from here to the railroad tunnel. Crown Point is the prominence to the right, Rooster Rock is the pinnacle to the left.

[3.4] **Base of Crown Point**. *Stop at the gate on the right directly across from Rooster Rock (0.2 mi past milepost 24). Do not block the gate.* From the road you can see the Priest Rapids hyaloclastite below the Priest Rapids intracanyon flow. You may also walk over to the base of Crown Point for a better view, but watch out for poison oak and trains. Crown Point is an excellent exposure of the thick Priest Rapids (Rosalia chemical type) intracanyon flow overlying a bedded hyaloclastite (also Rosalia chemical type). If you walk over to the base of Crown Point, collect a small, fresh sample of the Priest Rapids flow and hyaloclastite to compare to samples from exposures of this same flow at Stops 13 and 15. The lack of pillows at the lava/hyaloclastite contact suggests that the hyaloclastite was not excessively wet when the lava flowed over it. The combined thickness of the lava flow and hyaloclastite exceeds 215 m. A few large, subangular boulders of Columbia River basalt and "Skamania Volcanics" suggest flood or lahar transport. Note the graded bedding, local cross-bedding, and the degree of rounding of the clasts in the hyaloclastite seen here and compare this outcrop to the massive Rosalia hyaloclastite exposure at Stop 15. *Continue east on I-84.*



North face of Crown Point showing features of the Priest Rapids hyaloclastite deposit (Optional Side Trip A). A=contact between the columnar Priest Rapids basalt and the hyaloclastite complex. B=foreset-bedded hyaloclastite. C=parallel-bedded hyaloclastite. Differences in degree of induration between individual beds and resulting differences in susceptibility to weathering allow some of the beds to stand out in relief, producing the horizontal ridges seen here. D=scattered foreign boulders and cobbles of "Skamania Volcanics," Grande Ronde, and Frenchman Springs lithologies. The local availability of the rock types constituting the foreign clasts, their generally poor degree of rounding, and their relatively large size in comparison to the Priest Rapids hyaloclastic debris indicate that they were derived locally from the sides of the ancestral Columbia River canyon and not transported far. E=foreign boulder conglomerate.

[3.8] Rooster Rock exit. *Take Rooster Rock exit (Exit 25), cross over freeway, turn left before park entrance, and proceed west on I-84.*

[6.9] *Take Exit 22 to Corbett to return to main part of trip log.*

[8.6] Intersection with Old Scenic Highway (mile point 6.9 of main trip). Turn left toward Crown Point to resume main trip route.

END OF OPTIONAL SIDE TRIP A

7.4 Intersection. *Stay left on Old Scenic Highway.*

8.5 **STOP 2. Womens Forum State Park**. View former paths of the Columbia River. All three Columbia River channels (Priest Rapids at Crown Point, Bridal Veil in the next hillside beyond Crown Point, and modern Columbia River) intersect in this area. *Continue east on Old Scenic Highway.*

9.0 Junction. *Stay left on the road toward Crown Point.*

9.3 **STOP 3. West side of Crown Point**. *Stop at any of the small turnouts near milepost 11.* A Boring Lavas flow is intercalated with the upper member of the Troutdale Formation here. This Boring Lavas flow is a gray, open-textured basalt that is easily distinguished from the Columbia River basalt. It appears to have followed a small channel in this area; no pillows occur at the base. Note the red baked contact below this flow. Look carefully to see reddish-colored upper member Troutdale Formation vitric sandstone above the lava flow. Note also that in the Troutdale Formation here there are almost no quartzite pebbles and that most of the basaltic clasts are of the High Cascades-Boring Lavas type, with few Columbia River basalt clasts. This part of the upper member of the Troutdale Formation was deposited during a time of fairly intensive volcanism during which the Columbia River was being challenged by local volcanic eruptions. *Continue east on Old Scenic Highway.*

9.8 **OPTIONAL STOP. Vista House**. Several features can be seen better here than from Womens Forum State Park. The Pomona intracanyon flow is exposed in the quarry along the railroad tracks on the Washington side of the river. The Bridal Veil channel on the Oregon side of the river lies just east of the Bridal Veil exit from the freeway. Here at Vista House on Crown Point you are standing directly on top of the Priest Rapids intracanyon flow, more than 215 m above the former canyon bottom (155 m of lava flow on top of more than 60 m of hyaloclastite). Note the Boring Lavas shield volcanoes above the cliffs of Columbia River basalt on both sides of the river.

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.

10.3 *Park in the small turnout on the left side of the road and watch for traffic.*

STOP 4. Priest Rapids pillows on east side of Crown Point. Watch out for traffic. Walk around the corner from the turnout to see pillow basalts that were formed when lava flowed into water. Note the typical features of pillow lavas such as radial jointing, oval shapes, and glassy rinds. These pillows of Priest Rapids basalt occur above the level of bedded hyaloclastite and far above the bottom of the pre-Priest Rapids canyon. We think that the hyaloclastite deposit and the capping lava flow dammed up small tributaries, thereby creating ponded water where these pillows were formed. Remember the characteristics of these pillows and compare them to those of the invasive Priest Rapids lobes to be seen later on this trip at Stop 15.

10.5 The contact between the Priest Rapids intracanyon flow and the older rocks we call "Skamania Volcanics" is exposed here. These older rocks are exposed from here to just west of Shepperds Dell State Park where Columbia River basalt again crops out. We use the term "Skamania Volcanics" (Trimble, 1963; Tolan, 1982) for these rocks, but as they have not been radiometrically dated, we cannot at this time confidently place them into the proper pre-Columbia River basalt formation.

11.8 *Turn left off Old Scenic Highway onto Latourell Road just west of Latourell Park.* Pre-Columbia River Basalt Group rocks are exposed along this road.

12.1 Junction. Latourell Henry Road and Park Street. *Turn left onto Latourell Henry Road and drive toward the end of the road.*

12.4 *Park in the area before the private driveway.*

STOP 5. View west toward east side of Crown Point showing Priest Rapids lava/hyaloclastite contact. The Priest Rapids channel here is located at the contact between

View of the east side of Crown Point (Stop 5). Note contact between Priest Rapids lava and bedded hyaloclastite below.

earlier Columbia River basalt flows and the older "Skamania Volcanics." Streams apparently commonly develop along such contacts. *Return to Old Scenic Highway.*

12.9 Junction. *Turn left onto Old Scenic Highway.*

13.2 **STOP 6. Latourell Falls Park.** Walk up the short path to view lower Latourell Falls. This is an N_2 high MgO flow that probably filled an old stream valley developed at the margin of the preceding Columbia River basalt flows and the older volcanic rocks. Note the large stream boulders exposed at the base of the flow just below the colonnade. This flow does not have blocky jointing typical of most N_2 high MgO flows but instead has a well-developed entablature like most of the low MgO flows in western Oregon. The atypical jointing probably developed because this flow cooled within a canyon. Almost flat-lying Skamania dacite is exposed at the parking lot and on the path leading to the base of the falls. As dacite is very viscous and does not move far from its source, this outcrop may represent a vent area that was one source of volcaniclastic deposits and mudflows of the Eagle Creek Formation exposed farther east in the axis of the Cascade arch. The "Skamania Volcanics" in the Crown Point area formed a paleotopographic high which the Columbia River basalt flows did not cover. *Return to car and continue east on Old Scenic Highway or follow trail for Optional Side Trip B.*

OPTIONAL SIDE TRIP B

Upper Latourell Falls. The easy-to-hike trail which continues upward from the viewpoint goes to upper Latourell Falls. This trail is about half a mile long, with an elevation gain of about 400 ft. Along the trail above lower Latourell Falls are several exposures of entablature-jointed Frenchman Springs flows (Sand Hollow type). At the upper falls, water cascades over a Priest Rapids Member entablature/colonnade. *Return to car to resume main trip route.*

END OF OPTIONAL SIDE TRIP B

13.6 Skamania basalt outcrops on the right side of the road.

14.4 Shepperds Dell. N_2 low MgO Grande Ronde Basalt outcrops.

15.2 Bridal Veil State Park.

15.4 **STOP 7. Bridal Veil Creek.** *Park in the turnout to the left of the highway just before the bridge.* A slide block of Pomona Member basalt is exposed along the highway near milepost 16. Note the small plagioclase phenocrysts that are typical of Pomona lithology. You may want to collect a small, fresh sample to compare to nonintracanyon exposures of Pomona Member at Stop 11. Bridal Veil Creek here flows approximately along the contact between the Pomona intracanyon flow and R_2 Grande Ronde Basalt formerly exposed by stream erosion during the Miocene along this Bridal Veil channel. *Continue east on Old Scenic Highway.*

15.8 Palmer Mill Road junction. *Turn right here for Optional Side Trip C or continue on Old Scenic Highway.*

OPTIONAL SIDE TRIP C

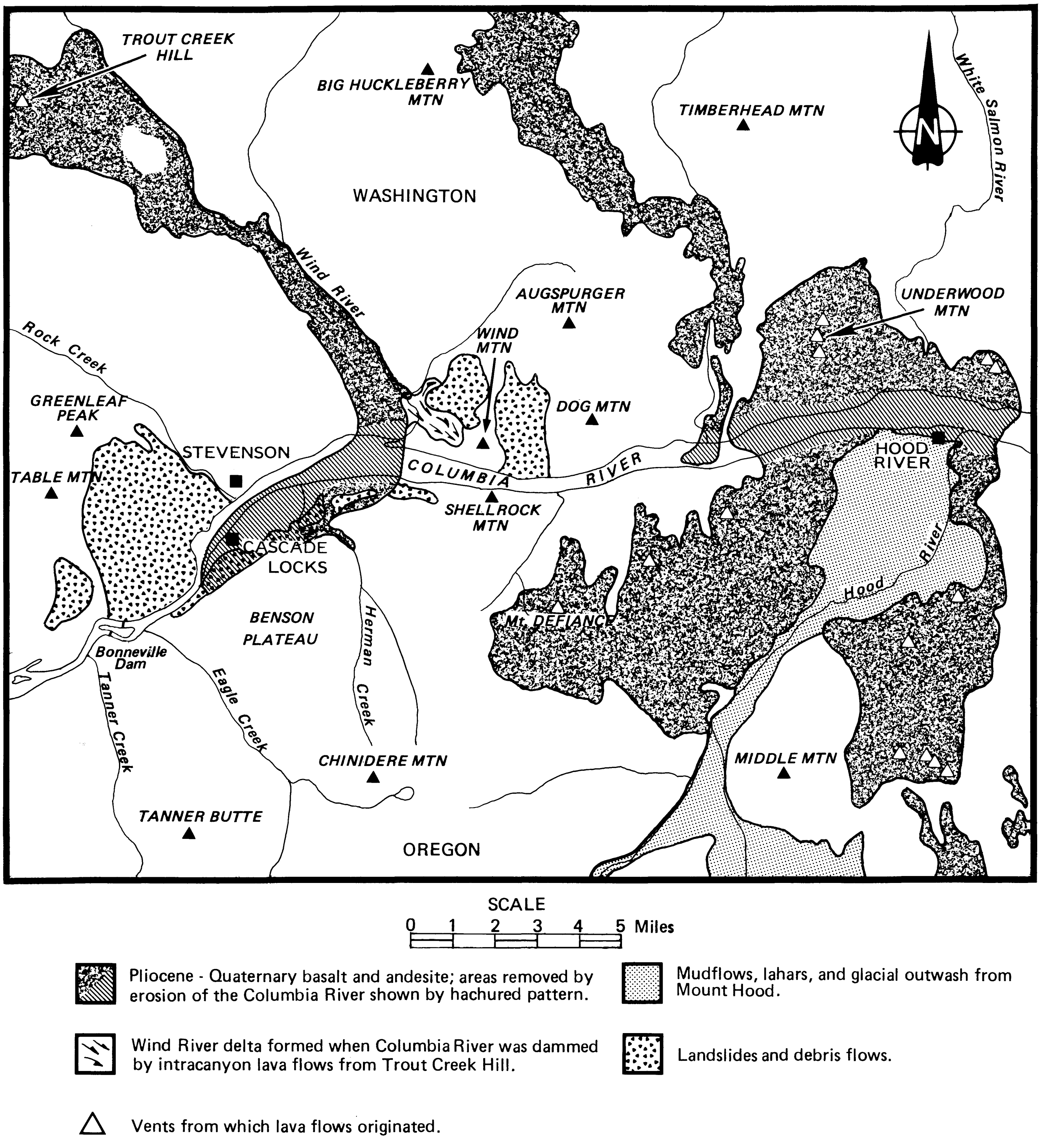
[0.0] **Palmer Mill Road.** On this side trip you can see Pomona intracanyon basalt, Rhododendron lahars, lower and upper member Troutdale Formation, and high-alumina basalt. A note of caution: This is a narrow, steep road that is not scenic but is geologically interesting. There is a place to turn around at the top of the hill, and it is safer to stop and look at outcrops on the way back down the hill. For that reason mileages of stops are given for both going up the road and coming down.

[0.3] Mound-shaped outcrop of Pomona intracanyon flow on the right. Many Columbia River basalt intracanyon flows are characterized by an entablature style of jointing that weath-

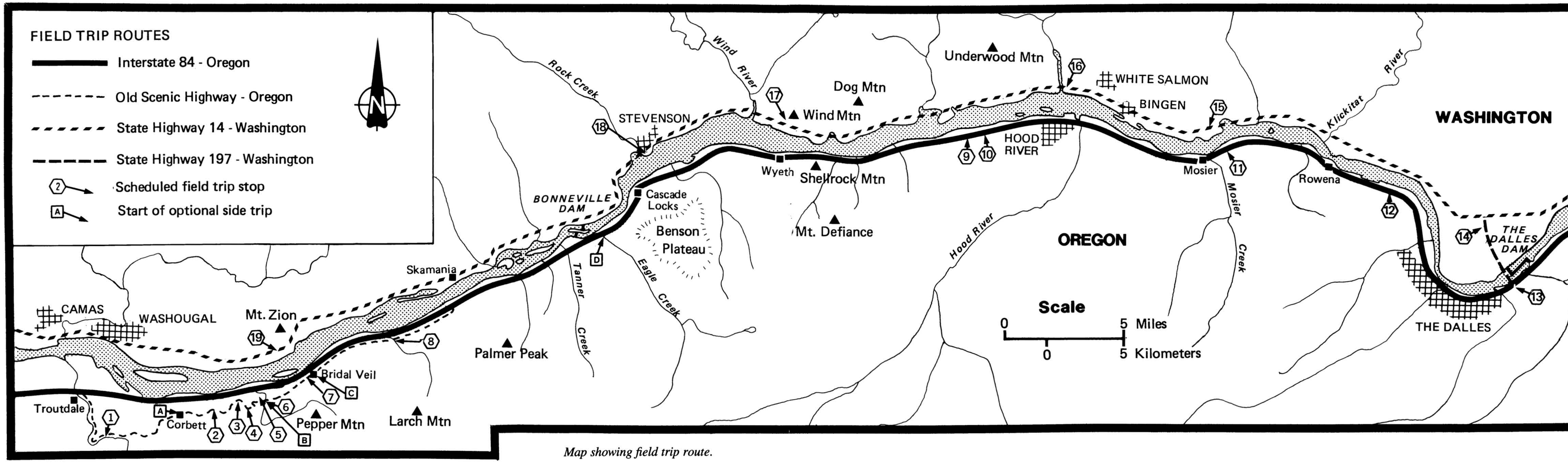
Lower Latourell Falls (Stop 6). This is an N_2 high MgO flow that appears to have been channelized at this point. The flow overlies a boulder conglomerate that is exposed at the base of the falls.

ers into these rounded tops. Overlying the Pomona here is a Rhododendron lahar. It is very poorly exposed in the road bank on the left. You may have to scrape a layer of soil or vegetation off to reveal it. (If you do, please be careful to keep the drainage ditch clear of debris.) The lahar consists of hornblende dacite clasts in a clay matrix (Tolan, 1982; Tolan and Beeson, 1984). This lahar is overlain by gravels and sands of the lower member of the Troutdale Formation.

[0.8] Outcrops of sands and gravels to this point belong to the lower member of the Troutdale Formation. Find a convenient spot to pull off the road and examine outcrops of these sands and gravels. The lower member of the Troutdale Formation here consists of micaceous arkosic sands and basaltic gravels (primarily Columbia River basalt) which contain between 5 to 12 percent exotic clasts (e.g., quartzite, schist, rhyolite; Tolan, 1982). Note the typical



Lava dam and landslide map showing former Pliocene-Quaternary lava dams and active landslides in the western part of the Columbia River Gorge. From Waters (1973, p. 146).



Map showing field trip route.

lack of cementation (lithification) of lower member sands and gravels. Exposures of the lower member of the Troutdale Formation are limited because these sands and gravels were confined to the paleocanyon of an ancestral Columbia River (Bridal Veil channel).

[1.2] A thin, deeply weathered Boring Lavas-type lava flow is exposed here. Note the vesicular flow top.

[1.3] **SIDE TRIP STOP.** Walk back down the road to observe the Boring Lavas flow (where road grade steepens). This high-alumina basalt flow is plagioclase phyric and quite vesicular. Regular cooling joints are not well developed, making this exposure difficult to recognize as a lava flow at first. From this point to the parking spot, upper member lithic sandstone of the Troutdale Formation is exposed in the road cut on the east (left) side of the road, and Frenchman Springs basalt (Sand Hollow type) crops out about 15 ft below the road in the canyon wall on the west side (at about 1,150- to 1,200-ft elevation). This marks the southwestern edge of the Bridal Veil channel. All of the Troutdale Formation above about 800-ft elevation is upper member, containing lithic and vitric sands produced from eruption of high-alumina basalts of the Boring-High Cascade Lavas. Notice the large subangular boulders of high-alumina basalt that are exposed above the lithic sands. The top of the Troutdale Formation is about 100 ft above the road at this point and is capped by high-alumina basalt flows. *Continue driving up the road to the intersection to turn around.*

[1.6] Turnaround. *Turn off on the road to the right and turn your car around. Return to Palmer Hill Road and start down the hill.*

[1.9] *Pass the last stop area.*

[2.2] Outcrop of upper member vitric sandstone.

[2.4] Lower member gravels (uphill point [0.8]).

[2.8] Pomona mound on left side of road (uphill point [0.3]).

[3.2] Junction with Old Scenic Highway. *Turn right to resume main trip route.*

END OF OPTIONAL SIDE TRIP C

16.0 Junction. *Continue toward Multnomah Falls.*

18.5 Wahkeenah Falls.

19.0 **STOP 8. Multnomah Falls** (rest rooms). Eleven low MgO Grande Ronde flows are exposed along Multnomah Creek, including one N_1, five R_2, and five N_2 flows. Six of these flows crop out from the river to the top of the upper falls; the rest are exposed upstream above the two falls you see here. Note a pillow sequence near the lip of the upper falls.

Observations of waterfalls occurring over Columbia River basalt (M.H. Beeson, unpublished data, 1978) have shown that falls often occur where flows are flat lying or dipping upstream. This condition allows blocks produced by vertical joints to be stable until support is withdrawn by erosion of softer interflow material at the base of individual flows. The rate of erosion of interflow areas probably largely controls the rate of retreat of the falls. Two falls are produced here because of a more easily eroded zone at the base of the upper falls. Furthermore, the amphitheater-shaped valley common to many of the falls within the Gorge is due to freeze-thaw action of water from the splash mist that penetrates the joints.

The contact between the Columbia River basalt and the underlying Eagle Creek Formation is exposed to the north, on the Washington side of the river, about midway up the side of the canyon; because of the regional dip to the south, however, the Eagle Creek Formation is not exposed here on the Oregon side. This is partly due to the southerly dip of the flows and partly due to the thinning Columbia River basalt section at the northern margin of the structural low through the ancestral Cascades that confined these flows. *Continue east on Old Scenic Highway.*

21.3 Oneonta Gorge.

21.6 Horsetail Falls.

22.0 Ainsworth State Park.

22.8 *Rejoin I-84 eastbound.*

25.5 McCord Creek. The Eagle Creek Formation is exposed here.

27.8 Fish Hatchery and Bonneville Dam exit (Exit 40).

29.1 Eagle Creek Park. *Take Exit 41 and turn right here for Optional Side Trip D or continue on I-84.*

OPTIONAL SIDE TRIP D

Eagle Creek Formation. *Park along the right side of the road just after leaving I-84.* The Eagle Creek Formation consists of mudflows and volcaniclastic rocks from andesite stratovolcanoes. One such source may be the Skamania lava flows exposed at Latourell Falls. The recent explosive eruption and subsequent mudflows at Mount St. Helens provide a modern analog that helps us to understand how this formation was produced. In these exposures of Eagle Creek Formation are subangular andesite clasts, petrified and carbonized wood, and lignite stringers. Look north across the river to see head scarps of the large Bonneville landslide to the right (east) of Table Mountain. The Bonneville landslide, the largest landslide in the gorge, may have dammed the Columbia River during Holocene time, probably giving rise to the Indian legend of the Bridge of the Gods (Waters, 1973). *Leave park and continue right on I-84 eastbound to resume main route.*

END OF OPTIONAL SIDE TRIP D

31.1 Cascade Locks. Notice the good view of the Bonneville landslide and scarp.

32.3 Fan-shaped columnar jointing in high-alumina basalt flow.

34.5 Quarry in Government Cove diorite intrusion exposed on the left.

36.2 Note the flat-topped Wind River intracanyon flow on the Washington side of the Columbia River. More than 35,000 years ago, a series of lava flows came down the Wind River canyon as intracanyon flows, entering the Columbia River on a 1-mi-wide front and damming the river (Waters, 1973). The dam lasted long enough for the Wind River to build a delta 150 ft thick and 1 mi long into the temporary lake (Waters, 1973, p. 145). The cone-shaped mountain ahead on the Washington side of the river is Wind Mountain, an intrusion.

37.0 Weigh station.

42.3 Starvation Creek State Park (optional rest stop). Dog Mountain, containing the thickest exposed section of low MgO Grande Ronde Basalt in this area (Anderson, personal communication, 1980), is across the river.

45.6 **STOP 9. West of Mitchell Point on I-84 eastbound (milepost 58).** Pre-Pomona lower member Troutdale gravels overlying Frenchman Springs flows exposed at road level. These gravels consist of mainly basaltic cobbles in a well-cemented sandstone matrix (Anderson, 1980). This conglomerate contains rare quartzite pebbles, suggesting that the ancestral Columbia River that deposited them in the Bridal Veil channel extended across the Columbia Plateau and was transporting exotic pebbles from drainage areas to

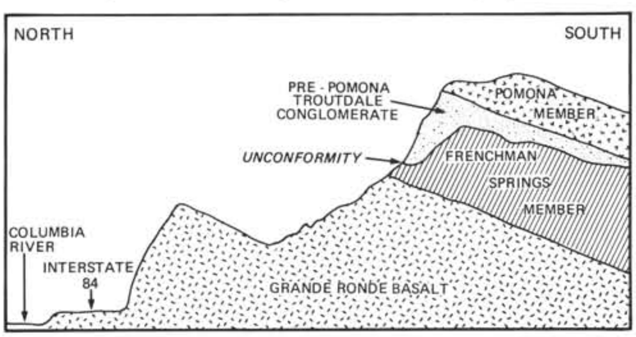
Pre-Pomona lower member Troutdale Formation exposed at road level (Stop 9). Here the Troutdale directly overlies Frenchman Springs Basalt.

the north and east into this area. If you took Optional Side Trip C, Palmer Mill Road, note the difference in appearance between this pre-Pomona Troutdale conglomerate and the lower member gravels exposed above the Pomona Member on Palmer Mill Road.

45.9 *Take exit to Mitchell Point Park.*

46.2 **STOP 10. Parking lot at Mitchell Point Park.** A view of Mitchell Point is to the right above the parking lot; the rocks immediately in front of the parking lot are Grande Ronde Basalt. Mitchell Point preserves the southern portion of the Bridal Veil channel; the northern portion was destroyed by the present-day Columbia River when it began incising the Gorge. This exposure of Pomona Member and pre-Pomona Troutdale was first recognized by J.L. Anderson (1980) and marks the eastern end of the Bridal Veil channel (Tolan and Beeson, 1984) where the river began to cut into the Cascade Range. The lower member Troutdale conglomerates seen underlying the Pomona Member here are the same as those just seen at Stop 9. The difference in elevation is an indication of the considerable structural deformation that has affected this area in the past 12 million years (m.y.). *Return to I-84 and continue east.*

48.4 Note the thick pillow-palagonite complex at the base of a post-Columbia River basalt high-alumina basalt flow exposed on both sides of the freeway. (*Do not attempt to stop and get off I-84 eastbound lanes here!*) We think that the interaction between lava flows, such as this one, and the Columbia River in the Bridal Veil channel produced the vast quantities of vitric sand which characterize the upper member of the Troutdale Formation. Across the Columbia River is the Underwood Mountain shield volcano. Note the angular unconformity between the flat-lying Underwood lava flows and the steeply-dipping Columbia River basalt flows. Flows from Underwood Mountain may have temporarily dammed the Columbia River, as did the Wind River flows, in Holocene time (see lava dam and landslide map, above).



Diagrammatic cross section through Mitchell Point (Stop 10), showing the preserved southern portion of the Bridal Veil channel of the ancestral Columbia River. From Anderson (1980, p. 197).

52.1 Hood River. (Highway 35 goes south to Mount Hood).

53.2 Across the river you can see the Bingen anticline.

56.5 You are passing through the Mosier syncline.

57.3 Mosier exit.

59.7 **STOP 11. East of Mosier on I-84 (milepost 72).** Exposure of Pomona Member basalt. Compare its texture here and at Bridal Veil Creek (Stop 7). Note that there are more plagioclase phenocrysts in the Bridal Veil intracanyon occurrence than in the sheet flow here.

Typical jointing of the Pomona Member (Stop 11).

60.4 Rest area.

65.7 **STOP 12. Ortley anticline.** *Stop near milepost 78.* View the natural cross section through the Ortley anticline exposed on the Washington side of the river. This fold is a thrust-faulted, asymmetrical anticline that is part of the southwestward continuation of the Columbia Hills anticline, which in turn is part of the Yakima Fold Belt. Here at Ortley the major features of a Yakima fold are well exposed. Field evidence suggests that Yakima folds began to grow at least 16 m.y. ago (Bentley and others, 1980b; Vogt, 1981; Reidel, in press). The extension of these developing anticlinal ridges and their broad intervening synclinal lows through the Miocene Cascade Range (Beeson and others, 1982; Beeson and Tolan, 1984) was one of the major factors controlling the various positions of the ancestral Columbia River in the Miocene Cascade Range.

68.3 Entering the Dalles syncline.

71.5 City Center, The Dalles.

74.3 *Take Exit 87 and turn right at the stop sign onto U.S. 197. Cross the railroad bridge and stop at the large turnout on the right side of the road just before Highways 197 and 30 divide.*

74.7 **STOP 13. The Dalles bridge junction. Priest Rapids flows.** This pillow-palagonite complex lies at the base of a Rosalia flow which is in turn overlain by a younger Lolo flow. Both flows are part of the Priest Rapids Member. The pillow complex overlies lake-bed deposits (diatomite) elsewhere in this area and here displays a westward imbrication. This evidence indicates that the Priest Rapids flow was advancing toward the west across a shallow lake that occupied the broad low centered where the Dalles syncline now lies. The ratio of hyaloclastite (now altered to palagonite) to pillows increases westward toward Mosier. We think that the increasing ratio of hyaloclastite to pillows indicates an environment of increasingly turbulent or rapidly moving water into which the Priest Rapids lava flowed. The evidence observed in this area, then, indicates to us that the head of the ancestral Columbia River canyon which the Priest Rapids Member entered must lie to the west (see discussion of Priest Rapids time in last month's issue, p. 93-94).

If you collected a sample of the Rosalia Priest Rapids flow at the base of Crown Point, compare it to a fresh sample from the colonnade overlying the pillow complex in the Rosalia flow here. Note the extreme differences in texture between the intracanyon and sheet portions of this same flow. *Turn around and drive across The Dalles bridge to Washington.* Note the scabland along the river that was formed by removal of soil cover and some bed rock during the Missoula floods.

78.0 **STOP 14. Roza flow.** *Pull off Highway 197 onto the narrow shoulder on the right side of the road.* Outcrops of vesicular, blocky-jointed Roza Member occur on both sides of the highway. The best exposures are on the left (west) side. The Roza Member consists of a single flow in this area. Find a clean, fresh surface on the outcrop. Note the great abundance of small, individual plagioclase phenocrysts. If you have collected samples of Frenchman Springs and Priest Rapids basalt, compare them to Roza samples. You can see why the Roza Member with its great abundance of phenocrysts makes such an excellent stratigraphic marker.

78.3 Junction of Highways 197 and 14. *Turn left on Highway 14 and proceed west toward Bingen and Vancouver.*

79.6 Large, platy Priest Rapids columns on the right.

83.5 Close-up view of the fault zone that you saw from across the river at Stop 13.

85.1 Lyle.

85.9 Klickitat River.

87.7 Rest area.

89.0 Pomona basalt.

91.3 **STOP 15. Priest Rapids hyaloclastite exposed in road cuts on the right.** Compare this massive deposit of Rosalia hyaloclastite to the bedding features occurring in the Rosalia deposit to the west at the base of Crown Point (Optional Side Trip A). If you collected a sample of the hyaloclastite at the base of Crown Point, compare it to a sample from this exposure. The angular shape of clasts in this deposit indicates little or no fluvial transport. Note the "pseudo-bedding" caused by post-depositional cementation patterns that have been accentuated by differential erosion. Invasive lobes of Priest Rapids lava and fragments of broken or incipient pillows are also exposed here. The hyaloclastite here fills a canyon eroded into the underlying Frenchman Springs flows seen along the highway at the western end of the hyaloclastite exposures. This is the easternmost known occurrence of Rosalia hyaloclastite filling a river canyon and probably represents the head of the pre-Priest Rapids canyon where displaced lake water and lava dynamically interacted and produced the hyaloclastic debris.

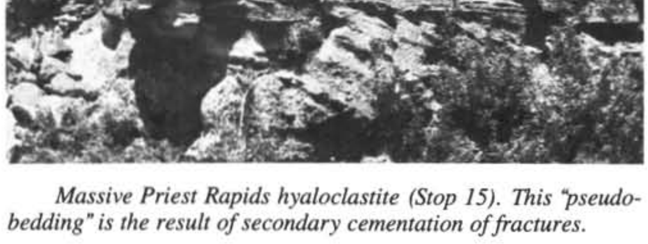
94.6 Bingen.

96.5 Hood River toll bridge. *Stay on Highway 14.*

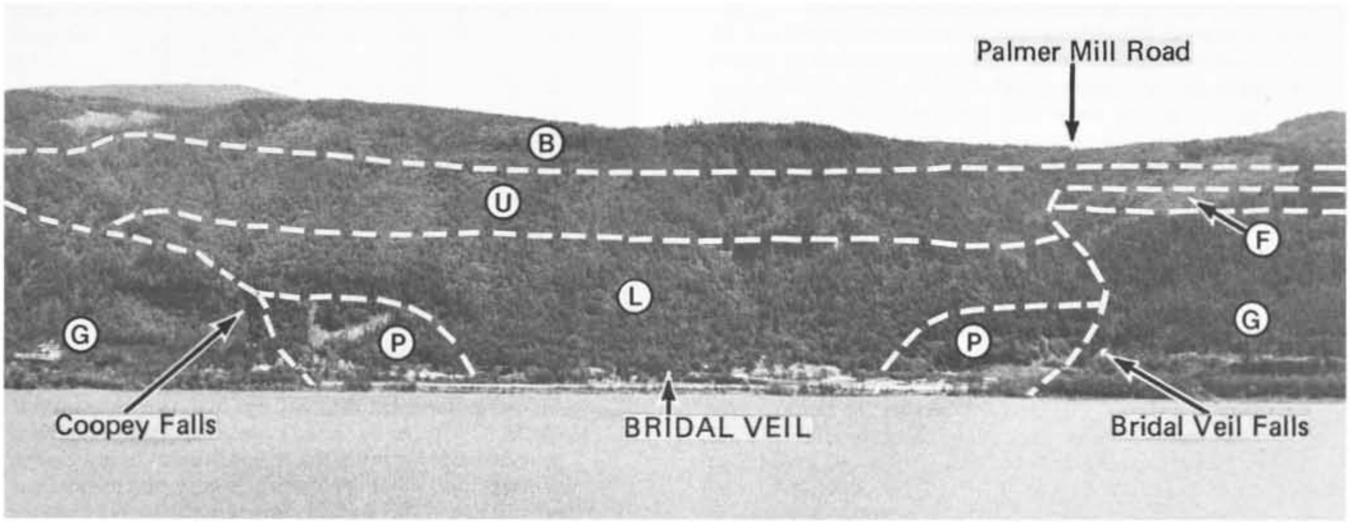
98.4 **STOP 16. Snipes Mountain conglomerate west of Underwood.** Quartzite-bearing gravels and sands exposed here belong to the Snipes Mountain conglomerate of the Ellensburg Formation (Bela, 1982). The gravels and sands were deposited by the ancestral Columbia River when it followed the Bridal Veil channel in post-Pomona time. These sediments are correlative with the post-Pomona lower member of the Troutdale Formation. This is a good place to contemplate the complex and confusing problem of what to name this unit. The fluvial sediments exposed here have been called the "Hood River Formation" (Buwalda and Moore, 1927, 1929), Dalles Formation (Hodge, 1938), Troutdale Formation (Allen and Hammond, *in* Allen, 1979) and, finally, Snipes Mountain conglomerate – Ellensburg Formation (Bela, 1982). With the exception of Hodge (1938), all of these geologists believed that this exposure represented deposits of the ancestral Columbia River, but the exact age of the unit was open to question. With our increased knowledge of the geology and paleodrainage history of this region, we now have a general understanding of the depositional history, distribution, and relative age of this deposit. However, we have a complex problem of what name to give it! We can eliminate Dalles Formation (Chenoweth Formation) from consideration, as it has been redefined, with origin and source totally different from the fluvial sediments under consideration. The names Snipes Mountain conglomerate (Ellensburg Formation) and Troutdale Formation are both perfectly valid for this deposit. At this point, some geologists have employed what might be called "territorial usage" of formational names, that is, deposits on the Washington side of the river are said to belong to the Ellensburg Formation, while similar deposits across the river in Oregon are assigned to the Troutdale Formation. This knotty problem is only one of many such complex nomenclature problems which exist for the Miocene-Pliocene sediments of the western and central Columbia Plateau.

107.7 Dog Mountain. Thickest (> 1.3 km) exposed unrepeated section of Columbia River basalt in western Washington (J.L. Anderson, personal communication, 1980).

110.0 **STOP 17. Wind Mountain quarry.** Wind Mountain is one of several microdioritic intrusions in this area (e.g., Government Cove and Shellrock Mountain across the river in Oregon; Free, 1976). Fragments of Columbia River basalt (xenoliths) have been found in almost all of these intrusives (Free, 1976), indicating that they are younger than the Columbia River basalt (specifically, Grande Ronde Basalt). Most geologists who have studied these intrusions believe that magma from them reached the surface and formed



Massive Priest Rapids hyaloclastite (Stop 15). This "pseudo-bedding" is the result of secondary cementation of fractures.



Cross section through the Bridal Veil channel (Bridal Veil, Oregon), as seen from Stop 19 on the Washington side of the river. The modern-day Columbia River has dissected a path oblique to the axis of the westerly trending Bridal Veil channel of the ancestral Columbia River. Grande Ronde Basalt (G) and Frenchman Springs Member (F) flows form the former canyon walls. Remnants of the Pomona Member intracanyon flow (P) indicate that it only partly filled the canyon, thereby allowing the ancestral Columbia River to remain in this channel in post-Pomona time. After the ancestral Columbia River had cut down through the Pomona Member, it began to deposit sands and gravels of the lower member (L) of the Troutdale Formation. Indurated lower member sandstones and conglomerates are well exposed in the cliff face behind and to the right of the town of Bridal Veil. The onset of voluminous high-alumina basaltic volcanism in the Cascades approximately 6 m.y. ago and the dynamic interaction between these lava flows and the ancestral Columbia River produced the tremendous amount of clastic and hyaloclastic debris that now characterizes the upper member (U) of the Troutdale Formation. The contact between the lower and upper members of the Troutdale Formation at Bridal Veil is gradational and is shown in a generalized manner on the photograph. Together, the lower and upper members of the Troutdale Formation at Bridal Veil have a thickness of over 335 m. We think they were deposited over a period of about 10 m.y. –from 12 to 2 m.y. ago. The ancestral Columbia River was forced from the Bridal Veil channel by high-alumina basalt flows (B) that eventually capped the channel and prevented the river from reoccupying it when the Cascades were uplifted about 2 m.y. ago.

volcanic edifices that were subsequently removed by erosion (Hodge, 1938; Lowry and Baldwin, 1952). Also consider that we now know that the long-lived Bridal Veil channel (from approximately 14 to 2 m.y. ago) of the ancestral Columbia River lay only a mile or less south of these intrusions. Were these intrusions emplaced after the establishment of the Bridal Veil channel, and did volcanoes erupt close by? If this did take place, how did it affect the ancestral Columbia River? To date, we have not been able to find volcanic debris within the Troutdale Formation that we can conclusively say originated from volcanic vents associated with these intrusives. Trace-element compositions of clasts from the Rhododendron lahars intercalated with the Troutdale Formation at Bridal Veil (Beeson and Maywood, *in* Tolan and Beeson, 1984) show no chemical similarity to these intrusives in the Gorge, yet the lahar clasts are compositionally indistinguishable from Rhododendron lava flows northwest of Mount Hood. Another possibility is that these intrusions were emplaced prior to the time of establishment of the Bridal Veil channel, a period of approximately 15.5 to 14 m.y. ago. The age of these intrusions is a key question, and radiometric age determinations are needed to help unravel this problem.

110.0 Home Valley.

112.0 Wind River bridge.

114.6 Pre-Columbia River Basalt Group Ohanapecosh lava flows exposed along here.

115.0 Stevenson.

117.1 **STOP 18. Stevenson.** *Turn left at the flashing signal onto Russell Ave. and drive toward the Columbia River to Water Front Park at Stevenson Landing. Park your car and walk to the water front.* Look directly across the river at the high-alumina basalt/hyaloclastite complex (red colored) exposed high along the north face of Benson Plateau. We know this hyaloclastite deposit was formed by dynamic interaction between a lava flow and turbulent water. But how could such a great volume of water have existed at that elevation? We think that the complex probably formed near present river level when the river was invaded by high-alumina basalt lava flows and was later elevated by Cascade upwarping while the river incised the Columbia River Gorge. Hyaloclastite generated along the ancestral Columbia River in this way was the source for the vitric sands in the upper member of the Troutdale Formation. *Turn around and return to Highway 14 by going left on First Street and right on Seymour Ave.*

117.4 Highway 14. *Continue west.*

119.9 Bridge of the Gods. *Stay on Highway 14.*

121.9 New Bonneville Dam power house view point.

126.6 Beacon Rock, a volcanic neck (optional rest stop).

136.5 **STOP 19. Cape Horn View Point (milepost 25).** *Be careful here. Stop at the narrow turnout on the left side of the highway. Watch for traffic. From here you have an excellent view of the Bridal Veil channel across the river.*

138.3 Crown Point view point.

138.6 Troutdale gravels are exposed all along the road in this area.

143.0 Washougal.

154.3 I-205 exit. *Take this exit south to I-84 and Portland.*

END OF GUIDED TRIP

Year of the Ocean, 1984-1985

A "Year of the Ocean" has been proclaimed to draw attention to the great significance the seas have for the life of the nation. In June, Governor Victor Atiyeh proclaimed 1984-1985 as "THE YEAR OF THE OCEAN" in Oregon. In his proclamation, the Governor said:

> The power of the ocean is reflected in our rugged and beautiful coastline and its life-giving rains in our lush green forests. We come down to the sea to rest, to play, and to be renewed. Nourishing ocean waters support our vital, yet threatened, fisheries. The ocean highway links our ports and hinterlands to neighbors nearby and far across the sea. Exploration for offshore minerals, oil, and gas is on the horizon.
>
> In recognition of these growing uses and demands for ocean resources, in 1983 President Reagan proclaimed a United States Exclusive Economic Zone for all resources out to a 200-mile limit. His action presents us with both an opportunity and a challenge: an opportunity to develop hitherto-unclaimed resources for the benefit of humankind and a challenge to do it with wisdom and stewardship.

At Coos Bay and Newport, Year of the Ocean kickoff celebrations were held in July. October and November will see a film festival at Oregon State University (OSU), with excellent films on marine mammals, aquaculture, estuaries, ocean resources, and similar subjects in a weekly series. OSU also makes such films available to the public (contact Candy Lavelle at OSU Sea Grant Communications in Corvallis, phone 754-2716).

More activities and events are planned on the national scene. A congressional resolution declaring 1984-1985 Year of the Ocean was signed by President Reagan on July 2. A news series is planned, various talk shows will focus on the subject, a cancellation stamp will go on sale, a national calendar is being assembled, and an ocean directory is being compiled. To get involved in such activities, you may contact Jim Good, College of Oceanography, Oregon State University, Corvallis, OR 97331, phone (503) 754-3771, or county Sea Grant Marine Extension agents in Astoria, Tillamook, Newport, Coquille, Gold Beach, and Portland. □

Gorda Ridge Technical Task Force meets

A technical Task Force appointed by Governor Vic Atiyeh met early in August with representatives from the State of California and Federal agencies to continue the evaluation of environmental, engineering, and economic impacts of possible leasing of polymetallic minerals on Gorda Ridge, a major geologic structure which lies off the coast of Oregon and northern California.

The Task Force met at the Marine Research Facility operated by the University of Southern California on Catalina Island, California, to adopt working guidelines and prepare a multi-year program of studies that will be undertaken to evaluate the geology and biology of Gorda Ridge and re-examine the need for Federal leasing of offshore minerals in the area. Later investigations will include an evaluation of related socio-economic impacts and land use along the coast of Oregon, California, and Washington state. The results of these studies will be used to re-evaluate the impacts of mining before a decision for leasing is made. The two-day meeting at Catalina included a review of ocean mining technology, a discussion of the results of recent preliminary exploration earlier this year by the submersible Alvin, and remarks by Carol Hallett, Assistant to Secretary of the Interior William Clark. Hallett indicted that the possibility of mining on the Gorda Ridge is very unlikely before the year 2000.

Oregon representatives on the Task Force are Jack Dymond and William Pearcy, both professors at the College of Oceanography at Oregon State University; Don Oswalt, Coastal Plan Analyst for the Department of Land Conservation and Development; Jay Rasmussen, Executive Director of the Oregon Coastal Zone Management Association; and Don Hull, State Geologist.

The next quarterly meeting of the Task Force will be held in the fall at Newport, Oregon, to visit the Mark O. Hatfield Marine Science Center and continue the assessment of the effects of offshore mineral leasing. □

Does Crater Lake have a discernible outlet?

Analyses of water samples from numerous cold springs near Crater Lake, Oregon, and of waters from the lake itself failed to turn up evidence of any obvious outlet for Crater Lake, according to U.S. Geological Survey scientists J.M. Thompson and L.D. White. They reported, at the fall meeting of the American Geophysical Union (AGU) in San Francisco in December 1983, that the lake in the crater of ancient Mount Mazama apparently has stabilized. The lake level is reasonably constant and water does not appear to be rising in the lake.

The cold spring waters sampled on the flanks of Mount Mazama contained minimal amounts of telltale Crater Lake components when analyzed. In fact, all the analyzed cold spring waters are derived from snowmelt and rain water. If there is subsurface leakage anywhere from Crater Lake, it may be entering the Rogue River or some other river where its small contribution is not discernible.

The following is the abstract of the presentation by Thompson and White at the AGU meeting in San Francisco:

Crater Lake, occupying the 10-km-diameter caldera in Mount Mazama, has no surface outlet. Because the surface elevation of the water is essentially constant, evaporation and subsurface discharge of lake water must equal recharge. Earlier investigators have estimated the subsurface discharge at 1.64 to 2.36 m^3/s (58-83 ft^3/s). Crater Lake water contains nearly 10 mg chlorine (Cl) per liter. In contrast, nearby Diamond Lake, located 14 km north of Crater Lake, contains less than 0.5 mg Cl per liter. This elevated Cl in Crater Lake, relative to other High Cascade lakes, is thought to indicate a component of hydrothermal fluid introduced through the lake bottom. Any local spring water that contains more than 1 mg Cl per liter may have a component of Crater Lake water. Waters from springs discharging at elevations less than mean annual lake level (1,882 m) and a few selected springs discharging above lake level were collected and chemically analyzed. One major spring, 21 km south-southwest of Crater Lake, the source of the Wood River, has an anomalously high Cl concentration (3.0 mg Cl per liter); the others contain less than 0.5 mg Cl per liter.

To verify this possible outlet of Crater Lake, high-discharging-spring water samples that were collected were analyzed for deuterium (D) and oxygen isotope 18 (^{18}O). All spring waters that were analyzed, including the Wood River sample, plot along the meteoric water line (typically -98.9 for D and -13.78 for ^{18}O) while samples from Crater Lake do not. Consequently, the Wood River, even though it has an anomalously high Cl concentration, cannot be an outlet for Crater Lake. No sampled spring analysis presents evidence of containing more than 10 percent Crater Lake water. Subsurface leakage from Crater Lake may enter the Rogue River or some other river where its small contribution cannot be discerned. □

Earth Science Editors to meet in Portland in October

The Association of Earth Science Editors (AESE) will hold its annual convention at the Portland Hilton on October 8-10, 1984. Featured will be sessions on editing publications, editing and preparing geologic illustrations and maps, preparing slides, starting a newsletter, and managing resources and planning strategically for publications. As part of the convention, a geologic field trip up the Columbia River Gorge and dinner at Timberline Lodge are scheduled for the afternoon and evening of October 9.

For additional information about AESE or the convention, contact Beverly F. Vogt, Oregon Department of Geology and Mineral Industries, 1005 State Office Building, Portland, OR 97201, phone (503) 229-5580. □

Help wanted in meteorite search

The Scientific Event Alert Network (SEAN) of the Smithsonian Institution is asking for help in determining the path of a large fireball that was seen during daylight on the West Coast. The fireball was first reported in Redding, California, at about 2:50 p.m. PDT on July 20, 1984. It was seen at slightly later times in Ukiah, California, and Medford, Oregon.

The very large fireball was brilliant in the daylight, dropping sparks and leaving a white smoke trail that lasted for several minutes. It was apparently moving to the northeast and descending at an angle of approximately 45°. Sonic booms were reported.

A fireball of this size may have produced fragments that survived the fall to earth. Additional information about the path of the fireball would help in the search for these meteorites. Anyone who saw the fireball is asked to call Dick Pugh at home (503/287-6733) or at Cleveland High School (503/233-6441). A message may also be left with Beverly Vogt, Oregon Department of Geology and Mineral Industries (503/229-5580), who will see that Pugh gets the information. □

USGS appoints new Western Regional Geologist

Carroll Ann Hodges of Woodside, California, research geologist with the U.S. Geological Survey (USGS), Department of the Interior, has been appointed Assistant Chief Geologist for the Western Region, headquartered in Menlo Park, California. She succeeds G. Brent Dalrymple, who has returned to research studies in isotope geology at Western Region headquarters after serving as Assistant Chief Geologist for three years.

Hodges joined the USGS Branch of Astrogeologic Studies in Menlo Park in 1970. Her research has consisted mainly of topical studies and mapping projects on the Moon and Mars. She was a principal investigator in Apollo 16 geologic analyses, both before and after the lunar mission.

Since 1982 she has served with the Survey's Branch of Western Mineral Resources as chief of an international minerals resource assessment project, evaluating the potential for occurence of mineral deposits in Colombia.

In her new post as Assistant Chief Geologist, Hodges will coordinate all USGS Geologic Division programs and manage division facilities in the Western Region states of Alaska, Arizona, California, Hawaii, Idaho, Nevada, Oregon, and Washington.

The Geologic Division includes scientists engaged in earthquake and volcanic research, marine geology, environmental and mineral resource studies, planetary geology, and other earth science investigations. □

Some mineral rights to revert to Federal Government

Time is running short for some who sold their land to the Federal Government during the 1930's depression. At the time, they retained mineral rights on their property, usually for 50 years, after which the rights were to revert to the Federal Government.

However, mineral-rights owners, their lessees, or other parties of interest may apply to extend their rights under "future interest" leasing before the 50-year deadline.

From 1911 to the start of World War II, the United States bought several million acres of private lands, either to promote conservation or to take marginal farmlands out of agricultural production during the Dust Bowl days. The sellers were allowed to retain mineral rights, usually for 50 years. The automatic rights transfers to the Federal Government will start on a large scale beginning next year and continuing into the 1990's.

Lands purchased under the 1937 Bankhead-Jones act are located in National Forests and Grasslands throughout the country. About two million acres were transferred to the Bureau of Land Management (BLM) in 1958.

As a courtesy, BLM is trying to identify parcels where the rights will revert, so rights owners can be notified. The agency is asking industry and the public to send the following information to the BLM office managing the geographic area for any parcel that might have changed mineral ownerships: (1) Copy of the conveyance document—usually a warranty deed. (2) Copy of the title opinion. (3) Abstract of title, listing transactions that have occurred. (4) Legal description of the parcel. For additional information, contact the local BLM office.

—*BLM News, Oregon and Washington*

Fireballs sighted

The following fireball sightings in Oregon were reported in the recent past:

July 15, 1984, observation by Aleta and Lewis Woodruff at 10:23 p.m. PDT, northeast of Portland. The fireball was first seen in the southeastern sky at 60° above the horizon, coming over the trees. It passed directly overhead and was last seen in the northwestern sky at 45° where it disappeared again behind trees. The duration of the event was 1 second, and the flight appeared to be parallel to the earth's surface. The size of the fireball was one-third the size of the full moon. The fireball was white and had a white tail which stretched along the entire observed flight path. No breakup or sound was observed, but the fireball did cast a shadow.

August 6, 1984, observation by Jean Frost at 9:45 p.m. PDT, 1 mi north of the St. John's bridge. The fireball, which had a halo around it, was first seen in the east at an altitude of 40° and last seen in the north at an altitude of 40°. The path of the flight appeared to be parallel to the earth's surface, and the very bright white fireball, which was one-fourth the size of the full moon, was visible for 4 to 5 seconds. Sparks appeared to come off the fireball, but no sound, breakup, or shadow was observed.

A different fireball was observed outside of the Portland area by Sue Cleis at 8:30 p.m. PDT (twilight) on August 7, 1984, about 5 mi north of Bend. The yellow-white fireball was first seen 40° east of north at an altitude of 45° and last seen on the same bearing at an altitude of 10°. The yellow-white fireball, which was about the size of Venus, was visible for 3 to 4 seconds. During its flight, it wobbled first to the east, flared, wobbled to the west, flared again, and then went straight down until burning out above the horizon. The fireball had a 35°-long, yellow-white tail and left a 1 to 2 second afterglow. No sound, breakup, or shadow was observed. □

AVAILABLE DEPARTMENT PUBLICATIONS

GEOLOGICAL MAP SERIES

GEOLOGICAL MAP SERIES	Price	No. copies	Amount
GMS-4: Oregon gravity maps, onshore and offshore. 1967	$ 3.00		
GMS-5: Geologic map, Powers 15-minute quadrangle, Coos and Curry Counties. 1971	3.00		
GMS-6: Preliminary report on geology of part of Snake River canyon. 1974	6.50		
GMS-8: Complete Bouguer gravity anomaly map, central Cascade Mountain Range, Oregon. 1978	3.00		
GMS-9: Total-field aeromagnetic anomaly map, central Cascade Mountain Range, Oregon. 1978	3.00		
GMS-10: Low- to intermediate-temperature thermal springs and wells in Oregon. 1978	3.00		
GMS-12: Geologic map of the Oregon part of the Mineral 15-minute quadrangle, Baker County. 1978	3.00		
GMS-13: Geologic map, Huntington and part of Olds Ferry 15-minute quadrangles, Baker and Malheur Counties. 1979	3.00		
GMS-14: Index to published geologic mapping in Oregon, 1898-1979. 1981	7.00		
GMS-15: Free-air gravity anomaly map and complete Bouguer gravity anomaly map, north Cascades, Oregon. 1981	3.00		
GMS-16: Free-air gravity anomaly map and complete Bouguer gravity anomaly map, south Cascades, Oregon. 1981	3.00		
GMS-17: Total-field aeromagnetic anomaly map, south Cascades, Oregon. 1981	3.00		
GMS-18: Geology of Rickreall, Salem West, Monmouth, and Sidney 7½-minute quads., Marion/Polk Counties. 1981	5.00		
GMS-19: Geology and gold deposits map, Bourne 7½-minute quadrangle, Baker County. 1982	5.00		
GMS-20: Map showing geology and geothermal resources, southern half, Burns 15-minute quad., Harney County. 1982	5.00		
GMS-21: Geology and geothermal resources map, Vale East 7½-minute quadrangle, Malheur County. 1982	5.00		
GMS-22: Geology and mineral resources map, Mount Ireland 7½-minute quadrangle, Baker/Grant Counties. 1982	5.00		
GMS-23: Geologic map, Sheridan 7½-minute quadrangle, Polk/Yamhill Counties. 1982	5.00		
GMS-24: Geologic map, Grand Ronde 7½-minute quadrangle, Polk/Yamhill Counties. 1982	5.00		
GMS-25: Geology and gold deposits map, Granite 7½-minute quadrangle, Grant County. 1982	5.00		
GMS-26: Residual gravity maps, northern, central, and southern Oregon Cascades. 1982	5.00		
GMS-27: Geologic and neotectonic evaluation of north-central Oregon: The Dalles 1°×2° quadrangle. 1982	6.00		
GMS-28: Geology and gold deposits map, Greenhorn 7½-minute quadrangle, Baker/Grant Counties. 1983	5.00		
GMS-29: Geology and gold deposits map, NE¼ Bates 15-minute quadrangle, Baker/Grant Counties. 1983	5.00		
GMS-31: Geology and gold deposits map, NW¼ Bates 15-minute quadrangle, Grant County. 1984	5.00		
NEW! GMS-32: Geologic map, Wilhoit 7½-minute quadrangle, Clackamas/Marion Counties. 1984	4.00		

OTHER MAPS

OTHER MAPS	Price	No. copies	Amount
Reconnaissance geologic map, Lebanon 15-minute quadrangle, Linn/Marion Counties. 1956	3.00		
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