Field Trip No. 8

7 May, 1975

Guidebook for the Geology and Scenery of the Snake River on the Idaho-Oregon Border from Brownlee Dam to Hells Canyon Dam

Compiled
by
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ILLUSTRATIONS

INTRODUCTION

The geologic traverse begins at Brownlee Dam (Mile 0.0) at an elevation of 1,826 feet and ends at Hells Canyon Dam (Mile 34.8), elevation 1,514 feet. In this 34 miles and 300-foot drop in river elevation, the exposed rock suite represents more than 180 million years in time. Miocene flows are exposed at Brownlee with older Permian and Triassic units in a general pre-Tertiary synclinal structure exposed toward Hells Canyon Dam.

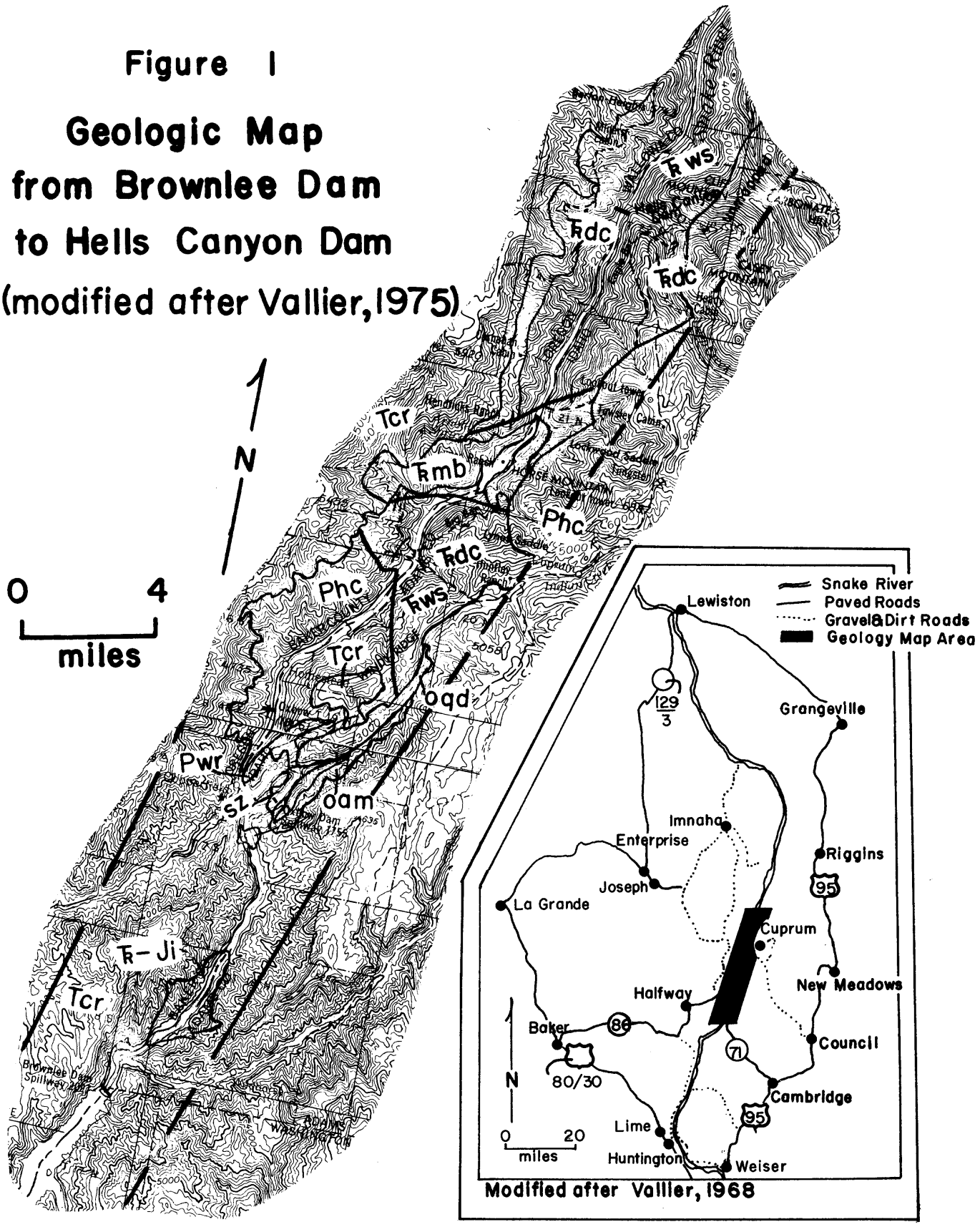
Six main geologic formations (see following page) are exposed in the roadcuts; formation names and contacts are those mapped and described by Vallier (1967, 1975) (Figure 1 - Geologic Map). A glossary of rock types accompanies this guide (final page). Heading north, horizontal flows of Columbia River Basalt (Miocene-Pliocene(?)) with a few varied Triassic intrusives are exposed from Brownlee Dam (Mile 0.0) to Copperfield, Oregon (Mile 12.0). Exposures of Windy Ridge Formation (Permian) are in the Copperfield area (Mile 12.0-Mile 13.3). Hunsaker Creek Formation (Permian) is exposed from Mile 13.3, south of Oxbow airstrip, to Mile 20.0, near Inca Gulch (Idaho) on the east side of the Snake River and Ashby Creek (Oregon) on the west. From Mile 20.0 to Mile 21.7, road cuts are in maroon and green units of the Doyle Creek Formation (Triassic) and in Wild Sheep Creek Formation (Triassic) from Mile 21.7 to Mile 24.5. The Martin Bridge Formation (Triassic) crops out in Big Bar area from Mile 24.5 to Kinney Creek, Mile 27.3. Rugged and steep outcrops of Wild Sheep Creek Formation bound the last miles of Hells Canyon Reservoir (Mile 27.3 to Mile 24.8).

Mileage to and from Hells Canyon Dam is given in the road log in two columns to the left of the text. For the traverse segment north of Copperfield, the third column lists pole numbers; these correspond to the aluminum numbers on the power line poles paralleling the Idaho Power and Light Company (IPALCO) road to Hells Canyon Dam. Asterisks (*) in the fourth column indicate recommended minimum stops.

Figure 1

Geologic Map from Brownlee Dam to Hells Canyon Dam

(modified after Vallier, 1975)



EXPLANATION

(Modified after Vallier, 1975)

STRATIFIED ROCKS

Tcr

TERTIARY

COLUMBIA RIVER GROUP; plateau basalt flows with some interbedded sediments. The older unit is Imnaha River Basalt and the younger, Yakima Basalt.

UNCONFORMITY

Trmb

MARTIN BRIDGE FORMATION; limestone and dolomite, some very carbonaceous.

? UNCONFORMITY ?

Trdc

TRIASSIC

DOYLE CREEK FORMATION; maroon and green volcanic breccia, metabasalt and keratophyre, volcanic sandstone and shale, tuff, conglomerate, and thin limestone beds.

? UNCONFORMITY ?

Trws

WILD SHEEP CREEK FORMATION; flows of metabasalt, pillow metabasalt, and breccia and volcanic sandstone.

UNCONFORMITY

Phc

PERMIAN

HUNSAKER CREEK FORMATION; predominantly volcanic breccia, sandstone, and siltstone with abundant conglomerate and tuff. Keratophyre and spilite flows.

Pwr

WINDY RIDGE FORMATION; keratophyre flow rocks and keratophyre tuff breccia.

INTRUSIVE AND SHEAR ZONE ROCKS

sz

OXBOW-CUPRUM SHEAR ZONE; mylonite, gneissic mylonite, amphibolite, schist, and phyllite with dikes of gabbro, diabase, quartz diorite, albite granite, and diorite. Most shearing and intrusive activity occurred during the Triassic and Jurassic periods.

TR-Ji

LATE TRIASSIC THROUGH MIDDLE JURASSIC INTRUSIVES; (some plutons in the Oxbow area may be Permian or Early Triassic). Rock types include gabbro, norite, diorite, quartz diorite, and albite granite. All have undergone some metamorphism.

oam

OXBOW AMPHIBOLITE; metamorphosed gabbro and basalt. Both Oxbow units (oam and oqd) may be either equivalent to the Triassic-Jurassic plutons described above or may be Permian and Triassic.

oqd

OXBOW QUARTZ DIORITE; mostly quartz diorite but includes zones of diorite and albite granite.

----- ?

CONTACT; dashed where approximately located, queried where uncertain.

----- ?

FAULT; dashed where approximately located, queried where uncertain; U, upthrown side; D, downthrown side.

MAP BOUNDARY

MAJOR GEOLOGIC FORMATIONS IN THE BROWNLEE-HELLS CANYON TRAVERSE

WINDY RIDGE FORMATION (PERMIAN)

The gray-green Windy Ridge Formation is composed of keratophyre and quartz keratophyre flows, and keratophyre tuffs and tuff breccia. The formation, cut by many mafic dikes, is 2,000 to 3,000 feet thick, and extends northward from the vicinity of Oxbow for about two miles. Outcrops are scattered and weathered yellow brown; most bedding planes are indistinct. Vallier (1967, p. 26) states that the Windy Ridge Formation was probably andesite or dacite before metamorphism.

HUNSAKER CREEK FORMATION (PERMIAN)

The light green to dark green Hunsaker Creek Formation is dominantly composed of volcaniclastic rocks (tuff, breccia, sandstone, siltstone and minor amounts of limestone and conglomerate) and some volcanic flow rocks (spilite and keratophyre). According to Vallier (1967, p. 46), tuff breccia, tuff, and tuffaceous sandstone and siltstone probably comprise more than 50 percent of the Hunsaker Creek Formation. Although sandstone and siltstone are the dominant volcaniclastic rock types, some conglomerate beds are greater than 40 feet thick and some tuff units are up to 50 feet thick. These units, totaling 8,000 to 10,000 feet in thickness, crop out in the area from Oxbow airstrip north to Hells Canyon Park and weather to gray and yellow brown.

WILD SHEEP CREEK FORMATION (TRIASSIC)

The gray-green to black Wild Sheep Creek Formation is composed of volcaniclastic rocks (volcanic breccia, graywacke, limestone, limy shale and conglomerate) and 10 to 15 percent flow rocks (keratophyre and spilite). Compared to the Hunsaker Creek Formation, Wild Sheep Creek Formation (up to 4,000 feet thick) contains a greater amount of gray-green volcanic breccia; thin dark carbonaceous limestone beds; and less conglomerate. Gray-green to green-black volcaniclastic units of dark brown weathered Wild Sheep Creek Formation crop out along the road south of Hibble Gulch and north of Kinney Creek to Hells Canyon Dam. Limestone and volcanic sandstone deposits of the formation are common to the south near Homestead.

DOYLE CREEK FORMATION (TRIASSIC)

The maroon Doyle Creek Formation is primarily composed of volcanic flow rocks (metabasalt and keratophyre) and volcaniclastic rocks (volcanic breccia, tuff, sandstone, siltstone, and conglomerate). The rugged, cliff-forming units, of 3,000 to 5,000 feet thickness, form mostly red to maroon with some dark green to black outcrops, and are best exposed south of Kinney Creek.

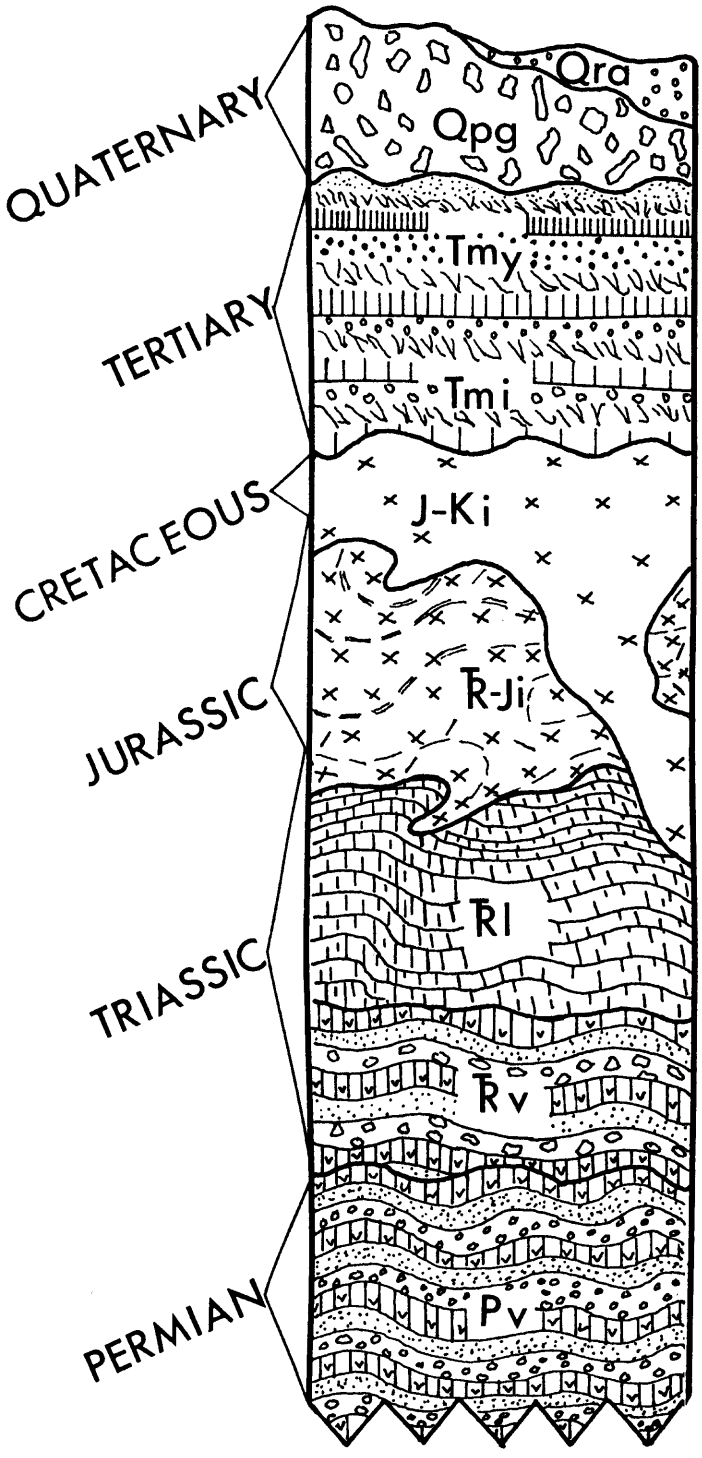
MARTIN BRIDGE FORMATION (TRIASSIC)

The Martin Bridge Formation is mostly composed of limestone with some dolomite units. All units tend to be gray to black and weather light gray. This formation, about 1,800 feet thick, forms steep cliffs in the Big Bar area and marks the narrow southern end of Hells Canyon.

COLUMBIA RIVER GROUP (MIOCENE-PLIOCENE(?))

The Columbia River Group, about 2,000 feet thick in the area, overlies the pre-Tertiary rocks at an angular unconformity and consists of two formations: Imnaha River Basalt and Yakima Basalt. The older Imnaha River Basalt generally has massive columnar jointing, forms steep bold outcrops, and in hand specimen displays large phenocrysts and a porphyritic texture; it extends to about 1,000 feet or more above the Brownlee Reservoir and is overlain by aphanitic Yakima Basalt. Yakima Basalt units tend to be highly fractured and irregularly jointed (rather than columnar) and as a result, form rounded slopes. Outcrops of both basalt formations weather from brown black to limonitic brown, although the older unit develops a more granular spheroidal appearance on weathering.

GENERALIZED GEOLOGIC COLUMN



ALLUVIUM		Recent fluvial deposits
COLLUVIUM		Pleistocene glacial outwash and debris
YAKIMA BASALT	COLUMBIA RIVER GROUP	Miocene plateau basalt flows with some interbedded sediments
IMNAHA BASALT	COLUMBIA RIVER GROUP	
GRANITIC PLUTONS		Cretaceous and minor Jurassic intrusive rock
METAMORPHOSED PLUTONS		Jurassic and older metamorphosed intrusive rock
MARTIN BRIDGE FORMATION	SEVEN DEVILS GROUP	Triassic submarine limestones and dolomite
DOYLE CREEK FORMATION	SEVEN DEVILS GROUP	Triassic submarine volcanic rocks and associated marine sediments
WILD SHEEP CREEK FORMATION	SEVEN DEVILS GROUP	
HUNSAKER CREEK FORMATION	SEVEN DEVILS GROUP	Permian submarine volcanic rocks and associated marine sediments
WINDY RIDGE FORMATION	SEVEN DEVILS GROUP	

FIGURE 2. Rock units of the Hells Canyon area (modified after Bond and others, in preparation).

ROAD LOG

(start) Mileage to N	(end) to S	Pole No.		
0.0	34.8			Brownlee Dam and Reservoir are bound by about 2,000' of Columbia River Basalt flows. North of the dam, the basalt flows are undisturbed and horizontal but in the spillway area, they dip about 10° SW from a small offset. The overlying Yakima Basalt forms colluvial slopes; the underlying Imnaha River Basalt is characterized by the massive columnar jointing and bold outcrops aligning the reservoir to the Oxbow; a few exhumed remnants of older rocks occur in this section.
3.0	31.8			View to the west is an outcrop of Lower Triassic(?) intrusive rocks. According to Brooks and Vallier (1967, p. 24), the vertically foliated outcrop is composed of metamorphosed quartz diorite, gabbro and diorite sheared along NE-trending faults.
5.0	29.8		*	Turnout near the approximate NE-trending fault contact of pre-Tertiary intrusive rocks on the west with volcaniclastic rocks, limestone and argillite of uncertain correlation, but probably Permian and/or Triassic in age. These bedded rocks dip steeply and in places are isoclinally folded; the exposure extends to within about 300' above river level.
8.8	26.0			View to the east; white travertine near the mouth of Warm Springs Creek cut in Imnaha River Basalt.
9.9	24.9		*	Turnout near Cottonwood Creek; to the west a foliated zone, mainly metamorphosed gabbro and basalt, rock types of the NE-trending Oxbow-Cuprum shear zone. Brooks and Vallier (1967, p. 251) described this foliated zone as cataclastic and mylonitized Paleozoic and Triassic (?) rocks including Lower Triassic (?) mylonitized intrusives.
11.1	23.7		*	Turnout at road bend near bottom of the Oxbow highway ramp. View to the east is of Oxbow Dam, Scorpion Creek and NE-trending Oxbow-Cuprum shear zone. The shear zone, inactive since the beginning of Miocene time, is locally a half mile wide and extends N 40°- 50°E for 25 miles into Seven Devils Mountains toward Cuprum, Idaho. The intensely deformed zone is composed mostly of Triassic quartz diorite and metamorphosed gabbro and basalt; in the Oxbow area, Permian or Triassic plutons are mostly albite granite with some norite, diorite and quartz diorite (Vallier, 1967, p. 245). According to Stearns and Anderson (1966, p. 8), the dominant metamorphic unit in the Oxbow area is actinolite schist and gneiss apparently derived from tuffaceous rocks; the schist is the dark greenish-gray rock and the lighter colored layers are gneiss. The Oxbow loop was formed by the superimposed Snake River on the NE-trending structures in pre-Tertiary rocks and on a NE-trending post-basalt fault.
11.3	23.5			Top of the Oxbow highway ramp is set in one of the two wind gaps on the Oxbow. Copperfield, Oregon, to the northwest, is located on an alluvial fan of Pine Creek and was originally settled during a mining rush in the 1890's. As pre-Miocene units are approached, their more resistant erosional aspect results in a narrow rugged topography typical of Hells Canyon often referred to as the Grand Canyon of the Snake.

Mileage to N	Mileage to S	Pole No.		
12.0	22.8			Junction with Highway 86 at Copperfield.
12.3	22.5			View to the east of Windy Ridge Formation (Permian) rugged, lichen-green keratophyre flow rocks and keratophyre tuff breccia and its approximate contact with Columbia River Basalt on the southern knob of Windy Ridge.
12.4	22.4	9		Junction with gravel road at east end of Snake River bridge at Copperfield.
12.55	22.25	11		Turnout across from Copperfield; look southward toward Oxbow of Snake River and the confluence of NE-trending Pine Creek. Geologically young (Miocene) Columbia River Basalt covers the Oxbow-Pine Creek area and overlies or is adjacent to the Windy Ridge Formation northwest of Copperfield. A steep westerly dip of the latter formation is shown by its V's in Hunter Creek canyon.
12.8	22.0	15	*	Small turnout in Windy Ridge Formation.
13.3	21.5	20		View to the east; approximate NE-trending fault contact of Windy Ridge Formation with the Hunsaker Creek Formation (Permian) which is commonly composed of volcanic breccia, sandstone, siltstone, conglomerate, keratophyre and spilite flows and tuff.
13.4	21.4	23		Small roadside gulch (Idaho). Two mafic dikes cut the Hunsaker Creek Formation. View to the west is of Homestead road tunnel in Hunsaker Creek Formation.
13.7	21.1	30		South end of Oxbow airstrip terrace; small adit in Hunsaker Creek Formation high on south side of Bob Creek canyon (Oregon).
14.4	20.4	40		Small turnout in Hunsaker Creek Formation; locally crops out as gray-green to green-black massive rock containing sodic plagioclase and magnetic minerals. In some places, the outcrop is altered and sheared. Small felsic dikes are common in the area (Idaho). Bob Creek (Oregon) is due west in Hunsaker Creek Formation.
14.8	20.0	44		Oxbow airstrip to the west.
15.1	19.7	50		Turnout across from Oxbow airstrip; scattered blebs of pyrrhotite in nearby outcrop of light green massive tuff. About 100' above road small adits and old fence mark the site of abandoned McCarty mine.
15.15	19.65			Turnout and boat landing; lichen green and iron stained well-jointed outcrop of Hunsaker Creek Formation.
15.4	19.4	52	*	Creek (unnamed) (Idaho); pink and purple units in Hunsaker Creek Formation. View to the west is of Holbrook Creek (Oregon) and alluvial fan derived from Hunsaker Creek Formation and overlying Columbia River Basalt.
15.6	19.2	56		Outcrop of sheared and altered Hunsaker Creek Formation; mafic dike visible.
		61		Small turnout.

Mileage to N	Mileage to S	Pole No.	
		66	Turnout in Hunsaker Creek Formation; bedded volcanic sediments with an altered or bleached zone. Road follows NE-trending fault zone. To the west is a panoramic view of Homestead, Oregon. Iron-stained dumps in the draw of Iron Dyke Creek are those of the Iron Dyke mine, first developed in the late 1890's for gold, silver and copper deposits associated with fault and shear zones. Production up to 1934 included 14 million pounds of copper. The mine, on patented claims owned by Butler Ore Co., is located in Hunsaker Creek Formation (mainly volcaniclastic conglomerate, breccia and tuff).
16.95	17.85	80	Across Snake River from mouth of unnamed creek (Oregon).
17.3	17.5		Turnouts near small creek; breccia zone exposed with small outcrop of green to black tuff (?). Sheared and weathered zones apparent within the outcrop. Road parallels NE-trending faults which also disrupt bedded Hunsaker Creek Formation to the west about a mile above the mouth of Herman Creek (Oregon). To the west is the site of old Rand-McCarthy gold, silver and copper prospects in volcanic breccias and tuffs.
17.7	17.1	90	Small gulch (Idaho) in Hunsaker Creek Formation; locally volcanic breccia of gray-green to purple and black clasts in a dark gray fine-grained matrix of the same material. View to the north is of light green porphyritic andesite which weathers limonitic brown overlain by a west-dipping black fine-grained volcanic sedimentary unit.
17.8	17.0	91	Outcrop of bedded maroon tuff striking N 60° E, dipping 65° NW.
18.0	16.8		Large crescentic slump scar visible to the west in Hunsaker Creek Formation.
18.25	16.55	95	Hells Canyon Park and rest area.
18.3	16.5	96	Kleinschmidt Grade junction which provides access to Cuprum five miles to the northeast. This is one of the first haulage roads for ore from the Seven Devils area.
18.6	16.2		Exposures of dark fine-grained volcanic units of Hunsaker Creek Formation on both sides of the river. The abandoned Ballard copper prospect is located in green tuff about a half mile west of the mouth of Ballard Creek (Oregon).
		100	Exposures of local, black unit of Hunsaker Creek volcanic breccia; generally composed of purple clasts in a green-black fine-grained matrix.
18.8	16.0		Turnout. View to the north is of a bedded green unit with steep westerly dip and a massive unit in Hunsaker Creek Formation. The old Idaho mine workings are in rhyolite; upslope are those of the River Queen and Azurite mines. The River Queen, once developed by several hundred feet of workings is reported to have produced $20,000 in copper ore in the late 1930's. The workings follow what Cook (1954) describes as a series of NE fractures in altered andesite tuffs, rhyolite and sedimentary units. Located nearby in the same geologic units, is the abandoned Azurite mine; it is reported to have carried pyrite, galena, chalcopyrite, sphalerite, and tetrahedrite in a gangue of quartz, dolomite and siderite from which $9,000 worth of ore was shipped prior to 1920.

Mileage to N	Mileage to S	Pole No.	
19.0	15.8		View of Hunsaker Creek units dipping northeast (Idaho).
19.2	15.6	107	Exposure near Azurite Gulch (Idaho); outcrop of Hunsaker Creek dark volcanic breccia with purple clasts. View to the south is of a NE-trending shear zone. Light green rhyolite, brecciated and bedded units form outcrops.
19.3	15.5	110	View of bedded units of Hunsaker Creek Formation for about a half mile to the north.
		111	Small gulch (Idaho).
19.5	15.3	117	Exposure of dark breccia unit (Idaho); adit is visible to west on Oregon side of canyon.
19.7	15.1		Road cut exposing basalt dikes trending north-northeast; possibly one of many feeders for the overlying Columbia River Basalt.
			Exposure of area disrupted by NE-trending faults.
20.4	14.8	120	Colluvium from formations cropping out upslope.
			Turnout in bedded, massive volcaniclastic rocks; mafic dike exposed.
20.2	14.6	123	Turnout at Inca Gulch; pink-maroon porphyritic volcaniclastic rocks of Hunsaker Creek Formation and its approximate contact with Wild Sheep Creek Formation (Triassic). Metabasalt, pillow metabasalt and pillow breccia typify the latter formation locally.
			View to the west of crescentic slump scar near Ashby Creek (Oregon). The alignment of Ashby Creek approximates the contact of Hunsaker Creek Formation to the south and Wild Sheep Creek Formation to the north; the latter is overlain by Doyle Creek Formation (Triassic) consisting of maroon and green volcanic breccia, metabasalt, keratophyre.
20.8	14.0	130	View to the west appears to be of a large slump block.
21.1	13.7		Turnout at Limepoint Creek and NE-trending fault zone in red-purple tuff and prophyritic tuffaceous greenstones of the Doyle Creek Formation. Two small adits on slopes above are workings of the Lime Peak mine; ore was
		135	in irregular breccia zones mineralized by chalcocite. This area is now part of the NE-trending Smith claim group encompassing a 10-square mile area leased by Sunshine Mines and undergoing current mineral evaluation. Doyle Creek Formation also crops out to the west directly upslope and northwest of the ranch area, and is overlain by horizontal units of
		136 *	Columbia River Basalt.
21.25	13.55		Exposures of maroon tuff of the Doyle Creek Formation to the east; Copper Creek to the west is cut in the same formation.

Mileage to N	Mileage to S	Pole No.	
21.75	13.05	145	Approximate contact of Doyle Creek Formation with Wild Sheep Creek Formation (Triassic) composed mainly of metabasalt, pillow basalt, and pillow breccia flows. The road is cut in the Wild Sheep Creek Formation from this contact northeast to the contact with Martin Bridge Formation (Triassic). Road parallels an anticlinal axis plunging southwest.
		149	Turnout in Wild Sheep Creek Formation.
22.2	12.6	150	Turnout for view of general stratigraphic setting. Wild Sheep Creek Formation exposed on both sides of the river, is unconformably overlain by Doyle Creek Formation; contact is about 1000' above river level. To the west-northwest (northwest of McGraw Creek), Wild Sheep Creek Formation is exposed below the NE-trending fault contact with the Martin Bridge Formation; limestone and dolomite units of the latter formation are broken by five or more NE-trending faults and are unconformably overlain by Columbia River Basalt.
22.4	12.4	153	Exposure of small spheroidally weathered basalt dike in Wild Sheep Creek Formation. View upslope and to the north is of Martin Bridge Formation contact with Wild Sheep Creek Formation; Columbia River Basalt is in the background to the west above Spring Creek (Oregon).
22.6	12.2	156	Exposure of felsic dike about 10' wide dipping north.
22.65	12.15	157	McGraw Creek (Oregon); this stream drains from the south parallel to Hells Canyon for 2 1/2 miles in Columbia River Basalt before it drains eastward through Martin Bridge Formation. The canyon then follows a contact between Doyle Creek Formation (to the south) and Martin Bridge Formation (to the north) and cuts through 1000' of Wild Sheep Creek Formation to the river.
22.9	11.9		Small turnout; general view of canyon.
	11.8	162	Exposures on both sides of the river of massive lichen-green metavolcanic rocks of Wild Sheep Creek Formation.
23.3	11.5	167	Spring Creek (Oregon); this stream drains from Columbia River Basalt down through 1000' of Martin Bridge Formation and about 300' of Wild Sheep Creek Formation to the Snake River.
23.4	11.4		Turnout; general view of area.
23.45	11.35	170	View of Wild Sheep Creek Formation showing maroon tuff and green blocky andesite (?) with variable attitudes. View to the north is of a syncline plunging southwesterly in Martin Bridge Formation.
		175	View of green-black fine-grained unit of Wild Sheep Creek Formation. Volcanic breccia of the same formation is exposed to the north (Idaho).
23.95	10.85	177	Turnout; small creek (Idaho).

Mileage to N	Mileage to S	Pole No.		
24.5	10.3			Turnout at Hibble Gulch; near the contact of Wild Sheep Creek Formation with Martin Bridge Formation.
		187	*	Contact of Wild Sheep Creek Formation with massive outcrop of Martin Bridge Formation. Pinched felsic dike about 10' wide dips north near or on the contact; small copper and iron stains are apparent on maroon tuff. Units of Martin Bridge Formation dip westerly on Oregon side.
24.8	10.0	189		Eckels Creek and trail in Martin Bridge Formation. NE-trending fault contact with Hunsaker Creek Formation is about a mile east and 1000' upslope. To the west Martin Bridge Formation is overlain by Columbia River Basalt.
24.9	9.9	190		View of Leep Creek campground to the west on alluvial fan across river (Oregon).
25.0	9.8	191		Exposure of minor folding and faulting as displayed by contorted vertical units.
25.5	9.3	197	*	Big Bar campground and Lynnes Ranch; area of an old landslide from west side of river and from which Big Bar was formed. This area was settled in the 1890's and used for farming and fruit growing; the produce was sold in the Seven Devils mining district. Terrace gravels are deposited at the south end of Big Bar.
25.7	9.1			Allison Creek cut in Martin Bridge Formation. A deposit of Quaternary volcanic ash is located near the road a few yards south of Allison Creek.
25.9	8.9			Limestone and dolomite units of the Martin Bridge Formation at the nose of a SW-plunging syncline.
26.4	8.4	210		View of Kirby Creek and campground (Oregon) across Snake River below 800' of Martin Bridge Formation overlain by Doyle Creek Formation cut by a NE-trending fault.
		218	*	Turnout; contact of Martin Bridge Formation with Wild Sheep Creek Formation,
27.3	7.5	220		just south of Kinney Creek. North of Kinney Creek, malachite stains joint surfaces of felsic layer in massive maroon fine-grained tuff of Wild Sheep Creek Formation.
27.5	7.3	222		Quarry in northeast-dipping Wild Sheep Creek Formation; here unconformably overlain by Hunsaker Creek Formation, to the west unconformably overlain by Doyle Creek Formation and Columbia River Basalt.
		224		Exposures of maroon and green blocky steep walls cut in Wild Sheep Creek Formation; bedded units dip west.
27.85	6.95	230		Exposures of small white stringers in green metavolcanic rocks.

Mileage to N	Mileage to S	Pole No.		
28.6	6.2	236		View of bedded purple and green-black volcaniclastic rocks of Wild Sheep Creek Formation steeply dipping northwesterly; minor folding and faulting evident. Contorted bedding dips west to vertical; small felsic dike about 2' wide dips northeast.
		245		Exposure of spheroidally weathered basalt.
29.0	5.8	248	*	Black Point lookout. Roadcut to the east exposes felsic dike about 10' wide dipping northeast in Wild Sheep Creek Formation. Squaw Creek (Oregon) along E-W fault trend.
29.6	5.15	256		Schoolmam Gulch (Idaho).
30.1	4.7	260		Exposure of vertical felsic dikes 1 to 5 feet wide; epidote and carbonate veinlets in mafic fine-grained metavolcanic rocks.
30.5	4.3	270		View to the west of Wild Sheep Creek units dipping westerly.
31.1	3.7			Sawpit Creek (Idaho) and Thirty-two Point Creek (Oregon); both in Wild Sheep Creek Formation unconformably overlain by Doyle Creek Formation.
		279		Small turnout.
32.5	2.3	297		Exposure of felsic dike at Eagle Bar (Idaho).
32.65	2.15	300		View to the northeast about 500' upslope of small adit and red building on Wild Sheep Creek Formation. Switchbacks on this slope provide access to the Red Ledge mine about 2 miles to the east in Deep Creek valley. The disseminated copper deposit of the Red Ledge mine and claims are held by Butler Ore. Co. and currently are undergoing exploration.
33.8	1.0			General view of reservoir; within a mile of Hells Canyon Dam the shoreline is along iron-stained rugged and steep outcrops of Wild Sheep Creek Formation; structural disturbance and local secondary emplacement of quartz and epidote are apparent.
34.0	0.8			View of NE-trending fault in Wild Sheep Creek Formation northwest of Steamboat Creek (Oregon).
34.3	0.5			Hells Canyon Dam.
34.8	0.0		*	Exposure of iron-stained rhyolite west of Wild Sheep Creek Formation dips moderately to steeply west as metavolcanic rocks at the dam site are on the northwest limb of a NE-trending anticline; bedding planes are 50 to 100' apart; vertical jointing common. View to the east is of Deep Creek Canyon (Idaho).
(end)	(start)			Short Creek (Oregon); rest area and end of roadway access.

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GLOSSARY OF ROCK TYPES

Albite granite: a coarse-grained, light-colored intrusive rock composed of sodium feldspar and 10-50 percent quartz.

Amphibolite: a dark-colored metamorphic rock consisting chiefly of amphibole and plagioclase with little or no quartz.

Andesite: a dark, fine-grained extrusive rock that, when porphyritic, contains phenocrysts of acid plagioclase and one or more mafic minerals.

Argillite: a hard, fine-grained rock derived from siltstone or shale that has undergone a higher degree of induration than is present in the siltstone or shale, but is less clearly laminated.

Basalt: a dark, commonly extrusive, mafic flow rock composed chiefly of plagioclase, clinopyroxene, and olivine in a glassy or fine-grained groundmass.

Dacite: a fine-grained extrusive rock with composition similar to andesite but having less calcic feldspar.

Diorite: a coarse-grained intrusive rock composed of dark amphibole, acid plagioclase, pyroxene and sometimes a minor amount of quartz.

Dolomite: a carbonate sedimentary rock containing calcium and magnesium. In the Hells Canyon area it is light colored and may contain minor amounts of volcanic rock fragments and grains of quartz and feldspar.

Gabbro: a dark, dense basic intrusive rock composed chiefly of plagioclase and clinopyroxene with or without olivine and orthopyroxene.

Gneiss: a foliated rock with alternating bands of dark-and bright-colored minerals and formed by metamorphism.

Keratophyre: an extrusive, submarine flow rock composed chiefly of albite, chlorite, calcite, leucoxene and white mica; altered andesite.

Limestone: a sedimentary carbonate containing calcium; may contain fragments of shells, limestone, and volcanic rocks along with grains of quartz and feldspar.

Metabasalt: metamorphosed basalt; see spilite.

Mylonite: a highly sheared, compact chert-like rock without cleavage and produced by microbrecciation with vertical foliation.

Norite: an intermediate-to-colored, coarse-grained intrusive rock composed chiefly of basic plagioclase and orthopyroxene.

Pillow metabasalt: metamorphosed pillow basalt characterized by spheroidal-shaped structure considered to be the result of subaqueous emplacement and chilling.

Quartz diorite: a plutonic rock having the composition of diorite with more than 20 percent quartz.

Quartz keratophyre: an extrusive submarine flow rock chiefly composed of quartz, albite, chlorite, calcite, leucoxene and white mica; altered dacite.

Schist: a strongly foliated rock formed by metamorphism.

Spilite: a mafic submarine flow rock composed chiefly of plagioclase and clinopyroxene in a matrix of iron-rich devitrified glass; altered basalt.

Tuff: a compacted pyroclastic deposit of volcanic ash and dust that may or may not contain up to 50 percent sediments such as sand or clay; in outcrop, tuff is difficult to distinguish from volcaniclastic sandstone and siltstone.

Volcaniclastic rock: a clastic rock containing volcanic material in various proportions; it is named without regard to its origin or environment, including the following:

Volcanic breccia: a coarse-grained rock composed of greater than 50 percent poorly sorted angular fragments and minor subrounded to well-rounded clasts that may or may not have a matrix.

Volcanic conglomerate: consists of volcanically derived, rounded, water-deposited clasts up to boulder and cobble size and which may or may not have a matrix.

Volcanic graywacke: an indurated rock that contains poorly sorted angular to subrounded grains of feldspar, quartz, and volcanic rock fragments.

Volcanic sandstone: an indurated deposit of sand-sized water-rounded pyroclastic fragments and a subordinate amount of non-volcanic detritus.

Volcanic shale: a fine-grained, indurated, volcanically derived detrital rock formed by compaction of clay, silt or mud-sized particles and characterized by finely stratified structure.

Volcanic siltstone: an indurated, volcanic detrital rock intermediate between sandstone and shale in which the matrix content makes up greater than 50 percent of the rock.

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