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Field Guide to the Geology and Mineralization of the South Pass Region, Wind River Range, Wyoming

by W. Dan Hausel and J. David Love

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FIELD GUIDE TO THE GEOLOGY AND MINERALIZATION OF THE SOUTH PASS REGION, WIND RIVER RANGE, WYOMING

W. DAN HAUSEL[1] and J. DAVID LOVE[2]

INTRODUCTION

The South Pass region has been the site of Wyoming's most important gold and iron ore production. Recent sampling in this region by the Geological Survey of Wyoming and the U.S. Geological Survey has identified numerous gold, copper, silver, arsenic, and some chromium, tin, and tungsten anomalies (Prinz, 1974; Love and others, 1978; Antweiler and others, 1980; Hausel, 1987b, 1991; Day and others, 1988). Total iron ore production has amounted to more than 90 million tons, but the amount of gold produced is unknown since few records were kept in the past. Estimates of gold production range from a conservative low of 70,000 ounces (Koschmann and Bergendahl, 1968) to more than 325,000 ounces for the South Pass-Atlantic City district (Hausel, 1987a, 1991). Estimated historic gold production for the Twin Creek paleoplacer along the northeastern margin of the South Pass greenstone belt is about 1,000 ounces (Jamison, 1911). Estimates are inadequate for the Lewiston district and no estimates are known for the Dickie Springs-Oregon Gulch placers, although the amount of precious metal recovered from these areas must have been considerably less than from the South Pass-Atlantic City district.

The field trip will proceed south from Lander along Wyoming Highway 28 to the South Pass region of the southern Wind River Range (**Figures** 1 and **2**). J. David Love will lead the group through Paleozoic and Mesozoic rocks and auriferous boulder conglomerates along the northeastern and southern edges of the Precambrian belt. W. Dan Hausel will lead the group through some Archean stratigraphy and lode gold properties in the metamorphic belt.

Please note: This field trip traverses private land and permission is required from land owners and mineral lease holders.

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Acknowledgments

Without the willingness of many property owners and claimants, we would be unable to conduct the excursion. Our appreciation is expressed to Jim Niggemeyer and Robert Klinger of Universal Equipment Company for access to areas adjacent to the Atlantic City mine. We also wish to thank Steve Gyorvary, Bob Johnson, and Dave Geible for providing unlimited access to their properties. Bart Rea and Bruce Ward gave permission to examine and collect samples at the Duncan mine, but requested we use extreme caution around the historic buildings and mine portals. We also thank Consolidated McKinney Resources for access to the Carissa mine.

JUNCTION OF U.S. HIGHWAY 287 AND WYOMING HIGHWAY 789 AT SOUTH EDGE OF LANDER TO SOUTH PASS.

Trip leader J. David Love.

The town of Lander is in an asymmetrical syncline in the Cody Shale between the northeast flank of the Wind River Range on the west and a series of en echelon anticlines that mark the western margin of the Wind River Basin. These anticlines, most of which are oil-bearing, are thrust away from the basin and towards the mountains, and are directly east of the northern part of the route.

Road log and stop descriptions

Cumulative mileage

0.0 Junction of U.S. Highway 287 and Wyoming Highway 789.

0.5 Top of hill. Road to the left (east) goes to the top of Cemetery Hill, which has outcrops of Lava Creek ash (age 620,000 years) that blew in from the Yellowstone National Park area. This ash is relatively pure, 5 to 10 feet thick, and underlain and overlain by fluvial gravel derived from the Wind River Range. The ash is horizontal and is about 140 feet above the adjacent Middle Fork of the Popo Agie River. This is the only known Pleistocene ash along

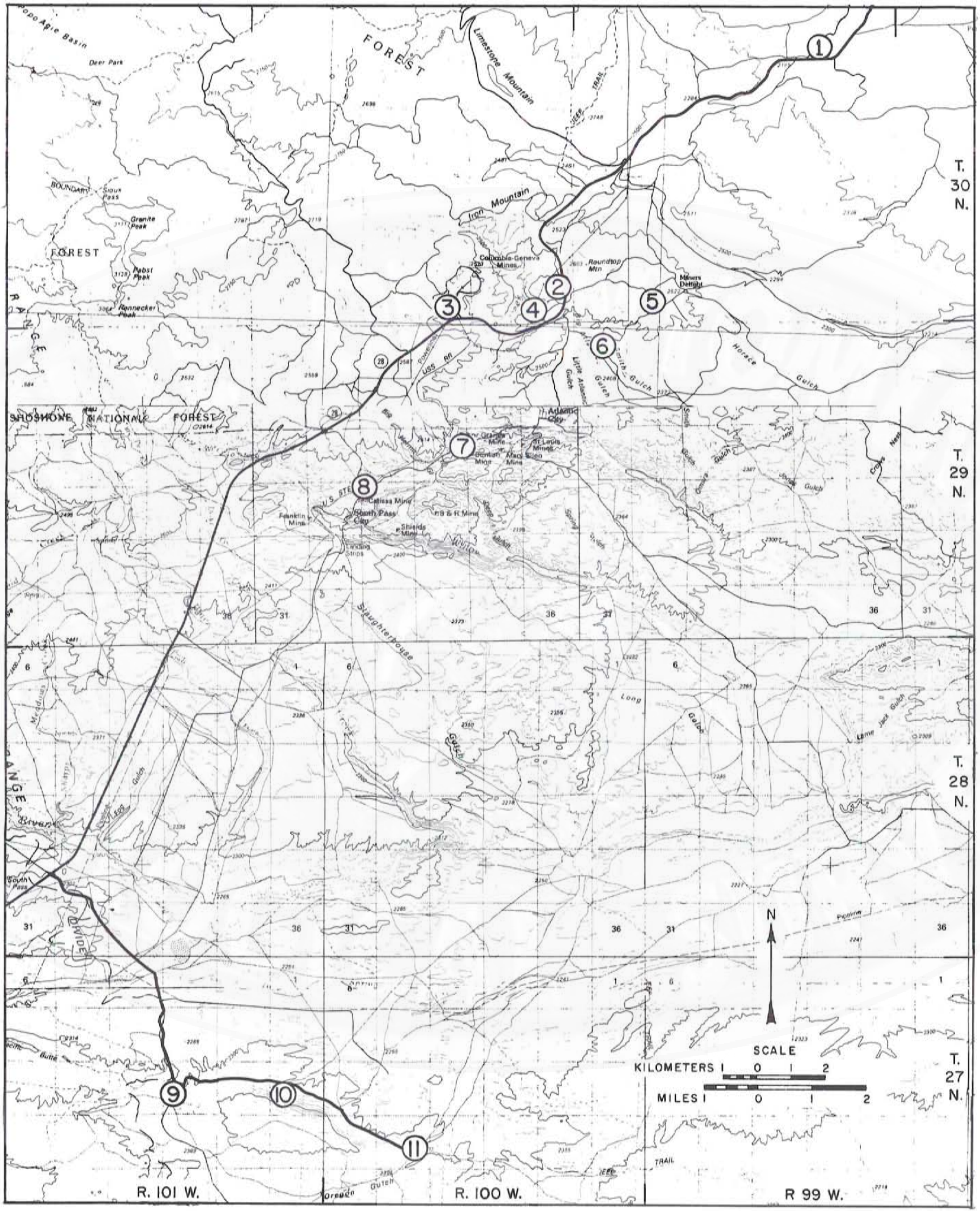


Figure 1. Topographic map showing trip route and stop locations.

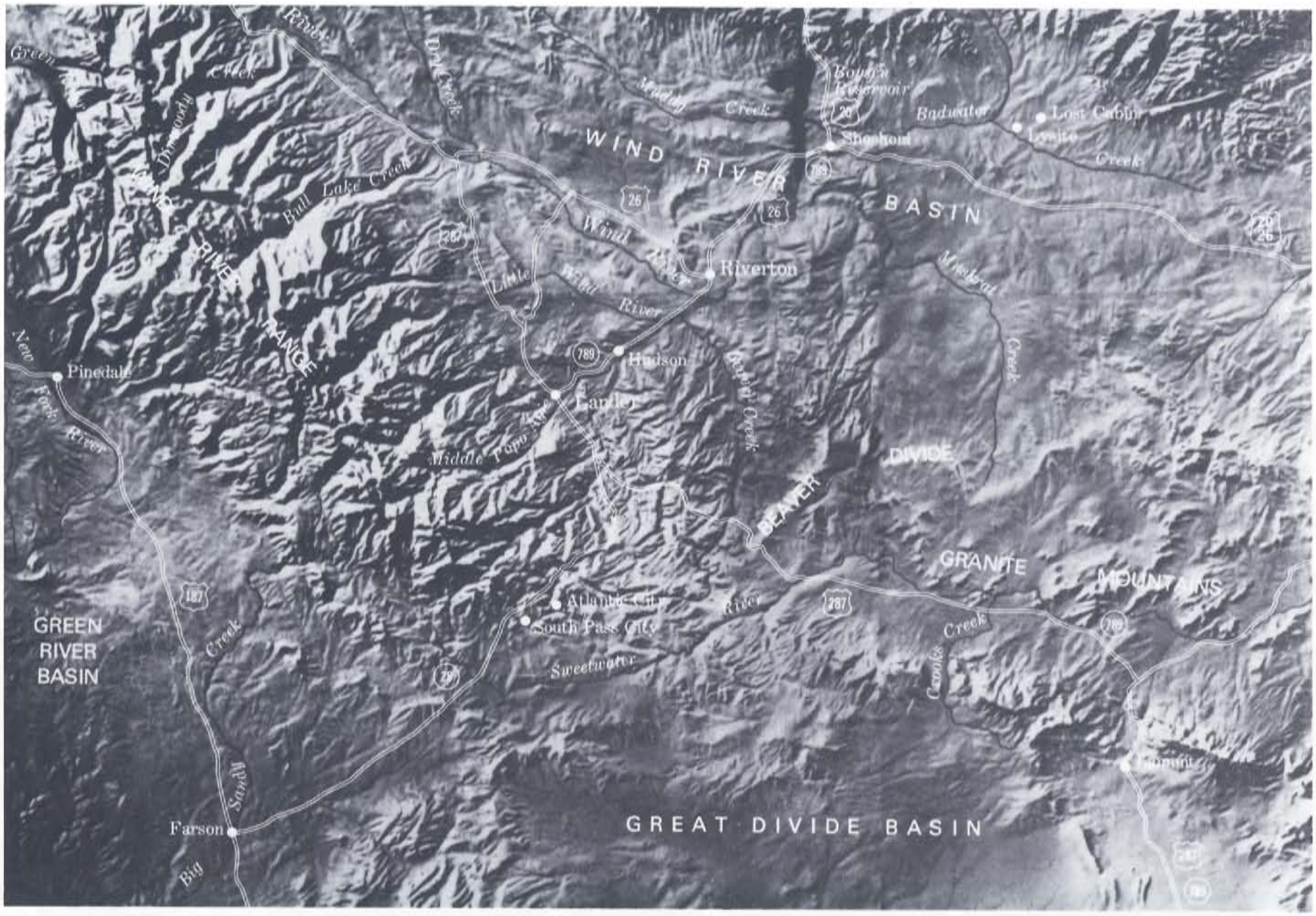


Figure 2. Relief map showing the field trip area and its relation to the Wind River Range and Basin, Great Divide Basin, Green River Basin, and Granite Mountains.

the southwestern margin of the basin so it is a key control point in determining the rate of excavation of this part of the basin. If the ash was deposited at of near the river level, as the gravels suggest, the calculated rate of downcutting of the valley would be about 1 foot in 4,400 years, more than three times slower than that farther north in the Wind River Basin, where the calculated rate is 1 foot in 1,600 years. The tectonic significance of this difference is under investigation.

2.4 Pass junction with Lyons Valley paved road to the east. On the eastern skyline are folded strata of the Cloverly, Thermopolis, Mowry, and Frontier formations (Cretaceous) on the flanks of the Dallas-Lander anticline. To the west is the high flat-topped Table Mountain, composed of granitic conglomerate in the Wind River Formation (Early Eocene). The conglomerate is nearly horizontal and rests with a spectacular angular unconformity (viewed from the north) on Paleozoic and Mesozoic rocks on the northeast flank of the range.

5.6 Historical marker stone on the left, in memory of D.R. Barr, Jerome Mason, and Harvey Morgan, who were killed by Indians June 27, 1870.

8.2 Pass junction with U.S. Highway 287. Continue straight ahead on Wyoming Highway 28. Road is still on Cody Shale. To the east about 3 miles are redbeds in the core of the Dallas Dome, which has been producing oil from the Tensleep and Phosphoria formations continuously since 1884. Oil springs on this anticline were first described by Captain B.L.E. Bonneville in 1832. The gray treeless Sheep Mountain on the skyline to the southeast is an anticline with dip slopes of the phosphate-rich Phosphoria Formation rising about 1,300 feet above the terrain. The anticline at Sheep Mountain is the southeast culmination of the series of anticlines, mentioned at the beginning of the road log, that extend for more than 50 miles along the western margin of the Wind River Basin.

9.0 Ledges of sandstone on the east side of the highway are in the Frontier Formation (Upper Cretaceous).

9.1 Pass county road to Red Canyon on the right (west). The canyon upstream is cut in Tensleep Sandstone (which supports trees). The bare east facing dip slope is in the Phosphoria Formation.

9.2 Cross Little Popo Agie River. Ridge of gray banded strata on the left is Mowry Shale.

14.1 Between 9.2 and 14.1 miles, the highway traverses the base of the Mowry Shale, which forms spectacularly banded ridges on the east. Note how grasses are confined to certain layers of shale. The sparsely tree-covered dip slope to the west is Muddy Sandstone (Lower Cretaceous). The high lumpy ridge on the far southeastern skyline is the Sheep Mountain anticline. This mileage point is the contact of the black, soft, fissile Thermopolis Shale and the overlying Muddy Sandstone.

16.0 Between 14.1 and 16.0 miles, the highway crosses down-section through a poorly exposed sequence of Cloverly, Morrison, Sundance, and Gypsum Spring formations. **Figure 3** shows better exposures of these formations 4 miles northeast. The Gypsum Spring Formation is exposed in the red roadcut on the right and consists of red shale and siltstone and slabby gray dolomite. White gypsum beds so prominent in sections to the north are leached out here.

16.1 Nugget Sandstone showing spectacular fossil sand dune cross-bedding (**Figure 4**).

17.0 For the next 0.3 miles, the highway traverses the Nugget Sandstone, below which is the prominently layered Popo Agie Member of the Triassic Chugwater Formation. At the southwest end of the roadcut on the left is the white, slabby, hard Alcova Limestone Member of the Chugwater Formation.

17.3 Angular unconformity between the Red Peak Member of the Chugwater Formation and the overlying basal conglomerate of the White River Formation (Oligocene). Superficially this conglomerate resembles that on Table Mountain south of Lander (at mile 2.4) but it differs in several important respects. The granite boulders here are generally fresh and unweathered whereas those on Table Mountain are typically deeply weathered. The matrix of the White River conglomerate is very tuffaceous whereas that on Table Mountain is not (Antweiler and others, 1980, p. 229).

17.9 **STOP 1. View north down Red Canyon** at the Game and Fish Commission turnout. High skyline to the west, on the northeast flank of the Wind River Range, displays sparsely timbered exposures of Madison, Amsden, and Tensleep formations. In the foreground to the northwest is a treeless dip slope of the Phosphoria Formation, which in this region never supports coniferous trees. The road up the dip slope leads to a well drilled for oil on an anticline perched on the flank of the range. This well was drilled to the Madison Limestone at a depth of 1,150 feet.

The strike valley at the bottom of Red Canyon is in the Red Peak Member of the Chugwater

Figure 3. Stratigraphic section on the east side of Derby Dome (the same sequence as along the route near mile 16.0 but better exposed.) Indicated are Nugget Sandstone (JTRn), Gypsum Spring Formation (Jgs), Sundance Formation (Js), Morrison Formation (Jm), and ridge-forming basal conglomerate of Cloverly Formation (Kcv) (photograph by J.D. Love).

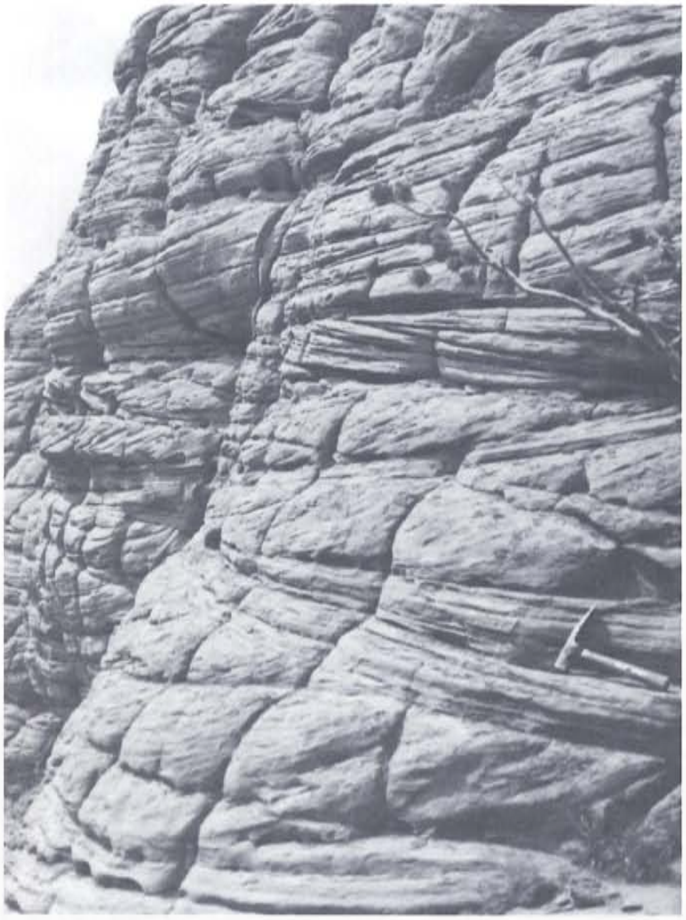


Figure 4. Close-up view of fossil sand dunes in the upper part of the Nugget Sandstone at mile 16.1 (photograph by Nancy Doelger).

Formation. The middle ridge on the east side is capped by the gray Alcova Limestone Member. Between it and the sparsely tree-covered, salmon pink Nugget Sandstone is the Popo Agie Member of the Chugwater Formation. The geology of the Red Canyon area and the phosphate reserves in the Phosphoria Formation were described by Rohrer (1973) and the gold in the White River Formation was described by Antweiler and others (1980).

18.2 Highway crosses Old Tweed ditch, which is still functioning. This ditch was dug nearly 100 years ago to carry water to gold placers along Red Canyon and also to placer gold operations in the basal conglomerate of the White River Formation (**Figure 5**) along the edge of the high upland surface to the east (Antweiler, and others, 1980). In the early 1900s, water was diverted onto this surface from springs and creeks to the west and southwest and carried in ditches 6 to 10 miles long to the major gold placer sites, where the original water supply was inadequate. **Figures 6** and **7** (never previously published) show the Ace Wilson placer operation about 1905, in the basal conglomerate of the White River Formation 7 miles east-southeast of this stop. We estimate that approximately 100,000 cubic yards of gravel were processed from this pit (Antweiler, and others, 1980, p. 283-284). The trace elements in the gold indicate (or suggest) that it was not derived from the known Atlantic City-South Pass gold veins.

18.6 Locked gate on left. Between 17.9 and 18.6 highway cuts on the left expose white tuff of the White River Formation where Dr. S.H. Knight collected an Oligocene titanothere many years ago.

19.0 Road to right is old South Pass-Lander stage road down Red Canyon. Highway is still on White River surface. Tweed Ditch crosses under the highway several times.

20.0 On the right is the contact between white tuffaceous claystones in the White River Formation and Tensleep Sandstone. Across the valley of Twin Creek to the south are timbered cliffs of Tensleep Sandstone.

20.5 Red shale in Amsden Formation on right.

20.8 Big roadcut on right displays white tuff in White River Formation plastered on mountainous topography cut in Amsden Formation.

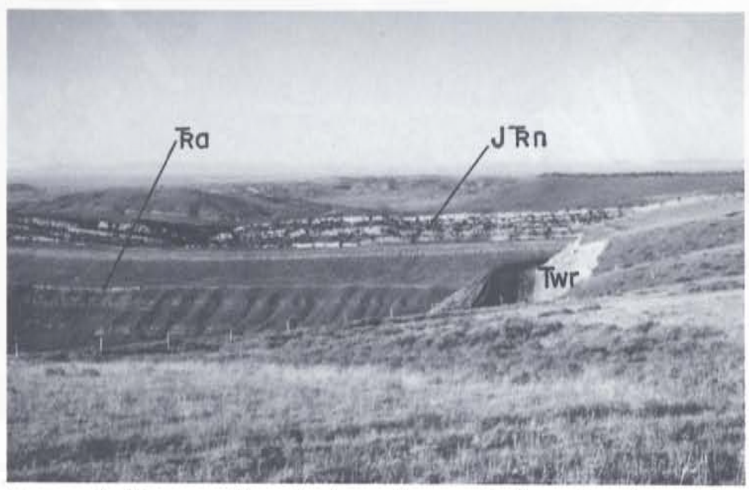


Figure 5. View northeast along the eroded north edge of the gold-bearing basal boulder conglomerate in the White River Formation in highway cut at mile 18.2, at the south end of Red Canyon. Indicated are White River Formation (Twr), Alcova Limestone Member of Chugwater Formation (Ꞧ a), and Nugget Sandstone (JꞦn) (Photograph by J.D. Love).

a.

b.

Figure 6. (a) Panorama of Ace Wilson gold placer workings in basal conglomerate of the White River Formation on Twin Creek, 6 miles east of stop 1 at the head of Red Canyon. Folded Mesozoic rocks are at upper left. (Photograph taken in 1905; collection of Ethel Waxham Love.) (b) Hydraulic operation in progress in Ace Wilson placer gold operation on Twin Creek. [For details see Antweiler and others (1980).(Photograph taken in 1905; collection of Ethel Waxham Love.)

20.9 Gray limestone in upper part of Madison Limestone on right. The north facing slope across the valley of Twin Creek to the south is White River Formation that nearly fills a pre-Oligocene valley cut in Paleozoic rocks. Tensleep and Madison formations are exposed on the south skyline.

21.4 Gray gnarly cliff of Bighorn Dolomite in roadcut on right.

22.6 Ledges of Cambrian sandstone and limestone on right.

22.9 Near top of hill at turnout on left are cream-colored plastic tuffaceous claystones in White River Formation, in which are embedded boul-

Figure 7. Close-up view of Ace Wilson gold placer pit in basal conglomerate of the White River Formation on Twin Creek. [For details and gold values see Antweiler and others (1980). (Photograph taken in 1905; collection of Ethel Waxham Love.)]

ders of Paleozoic and sparse clasts of Precambrian rocks.

23.2 Big outcrop on left in roadcut is plastic, blocky, gray tuffaceous claystone and red-speckled tuffaceous siltstone showing typical White River lithologies.

23.9 Brown ledges of Flathead Sandstone on right.

24.0 Cross Beaver Creek. Old gold placer workings on north side of creek are in White River Formation conglomerate (Antweiler, and others, 1980).

24.6 For the next 0.8 mi, big outcrops in roadcut on left show white tuff, claystone, and siltstone in White River Formation. At top, a conglomerate of Precambrian clasts 50 feet thick may be basal Miocene Split Rock Formation.

25.9 White River Formation strata overlap black Precambrian schist in roadcut on left. From this point, the field conference enters the South Pass greenstone belt and will be leaving Highway 28 for dirt roads. Because we will be back-tracking, mileages will no longer be given until we leave the Carissa mine area (stop 8) and return to Highway 28. Refer to **Figure 8** for the stop locations in the greenstone belt.

THE SOUTH PASS GREENSTONE BELT

Trip leader W. Dan Hausel.

Several authors have interpreted this Precambrian terrane to represent a partially exposed and fragmented Archean greenstone belt (Condie, 1967, 1981; Bayley and others, 1973; Houston and Karlstrom, 1979; Karlstrom and others, 1981; Houston, 1983; Hausel, 1987a, 1991; Hull, 1988; Hausel and Hull, 1990). However, the dominance of metagreywacke in the belt is also somewhat reminiscent of the metasedimentary subprovinces in the Canadian shield (McGowan, 1990).

The South Pass greenstone belt forms a tripartite succession of mostly low-rank (greenschist- to amphibolite-facies) metamorphosed sedimentary, volcanic, and plutonic rocks. The greenstone belt has been folded into a synclinorium and subjected to a minimum of three and possibly four episodes of deformation. Bedding and several structural elements (foliation, isoclinal fold axes, and auriferous shear zones) parallel the axis of the synclinorium.

The exposed metamorphic terrane crops out over an area of 150 to 250 mi^2. The northwestern and southeastern flanks of the belt are in fault contact with and/or intruded by granodiorite plutons (~2.6 Ga). These plutons represent a major Late Archean cratonization event that was followed by intrusion of small domical granite stocks emplaced along the western margin of the greenstone belt. Intrusion of these granites and movement along some Archean structures, produced local refolding.

The northeastern and southern flanks of the belt are buried by Phanerozoic rocks. In the northeast, the Precambrian rocks underlie a relatively complete Phanerozoic section. To the south and in the northeast, Tertiary sedimentary rocks blanket large areas of the Precambrian supracrustal rocks. The Tertiary sedimentary units progressively thicken southward to the Continental fault.

Archean stratigraphy

Supracrustal rocks of the greenstone belt have been subdivided into four mappable units (**Figure 8**). The youngest is the Miners Delight Formation

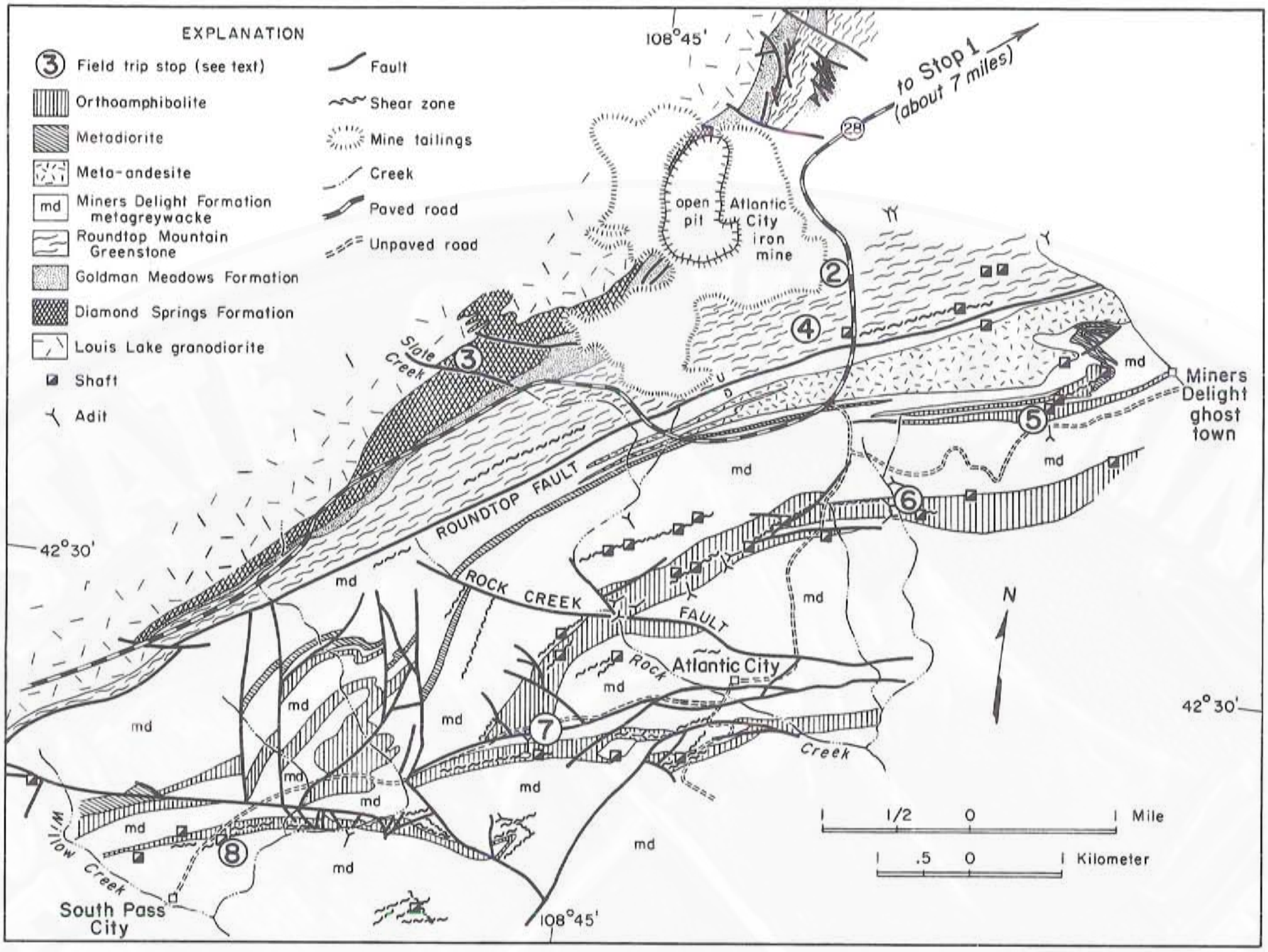


Figure 8. Geologic map of the South Pass-Atlantic City district (modified from Hausel, 1991), showing stop locations 2 through 8.

(MDF), which has yielded a Rb-Sr whole-rock isochron of 2.8 Ga (Z.E. Peterman, personal communication to Stuckless and others, 1985). This age probably represents the timing of regional metamorphism. The MDF is relatively thick and dominated by metagreywacke. Because of folding and transposition of bedding, the actual thickness of the MDF is unknown, but it is estimated to be between 5,000 and 20,000 feet.

Essentially all of the lode mines in the Lewiston district were developed in shear zones along the limb of a district-wide fold in metagreywacke. In the South Pass-Atlantic City district, many of the mines occur in shears spatially associated with a prominent belt of hornblende-plagioclase amphibolite. The amphibolite is a complex mixture of amphibolite, metagabbro, metadiabase, and metabasalt with dominant tholeiitic chemistries.

A less prominent belt of ultramafic schist lies structurally above (but stratigraphically below) the amphibolites (Bayley and others, 1973). These rocks include actinolite schist and tremolite/actinolite-talc-chlorite schist, some of which are carbonate or calc-silicate altered. Chemically, they are similar to komatiite (Bow, 1986; Hausel, 1987b). Between these two units is a mixed member of metagreywacke, massive metabasalt, vesicular metabasalt, chlorite schist, metaconglomerate, and meta-agglomerate.

Metagreywacke and greywacke schist, the most common rock types found in the MDF, are commonly fine grained, poorly sorted, massive, gray to black, with bedding overprinted by foliation. Mineralogically, the metagreywacke consists of angular to subangular quartz, plagioclase (oligoclase), and rock fragments in a recrystallized matrix of biotite, untwinned plagioclase, and quartz, with or without garnet, chlorite, and sericite. Locally, some greywackes are spotted with porphyroblasts of altered cordierite (and andalusite?) replaced by a mixture of quartz, sericite, and biotite. Lithic fragments of chert, quartzite, and phyllite are common, but igneous fragments are rare. In addition to metagreywacke and amphibolite, the MDF has some thin units of meta-andesite, cherty metagreywacke, metaconglomerate, quartzite, metatuff, and tuffaceous quartzite.

The MDF is separated from the underlying Roundtop Mountain Greenstone (RMG) by the Roundtop fault, located along the northwestern margin of the greenstone belt (Bayley and others, 1973). Locally, the Roundtop fault includes a relatively broad mylonitic and brecciated zone termed the Roundtop Mountain deformation zone by Hull (1988).

The RMG is found in both limbs of the South Pass synclinorium. Better outcrops occur along the northern margin of the belt at Roundtop Mountain, where the formation is about 1,000 feet thick. Here, the unit consists of greenschist-facies greenstones, greenschists, metadiabase, pillow metabasalt, and minor actinolite and chlorite schist that grade into amphibolite facies to the southwest (Bayley and others, 1973). With the exception of actinolite schist, these rocks have tholeiitic affinity (Harper, 1985; Hausel, 1987b). The actinolite schist is chemically similar to basaltic komatiite. Gold in the RMG is in shear zones, discrete quartz veins, and chalcopyrite-quartz-carbonate veins.

Underlying and grading into the greenstones is the Goldman Meadows Formation (GMF). The GMF consists of amphibolite, quartzite, mica schist, porphyroblastic mica schist, and banded iron formation (BIF). Both para- and orthoamphibolite are present. Quartzite includes both orthoquartzite and fuchsitic quartzite; mica schist includes biotite and muscovite schist with common andalusite porphyroblasts; and BIF is formed of banded quartz-magnetite-amphibole schist containing selvages of chlorite schist. Locally, the BIF has stratiform and crosscutting veins of quartz, pyrite, and accessory chalcopyrite. Some local gold anomalies (up to 1.37 ppm Au) have been detected in the BIF (Hausel, 1987b).

The lowermost formation, the Diamond Springs Formation (DSF), consists of amphibolite, metadiabase, metabasalt, serpentinite, and tremolite/actinolite-talc-chlorite schist (Hausel, 1987b). Where exposed, it forms a conformable contact with the overlying GMF. The major-element chemistry of amphibolites and schists of the DSF are suggestive of high-MgO tholeiites and basaltic and ultramafic komatiites. The "immobile" trace-element chemistry (Ti, Zr, Y, V, Cr, Ni, Nb) is also consistent with mafic and ultramafic precursors (Harper, 1986; Hausel, 1987b, 1991).

The structure of the greenstone belt is complex. Hull (1988) defined folds and associated minor structures based on morphology. The initial layer-parallel shortening of the MDF produced isoclinal to tight, shallow-plunging folds with an upright cleavage and rare egg-basket crossfolds. Flattening and rotation of early buckle folds produced steeply plunging upright isoclines with mylonitic schistosity. Buckle folds and crenulation cleavage adjacent to the Roundtop Mountain deformation zone are common (Hull, 1988). Other workers have identified three to four episodes of deformation.

Stop descriptions

Stop 2. Atlantic City iron mine (overview). The open pit was developed in BIF of the Goldman Meadows Formation (**Figure 9**). The iron formation is generally less than 100 feet thick but has been structurally thickened at the mine site by internal folding and plication, and by repetition along faults and slippage along foliation.

U.S. Steel Corporation operated the mine from 1962 to 1983 and recovered more than 90 million tons

Figure 9. The Atlantic City iron mine and mill (photograph by W.D. Hausel).

Figure 10. Cumulate textured serpentinite near Atlantic City mine. The granular texture is the result of serpentine pseudomorphs after pyroxene and olivine. Some pseudomorphs are accented by magnetite crusts (photograph by W.D. Hausel).

of taconite before selling the mine to Universal Equipment Company, the current owners. At full capacity, 5.5 million tons of taconite were mined and milled each year. The taconite was extracted and pelletized at the mine site and then shipped by rail to the Geneva Steel Works near Provo, Utah. Mapping by Bayley (1963) and Hausel (1987c, 1988), indicates a large unmined resource remains in the open pit and continues to the northeast and southwest. In 1968, R.W. Bayley reported mine reserves to total 300 million tons (~30% Fe).

Stop 3. Diamond Springs Formation and Goldman Meadows Formation west of the Atlantic City mine entrance. Drive west from stop 2 on Highway 28 for approximately 3 miles. The entrance to the Atlantic City iron mine will be on the right (north). Turn on this road and then turn immediately to the left (west) into the Pacific Power and Light substation. Park near gate.

Walk about 100 yards west from the Pacific Power and Light substation to an outcrop of cumulate-textured serpentinite (**Figure 10**). This is a relatively fine-grained, conformable serpentinite that is increasingly chlorite rich to the south (top?). Based on its chemistry and fine-grained texture, the serpentinite is interpreted to be a metamorphosed peridotite flow (Hull, 1988; Hausel and Hull, 1990). The whole-rock chemistry for serpentinites of the DSF suggests ultramafic komatiite. These rocks have Mg0 contents of 26.6 to 38.1%, Cr contents of 1,700 ppm to 10,100 ppm, and Ni contents of 860 ppm to 2,570 ppm. A sample of serpentinite from this locality yielded 30.6% Mg0, 2,700 ppm Cr, and 1,200 ppm Ni (**Table 1**, no. 23D). The CaO/Al_2O_3 ratio is low, possibly because of CaO depletion during serpentinization.

Cross-fiber asbestos veinlets occur near the northern edge of this outcrop and about a mile northeast on the northern highwall of the Atlantic City mine. At the latter location, known as the Fire King mine, a small amount of asbestos-bearing serpentinite was mined prior to 1921.

The gold content of the serpentinites is low, varying from less than 0.005 ppm to 0.016 ppm (Hausel, 1991). These values are higher than the average ultramafic rock (0.0008 ppm Au) reported by Kerrich (1983).

From the serpentinite, walk west to Slate Creek to examine BIF bank-fill boulders. These boulders were mined from the Atlantic City open pit and dumped here to support the creek banks during flash flooding. The boulders are representative of the iron formation member of the GMF, which lies above the DSF. The BIF consists of banded magnetite-metachert with varying amounts of amphibole and chlorite with a microhornfelsic texture. Isoclinal folds and foliation-conformable, boudinaged, quartz veins and veinlets are common. Sulfides (pyrite and uncommon chalcopyrite) occur along foliation, locally. The average iron content is 33.0% (Bayley, 1963). The gold content is poorly known; a few samples collected and analyzed for gold varied from <0.005 ppm to 1.3 ppm, indicating the iron formation may be a viable exploration target. A typical analysis of Goldman Meadows Formation BIF is listed in **Table 1** (no. 1G).

Walk north along Slate Creek and cross the railroad bed. Some bank fill on the north side of the bed consists of GMF metapelite transported here from the open pit. Many of these schists are porphyroblastic. The most common porphyroblasts are andalusite and almandine. A few schists display tight to isoclinal folds and prominent cleavage. Continue up the slope across tholeiitic metagabbro, metadiabase, metabasalt, felsic gneiss, and talc-chlorite schist.

The gneiss is an S-type gneiss believed to have been tectonically emplaced into the greenstone belt

Table 1. Whole-rock and trace element analyses for some representative rocks from South Pass.

Sample number	23D	1G	38D	21R	21M	95M	44M	53M
SiO_2	37.80	56.10	44.70	52.79	64.40	58.16	44.18	41.52
Al_2O_3	4.18	0.23	6.27	13.77	14.30	17.44	8.45	10.50
TiO_2	0.40	<0.03	0.71	1.01	0.60	1.16	0.79	0.66
Fe_2O_3	14.60	33.40	12.60	12.96	5.89	1.22	10.55	10.58
FeO	—	7.55	—	—	—	4.31	—	—
MnO	0.17	0.19	0.16	0.20	0.09	0.11	0.17	0.19
MgO	30.60	0.76	21.20	6.69	3.08	3.01	20.84	20.49
CaO	2.56	1.50	7.09	10.31	2.88	5.81	7.17	7.74
Na_2O	0.03	<0.20	0.18	1.90	3.28	4.17	0.66	0.30
K_2O	0.03	<0.03	<0.03	0.04	2.46	1.70	<0.03	0.17
P_2O_5	0.34	0.10	0.29	0.28	0.31	0.46	0.42	0.20
CO_2	—	0.02	—	—	—	0.40	—	—
LOI	8.80	0.27	4.70	1.70	0.60	1.59	4.8	4.6
TOTAL	99.69	100.12	99.60	101.65	97.98	99.58	98.19	96.95
CaO/Al_2O_3	0.61	—	1.06	0.75	—	—	0.8	0.7
Ti/V	—	—	—	24	—	—	—	—
Ag(ppm)	<5	<2	<5	<0.1	—	—	<5	—
As(ppm)	2	10	3	—	29	—	2	80
Au(ppb)	6	<8	<5	<5	13	—	<5	20
Cr(ppm)	2,700	11	3,100	200	217	—	1,400	2,047
Ni(ppm)	1,200	14	1,200	48	43	—	630	409
Pd(ppb)	6	—	2	—	—	—	<2	—
Pt(ppb)	20	—	15	—	—	—	<15	—
V(ppm)	—	16	—	244	—	—	—	—

Sample descriptions:

23D, cumulate serpentinite from Diamond Springs Formation near Atlantic City mine entrance (Hausel, 1991)

1G, banded oxide facies magnetite-quartz-amphibole iron formation from Goldman Meadows Formation near Lewiston Lakes (Hausel, 1991)

38D, talc-chlorite-tremolite schist from Diamond Springs Formation north of sample 23D (Hausel, 1991)

21R, greenstone (metabasalt) (Hausel, 1991)

21M, metagreywacke from Lewiston district (Hausel, 1991)

95M, meta-andesite (average of 3 analyses from Peabody Ridge) (Bayley and others, 1973)

44M, actinolite schist (Hausel, 1991)

53M, tremolite schist (Bow, 1986)

(Talpey, 1984). The talc-chlorite-tremolite schist (**Table 1**, no. 38D) is chemically equivalent to a peridotitic komatiite and is interpreted to be a metamorphosed komatiite or subvolcanic equivalent. Nearby, metabasalt displays ellipsoidal fractures suggestive of pillows (Greg Harper, personal communication, 1986). This unit is tightly folded; fold limbs are crenulated.

Stop 4. Roundtop Mountain Greenstone and deformation zone. Backtrack to the east along Highway 28 for about 2 miles. On the left (north) is a Highway Department substation. Turn off Highway 28 at this point and drive past the station to the dirt road on the north. Continue a few hundred feet and stop in the topographic saddle at the base of the hill.

The saddle marks the trend of the Roundtop fault (named by Bayley, 1965) or more specifically, the Roundtop Mountain deformation zone (named by Hull, 1988), which is an Archean terrane boundary separating the Miners Delight terrane to the southeast from the Roundtop Mountain and other terranes to the northwest. The Roundtop Mountain deformation zone (RMDZ) juxtaposes two sequences that differ in paleoenvironment, provenance, lithologies, geochemistry, and metamorphic grade (Hull, 1988).

To the north, the strongly foliated Roundtop Mountain Greenstone is cut by metadiabase and metabasalt sills. The anastomosing greenstone foliation is often buckled into chevrons or kinks, especially near the RMDZ. Metagreywacke overlies the greenstones adjacent to the RMDZ. Nearby, pillows in the greenstones and graded bedding in metagreywacke indicate the top of this unit lies to the south.

South of the RMDZ is Miners Delight metagreywacke and metaconglomerate. Though intense deformation and amphibolite-facies metamorphism has obscured most primary textures, metagreywacke can be identified by characteristic elliptical biotite clots and occasional quartz sand grains. Where found, graded bedding indicates the Miners Delight rocks are younger to the north. Thus, the two terranes face each other across the RMDZ (Bayley and others, 1973; Hull, 1988).

The highest grade tectonites in the RMDZ are strongly schistose and laminated, black amphibolitic mylonites and ultramylonites. Foliation is uniform and essentially vertical in the RMDZ mylonites (Hull, 1988; Hausel and Hull, 1990).

The mylonites and adjacent rocks are cut by a complex sequence of retrograde deformation zones that show a variety of movement directions and senses. Chlorite- and quartz-coated slickensides, often with subhorizontal slickenlines, are also found on many foliation surfaces (Hull, 1988). Laramide deformation overprints Archean deformation in broad zones containing calcite-cemented breccia and gouge.

Continue upslope across greenstones and a weakly foliated metaleucodacite porphyry sill with narrow joint-controlled, foliation-parallel quartz veinlets that have been prospected at several points along trend. Phenocrysts of oligoclase and quartz occur in a dense sericitized groundmass with minor disseminated arsenopyrite. The sill was emplaced along a shear in the greenstones that yields weak gold anomalies. Bayley and others (1973) reported a sample from the sill assayed 0.01 opt Au and 0.01 opt Ag.

Walk east to the cliff near the power line. Here are some well-preserved deformed pillow lavas (**Figure 11**). Although the pillows are stretched parallel to foliation, the cusps provide the same top solution in most outcrops, i.e., the top of the RMG lies to the south (Bayley, 1965). The greenstones are metatholeiites (see **Table 1,** no. 21R). Mineralogically, these rocks are composed of chlorite, actinolite, epidote, and minor apatite. The original plagioclase has been entirely sausseritized.

Stop 5. Peabody Ridge. From the Highway Department substation, drive south across Highway 28 to the graded road to Atlantic City. Continue south for about 0.5 mile. Turn left (east) at the road junction and drive another 1.5 miles. Stop at the base of Peabody Ridge.

Peabody Ridge overlooks the Gold Dollar mine. The Gold Dollar adit, located in the valley to the south, was driven 1,350 feet across regional foliation with the intent of intersecting the western extent of the Miners Delight lode. The Miners Delight lode is traceable from the Gold Dollar shaft 3,000 feet east to the Miners Delight mine before it disappears under eluvial cover. At the Miners Delight mine, the shear is folded.

On the skyline to the south, the northern flanks of Oregon Butte and Continental Peak mark the approximate trace of the Continental fault. South of the fault scarp is an extensive paleoplacer (Love and others, 1978).

Figure 11. Pillow lavas in Roundtop Mountain Greenstone metabasalt (photograph by W.D. Hausel).

This southern slope of Peabody Ridge has a variety of rock types, including amphibolite, metaandesite porphyry, cherty metagreywacke, metatuff, and metagreywacke. The metagreywacke is proximal facies, formed of subangular quartz and feldspar (oligoclase) grains in a biotite, quartz, and feldspar matrix. Rock fragments include metachert, quartzite, and phyllite; igneous fragments are uncommon in the greywackes. Primary sedimentary features include channels, crossbeds, and graded beds (**Figure 12**). Whole-rock compositions range from granitic to basaltic, averaging granodioritic to quartz dioritic (Condie, 1967; Hausel, 1987b) (**Table 1,** no. 21M). Several beds of cherty metagreywacke crop out along the slope as resistant low ridges. These commonly exhibit ultramylonitic to mylonitic textures in thin section.

Figure 12. Proximal-facies metagreywacke on Peabody Ridge. This outcrop has well-developed graded bedding indicating the top of the unit lies to the north (top of photo), however crossbedding (bottom of photo) indicates the top lies to the south. This enigma is resolved by assuming the joint surface separating the two sedimentary structures represents an isoclinal fold axis (photograph by W.D. Hausel).

The metagabbro is a foliated, medium-grained, hornblende-plagioclase (tholeiitic) amphibolite. Meta-andesite includes massive trachytic porphyry and vesicular flows (**Table 1**, no. 95M) consisting of oligoclase and hornblende phenocrysts in a dense microlitic groundmass of biotite and hornblende and a fine-grained residue of feldspar and quartz (Bayley and others, 1973).

Stop 6. Snowbird mine. From Peabody Ridge, backtrack 1.3 miles to Big Atlantic Gulch. South of the B.L.M. campground turn left along the Big Atlantic Gulch jeep trail. You will pass the Big Atlantic Gulch adit at about 0.1 mile before arriving at the Snowbird mine at 0.3 mile. Park off the side of the road.

The Snowbird mine was developed on two different lodes. The northern lode is a massive breccia vein with two generations of quartz, massive calcite, and abundant sulfides (pyrite and subordinate chalcopyrite) (**Figure 13**). Breccia clasts are country rock fragments. The host for the vein includes metagreywacke and metabasalt.

Bayley and others (1973) reported a model lead date of 2.8 Ga for the deposit, but the Snowbird has two different vein systems and it is not known from which lode the sample was taken. One vein is the sulfide-rich breccia vein described in the previous paragraph and the second vein system is a sulfide-poor carbonated mylonite and shear 320 feet to the south.

Jamison (1911) estimated 375 ounces of gold were recovered from the mine. Prinz (1974) recovered a calcite-quartz sample from the mine dump that assayed 0.13 opt Au with 30 ppm As. It is not known which of the two veins this sample was taken from. Samples collected every 10 feet from the northern breccia vein had a paucity of gold; they ranged from no detectable gold and silver to only 0.37 ppm Au, 0.5 ppm Ag, with 197 ppm Cu (Hausel, 1991). The vein may be more suited to be a smelter flux than a primary gold deposit.

Return to the graded road and backtrack west to the junction. Turn left (south) and drive to Atlantic City (about 1.5 miles from the junction). Atlantic City was established during the early gold rush and may have housed more than 500 people in 1870. The town was well known for having one of the best "French Quarters" in the Rocky Mountain region and the first brewery in the state.

Figure 13. The Snowbird breccia vein consists of white massive calcite with two generations of gray quartz and associated pockets of massive pyrite. Country rock clasts are metagreywacke and metabasalt (photograph by W.D. Hausel).

Figure 14. View of the historic Duncan mine buildings. Combined production records and historic estimates suggest total gold production from the mine was about 3,790 ounces of gold (photograph by W.D. Hausel).

Rock Creek runs through Atlantic City. From 1933 to 1941, this creek bed was dredged along a 6-mile stretch. Dredge tailings are visible along the stream banks. The gravels averaged 0.012 oz/yd^3 Au, and in the first year of operation nuggets as large as 3.4 ounces were recovered (Ross and Gardner, 1935). Historic reports also describe two pieces of gold-bearing rock found before 1905; one was fist-sized with 24 ounces of gold, and the other was a boulder with an estimated 40 pounds of gold (Wyoming Industrial Journal, 1905, v.6, no. 12, p.18).

Stop 7. Duncan mine area. Continue through Atlantic City, cross Rock Creek, and turn right (west) to South Pass City at the junction. Drive another mile and the Duncan head frame and mill will appear on the hill to the left (south) (**Figure** 14). Park off the road.

The roadcut exposes actinolite schist. Chemically, this unit is equivalent to a peridotitic komatiite (MgO = 20.84%, Cr = 1,400 ppm, and Ni = 630 ppm) (**Table 1**, no. 44M), although the ite (MgO = 20.84%, Cr = 1,400 ppm,) rare-earth element content is elevated and more typical of basaltic komatiite.

Walk south across the road and up the hill west of the Duncan mine, crossing metagreywacke until you reach the Exchange adit, which is in amphibolite. The Exchange adit is a short adit developed in a shear in amphibolite near the amphibolite-metagreywacke contact. Note the isoclinal fold in the wallrock adjacent to the shear (**Figure 15**). Boudinaged quartz occurs in the shear and two generations of cherty quartz are in the south wall of the shear. Samples taken over a 40-foot width in the adjacent wallrock exhibited evidence of silica flooding and potassium enrichment that

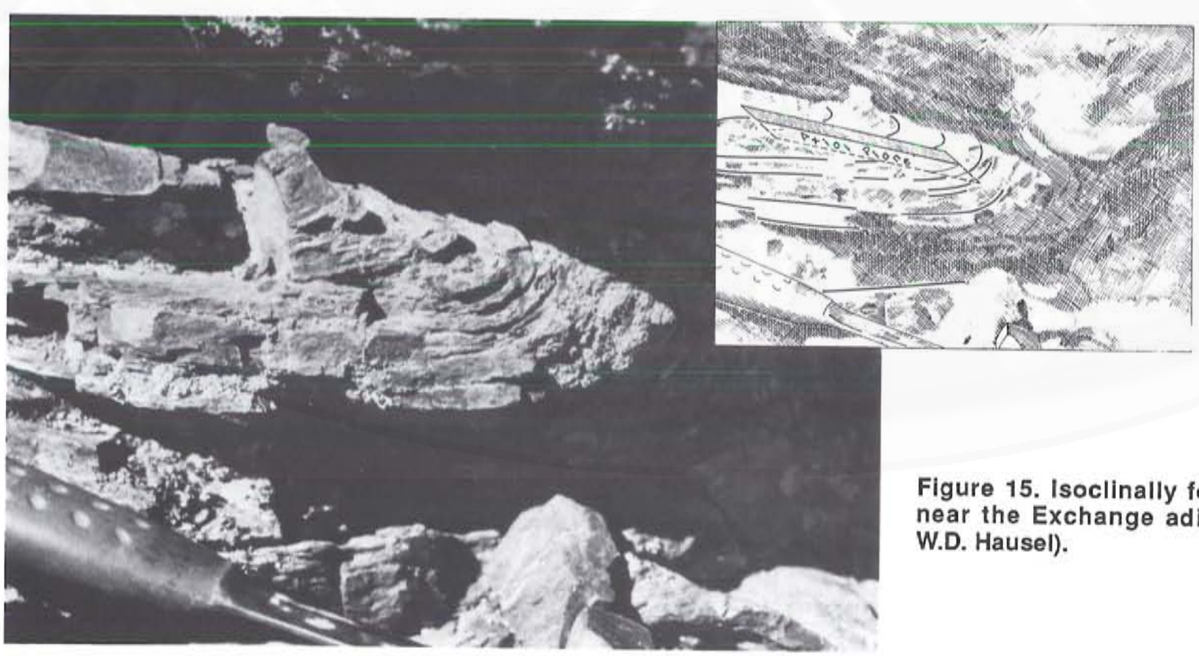


Figure 15. Isoclinally folded amphibolite near the Exchange adit (photograph by W.D. Hausel).

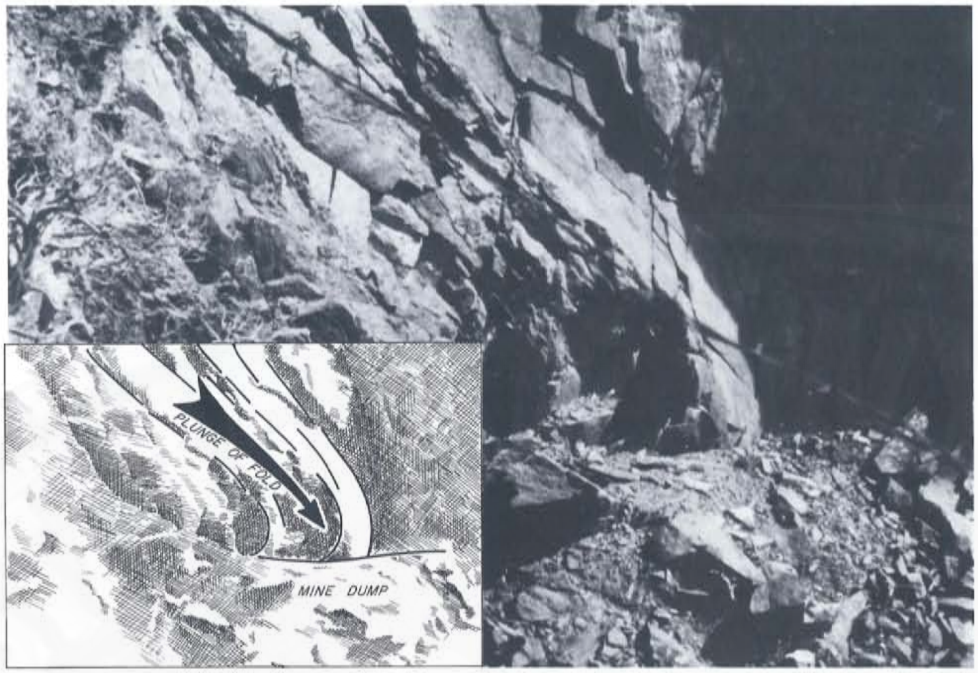


Figure 16. Fold closure in the Duncan shear (photograph by W.D. Hausel). Schematic on left shows fold geometry.

declines rapidly away from the shear. This enrichment is petrographically manifested in increased amounts of quartz and sericite.

Continue south to a small metatonalite plug west of the Duncan shaft. The metatonalite consists of quartz and oligoclase phenocrysts in a recrystallized matrix of sericite, quartz, and feldspar. The plug exhibits an east-west foliation inherited from a Duncan shear zone it intruded.

Walk east to the glory hole adjacent to the shaft. The trend of the shear in the glory hole is oblique to the principal shears at the Exchange prospect and to the east at the Mary Ellen mine. This is the same shear found near the Mary Ellen mine and at the metatonalite plug to the west but it has been modified by a steeply plunging, north trending drag fold (**Figure 16**). The fold encloses an ore shoot that yielded 0.96 opt Au from a 2-foot channel sample. The adjacent wallrock is also fractured, sheared, and mineralized over a width of nearly 40 feet. Samples taken in this zone yielded 0.19 opt to 0.015 opt Au (Hausel, 1989).

Stop 8. Carissa mine (optional). If time permits, drive west to the Carissa mine located above South Pass City (about 2 miles).

The Carissa mine has been one of the two most productive gold mines in the district. The mine is 400 feet deep with five levels and has more than 2,400 feet of drifts, although this does not include stopes. According to Jamison (1911), early production was 50,000 ounces of gold. However, some production figures reported by the *Wyoming Industrial Journal* for 1899 to 1902 indicated 179,024 ounces of gold were recovered over the 4-year period. The average ore grade was reported at 0.3 opt Au with a tenor ranging from a trace to 260 opt Au.

The gold-bearing shear zone (**Figure 17**) ranges from 6 to 50 feet wide and includes more than one generation of quartz. Quartz boudins parallel the penetrative shear fabric and later folded veins trend perpendicular to the shear. Still later quartz breccia veins cut the shear fabric. Some stope-scale ore shoots exposed underground were controlled by folds (Bow, 1986). Chlorite and hematite are prominent in the shear zone.

The wallrock metagreywacke is fractured and rehealed over a 200- to 300-foot width. Interfolial veins and veinlets are common in the wallrock. Composite chip samples taken in the wallrock over a 97-foot width yielded an average gold value of 800 ppb. Thirty-seven feet of the northern wallrock averaged 1.37 ppm (0.04 opt) Au. Another 30-foot composite chip sample within this zone averaged 2.4 ppm (0.07 opt) Au (Hausel, 1989).

Drilling on the property by Consolidated McKinney Resources verified the presence of an 80-foot-wide mineralized envelope at depth. Mineralized core contained a trace to 2.5 opt Au (deQuadros, 1989). Earlier drilling by Anaconda Minerals Company verified the continuation of the mineralized shear to a minimum depth of 930 feet (de Quadros, 1989). Carbonated tremolite/actinolite-talc-chlorite schist adjacent to the shaft house has similar chemistry to peridotitic komatiite (**Table 1**, no. 53M).

Drive north to return to Highway 28. Mileages will restart from 0.0 and continue to Oregon Buttes.

SOUTH PASS CITY TO OREGON BUTTES

Trip leader J. David Love.

Road log and stop descriptions

Cumulative mileage

0.0 Junction of South Pass City road with Highway 28; turn left. Thin remnants of Miocene

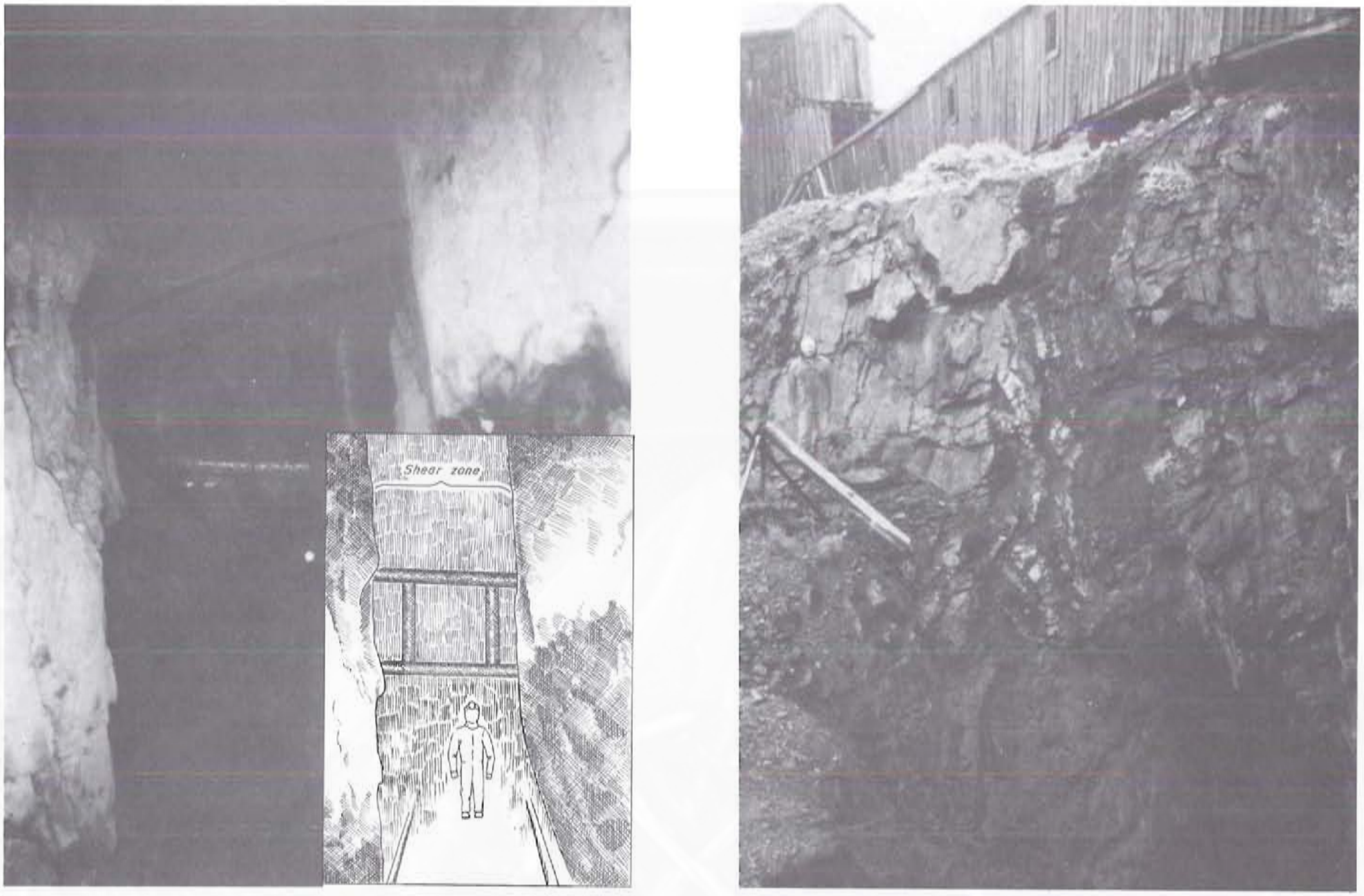


Figure 17. (a) The 350-foot level of the Carissa mine. The tunnel roughly outlines the auriferous shear which is about 6 feet wide and nearly vertical. (b) The same shear exposed on the surface showing boudinaged quartz (photographs by W.D. Hausel).

white tuff and conglomerate are preserved on rough paleotopography.

1.4 Pass filling station and store on right.

2.8 Highway traverses a broad upland surface that is probably near the upper limit of burial of the southern part of the Wind River Range. Precambrian knobs are partly buried by white tuffaceous sandstone and conglomerate of uncertain correlation. These deposits could be part of the Split Rock or overlying Moonstone formation, both of Miocene age.

6.1 Turnout on left to State Historical Society sign with a commemorative description of the "Oregon Trail-Lander Cutoff-South Pass area...." The Oregon Trail crosses the Continental Divide at the south end of the Wind River Range. The Lander Cutoff was a shortcut to the Snake River country.

7.8 Good view to the left (south) showing Continental Peak and farther west the Oregon Buttes. Closer, to the right, is the prominent ridge of Pacific Butte, composed of lower Eocene conglomerate upfaulted on the south side of the Continental normal fault. Rocks in the foreground are Miocene strata tilted south and down-dropped by post-Split Rock-Moonstone hinging down of the south end of the Wind River Range. Zeller and Stephens (1969) published a detailed geologic map of the area.

9.2 Rest area on right.

9.3 Sweetwater River bridge. The course of this river is interesting. The stream heads on the west side of the Wind River Range (**Figure 2**), flows southwestward to the margin of the Green River Basin, then turns abruptly eastward, flows through a canyon in the Wind River Range, and continues eastward winding across the granite crest of the partly exhumed Granite Mountains for nearly 100 miles to join the North Platte River on the crest of the uplift.

10.1 Turn left off highway onto gravel road going south toward Oregon Buttes. The geology and stops along the route from this road junction are shown on **Figure 18**. Sign shows that the road goes to the Tri-Territorial Monument. This is the junction of the Oregon Territory (acquired in the Spanish American Compromise of 1846) the Louisiana Purchase (acquired from France in 1803), and the Mexican Treaty land (acquired in 1848). Continental Peak (elevation 8,431 feet), 12 miles to the southeast, rises nearly 1,000 feet above the adjacent terrain. The peak is composed of middle Eocene Bridger Formation and is capped by a tiny remnant of Split Rock Formation. Oregon Buttes, 8 miles to the south (elevations 8,612, 8,571, and 8,495 feet) rise about 1,000 feet above the plains. On the lower slopes, Wasatch and Green River formations are exposed. The upper slopes are Bridger Formation and the caprock cliffs are basal conglomerates, probably of Split Rock Formation (**Figure 19**).

11.3 Note knob of Precambrian rocks protruding through the Split Rock Formation 200 yards to the east.

11.8 Good exposures of chalky, white, siliceous, tuffaceous sandstone in the Split Rock Formation. About half a mile to the right (west) is the site of the American Quasar, Skinner-Federal oil test. The well was drilled through 440 feet of Tertiary strata, then about 8,000 feet of Precambrian igneous and metamorphic rocks on the overriding (southward-moving) Wind River Range thrust plate, then nearly 7,000 feet of faulted and steeply dipping Upper Cretaceous sedimentary rocks within the overridden northeast margin of the Green River Basin.

13.4 Cross abandoned railroad grade. This spur line went from Rock Springs to the now closed Atlantic City iron mine viewed from previous stops.

13.8 Pass road to right, which follows the old Oregon Trail, most used in the 1850s. About a mile to the west are stone monuments commemorating Eliza Spalding and Narcissa Whitman, the first White women to cross the Wyoming part of the Continental Divide on July 4, 1836.

15.0 Pass road to right, which goes to the West Coast, Skinner oil test. Its record of rocks encountered is sketchy and subject to several interpretations. My best guess is that Tertiary rocks extend to about 2,350 feet and Precambrian igneous and metamorphic rocks on the Wind River Range thrust plate to either 5,000 or 7,000 feet. Below the thrust plate, the test drilled Upper Cretaceous strata to a total depth of 8,183 feet.

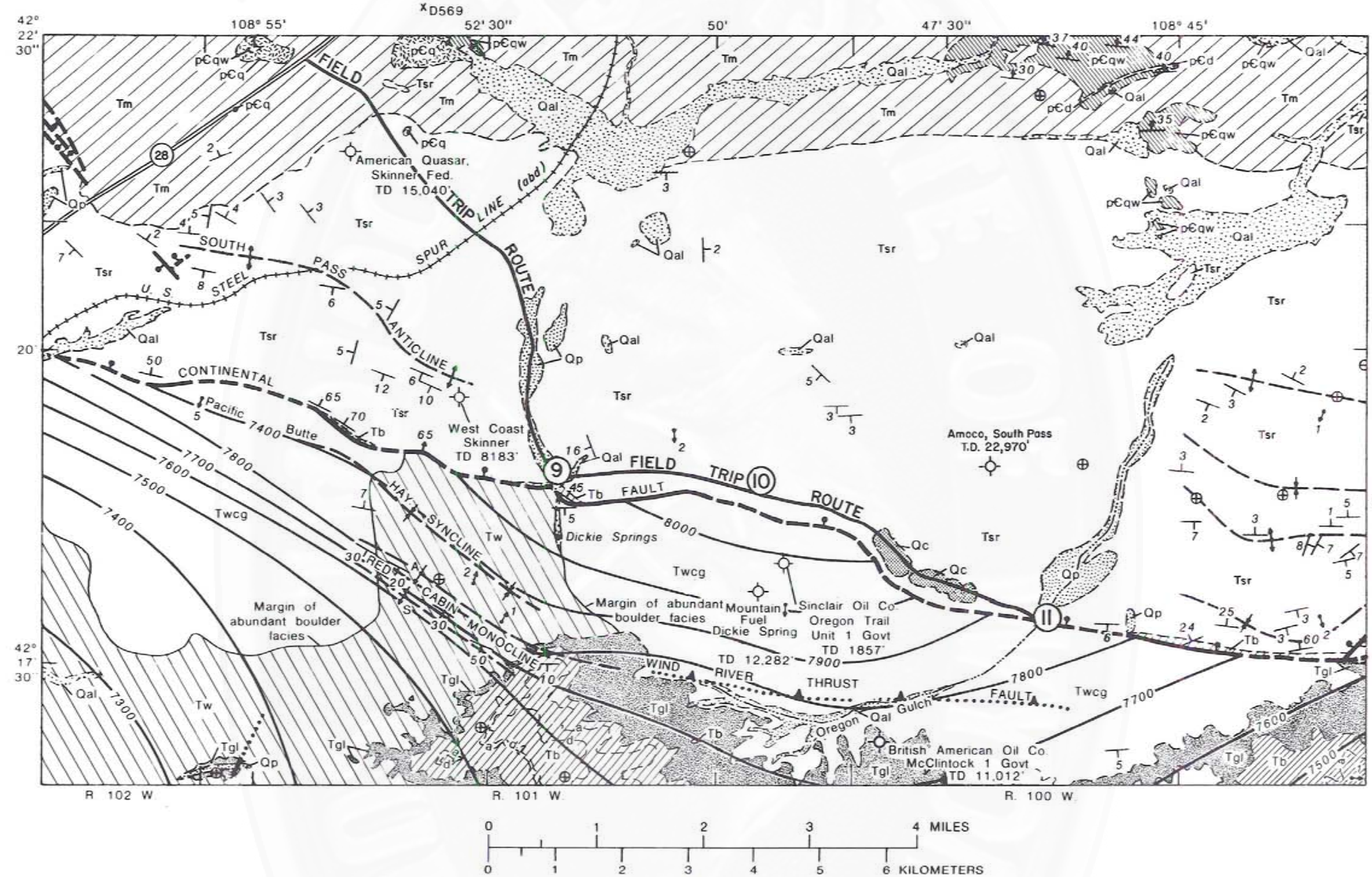
15.9 Note seismic line roads to the west and a trench that was dug in an attempt to expose the Continental normal fault plane.

16.1 **STOP 9** (200 feet north of road junction). **Overview of Placer mine area.** Note old placer ditches and workings to south. The water from Dickie Springs was used to concentrate the gold in sluice boxes. Note gray outcrops of sandstone in the Split Rock Formation just north of the route where it turns east and crosses Dickie Springs Draw. From here on, the route lies just north of the break in slope that marks the surface trace of the post early Miocene Continental normal fault (**Figure 18**), along which the conglomerate facies of the Wasatch Formation is raised 1,000 feet or more with respect to the rocks on the north side of the fault. This normal fault offsets the older buried Laramide thrust plate that put Precambrian rocks on Cretaceous strata.

18.3 **STOP 10. Main placer workings reported by E.A. Green** (*in* Love and others, 1978), first excavated in the late 1800s, and reworked in the 1930s and 1980s. Gold shown in the **frontispiece** (center photo) came from this site. This operation was hampered by lack of water to concentrate the gold. On the hillside to the southeast can be seen faint traces of a ditch that brought water in from a small spring (now with intermittent flow) 1.5 miles to the east.

18.7 Note modern placer workings in draw 150 yards to north.

23.9 **STOP 11. Old placer workings along Oregon Gulch.** Most of these are in boulder debris derived from the upraised conglomerate in the Wasatch Formation. They have been reactivated sporadically for the last hundred years. The limited water supply in Oregon Gulch, however, was a constant problem and was largely responsible for the lack of success of these ventures. As discussed by Love and others (1978), the trace elements in the gold from the Dickie Springs-Oregon Gulch area are not in the same proportion as those in the gold-bearing veins in Precambrian rocks of the Atlantic City-South Pass area. Therefore, we postulated that the Dickie Springs-Oregon Gulch gold was derived from a hitherto unknown separate buried source (Love and others, 1978, figure 1).



EXPLANATION

- Approximate contact
- Fault, showing dip--Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side
- Concealed thrust fault--Sawteeth on upper plate
- Approximate anticline
- Approximate syncline
- Approximate monocline--Showing trace of axis; A, axis of anticlinal bend; S, axis of synclinal bend
- Strike and dip of beds
- Strike and dip of metasediments--Top of beds known from sedimentary features
- Component of dip--Dot marks point of observation
- Horizontal beds
- Structure contours--Drawn on base of Laney Member of the Green River Formation. Contours omitted north of Continental fault
- Sinclair Oil Co. Oregon Trail Unit 1 Govt TD 1857' — Dry hole--Showing total depth in feet

Figure 18. Geologic map of Dickie Springs-Oregon Gulch area (from Zeller and Stephens, 1969), showing the conglomeratic facies of the Wasatch Formation south of the Continental fault. Indicated are granite (Peq) and metagreywacke (Peqw), of Precambrian age; Wasatch Formation (Tw), conglomerate facies of Wasatch Formation (Twcg), Laney Member of Green River Formation (Tgl), Bridger Formation (Tb), Split Rock Formation (Tsr), Moonstone Formation (Tm), all of Tertiary age; pediment deposits (Qp), colluvium (Qc), and alluvium (Qal), all of Quaternary age. The northwestern extension of the Wind River thrust fault is not known. (Modified from Love and others, 1978.)

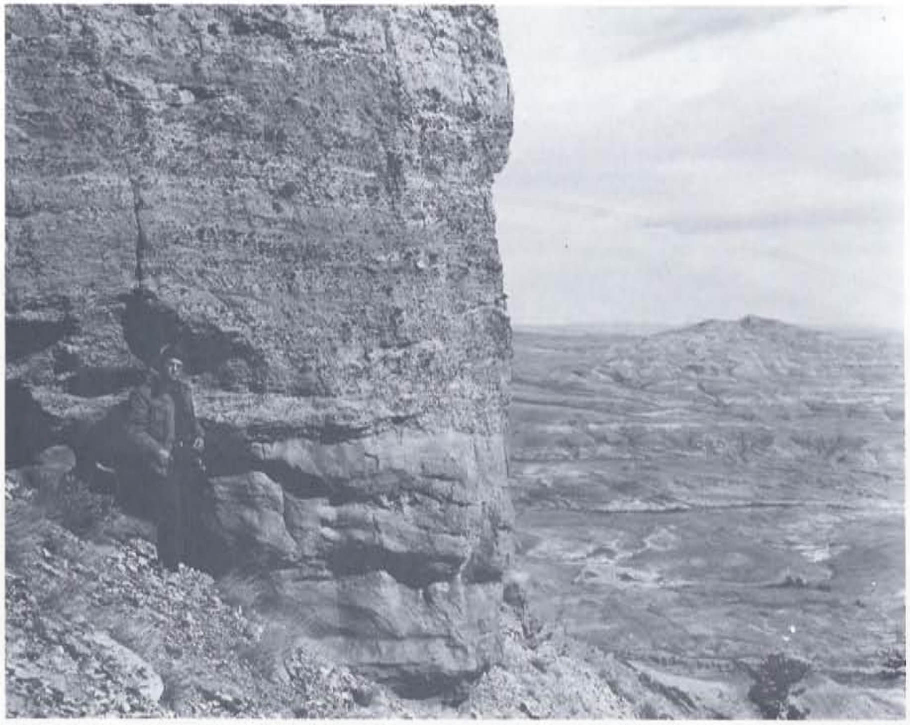


Figure 19, View east showing basal conglomerate in Split Rock Formation capping Oregon Buttes. Badlands at right are in the Wasatch and Bridger formations. Continental Peak is at far right 7 miles away (photograph by J.D. Love).

In 1982, Amoco Production Company drilled a well to 22,970 feet 1.5 miles north-northwest of this stop. Tertiary rocks were drilled to 1,650 feet, Precambrian igneous and metamorphic rocks to 6,990 feet, and Cretaceous strata below that. Two samples of Tertiary conglomerate in drill cuttings and many of Precambrian rocks between depths of 2,200 and 7,100 feet were analyzed by the U.S. Geological Survey. They all showed small amounts of gold (J.C. Antweiler, written communication, 1975). Maximum amount was 1 ppm (about $10.00 per ton at 1991 prices). No cores of Precambrian rocks were taken. The occurrence of gold in this large Precambrian interval suggests that our hypothesis has enough merit to warrant more detailed exploration. In addition to surface studies, an airborne magnetic survey and an induced polarization evaluation, followed by two drill holes by Hecla Mining Company between 1985 and 1987 indicated linear anomalies near the Continental fault (Foster Howland, written communication, 1991). These linear anomalies may represent concentrations of pyrite in the basal conglomerate of the Wasatch Formation, "Iron Formation" in Precambrian rocks (known to be gold-bearing in adjacent areas), or possibly other types of mineral concentrations. As of 1991, these anomalies have not been drilled.

Loen (1987) made a negative assessment of the gold potential of the Dickie Springs-Oregon Gulch area as part of a study of this as a proposed wilderness. His conclusion was based on a limited number of surface samples, many of which were not specifically located on his map. In addition, the technique of his sampling apparently was not comparable to ours. Therefore, it seems likely that the gold potential of this area has not yet been accurately determined.

REFERENCES CITED

Antweiler, J.C., Love, J.D., Mosier, E.L., and Campbell, W.L., 1980, Oligocene gold-bearing conglomerate, southeast margin of Wind River Range, Wyoming: Wyoming Geological Association 32nd Annual Field Conference Guidebook, p. 223-237.

Bayley, R.W., 1963, Preliminary report on the Precambrian iron deposits near Atlantic City, Wyoming: U.S. Geological Survey Bulletin 20, 23 p.

Bayley, R.W., 1965, Geologic map of the Miners Delight Quadrangle, Fremont County, Wyoming: U.S. Geological Survey Geological Quadrangle Map GQ-773, scale 1:24,000.

Bayley, R.W., 1968, Ore deposits of the Atlantic City district, Fremont County, Wyoming, *in* Ridge, J.D., editor, Ore deposits of the United States 1933-1967: American Institute of Mining Engineers, New York, N.Y., p. 598-604.

Bayley, R.W., Procter, P.D., and Condie, K.C., 1973, Geology of the South Pass area, Fremont County, Wyoming: U.S. Geological Survey Professional Paper 793, 39 p.

Bow, C.S., 1986, Structural and lithologic controls on Archean greywacke-hosted gold mineralization in the Sweetwater district, Wyoming, U.S.A., *in* Keppie, J.D., Boyle, R.W., and Hanes, S.J., editors, Turbidite-hosted gold deposits: Geological Association of Canada Special Paper 32, p. 107-118.

Condie, K.C., 1967, Geochemistry of Early Precambrian greywackes from Wyoming: Geochimica et Cosmochimica Acta, v. 31, p. 2135-2149.

Condie, K.C., 1981, Archean greenstone belts: Elsevier, Amsterdam, the Netherlands, 434 p.

Day, W.C., Hill, R.H., Kulik, D.M., Scott, D.C., and Hausel, W.D., 1988, Mineral resources of the Sweetwater Canyon Wilderness study area, Fremont County, Wyoming: U.S. Geological Survey Professional Paper 1757-D, 22 p.

deQuadros, A.M.,1989, Report on the diamond drill program July-August 1989 at the Carissa mine property, South Pass City, Fremont County, Wyoming for Consolidated McKinney Resources Ltd.: Vancouver, B.C. (unpublished report) 76 p.

Harper, G.D., 1985, Dismembered Archean ophiolite, Wind River Range, Wyoming (U.S.A.): Ofioliti, v. 10, p. 297-306.

Harper, G.D., 1986, Dismembered Archean ophiolite in the southeastern Wind River Mountains, Wyoming - remains of Archean oceanic crust, *in* DeWit, M.J., and Ashwal, L.D., editors, Workshop on tectonic evolution of greenstone belts: Lunar and Planetary Institute Technical Report 86-10, p. 108-110.

Hausel, W.D., 1987a, Structural control of Archean gold mineralization within the South Pass greenstone terrain, Wyoming (U.S.A.),*in* Hurst, R.W., Davis, T.E., and Augustithis, S.S., editors, The practical applications of trace elements and isotopes to mineral resources evaluation: Theophrastus Publications, Athens, Greece, p. 199-216.

Hausel, W.D., 1987b, Preliminary report on the gold mineralization, petrology, and geochemistry of the South Pass granite-greenstone belt, Wind River Range, Wyoming: Wyoming Geological Association 38th Annual Field Conference Guidebook, p. 287-304.

Hausel, W.D., 1987c, Revised geologic map of the Miners Delight Quadrangle, Fremont County, Wyoming: Geological Survey of Wyoming Open file Report 87-10, scale 1: 24,000.

Hausel, W.D., 1988, Revised geologic map of the Louis Lake Quadrangle, Fremont County, Wyoming: Geological Survey of Wyoming Open File Report 88-12, scale 1: 24,000.

Hausel, W.D., 1989, The geology of Wyoming's precious metal lode and placer deposits: Geological Survey of Wyoming Bulletin 68, 248 p.

Hausel, W.D., 1991, Economic geology of the South Pass granite-greenstone belt, Wind River Range, western Wyoming: Geological Survey of Wyoming Report of Investigations 44, 129 p.

Hausel, W.D., and Hull, J.M., 1990, Guide to gold mineralization and Archean geology of the South Pass greenstone belt, Wind River Range, Wyoming, *in* Roberts, Sheila, editor, Geologic field tours of western Wyoming and parts of adjacent Idaho, Montana, and Utah: Geological Survey of Wyoming Public Information Circular 29, p.179-191.

Houston, R.S., 1983, Wyoming Precambrian Province - example of the evolution of mineral deposits through time? *in* Roberts, Sheila, editor, Metallic and nonmetallic deposits of Wyoming and adjacent areas, 1983 conference proceedings: Geological Survey of Wyoming Public Information Circular 25, p. 1-12.

Houston, R.S., and Karlstrom, K.E., 1979, Uranium-bearing quartz-pebble conglomerates—exploration model and United States resource potential: U.S. Department of Energy Open File Report GJBX-1(80), 510 p.

Hull, J.M., 1988, Structural and tectonic evolution of Archean supracrustals, southern Wind River Range, Wyoming: Ph.D. dissertation, University of Rochester, New York, 280 p.

Jamison, C.E., 1911, Geology and mineral resources of a portion of Fremont County, Wyoming: Geological Survey of Wyoming Bulletin 2, Series B, 90 p.

Karlstrom, K.E., Houston, R.S., Flurkey, A.J., Coolidge, C.M., Kratochvil, A.L., and Sever, C.K., 1981, A summary of the geology and uranium potential of Precambrian conglomerates in southeastern Wyoming, v. 1: U.S.Department of Energy Open File Report GJBX-139(81), 541 p.

Kerrich, R., 1983, Geochemistry of gold deposits in the Abitibi greenstone belt: Canadian Institute of Mining and Metallurgy Special Volume 27, 75 p.

Koschmann, A.H., and Bergendahl, M.H., 1968, Principal gold producing districts of the United States: U.S. Geological Survey Professional Paper 610, 283 p.

Loen, J.S., 1987, Geologic map of part of the Dickie Springs and Pacific Springs quadrangles Fremont County, Wyoming: U.S. Geological Survey Miscellaneous Field Studies Map MF-1972, scale 1:24,000.

Love, J.D., Antweiler, J.C., and Mosier, E.L., 1978, A new look at the origin and volume of the Dickie Springs-Oregon Gulch placer gold at the south end of the Wind River Range: Wyoming Geological Association 30th Annual Field Conference Guidebook, p.379-391.

McGowan, K.I., 1990, Thermochemical conditions for the formation of Archean lode gold mineralization at Atlantic City-South Pass, Wyoming: Ph.D. dissertation, Iowa State University, Ames, 159 p.

Prinz, W.C., 1974, Map showing geochemical data for the Atlantic City gold district, Fremont County, Wyoming: U.S. Geological Survey Miscellaneous Investigations Map I-865, scale 1:24,000.

Rohrer, W.L., 1973, Geologic map of the phosphate reserve in the Lander area, Fremont County, Wyoming: U.S. Geological Survey Mineral Investigations Field Studies Map MF-305, scale 1:24,000.

Ross, C.L., and Gardner, E.D., 1935, Placer methods of the E.T. Fisher Company, Atlantic City, Wyoming: U.S. Bureau of Mines Information Circular IC-6846, 11 p.

Stuckless, J.S., Hedge, C.E., Worl, R.G., Simmons, K.R., Nkomo, I.T., and Wenner, D.B., 1985, Isotopic studies of the Late Archean plutonic rocks of the Wind River Range, Wyoming: Geological Society of America Bulletin, v. 96, p. 850-860.

Talpey, J.G., 1984, Geochemical and structural evolution of Archean gneisses at South Pass, Wyoming: M.S. thesis, University of Rochester, New York, 102 p.

Zeller, H.D., and Stephens, E.V., 1969, Geology of the Oregon Buttes area, Sweetwater, Sublette, and Fremont counties, southwestern Wyoming: U.S. Geological Survey Bulletin 1256, 60 p.

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