WYOMING STATE GEOLOGICAL SURVEY
Gary B. Glass, State Geologist

GEOLOGY AND GOLD MINERALIZATION OF THE RATTLESNAKE HILLS, GRANITE MOUNTAINS, WYOMING

by

W. Dan Hausel

Report of Investigations No. 52
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Laramie, Wyoming

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Front Cover: Goat Mountain, a Tertiary volcanic plug, is located on the western margin of the Rattlesnake Hills greenstone belt. About 500 feet of relief is shown in this view. Photograph by W. Dan Hausel.

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Abstract

The Rattlesnake Hills represent a fragment of a partially exposed synformal Archean greenstone belt within the Wyoming craton. The hills were later intruded by Tertiary alkalic volcanic rocks. The supracrustal belt has been subjected to multiphase deformation during the Archean and later brittle deformation during the Laramide orogeny. Ductile deformation during the Archean produced foliation, and at least two episodes of folding.

The exposed core of the Rattlesnake Hills forms an Archean supracrustal belt of metasedimentary and metavolcanic rock that has been intruded by more than 40 Tertiary alkalic plugs and dikes. Recent mapping by the author shows the supracrustal belt to consist of a refolded, isoclinally folded, greenstone belt fragment with a lower(?) metasedimentary unit, a middle metavolcanic unit, and an upper metagreywacke/metachert unit. The lower(?) metasedimentary unit consists of metapelite, quartzite, banded iron formation, and amphibolite named the Barlow Springs Formation. The Barlow Springs Formation appears to be overlain by pillowed metatholeiites of the McDougal Gulch Metavolcanics, which, in turn, is overlain by metagreywacke with intercalated metachert of the UT Creek Formation. The northern limb of the Rattlesnake synform was not uplifted and presumably underlies the Phanerozoic rocks north of the uplift.

At least three episodes of gold mineralization are recognized in the district. These include syngenetic stratabound exhalitive mineralization, epigenetic mineralization, and disseminated epithermal gold associated with the volcanic activity. The presence of anomalous gold associated with the Tertiary alkalics suggests that this region represents a favorable exploration target for large-tonnage, low-grade, gold mineralization.

Introduction

As part of a continuing investigation of Wyoming's mineral resources, the Wyoming State Geological Survey mapped the Rattlesnake Hills supracrustal belt in 1992 and 1993 while examining the mineral resource potential of the region. This investigation followed field reconnaissance of the area in 1982, when anomalous gold was detected in a pyritiferous metachert at the Lost Muffler prospect (Hausel and Jones, 1982). The prospect was named by the author following a traverse over rough terrain along the northern flank of the Rattlesnake Hills and subsequent minor damage to the Survey's field vehicle. Unless the reader is looking to find other descriptive names for prospects in the Rattlesnake Hills, it is recommended that the district be accessed from the south.

During the 1992-1993 mapping project, a 16-square-mile fragment of an Archean greenstone belt was identified in the Rattlesnake Hills. The strikingly similar lithologies in the Rattlesnake Hills to those of Wyoming's principal historic gold district in the South Pass greenstone belt suggested that the Rattlesnake Hills might provide a similar favorable terrane for gold. In addition to having similar Archean lithologies, the Rattlesnake Hills supracrustals have also been disrupted by Tertiary alkalic plugs and stocks, providing additional potential hosts for gold mineralization.

During this project, gold mineralization was identified in stratabound exhalitive zones and veins in the Archean supracrustal succession, in epithermally altered Tertiary volcanics and breccia zones, and in other breccia zones and stockworks. Gold anomalies are particularly abundant along the southwestern margin of the greenstone terrane. The author believes that the district has potential for both large-tonnage, low-grade, gold mineralization and small, higher-grade, stratabound gold deposits. The greater commercial potential appears to lie in low-grade mineralized zones (where gold deposits could be surface-mined), although the development of both types of deposits in concert could provide a more attractive exploration target.

The Rattlesnake Hills supracrustal succession is interpreted to have been deposited in an ancient back-arc basin in an Archean sea. Crustal shortening resulted in an intensely deformed and folded terrane sometime during the Archean. Much later, Laramide deformation resulted in uplift and erosion of the supracrustal succession in the core of the Rattlesnake Hills. The area was also disrupted by several small Tertiary volcanic centers.

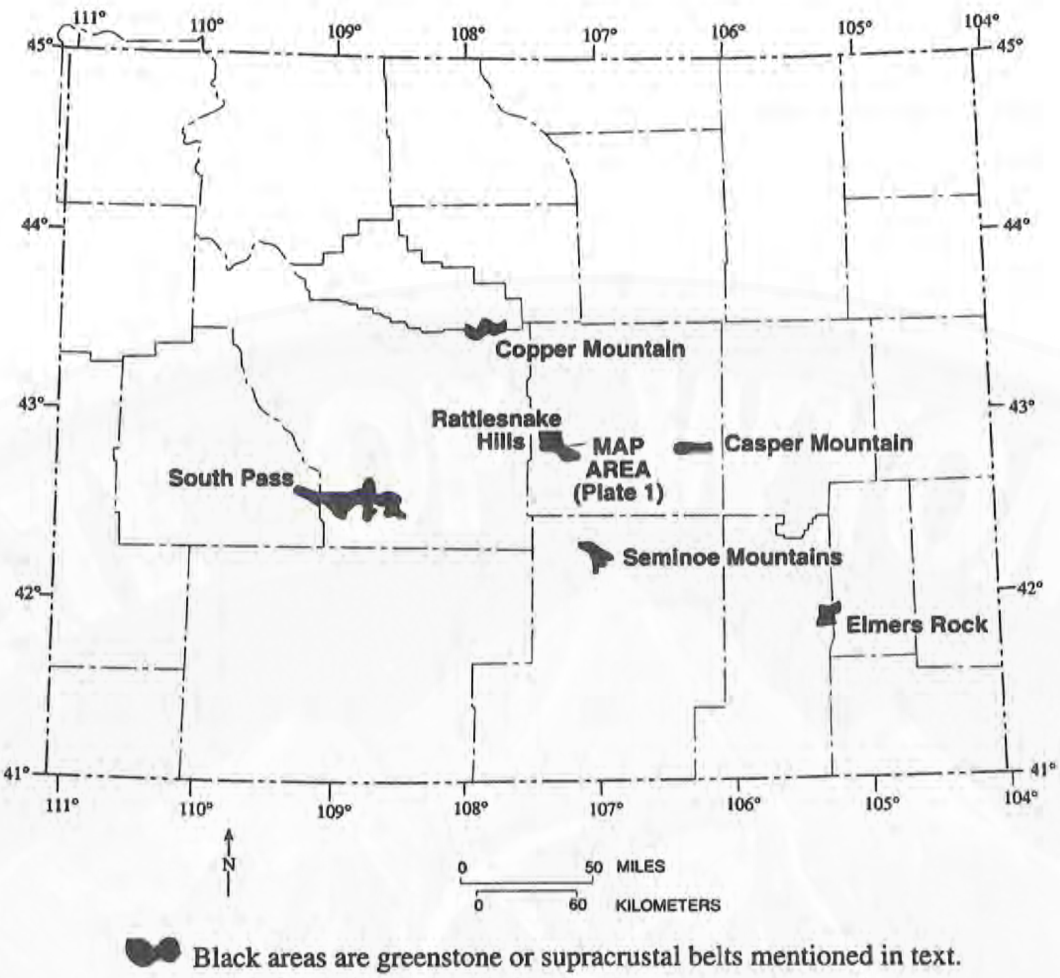

Figure 1. Location map of the Rattlesnake Hills, central Wyoming, showing locations of other Archean supracrustal terranes.

Accessibility and acknowledgments

The Rattlesnake Hills lie along the northern flank of the Granite Mountains approximately 50 air miles west of Casper in central Wyoming, at an average elevation of about 7500 feet above sea level (**Figure 1**). The district can be reached by driving west along the Dry Creek graded road after exiting State Highway 220 at Steamboat Lake. From Steamboat Lake, the Rattlesnake Hills lie several miles to the northwest.

I would especially like to thank Tim Fenster, foreman of the Circle Bar Ranch, and Dave and Ben France of the Cottonwood Ranch for their hospitality and information on various access routes in the Rattlesnake Hills. Dick Fruchey and Hank Hudspeth also provided important information and discussions on some of the mineral properties. Special thanks are given to my son Eric J. Hausel who assisted me in the field in 1993, and to Suzanne (Jones) Luhr who assisted the author during the initial field reconnaissance of the Rattlesnake Hills in 1982.

Previous investigations

Even though the Rattlesnake Hills received minor prospecting interest in the past, none of the prospects were ever developed beyond this phase. As a result, the Rattlesnake Hills were not included in any known historical mining district. This lack of interest in the Rattlesnake Hills is echoed by the available mining and mineral resource reports on the area – no mining or prospecting reports prior to 1904 could be found on the area. And the only early report found on the region gave a cursory mention of the presence of asbestos, iron, copper, and gold (*Wyoming Industrial Journal*, 1904, v. 5, p. 232). According to that source, asbestos was discovered in the area in 1904 followed by the discovery of a free-milling gold vein (no location was given). The *Journal*, which was known for its flamboyant descriptions, also described an immense vein of Bessemer iron ore with 66% iron and only 4% silica "with a million tons in site."

By the mid-20th century, the Rattlesnake Hills began to attract attention for academic research on the origin of several eroded Tertiary alkalic and calc-alkalic plugs found intruding the Rattlesnake Hills. Carey (1954, 1959) initially studied the volcanic petrology and mapped the Rattlesnake Hills, leaving the Precambrian terrane as "undifferentiated." This was followed by a similar study on the Tertiary volcanics by Pekarek (1974, 1977). More recent work on the volcanic rocks was published by Hoch and Frost (1993), who described the presence of nearly 50 mid-Tertiary igneous plugs, dikes, and sills exposed along the Rattlesnake Hills. The volcanics were grouped into an eastern and western felsic group separated by a central alkalic group. Studies on the ancient Archean rocks and the economic geology of the area were essentially nonexistent as pointed out by Love (1970) in his treatise on the Granite Mountains.

In 1982, the author visited the Rattlesnake Hills to search for disseminated gold mineralization as part of a grant provided by the University of Wyoming's Mining and Mineral Resource and Research Institute. During the investigation, anomalous gold was found in pyritiferous metachert cut by a tributary of UT Creek in the central portion of the district (Hausel and Jones, 1982). Several Tertiary plugs were also recognized as potential sources of disseminated gold and auriferous skarns, but because of limited funding, the Tertiary volcanics were not initially evaluated.

American Copper and Nickel Company (ACNC) began to explore the Rattlesnake Hills for gold in 1983. The program was encouraging and identified several gold anomalies in structurally prepared Archean metamorphic rocks and in Tertiary volcanics (John T. Ray, personal communication, 1992). However, the project was dropped in 1987.

Nearly five years later, in 1992, Canyon Resources acquired the property previously explored by ACNC; in the following year, the company joint-ventured the property with Newmont Exploration. In 1993, at least two Canadian companies initiated reconnaissance exploration programs in the district and filed mining claims for gold. During 1995, Newmont Exploration terminated their interest in the Rattlesnake Hills.

At least one large-tonnage, low-grade gold deposit with a reported average of 0.042 opt (ounce per ton) was identified in the area during the past several years. Significant stratabound gold mineralization that averaged more than 0.3 opt over a 10-foot thickness was also apparently intersected at depth. It is not known how many other (if any) significant anomalies have been discovered in the district.

Because of the potential for commercial gold mineralization, the author returned to the district to map the greenstone terrane. During the 1992 and 1993 field seasons, all or portions of 30 sections of the metamorphic supracrustal terrane were mapped (**Plate 1**), and a preliminary, first report on the economic geology of this little known district was published (Hausel, 1995). At about the same time, but independent of the Wyoming State Geological Survey, George Langstaff, a graduate student at the Colorado School of Mines, initiated a similar mapping project of part of the Rattlesnake Hills (Langstaff, 1994a). The work presented here is Hausel's final report on the geology and gold mineralization of the Rattlesnake Hills.

Geologic setting

The Rattlesnake Hills lie along the northeastern edge of the Granite Mountains of central Wyoming. The Granite Mountains consist of scattered, low-lying hills of bare outcrops of 3200 Ma (million year old) tonalitic gneiss intruded by 2610 Ma granite with scattered fragments of supracrustal metamorphic rocks (Peterman and Hildreth, 1978). The largest fragments of supracrustal rocks in the Granite Mountains occur in the Rattlesnake Hills and in the Tin Cup district several miles to the southwest. Smaller fragments of metamorphic rocks have been mapped south and west of the Rattlesnake Hills at Barlow Gap and Black Mountain (Bickford, 1977; Langstaff, 1994b, c).

The Granite Mountains, as well as the Rattlesnake Hills, were uplifted during the Laramide orogeny (Love, 1970). The uplift of the Rattlesnake Hills produced a Laramide structure with Phanerozoic sedimentary rocks dipping to the northeast off the Precambrian core exposed in the central part of the Rattlesnake Hills. These Phanerozic sedimentary rocks range in age from Cambrian to Tertiary (Love, 1970; Pekarek, 1977).

The Precambrian core of the Rattlesnake Hills is dominated by a synformal succession of metamorphic supracrustal rocks in which only the southern limb of the synform is exposed. The northern limb is interpreted to lie to the north under the Phanerozoic sedimentary cover. The metasedimentary and metavolcanic rocks crop out over an area of approximately 16 square miles and are fault-bounded along the southern flank. The northern flank of the Rattlesnake Hills is unconformably overlain by northerly-dipping Paleozoic and Mesozoic sedimentary rocks which are part of the southern margin of the Wind River Basin. Tertiary sedimentary rocks unconformably overlie portions of all of these units.

The Archean supracrustal rocks in the core of the Rattlesnake Hills uplift were deposited in a back-arc basin in an ancient sea 3.2 to 2.6 Ga (billion years ago). The lowermost supracrustal rocks in the synform are interpreted to have been deposited in a tectonically quiet, shallow water basin that was periodically interrupted by occasional exhalitive eruptions. These rocks are overlain by metabasalts and related rocks which suggest that the basin began sinking during the early formation of an island arc. The deposition of the uppermost succession of rocks included more evolved volcanic material and abundant sediments deposited in the basin as the island arc and adjacent craton showed signs of uplift and subsequent erosion. The basin was tectonically shortened near the end of its evolution, producing a compact package of isoclinally folded rock that now stands on end. Regional metamorphism accompanied tectonic shortening and the rocks were upgraded to lower amphibolite facies.

The Archean rocks of the Rattlesnake Hills, as well as the Granite Mountains, currently lie within an ancient craton known as the Wyoming Province (Engle, 1963; Condie, 1976; Houston, 1983). The metamorphic core of the Rattlesnake Hills is similar to other supracrustal terranes mapped elsewhere in the Wyoming craton (**Figure 1**). These include the South Pass greenstone belt in the Wind River Mountains (Hausel, 1987, 1991), the Seminoe Mountains greenstone belt (Klein, 1981; Hausel, 1994), the Copper Mountain supracrustal belt in the Owl Creek Mountains (Hausel and others, 1985), the Elmers Rock greenstone belt in the central Laramie Mountains (Graff and others, 1982), Casper Mountain (Gable and others, 1988), and the Tin Cup district and Barlow Gap area in the Granite Mountains (Bickford, 1977; Langstaff, 1994b, d). Although the Tin Cup and Copper Mountain districts are more typical of high-grade supracrustal terranes, the remaining terranes including the Rattlesnake Hills are more typical of greenstone belts (Hausel and others, 1991).

The Rattlesnake Hills represent a small fragment of a larger greenstone terrane that is interpreted to continue under the surrounding sedimentary cover. The Rattlesnake Hills appear to be lithologically similar to some of the other supracrustal terranes mapped in Wyoming, but possibly have greatest affinity to the South Pass belt. The exposed fragment of the supracrustal terrane is part of an eroded remnant of a northwest-plunging Laramide anticline on the northern flank of the Granite Mountains (Pekarek, 1977). The anticline was produced by Laramide deformation in the Late Cretaceous to Eocene.

After the major compressional phase of the Laramide orogeny ended in the earliest Eocene, the Sweetwater arch (which includes the Granite Mountains) started to rise again in late early Eocene time, resulting in a major east-west trending horst in central Wyoming. Major Laramide faults in the region trend east-west and northeasterly. Additional vertical movement on the newly formed North and South Granite Mountain faults was 5000 and 3000 feet, respectively (Love, 1970). The uplift may have sufficiently lowered the pressure in the lower crust, favoring magma generation followed by volcanic activity during the middle and late Eocene in the Rattlesnake Hills.

Nearly 50 felsic and alkalic stocks, laccoliths, domes, dikes, and plugs intruded the Rattlesnake Hills during the Eocene. These rocks have rhyolitic, quartz latitic, latitic, trachytic, soda trachytic, alkali mela-trachytic, and phonolitic compositions (Pekarek, 1977; Hoch and Frost, 1993). The felsic volcanics lie immediately southwest and east of the greenstone belt, while the alkalic volcanics intrude the Precambrian core of the Rattlesnake Hills. Some pyroclastic debris found in the Late Eocene Wagon Bed Formation has been interpreted to have originated from the quartz latitic eruptive centers.

According to Pekarek (1977), two separate magmas (quartz latite and phonolite) were formed by partial fusion in the lower crust. In order to produce the suite of observed undersaturated and saturated volcanic rocks present in the Rattlesnake Hills, fractional crystallization and/or magma mixing was necessary.

Alkalic plugs intrude the Precambrian succession at several locations in the Rattlesnake Hills. These are primarily phonolites and quartz latites. The Precambrian succession adjacent to phonolite is typically unaltered and coherent. However, the metamorphic rocks adjacent to some of the quartz latites are often iron-stained, brecciated, hydrothermally altered, and provide potential targets for large-tonnage, low-grade, gold deposits.

The Oligocene was a time of crustal stability in the Rattlesnake Hills. During this time, a major erosional surface developed on the Precambrian schist and on the middle and late Eocene Wagon Bed Formation. Boulder channel deposits originating from northeasterly flowing Oligocene streams now form linear ridges in the vicinity of UT Creek. The conglomerates are topographically higher in elevation than UT Creek which is the result of topographic inversion. During the Miocene and Pliocene, the Rattlesnake Hills were further modified by faulting (Pekarek, 1977).

After the Granite Mountains horst rose relative to the Rattlesnake Hills near the end of early Eocene time, the fault was inactive until Miocene when the Granite Mountains began to subside relative to the Rattlesnake Hills. Reactivation of the North and South Granite Mountains faults, but with a reversed sense of motion, occurred at this time. Subsidence reached a climax with downfaulting along the North and South Granite Mountains faults in late Miocene time (Love, 1970). The North Granite Mountains fault has a very prominent post-Laramide fault-line scarp with as much as 600 feet of relief. It is estimated that as much as 1000 to 1200 feet of post-middle Miocene offset occurs along this fault (Love, 1970).

Structure

The supracrustal rocks of the Rattlesnake Hills were initially deposited in a back-arc basin. As this basin closed, the rocks of the basin were folded into a tight, isoclinally folded accordion-like basin. Sometime during this early Archean deformation, the rocks were foliated and metamorphosed to amphibolite facies. During Laramide deformation, a portion of the greenstone belt was uplifted and was later exposed in the core of the Rattlesnake Hills anticline. The uplift of the Sweetwater arch and subsidence of the Wind River Basin to the north was initiated in latest Cretaceous and continued through earliest Eocene time.

Subsidiary folds, including the Rattlesnake Hills uplift and its reverse fault, formed during earliest Eocene time. The Sweetwater arch was thrust southwestward along the Emigrant Trail thrust fault. The Granite Mountains rose vertically as much as 3000 to 5000 feet along the North and South Granite Mountains faults during early to middle Eocene. The uplift was followed by 20 Ma of stability with only minor, local, tectonic activity. The Rattlesnake Hills volcanic activity and associated local doming and faulting developed during the first five million years of this period. The Granite Mountains area began to subside during Miocene time and continued to subside until Pleistocene time. Downfaulting of the Granite Mountains graben along the North and South Granite Mountains faults occurred in late Miocene time (Love, 1970).

The Precambrian rocks in the core of the Rattlesnake Hills anticline are lower to middle amphibolite grade, isoclinally-folded, metasediments and metavolcanics that are part of a regional synform. Structurally, the greenstone terrane is relatively complex with lower order, foliation-parallel, steeply-plunging, isoclinal folds and refolded isoclinal folds (**Figure 2**). At some localities, steeply-plunging open and chevron folds with fold axes obtuse to perpendicular to the isoclinal axes occur but are less common.

Along the southern margin of the belt, isoclinal folds mapped in the border gneiss complex commonly exhibit different orientations than the isoclinal folds in the supracrustal succession. These, along with "s" folds, suggest the presence of an antiform between the border gneiss and the metagreywackes of the UT Creek Formation.

Laramide deformation resulted in the uplift of the Rattlesnake Hills. The northwest-plunging Rattlesnake Hills uplift is one of several en echelon northwest-plunging, Laramide-age anticlines on the north flank of the Granite Mountains. The anticline is asymmetrical and broken by a high angle reverse fault. Paleozoic and Mesozoic rocks on the northeastern flank of the anticline have a nearly constant strike of about N45°W, with dips that vary from 10°NE to 50°NE (Pekarek, 1977).

Pekarek (1977) noted three periods of Laramide faulting in the Rattlesnake Hills. These included: (1) faulting during uplift of the Rattlesnake Hills at

a.

b.

c.

Figure 2. Typical folds in the Rattlesnake Hills supracrustal belt. (a) Refolded isoclinal fold to the right of the hammer. The fold is accented by a growth of lichen. (b) Chevron folds in amphibolite gneiss. (c) Tight fold in metagreywacke.

the beginning of the Laramide orogeny; (2) faulting associated with middle and late Eocene volcanic activity; and (3) faulting in conjunction with subsidence of the Granite Mountains during post-middle Miocene time. A small earthquake recorded at the west end of the North Granite Mountains fault zone on April 22, 1973, indicates some faults are still active in the region (Pekarek, 1977).

Typically, Laramide deformation is brittle whereas Archean-related deformation was ductile. On some structures, both ductile and brittle deformation is evident indicating that some Archean structures were reactivated during the Laramide orogeny. Brittle deformation includes gouge zones and brecciation parallel to regional foliation.

Tertiary volcanism occurred early in the Laramide orogeny and resulted in the disruption of some metamorphic units in the core of the Rattlesnake Hills anticline. Where disruption occurred, breccias formed adjacent to the plug or stocks.

Archean supracrustal rocks

The core of the Rattlesnake Hills consists of a fragment of refolded Archean supracrustal rocks. The greenstone belt consists of three distinct rock units. A lower metasedimentary unit of metapelite, quartzite, banded iron formation, and amphibolite is named the Barlow Springs Formation. The Barlow Springs Formation is overlain by pillowed metatholeiites of the McDougal Gulch Metavolcanics, which, in turn, are overlain by metagreywackes with intercalated metacherts and metatholeiites of the UT Creek Formation. The northern limb of the Rattlesnake synform is not exposed and presumably underlies the Phanerozoic rocks north of the uplift.

The Rattlesnake Hills supracrustal succession exhibits several similarities to supracrustals mapped in the South Pass greenstone belt (Hausel, 1991). However, the Rattlesnake Hills lacks a lower ultramafic to mafic metavolcanic unit that is present at South Pass.

Barlow Springs Formation

The Barlow Springs Formation was named for its lithological similarities to metasedimentary outcrops near Barlow Springs, a short distance south of the mapped area. The formation is located on the extreme southwestern margin of the Rattlesnake Hills greenstone belt and forms an unconformable contact with the Rattlesnake Hills gneiss complex to the south, and a conformable contact with the McDougal Gulch Formation to the north. The southern contact of the formation with the gneiss complex to the south is partially conformable except to the southeast where structural deformation has made it difficult to determine the original relationships between these two rock units. The contact is typically disconformable and the two units are fault bounded along the eastern extent of the contact.

Rocks of the Barlow Springs Formation have steeply dipping to vertical foliation. The formation is exposed over a relatively small area and trends to the northwest for a distance of about 7000 feet prior to disappearing under the younger Wagon Bed Formation (Eocene). To the southeast, the formation terminates against the Cottonwood Creek fault. At its greatest width, the formation is about 900 feet wide.

The Barlow Springs Formation is interpreted to be the lowermost supracrustal unit of the Rattlesnake Hills synform and to lie along the southern limb of the synform. The northern limb of the synform is not exposed.

The rocks of the formation are predominantly metasedimentary. Lithologically, the unit is similar to metasedimentary rocks located south of the Rattlesnake Hills in the vicinity of Barlow Gap (Bickford, 1977; Langstaff, 1994b), and similar to the Goldman Meadows Formation in the South Pass greenstone belt (Hausel, 1991), the Seminoe Formation in the Seminoe Mountains greenstone belt (Hausel, 1994), and Metamorphic Unit 2 in the Copper Mountain supracrustal belt (Hausel and others, 1985). The formation is composed of metapelite, quartzite, banded iron formation, metafelsite, and amphibolite, intruded by narrow metagabbroic sills and plugs. The amphibolites are orthoamphibolites and include tremolite-chlorite schists and metabasalt.

The iron formation in the Barlow Springs Formation grades from magnetite-rich schist to grunerite-rich schist. The magnetite-rich schist, or oxide facies banded iron formation, lies adjacent to the grunerite-rich unit. A sample of the banded quartz-magnetite-minor grunerite oxide-facies iron formation (Sample RH25-92) collected from the NW section 25, T32N, R88W, yielded 64.74% Fe_2O_3 and 23.13% SiO_2 (**Table 1 and Appendix A**). The analysis shows the sample to be iron-rich compared to most taconites in other Wyoming greenstone terranes. The enrichment of iron may partially be due to oxidation; however, the hand specimen showed only minor evidence of hematitization. Only a few samples from the oxidized portions of the Seminoe Formation in the Seminoe Mountains greenstone belt have comparable iron content (for comparison see Hausel, 1994).

The iron formation sample also yielded comparatively high MgO and CaO and low P_2O_5 and SiO_2. The MgO and CaO content are more typical of a cummingtonite-rich iron formation. Overall, the high iron and low silica would make this unit an attractive iron prospect, but unfortunately, the available tonnage of the iron formation is minor.

A sample of grunerite-rich, banded quartz-grunerite-minor magnetite silicate-facies iron formation (Sample RH24-92) was collected near the magnetite-rich rock in NW section 25. This sample yielded 15.62% Fe_2O_3 and 79.12% SiO_2 (**Table 1**).

Both samples (RH24-92 and RH25-92) were tested for gold with no measurable precious metal content (**Table 1**). Other samples of iron formation collected in the district were also tested for gold, and anomalous gold was detected in brecciated iron formation (see **Economic Geology** section below).

Table 1. Whole rock chemical analyses of rocks from the Barlow Springs Formation. Analyses in weight percent, except where noted. Abbreviations: ppb = parts per billion; ppm = parts per million; dashes indicate not analyzed.

Oxide/element	RH24-92	RH25-92	RH12-92	RH26-92	RH28-92
SiO_2	79.12	23.13	64.24	36.92	49.78
TiO_2	0.02	0.02	0.64	0.65	0.16
Al_2O_3	0.19	0.58	13.15	16.64	4.87
Fe_2O_3	15.62	64.74	6.40	14.33	8.86
MnO	0.18	0.26	0.12	0.11	0.18
MgO	1.91	4.73	0.86	14.39	19.50
BaO	0.002	0.004	0.003	0.006	0.003
CaO	2.25	5.09	12.28	10.05	11.46
Na_2O	0.03	0.13	0.04	0.07	0.35
K_2O	0.15	0.27	0.06	0.21	0.18
Cr_2O_3	0.04	0.01	0.03	0.56	0.27
P_2O_5	<0.03	<0.03	0.18	0.04	<0.03
LOI	0.80	<0.05	1.55	5.91	2.86
Total	100.32	98.95	99.54	99.89	98.48
S	<0.02	<0.02	<0.02	0.03	<0.02
Au (ppb)	<5	<5	-	6	<5
Ni (ppm)	-	-	-	302	408

Lithologies of samples as follows: RH24-92, banded quartz-grunerite-minor magnetite iron formation; RH25-92, banded quartz-magnetite-minor grunerite iron formation, RH12-92, metarhyolite; RH26-92, talc-chlorite schist; and RH28-92, actinolite schist.

Limited exposures of talc-chlorite schist (Sample RH26-92) and actinolite schist (Sample RH28-92) were found adjacent to the iron formation. These retained no primary textures because they were destroyed during regional deformation and metamorphism. Thus, assessment of the rock chemistry is necessary to determine the protolith of the samples.

Both schists have ultramafic affinity. The talc-chlorite schist yielded 14.39% MgO with only 36.92% SiO_2 and the actinolite schist yielded 19.5% MgO with 49.78% SiO_2 (**Table 1**). The talc-chlorite schist has background levels of nickel (302 parts per million or ppm Ni) when compared to other ultramafic rocks with similar MgO content. The chromium content (0.56%) is also consistent with ultramafic chemistry. Furthermore, the sample has a CaO/Al_2O_3 ratio of 0.6, a Al_2O_3/TiO_2 ratio of 25.3, and is similar in overall composition to the basaltic komatiites in the Seminoe Mountains greenstone belt (Hausel, 1994). The sample composition of the talc-chlorite schist falls within the basaltic komatiite field of the Jensen AMF diagram (**Figure 3**).

In addition to high magnesium and low silica, the actinolite schist (Sample RH28-92) contains 408 ppm nickel, 0.27% chromium, a CaO/Al_2O_3 ratio of 2.4, and a Al_2O_3/TiO_2 ratio of 30.4 (**Table 1**). This composition is similar to some of the carbonated peridotitic komatiites in the South Pass and Seminoe Mountains greenstone belts (Hausel, 1993), except that the Al_2O_3/TiO_2 ratio is unusually high. Most rocks of this composition in other Wyoming greenstone belts have Al_2O_3/TiO_2 ratios of about 22. The high ratio is apparently due to depletion of TiO_2 relative to Al_2O_3.

The actinolite schist (Sample RH28-92) has been pervasively sheared and altered and metasomatism has undoubtedly played a part in significantly altering the relative amounts of the oxides in the sample. Based on the available data, the protolith of the schist may have been a ultramafic komatiite or

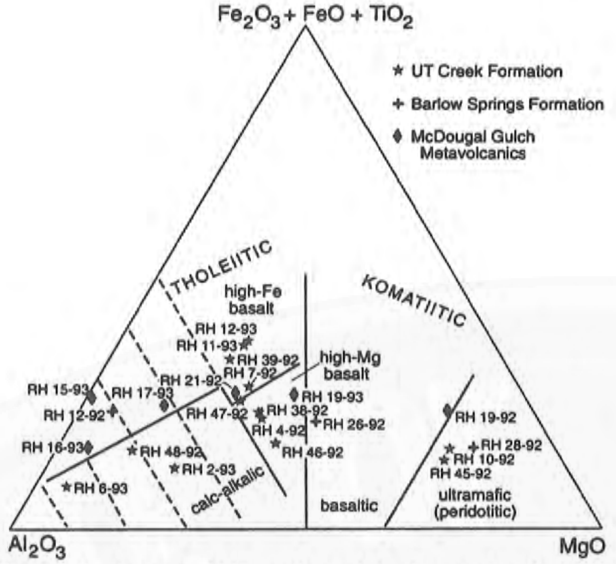

Figure 3. Jensen AMF cation plot of samples from the Rattlesnake Hills greenstone belt.

subvolcanic equivalent. The composition of the schist falls within the peridotitic (ultramafic) komatiite field on the Jensen AMF diagram (**Figure 3**).

Near the southeastern margin of the formation, a tan, weathered, banded metarhyolite(?) (Sample RH12-92) was found that produces greenish fresh surfaces. This rock contains uncommon "quartz eyes." Petrographically, the rock contains minor chlorite and clinozoisite with accessory carbonate and abundant quartz. Chemically, the rock contains 64.24% SiO_2, high CaO (12.28%), and very low Na_2O (0.04%) and K_2O (0.06%) (**Table 1**). The sample plots within the tholeiitic rhyolite field of the Jensen diagram (**Figure 3**).

The Barlow Springs Formation also includes some intercalated members of kink-banded pelitic schist, white quartzite, and tawny brecciated quartzite. The metapelitic units include hematite-biotite schist, biotite-muscovite schist, chlorite-muscovite schist, quartzofeldspathic gneiss, biotite-quartz-chlorite-sericite-almandine schist, and porphyroblastic-muscovite schist. The porphyroblasts in the muscovite schist were examined by X-ray diffraction (XRD), but no primary grains were preserved. Only the replacement products, sericite and quartz, were detected (Robert Gregory, personal communication, 1995). But based on the morphology of these grains, the porphyroblasts were possibly pseudomorphs after cordierite or andalusite.

The quartzites in this formation consist of thin beds of orthoquartzite. These include milky quartzite, tawny quartzite stained with minor limonite, and some light greenish fuchsitic quartzite.

Mafic amphibolites also occur in the formation. These include metagabbros and amphbolite schists. The metagabbro has gneissic texture; the schist is restricted in outcrop, locally exhibiting subophitic texture. This latter amphibolite is interpreted as a metamorphosed basalt.

McDougal Gulch Metavolcanics

The McDougal Gulch Metavolcanics lie stratigraphically above and geographically north of the Barlow Springs Formation. The formation is well exposed in McDougal Gulch from whence it derives its name.

The McDougal Gulch Metavolcanics consist of 5000 feet of amygdaloidal metabasalts, porphyritic metabasalts, amphibolite schists, pillow metabasalts, metatuffs, and a thin talc-chlorite schist. At a few locations, pillow selvages were found supporting the interpretation that the McDougal Gulch Metavolcanics were deposited on a seabed, similar to other greenstone terranes (**Figure 4**). But because of tectonic stretching, the morphology of the pillows could only be used with confidence for top determina-

Figure 4. Pillows in metabasalts of the McDougal Gulch Metavolcanics.

tions at one or two locations. Additionally, some shelves (or drainage cavities) in a few pillows were also used to determine bed tops. Where determined, the tops of the individual flows were located to the north.

The formation was traced for nearly 12,000 feet along a northwesterly strike with widths up to 2700 feet near the southwestern edge of the greenstone terrane. The foliation and apparent bedding in the McDougal Gulch Formation is conformable with the underlying Barlow Springs Formation and the overlying UT Creek Formation. Several narrow metagabbro sills and a felsic (tonalitic) dike intrude the metavolcanic rocks.

The formation hosts several veins and the rocks are fractured at several locations producing brittle deformation breccias. Possibly, the competency of the formation resulted in a much greater fracture frequency than the adjacent formations, and could imply that this unit may have highest potential for hosting epigenetic gold mineralization. Additionally, the mafic rocks may also have provided a more favorable source rock for exhalitive mineralization (see **Economic Geology** below).

Metabasalt collected from the McDougal Gulch Metavolcanics for whole rock geochemistry has tholeiitic basalt affinity (**Table 2**). The sample of pillow metabasalt (Sample RH21-92) consists of hornblende and oligioclase, and geochemically is a high-iron tholeiitic basalt. The sample contained 49.17% SiO_2, 15.05% Al_2O_3, 11.8% Fe_2O_3, 6.01% MgO, and 10.42% CaO and is comparable to metabasalts in the Seminoe Mountains greenstone terrane and the South Pass greenstone belt.

Table 2. Whole rock chemical analyses of rocks from the McDougal Gulch Metavolcanics. Analyses in weight percent, except where noted. Abbreviations: ppb = parts per billion; ppm = parts per million; dashes indicate not analyzed.

Oxide/element	RH14-92	Oxide/element	RH18-93	RH19-93	RH16-93	RH19-92	RH21-92	RH17-93
SiO_2	65.83	SiO_2	62.02	65.79	69.76	48.3	49.17	63.06
TiO_2	0.31	TiO_2	0.76	0.59	0.79	0.52	1.08	0.75
Al_2O_3	0.29	Al_2O_3	13.92	8.39	14.05	5.52	15.05	13.73
Fe_2O_3	25.77	Fe_2O_3	6.99	8.68	3.79	14.02	11.8	7.82
MnO	0.03	MnO	0.18	0.14	0.13	0.22	0.21	0.18
MgO	0.05	MgO	2.29	6.13	0.78	19.11	6.01	2.40
BaO	0.006	BaO	0.11	0.02	0.07	0.009	0.009	0.165
CaO	1.56	CaO	4.10	5.99	1.48	7.60	10.42	4.10
Na_2O	0.06	Na_2O	3.99	1.33	3.66	0.20	2.83	3.09
K_2O	0.21	K_2O	2.51	0.78	3.07	0.20	0.50	2.81
Cr_2O_3	0.03	Cr_2O_3	0.01	0.04	0.01	0.17	0.04	<0.01
P_2O_5	<0.03	P_2O_5	0.13	0.03	0.13	0.17	0.11	0.12
LOI	5.58	LOI	1.10	1.28	1.38	3.36	1.10	1.04
TOTAL	99.72	TOTAL	98.12	99.19	99.09	99.39	98.33	99.38
S	0.04	S	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Au (ppb)	86	Au (ppb)	11	37	9	14	<5	7
Ag (ppm)	0.3	Cr (ppm)	21	132	27	-	-	20
Cu (ppm)	122	Ni (ppm)	22	47	28	434	39	23
Pb (ppm)	17	Ga (ppm)	-	-	-	-	-	-
Zn (ppm)	24	V (ppm)	119	97	93	75	75	119
Mo (ppm)	12							
As (ppm)	239							
Sb (ppm)	5.1							
Hg (ppm)	<0.01							

Lithologies of samples as follows: RH14-92, jasperized quartz breccia vein hosted by metabasalt in E/2 Sec. 25, T.32N., R.88W; RH18-93, metatuff; RH19-93, metatuff; RH16-93, tuffaceous metagreywacke; RH19-92, talc-chlorite schist; RH21-92, pillowed metabasalt; RH17-93 amphibolite gneiss.

The McDougal Gulch Metavolcanics also include a minor outcrop of talc-chlorite schist. As no primary textures were observed in the schist, Sample RH19-92 was analyzed for whole rock chemistry in an attempt to determine its protolith. The sample contained 48.3% SiO_2, 19.11% MgO, 5.52% Al_2O_3, 0.52% TiO_2, 7.6% CaO, 434 ppm Ni, and 1700 ppm Cr_2O_3 (**Table 2**). The silica content is relatively high for a high-magnesian rock; however, the CaO/Al_2O_3 ratio of 1.4 suggests the sample has basaltic komatiite chemistry.

Other samples collected for analysis included a group of metatuffs (Samples RH18-93, RH19-93, and RH16-93). Sample RH16-93 has the appearance of an aphanitic tuffaceous metagreywacke, and Samples RH18-93 and RH19-93 are also tuffaceous rocks. The relatively high silica content of the samples support a tuffaceous protolith and the presence of quartz-feldspar clots in a mafic matrix in Sample RH18-93 is consistent with tuffaceous origin. The samples varied from 62.02 to 69.76% SiO_2, 0.78 to 3.07% K_2O, 1.33 to 3.99% Na_2O, and 1.48 to 5.99% CaO. The MgO content of the samples varied from 0.11% to a high of 6.13% (**Table 2**).

Sample RH17-93, described as a gabbroic gneiss in the field, contains pink feldspar in a gabbroic matrix. The feldspar may be a contaminate, although no reaction rims were observed. However, any igneous reaction rims, in all probability, would have been destroyed during metamorphism. The sample yielded 63.06% SiO_2, 7.82% Fe_2O_3, 13.73% Al_2O_3, 0.75% TiO_2, 2.4% MgO, 4.1% CaO, 3.09% Na_2O, and 2.81% K_2O (**Table 2**). The whole rock chemistry suggests the sample has dacitic affinity.

The metavolcanics also host a distinct iron-stained, jasperized, quartz breccia vein near the E2 section 25, T32N, R88W which may have been an iron-rich exhalite. The vein has been prospected at several locations (see **Economic Geology** below) along strike.

UT Creek Formation

The UT Creek Formation forms a mappable unit 47,000 feet long and 12,000 feet wide which lies stratigraphically above the McDougal Gulch Metavolcanics and lies in the central trough of the Rattlesnake Hills synform. The synformal axis lies near Sandy Mountain in the southern portion of the belt (**Plate 1**). The formation is named for the exposures found along UT Creek, a north-northeasterly trending fault-controlled drainage which cuts the greenstone belt in half.

The UT Creek Formation is dominated by a thick succession of metagreywackes and tuffaceous metagreywackes, separated by a relatively thick metavolcanic member. The metavolcanics consist of metabasalts and associated metagabbroic dikes and sills with limited exposures of both felsic and ultramafic metavolcanic rocks.

Metagreywackes of the UT Creek Formation consist of fine- to medium-grained metagreywackes with subordinate amounts of siliceous pyroclastic beds, tuffaceous metagreywackes, and minor interbedded metachert, graphitic schist, and metafelsite. The metagreywackes are considered distal turbidites on the basis of their fine-grained texture and fine lamination. Graded beds and crossbeds are lacking.

The metagreywackes have similar chemistry to the metagreywackes mapped in the Miners Delight Formation at South Pass. These rocks in the Rattlesnake Hills range from 59.79 to 65.94% SiO_2, 15.94 to 18.96% Al_2O_3, 2.57 to 6.76% Na_2O, and 0.8 to 4.9% K_2O (**Table 3**). Based on the whole rock chemistry, the source terrane for the Rattlesnake Hills metasedimentary rocks had a distinct intermediate component (**Figure 5**).

For the most part, the metagreywackes are fine-grained, micaceous quartzites, with a few thin tuffaceous metagreywackes containing stretched lapilli. Locally, a few metagreywacke beds are relatively aluminous and have millimeter-size almandine garnet microporphyroblasts with larger, centimeter-size, altered porphyroblasts. These porphyroblastic schists are similar to the "peanut" schists mapped at South Pass. XRD studies on the porphyroblasts from the UT Creek Formation resulted only in the identification of the replacement products mica and quartz (Robert Gregory, personal communication, 1994). However, based on the morphology of these pseudomorphs, the original porphyroblasts were probably cordierite or possibly andalusite.

The north-central portion of the UT Creek Formation is occupied by a relatively thick succession of a mafic dike-flow complex which thins and pinches along the Lost Muffler fault to the east (**Plate 1**). This complex is composed primarily of metabasalt with metagabbroic feeder dikes and sills, rare metapyroxenites, talc schist, dacite and rhyolite, and exhalitive units including graphitic schist, pyritiferous quartz veins, and jasperoids.

The mafic metabasalts of the metavolcanic member of the UT Creek Formation are typically black,

Table 3. Whole rock chemical analyses of metasedimentary rocks from the UT Creek Formation. Analyses in weight percent, except where noted. Abbreviations: ppb = parts per billion; ppm = parts per million; dashes indicate not analyzed. All samples are metagreywackes.

Oxide/element	RH5-92	RH8-92	RH10-92	RH34-92	RH1-93	RH2-93	RH3-93	RH4-93
SiO_2	64.11	61.65	59.79	63.22	65.94	60.22	63.81	60.42
TiO_2	0.52	0.64	0.68	0.58	0.56	0.41	0.65	0.42
Al_2O_3	15.94	16.41	18.05	16.08	16.21	18.13	16.48	18.96
Fe_2O_3	4.72	6.43	6.60	5.69	4.93	4.93	5.80	5.46
MnO	0.07	0.07	0.07	0.06	0.05	0.06	0.07	0.05
MgO	2.54	3.33	3.60	3.10	2.04	4.68	2.62	3.57
BaO	0.083	0.12	0.165	0.092	0.073	0.051	0.119	0.163
CaO	3.09	2.44	2.96	2.03	2.19	1.32	2.41	1.80
Na_2O	4.11	3.75	4.38	4.74	5.11	6.76	4.52	2.57
K_2O	2.19	3.00	2.91	2.59	1.96	0.80	2.50	4.90
Cr_2O_3	0.03	0.04	0.04	0.03	0.03	0.03	0.04	0.01
P_2O_5	0.23	0.25	0.24	0.19	0.12	0.21	0.17	0.18
LOI	0.89	1.17	0.94	1.64	0.53	2.46	0.88	2.61
TOTAL	98.51	99.29	100.41	100.04	99.75	100.07	100.07	101.11
S	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

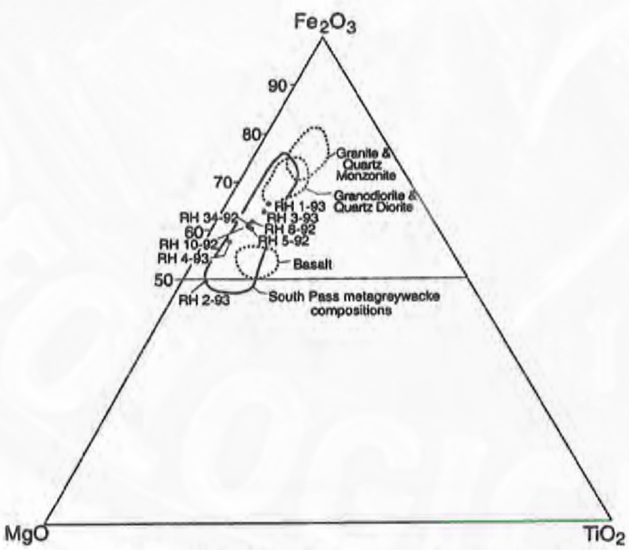

Figure 5. Fe_2O_3-TiO_2-MgO ternary diagram showing the compositional ranges of the Rattlesnake Hills metagreywackes (solid dots) compared to some common igneous rocks (dotted lines) and the range of metagreywacke compositions for South Pass (solid line).

fine-grained to aphanitic metabasalts. These rocks are weakly foliated to massive. At one location (Sample RH11-93) the outcrop had a faint hint of pillow texture. Microscopically, these metabasalts consist of oligioclase feldspar and amphibole with minor opaque minerals in an allotropic granular to subophitic texture. The chlorite schist in the metavolcanic member is a strongly foliated schist that may represent an intensely deformed and altered basalt.

The compositions of the metabasalts vary from 48.4 to 52.63% SiO_2, 0.76 to 1.96% TiO_2, 7.21 to 16.75% Fe_2O_3, 4.97 to 8.59% MgO, and 0.03 to 0.08% Cr_2O_3 (**Table 4**). Geochemically, these are iron-rich tholeiites typical of metabasalts found in other greenstone belts worldwide, as well as in Wyoming (**Figure 3**). Only the chlorite schist fell within the high-magnesian field of the Jensen diagrams. Similar iron-rich tholeiites occur in the uppermost unit of the South Pass greenstone belt (Miners Delight Formation).

The metagabbros within the metavolcanic member of the UT Creek Formation were expected to have similar geochemical characteristics to the metabasalts, especially if they represent feeder dikes for the mafic flows and erupted from the same magma chamber. Geochemically, the metagabbros vary from 47.26 to 49.25% SiO_2, 0.87 to 2.04% TiO_2, 11.19 to 17.38% Fe_2O_3, 5.65 to 8.51% MgO, and 0.03 to 0.05% Cr_2O_3, and are comparable to the metabasalts in composition (**Table 4**). Two of the four metagabbro samples fell within the iron-rich tholeiitic field and two fell within the magnesian-

Table 4. Whole rock chemical analyses of metaigneous rocks from the UT Creek Formation. Analyses in weight percent, except where noted. Abbreviations: ppb = parts per billion; ppm = parts per million; dashes indicate not analyzed.

Oxide/element	RH4-92	RH6-92	RH7-92	RH38-92	RH39-92	RH45-92	RH46-92	RH47-92	RH48-92	RH10-93	RH11-93	RH12-93
SiO_2	48.13	68.67	48.4	47.26	51.79	46.82	52.63	49.25	61.06	46.74	48.66	47.92
TiO2	0.93	0.29	1.30	0.87	1.65	0.44	0.76	0.96	0.62	0.52	1.96	2.04
Al_2O_3	15.75	16.22	15.07	16.40	13.83	7.97	13.89	15.64	17.46	7.18	13.71	13.84
Fe_2O_3	11.19	2.24	13.16	11.68	14.03	8.27	7.21	11.62	5.32	9.17	16.75	17.38
MnO	0.17	0.03	0.21	0.19	0.24	0.16	0.12	0.19	0.08	0.17	0.22	0.23
MgO	8.39	0.80	6.80	8.51	4.97	21.2	8.59	6.48	2.42	20.97	5.48	5.65
BaO	0.011	0.173	0.025	0.024	0.007	0.014	0.118	0.016	0.134	0.022	0.067	0.077
CaO	9.69	2.01	10.99	10.34	9.70	9.43	9.15	10.14	3.98	9.53	9.94	9.45
Na_2O	2.17	5.45	2.18	1.86	2.12	0.27	3.37	2.03	4.31	0.51	2.06	2.12
K_2O	0.78	1.85	0.36	0.79	0.28	0.33	1.09	1.20	3.01	<0.05	0.24	0.52
Cr_2O_3	0.04	0.01	0.06	0.05	0.03	0.23	0.08	0.04	<0.01	0.26	0.03	0.03
P_2O_5	0.07	0.17	0.11	0.05	0.09	0.25	0.48	0.07	0.41	0.21	0.15	0.15
LOI	1.84	1.22	0.86	1.31	0.50	4.77	1.80	1.36	1.04	3.78	1.12	0.98
TOTAL	99.15	99.13	99.52	99.32	99.25	100.16	99.30	99.01	99.84	99.06	100.39	100.39
S	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.03	0.02	0.02
Au (ppb)	-	-	-	-	-	<5	<5	<5	-	-	<5	<5
Cr (ppm)	-	-	-	-	-	-	-	-	-	610	128	124
Ni (ppm)	40	-	26	-	19	379	73	25	18	670	-	-
V (ppm)	78	-	102	-	131	-	-	147	77	-	181	179

Lithologies of samples as follows: RH4-92, metagabbro and the host rock for the Lost Muffler mineralized zone; RH6-92, gray, foliated, felsite porphyry with white feldspar phenocrysts in an aphanitic groundmass; RH7-92, metabasalt; RH38-92, metagabbro; RH39-92, metabasalt; RH45-92, talc schist; RH46-92, chlorite schist; RH47-92, diorite; RH48-92, metadacite porphyry; RH10-93, metapyroxenite; RH11-93, deformed pillowed metabasalt; and RH12-93, metagabbro.

rich tholeiitic field (**Figure 3**), and are chemically similar to metagabbros in the South Pass and Seminoe Mountains greenstone belts.

Rocks with ultramafic affinity in the metavolcanic member of the UT Creek Formation have limited extent. Two ultramafic samples collected for analysis included an ultramafic schist (Sample RH10-93) and a talc schist (Sample RH45-92). The ultramafic schist is a tremolite/actinolite-talc-chlorite schist comparable to peridotitic komatiite based on chemistry (**Figure 3**). The sample yielded 20.97% MgO, 670 ppm Ni, 610 ppm Cr, and a CaO/Al_2O_3 ratio of 1.3 (**Table 4**). Microscopically, the talc schist is a talc-tremolite/actinolite-cummingtonite schist and yielded 21.2% MgO, 379 ppm Ni, 2300 ppm Cr_2O_3, and a CaO/Al_2O_3 ratio of 1.2 comparable to peridotitic komatiite (**Table 4** and **Figure 3**). Even though the primary texture for these samples has been destroyed, based on their chemistry, the rock protoliths were probably komatiites. Similar ultramafic schists (principally actinolite schists) were identified in the Miners Delight Formation at South Pass (Hausel, 1991).

Intermediate to felsic igneous rocks are uncommon in the metavolcanic member of the UT Creek Formation. Where found, these include felsite and metadacite porphyries. The felsite porphyry (Sample RH6-92) is a gray (pink on weathered surface), foliated felsite with porphyritic texture. The phenocrysts consist of 0.25-inch-long euhedral to subhedral white feldspar grains and some small (millimeter size) quartz "eyes." The feldspars include microcline, partially replaced by chlorite and sericite, and some quartz "eyes" in a matrix of quartz, biotite, uncommon microcline, and opaques which produce a porphyroblastic texture. Chemically, the felsite porphyry contains 68.67% SiO_2, 5.45% Na_2O, and 1.85% K_2O.

The metadacite porphyry (Sample RH48-92) consists of labradorite and chlorite-epidote after plagioclase phenocrysts in a groundmass of quartz, feldspar, and chlorite. The whole rock chemistry, with 61.06% SiO_2, 4.31% Na_2O, 3.98% CaO, and 3.01% K_2O (**Table 4**), is comparable to dacite.

The lithology and geochemistry of the rock units of the UT Creek Formation are similar to those mapped in the uppermost unit of the Seminoe Mountains greenstone belt (Seminoe Formation) (Hausel, 1994), and to the uppermost unit of the South Pass greenstone belt (Miners Delight Formation) (Hausel, 1991). The UT Creek metagreywackes have a strong intermediate component suggesting the source terrane for these rocks was probably geochemically similar to metagreywackes mapped elsewhere in the Wyoming Province (**Figure 5**).

The metabasalts of the metavolcanic member of the UT Creek Formation are dominated by iron-rich tholeiites typical of metabasalts found in the upper parts of other greenstone belts in Wyoming (**Figure 3**), as well as the world. The associated metagabbros include both iron tholeiites and magnesian tholeiites, similar to the metavolcanic rocks found in the Miners Delight Formation at South Pass.

Border gneiss

The southwestern margin of the greenstone terrane is bordered by a gneiss complex that is older than the greenstone terrane based on the unconformable contact with the greenstone rocks and the more intense deformation textures seen in this complex (**Plate 1**). Locally, the foliation of the gneiss complex is conformable to the Rattlesnake Hills supracrustals, but for the most part, the foliation of the gneiss is oblique to perpendicular to the foliation and bedding in the supracrustals. Lithologically, the gneiss complex consists of alternating units of quartzofeldspathic gneiss, felsic gneiss, amphibolite gneiss, quartzite, fuchsitic quartzite, and metapelite.

The felsic and quartzofeldspathic gneisses are tawny to orange on the weathered surfaces, and are strongly foliated and brecciated, with limited quartz veins. Locally, the gneiss consists of fractured and brecciated milky quartz which produces a quartz breccia. In places, the gneiss hosts iron-stained, stockwork-like breccia with numerous intersecting specular hematite veinlets in ultramylonite. Mixed in the felsic and quartzofeldspathic gneiss is a medium-grained granitic gneiss with minor diabase. This gneiss has numerous quartz phenocrysts with common epidote and milky quartz veins.

The felsic gneiss locally grades into mafic gneiss, which is a greenish-grey to brownish-red amphibolite gneiss rehealed by numerous quartz stringers producing a stockwork-like texture (**Figures 6** and **7**). Diabase also occurs in this unit, and is a brown, fine-grained mafic rock with some specular hematite. The mafic gneiss becomes more stockwork-like to the north. Locally, the rock exhibits porphyritic texture.

Granite to the south of the gneiss and quartz breccia veins is pink, fine-grained, non-foliated rock. Locally, the granite contains some diabase pods which are partially brecciated and rehealed by gra-

Figure 6. Close-up view of stockwork breccia in the border gneiss complex of the Rattlesnake Hills greenstone belt.

nitic material. This area contains intermittent layers and lenses of coarse-grained granitic gneiss mixed with layers of fine-grained granite. Farther south, the granite contains alternating layers of fine-grained granite and relatively coarse-grained porphyritic and weakly foliated granodiorite.

Tertiary subvolcanic rocks

Nearly 50 vents and intrusive bodies of middle and late Eocene age were recognized by Pekarek (1977) and Carey (1959). These are peraluminous alkaline and calc-alkaline subvolcanic rocks that form plugs and dikes. Seven rock types were reported by Pekerek (1977) as rhyolite, quartz latite, latite, trachyte, soda trachyte, alkali mela-trachyte, and phonolite. Because the earlier studies by Pekarek (1977), Carey (1959), and Hoch and Frost (1993) provided numerous details on the chemistry and mineralogy of these rocks, these units were not studied during this project.

Economic geology

The core of the Rattlesnake Hills represents an Archean greenstone belt fragment intruded by several Tertiary alkalic plugs and dikes. Until 1982, the district received only minor interest or prospecting for mineral resources, yet the district may be one of the better exploration targets in Wyoming for gold.

Only a small number of prospect pits, shallow shafts, and a few short adits (based on the small size of the mine dumps) have been dug in the Rattlesnake Hills. The majority of the prospects occur near the southwestern margin of the greenstone belt on a group of parallel veins and exhalites south of Sandy Mountain and Oshihan Hill. Another group of prospects occur in the vicinity of UT Creek along the Lost Muffler trend.

Modern gold exploration began shortly after anomalous gold mineralization was found in 1982 at the Lost Muffler prospect along UT Creek (Hausel and Jones, 1982). The gold was detected in a sulfide-rich metachert exhalite associated with minor jasperoid. In addition to exhalitive gold, gold anomalies have also been detected in quartz veins, breccia veins, stockworks, and in Tertiary volcanics and breccias (Hausel, 1995). In general, the Rattlesnake Hills supracrustal belt has potential for both stratabound and disseminated gold mineralization.

Although the gold deposits in the Rattlesnake Hills are much lower grade than many of the gold occurrences identified in the South Pass and Seminoe Mountains greenstone belts by the Wyoming State Geological Survey, the potential for gold deposits that can be mined from an open pit in the Rattlesnake Hills makes this area an attractive gold target. Although some of the auriferous exhalites and veins in the Rattlesnake Hills could potentially be exploited in concert with adjacent disseminated gold mineralization, the grades of these deposits appear to be too low to justify exploitation by themselves.

Figure 7. View along strike of intensive stockwork breccia in the border gneiss complex of the Rattlesnake Hills greenstone belt.

In addition to Archean gold, epithermal gold occurs in association with some Tertiary volcanics and disruptive breccias. These latter occurrences are potential targets for large-tonnage, low-grade gold mineralization. Although no skarns have yet been identified, the possibility of auriferous skarns and replacement deposits in favorable Phanerozoic host rocks such as the carbonate units in the Gros Ventre Formation and Madison Limestone, should be considered where intruded by the Tertiary subvolcanics.

The only other known bulk tonnage, low-grade gold targets in the State occur at Copper King in the Silver Crown district of the Laramie Mountains, the Bear Lodge district of the Black Hills, and possibly in the Mineral Hill district of the Black Hills (Hausel, 1989). Other regions of the State considered as possible targets for bulk tonnage gold deposits include the Green River Basin (Hausel and others, 1995) and the Absaroka Mountains.

Since 1982, several companies have explored the Rattlesnake Hills; however, only two companies are known to have initiated drilling programs, both of which resulted in the discovery of significant gold anomalies. These programs were conducted by American Copper and Nickel Company, which drilled 32 holes for a total of 9825 feet between 1983 to 1987, and Newmont Exploration, which drilled 14 holes for a total of 10,705 feet between 1993 to 1995. It is rumored that a large-tonnage, low-grade gold resource was outlined with considerable potential for expansion.

Wall rock alteration was not studied in detail during this project. However, many of the mineralized zones in the district are associated with limonite stains. Wall rock alteration adjacent to Tertiary latite includes highly chloritized rock with some epidote, and tremolite-producing calc-silicate alteration assemblages.

This current study by the Wyoming State Geological Survey identifies several gold anomalies and describes several potential gold targets. The gold anomalies are subdivided into stratabound and disseminated deposits.

Stratabound gold deposits

The stratabound deposits include exhalites, foliation-parallel and breccia veins, and banded iron formation. Many of the stratabound occurrences in the Rattlesnake Hills are interpreted as Archean exhalites formed by fumarolic activity in an Archean sea. Where these exhalites were sampled, the gold appears to be erratically distributed, suggesting the possibility of structural control. In general, the exhalites are ferruginous cherts with trace amounts of pyrite and arsenopyrite, although some massive pyrite is associated with an exhalite in the UT Creek area.

Lost Muffler mineralized zone

The Lost Muffler mineralized zone consists of a cherty unit associated with jasperoid, sulfides, and graphitic schist that is hosted by metatholeiite. The mineralized zone was traced 4800 feet along strike. Only eight small prospect pits and one short adit were found intersecting the exhalite along this entire trend.

The Lost Muffler mineralized zone is split into two separate fragments by the UT Creek fault in the UT Creek drainage. The eastern portion of the exhalite is offset and displaced 1500 feet south relative to the western portion. The western zone is approximately 2200 feet long, whereas the eastern zone consists of 2600 feet of exhalite east of UT Creek (**Plate 1**). The exhalite lies within the metavolcanic member of the UT Creek Formation and is hosted by metabasalt and metagabbro. The metagabbro is a high-magnesian metatholeiite similar in composition to the metatholeiites which host the principal auriferous shear zones in the Atlantic City area of the South Pass greenstone belt.

The Lost Muffler mineralized zone is dominated by metachert with lesser quartz and jasperoid enclosed in a thin graphitic schist. Pyrite is locally abundant and galena occurs only in minor amounts in the exhalite.

Two 44-inch composite chip samples were collected from the pyritiferous metachert at the Lost Muffler adit in the SW section 16, T32N, R87W, in 1982. These samples, analyzed by Wyoming Analytical Laboratories, yielded 0.13 opt and 0.22 opt Au. Two grab samples of pyritized metachert collected from the mine dump assayed 0.03 and 0.04 opt Au, and 0.03 opt Ag.

Later samples collected in the mineralized zone and analyzed by Bondar-Clegg yielded anomalous gold, but an order of magnitude lower than the first group of composite chip samples collected in 1982. The difference in the assay results may have been due to either the nugget effect or analytical error.

To date, all of the samples collected in the metachert by the WSGS ranged from <0.2 to 2.0 ppm Ag, <5 ppb (parts per billion) to 7.55 ppm Au, <0.01 to 0.021 ppm Hg, 38 to 432 ppm Cu, 61 to 1307 ppm Pb, 35 to 309 ppm Zn, 5 to 36 ppm Mo, <5.0 to 124 ppm As, and 1.4 to 38.6 ppm Sb (Samples LMP82-1, LMP82-2, LMP82-3, LMP82-4, RH1-92, RH2-92, RH3-92, RH44-92, RH21-93, RH22-93, RH23-93, **Tables 5** and **6**). The gold, silver, copper, and lead are considered anomalous in these samples.

Another sample collected south of the Lost Muffler mineralized zone within the metavolcanics con-

Table 5. Selected trace metal analyses of mineralized samples from the Rattlesnake Hills district. Analyses in parts per million, except where noted. Abbreviations: ppb = parts per billion; percentages are weight percents; dashes indicate not analyzed.

Element	RH1-92	RH2-92	RH3-92	RH9-92	RH11-92	RH13-92	RH15-92	RH18-92	RH20-92	RH22-92	RH23-92	RH29-92	RH30-92
Ag	1.2	1.8	2	<0.2	0.9	1.1	0.2	0.5	1.2	<0.20	0.6	0.2	0.5
Au (ppb)	114	21	52	8	26	29	157	16	925	<5	92	300	<5
Hg	<0.01	<0.01	0.021	<0.01	0.139	0.013	<0.01	<0.01	0.028	0.012	0.372	-	-
Cu	38	432	123	57	614	423	263	22	524	37	125	-	-
Pb	197	1307	61	16	<2	9	41	11	42	16	8	-	-
Zn	35	90	59	33	25	253	18	53	12	37	4	-	-
Mo	5	6	12	9	10	18	10	16	5	8	5	-	-
As	88	124	20	75	213	110	1080	68	16500	91	131	-	-
Sb	38.6	2	1.4	3.3	1.8	1.6	11	4.6	8.2	1.5	0.4	-	-

Lithologies of samples as follows: RH1-92, Lost Muffler pyritiferous metachert; RH2-92, Lost Muffler pyritiferous metachert; RH3-92, Lost Muffler jasperoid; RH9-92, brecciated and carbonated graphitic schist with quartz breccia and jasperoid; RH11-92, iron-rich quartz-breccia vein; RH13-92, quartz breccia vein; RH15-92, cupriferous quartz vein; RH18-92, breccia; RH20-92, arsenopyrite-bearing quartz; RH22-92, volcanic breccia; RH23-92, banded chert; RH29-92, iron-stained quartz breccia; RH30-92, banded iron formation.

Table 5 continued.

Element	RH31-92	RH32-92	RH33-92	RH35-92	RH36-92	RH37-92	RH43-92	RH44-92	RH3-93A	RH9-93	LMP82-1	LMP82-2	LMP82-3	LMP82-4
Ag	1.8	<0.2	1.7	0.56	<0.2	0.28	<0.2	1.5	<0.2	-	-	-	1.03	-
Au (ppb)	367	109	164	800	300	5000	<5	10	<5	11	7550	4460	1030	1370
Hg	0.101	<0.01	0.083	-	-	-	<0.01	0.033	-	-	-	-	-	-
Cu	835	37	163	1000	-	-	146	599	49	-	-	-	-	-
Pb	12	<2	55	-	-	-	<2	113	7	-	-	-	-	-
Zn	52	4	17	-	-	-	44	571	34	-	-	-	-	-
Mo	19	4	10	-	-	-	3	13	-	-	-	-	-	-
As	4720	8820	543	-	-	-	6.2	82	-	-	-	-	-	-
Sb	2.5	3.1	0.8	-	-	-	0.7	4.2	-	-	-	-	-	-

Lithologies of samples as follows: RH31-92, quartz breccia with pyrite; RH32-92, quartz breccia with arsenopyrite; RH33-92, iron-stained breccia; RH35-92, quartz vein; RH36-92, iron-stained stockwork-like breccia in mylonitic zone in the border gneiss; RH37-92, brecciated iron formation; RH43-92, brecciated metagabbro; RH44-92, gossaniferous brecciated metagabbro; RH3-93A, brecciated metagreywacke; RH6-93, brecciated iron formation; LMP82-1, composite chip sample collected across Lost Muffler pyritiferous metachert; LMP82-2, composite chip sample collected across Lost Muffler pyritiferous metachert; LMP82-3, pyritiferous metachert from Lost Muffler prospect; and LMP82-4, pyritiferous metachert from Lost Muffler prospect.

Table 6. Trace metal analyses of mineralized samples from the Rattlesnake Hills district. Analyses in parts per million, except where noted. Abbreviations: ppb = parts per billion; percentages are weight percents; dashes indicated not analyzed.

Element	RH6-93	RH8-93	RH13-93	RH14-93	RH19-93A	RH20-93	RH21-93	RH22-93	RH23-93
Ag	<0.2	<0.2	<0.2	<0.2	<5	<5	<0.2	0.5	<0.2
Au (ppb)	28	103	9	29	370	44	31	11	<5
Ir (ppb)	-	-	-	-	<100	<100	-	-	-
Hg	0.043	0.04	0.078	0.015	-	-	<0.010	<0.010	<0.010
Bi	<5	<5	<5	<5	-	-	8	6	<5
Cu	285	128	62	1369	-	-	167	110	130
Pb	17	67	11	14	-	-	13	12	11
Zn	42	78	297	95	<200	<200	309	66	137
Mo	15	2	11	8	54	<2	36	<1	8
Co	3	16	12	9	<10	<10	8	1	2
Fe (%)	>10	3.61	6.18	5.71	7	8.2	8.34	6	3.87
Na (%)	-	-	-	-	1.7	2.8	-	-	-
Cr	155	24	108	78	170	<50	51	70	146
Ni	4	32	31	15	<20	<20	22	9	9
Cd	-	-	-	-	<10	<10	-	-	-
As	290	222	36	25	345	103	95	9	<5
Sb	7	6	8	7	11	4.1	<5	<5	7
Sn	-	-	-	-	<200	<200	-	-	-
W	<20	<20	<20	<20	55	18	<20	<20	<20
Se	-	-	-	-	<10	<10	-	-	-
Te	-	-	-	-	<20	<20	-	-	-
Th	-	-	-	-	7.6	7.5	-	-	-
U	-	-	-	-	5.5	3.1	-	-	-
Rb	-	-	-	-	280	110	-	-	-
Zr	-	-	-	-	<500	<500	-	-	-
Ce	-	-	-	-	2	3	-	-	-
Ba	548	1212	99	110	1000	980	154	23	41
La	-	-	-	-	49	34	-	-	-
Cs	-	-	-	-	98	66	-	-	-
Sm	-	-	-	-	6.5	6	-	-	-
Eu	-	-	-	-	3	2	-	-	-
Tb	-	-	-	-	<1	<1	-	-	-
Yb	-	-	-	-	<5	<5	-	-	-
Lu	-	-	-	-	<0.5	<0.5	-	-	-
Sc	-	-	-	-	25	15	-	-	-
Hf	-	-	-	-	8	6	-	-	-
Ta	-	-	-	-	<1	<1	-	-	-
Br	-	-	-	-	7	4	-	-	-
Mn	2150	1116	172	355	-	-	130	73	83

Lithologies of samples as follows: RH6-93, brecciated iron formation; RH8-93, volcaniclastics along flank of Tertiary dike; RH13-93, limonite-stained quartz vein; RH14-93, metabasalt breccia adjacent to Tertiary volcanics with a trace of copper carbonate, quartz, and limonite; RH19-93A, composite chip sample of Tertiary volcanics from Sandy Mountain; RH20-93, composite chip sample of Tertiary volcanics from Sandy Mountain; RH21-93, gray limonitic quartz; RH22-93, limonite-stained quartz vein in graphitic schist; RH23-93, limonite-stained quartz.

sisted of carbonated graphitic schist with quartz breccia and jasperoid similar to the Lost Muffler. Sample RH9-92 (**Table 5**) was collected from a prospect pit but did not yield anomalous mineralization.

Quartz breccia veins in the McDougal Gulch Metavolcanics

Narrow, foliation-parallel quartz breccia veins hosted by tholeiitic metabasalts of the McDougal

Gulch Metavolcanics were mapped in sections 23, 24, and 25, T32N, R88W. These veins consist of brecciated quartz with lesser chert, jasperoid, pyrite, and arsenopyrite and have a similar appearance to the Lost Muffler exhalite. Samples collected from a 4500-foot-long, narrow, mineralized vein yielded <0.2 to 1.8 ppm Ag, 92 to 925 ppb Au, <0.01 to 0.372 ppm Hg, 37 to 835 ppm Cu, 91 ppm to 1.65% As, <2 to 55 ppm Pb, 4 to 52 ppm Zn, 4 to 19 ppm Mo, and 0.4 to 8.2 ppm Sb (Samples RH20-92, RH23-92, RH31-92, RH32-92, RH33-92, **Table 5**).

The McDougal Gulch metavolcanics also host a distinct iron-stained, jasperized, quartz breccia vein near the E/2 section 25, T32N, R88W. The breccia vein has been prospected at several locations. A sample of the hematitic breccia vein (RH14-92) yielded 65.83% SiO_2, 25.77% Fe_2O_3, and 86 ppb Au (**Table 2**). The protolith of this rock may have been an iron-rich exhalative.

Other samples (RH11-92, **Table 5**, and RH6-93, **Table 6**) collected in the hematitic breccia vein yielded trace gold (26 ppb and 28 ppb Au) with anomalous values in copper (614 and 285 ppm Cu) and arsenic (290 and 213 ppm As). Other small stratiform, quartz breccia veins in this region yielded anomalous metal contents ranging from <0.2 to 1.1 ppm Ag, 9 to 300 ppb Au, 62 to 423 ppm Cu, 18 to 297 ppm Zn, and 36 to 1080 ppm As (Samples RH13-92, RH15-92, RH29-92, RH13-93, **Tables 5** and **6**).

These "veins" are interpreted as exhalites subjected to later brittle deformation during the Laramide orogeny. The exhalites are good exploration targets, and past drilling of some of these zones yielded highly anomalous gold values (>0.3 opt Au) over thicknesses of 10 feet (Dick Fruchey, personal communication). The abundance of exhalites in the McDougal Gulch Formation may present a sizable resource, in that six parallel, limonite-stained, quartz-rich breccia zones and veins were identified between Samples RH16-93 and RH19-93 (**Plate 1**).

Quartz breccia veins hosted by the UT Creek Formation

Some quartz breccia veins also occur in the metagreywacke section of the UT Creek Formation. These metagreywacke-hosted veins are much less common than those hosted by metavolcanic rocks in the McDougal Gulch Formation. Sample RH35-92 (**Table 5**) collected adjacent to a shallow shaft west of UT Creek yielded 0.56 ppm Ag, 800 ppb Au, and 0.1% Cu.

Banded iron formation

Samples of banded iron formation from the district are typically poorly mineralized except where the iron formation has been modified by latter deformation (**Figure 8**). In this case, the iron formation may be epigenetically mineralized, similar to localized disrupted iron formation in the South Pass and Seminoe Mountains greenstone belts (Hausel, 1993).

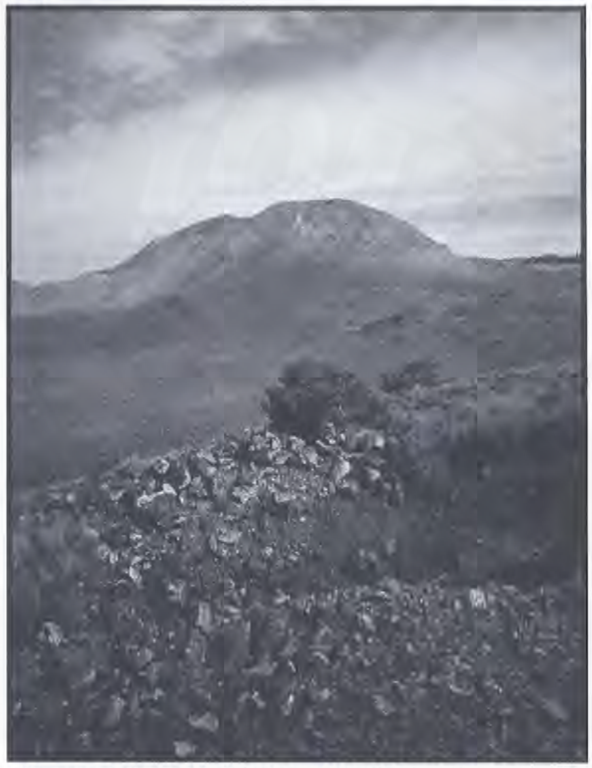

Figure 8. Prospect pit in brecciated iron formation near the Goat Mountain Tertiary stock.

Sample RH37-92 of the brecciated iron formation from a prospect pit along McDougal Gulch in NW section 25, T32N, R88W (**Figure 8**), was highly anomalous in gold. The sample yielded 0.28 ppm Ag, and 5.0 ppm Au (**Table 5**). Iron formations are typically good hosts for both syngenetic and epigenetic gold mineralization. However, in the Wyoming greenstone belts, only epigenetic gold mineralization has been recognized to date. Typically, these anomalies are localized in narrow zones and are discontinuous. Other iron formation samples (RH30-92 and RH9-93) were essentially unmineralized and contained <5 and 11 ppb Au, respectively (**Table 5**).

The available tonnage of iron formation in the district is minor; however, additional iron formation occurs in the Barlow Gap area two miles south of the Rattlesnake Hills. Four samples collected from iron formation in the Barlow Gap area (**Table**

7), consisted of low-grade banded iron formation, brecciated iron formation, and a quartz vein in the iron formation. The iron formation contained relatively low amounts of iron (7.83 to 25.87% Fe_2O_3) and high silica (69.03 to 83.52% SiO_2) with essentially background gold (6 to 10 ppb Au) and silver (<0.2 to 0.3 ppm Ag). These deposits were investigated by Western Standard Corporation of Riverton, Wyoming in 1984, and most samples collected by Western Standard in the Barlow Springs iron formations yielded no detectable gold or silver. Three of the samples yielded a trace to 0.06 opt Au and none to 0.1 opt Ag (Wyoming State Geological Survey unpublished mineral files).

Table 7. Whole rock and trace element analyses of samples from the Barlow Gap area about two miles south of the Rattlesnake Hills. Analyses in weight percent, except where noted. Abbreviations: ppb = parts per billion; ppm = parts per million; dashes indicate not analyzed.

Oxide/element	BG1-93	BG2-93	BG3-93	BG4-93
SiO_2	69.03	-	83.52	74.80
TiO_2	<0.01	-	<0.01	<0.01
Al_2O_3	0.18	-	0.24	0.19
Fe_2O_3	25.87	-	7.83	17.72
MnO	0.28	-	0.13	0.28
MgO	2.73	-	1.14	3.05
BaO	0.012	-	0.013	0.006
CaO	1.98	-	3.93	2.89
Na_2O	<0.01	-	0.03	0.05
K_2O	<0.05	-	<0.05	<0.05
Cr_2O_3	0.03	-	0.03	0.02
P_2O_5	<0.03	-	<0.03	<0.03
LOI	<0.05	-	3.30	0.53
Total	100.26	-	100.25	99.62
S	<0.02	-	0.02	<0.02
Au (ppb)	10	6	7	7
Ni (ppm)	-	-	-	-
Ag (ppm)	-	0.3	<0.2	<0.2

Sample lithologies as follows: BG1-93, quartz-grunerite-minor magnetite banded iron formation collected from W/2 section 10, T31N, R88W; BG2-93, quartz vein cross-cutting iron formation in W/2 section 10, T31N, R88W; BG3-93, low-grade iron formation breccia cemented by quartz, jasper, and calcite in SE section 9, T31N, R88W; and BG4-93, low-grade banded iron formation in center section 9, T31N, R88W.

Disseminated gold deposits

The Rattlesnake Hills were intruded by several alkalic plugs during the Eocene. Locally, the volcanics disrupted the Precambrian metamorphics and produced weakly altered brittle breccias. The alteration includes carbonate, iron-oxide, k-feldspar, and sericite replacement veinlets and breccia fillings with localized zones of massive quartz replacements along the margins of Sandy Mountain and Oshihan Hill, as well as in the narrow valley between these two plugs. Some of the breccias and nearby volcanic plugs are weakly anomalous in gold.

Tertiary volcanics

The Tertiary alkalic stocks and plugs in the Rattlesnake supracrustal succession range in composition from latite to phonolite. Additionally, a weak, pervasively altered zone associated with Sandy Mountain in section 24, T32N, R88W (**Plate 1**) consists of irregular zones of highly fractured and weakly altered metagreywacke with carbonate veinlets and minor jasperoids. Both the altered zone and the volcanics at Sandy Mountain are anomalous in gold (**Figure 9**).

Two composite chip samples (RH19-93A and RH20-93) of the Tertiary volcanics at Sandy Mountain were collected to test for gold mineralization. These were both anomalous and yielded 370 and 44 ppb Au, respectively (**Table 6**). Drilling in this area has also identified low-grade gold mineralization below the surface. Low-grade gold mineralization at an average grade of 0.024 opt was reportedly intersected over a few hundred feet of thickness (Dick Fruchey, personal communication).

The disrupted Precambrian supracrustals and the Tertiary volcaniclastics near Oshihan Hill are also weakly anomalous in gold. Samples RH18-92, RH22-92, RH8-93, and RH14-93 of these breccias yielded gold values ranging from <5 to 103 ppb (**Tables 5 and 6**).

Other breccia zones were also mapped in the district. These were not sampled in detail and need further work. At one locality, brecciated metagreywacke was found in the UT Creek Formation along the eastern end of the supracrustal belt (**Figure 10**). The breccia was weakly stained by hematite and limonite but yielded no anomalous precious metals (Sample RH3-93A, **Table 5**). At another location, Samples RH43-92 and RH44-92 (**Table 5**) of brecciated metagabbro(?) in UT Creek were collected in the N/2 section 21, T32N, R87W. The primary rock texture was destroyed and the samples contained abundant limonite boxworks, kaolinized lithic fragments, and minor secondary quartz. Sample RH43-92 was not mineralized, but

RH44-92, the more intensely altered of the two, contained trace gold (10 ppb) and silver (1.5 ppm).

Border granite-gneiss

Rocks in the border granite-gneiss complex along the southwestern margin of the greenstone belt are highly fractured with abundant stockwork-like veinlets. One sample (RH36-92, **Table 5**) collected in this complex consisted of iron-stained stockwork breccia in the granite-gneiss near the center of section 25. This sample was highly anomalous and yielded 300 ppb Au. In that the gneissic stockworks are fairly widespread, this area should be investigated in greater detail.

Figure 9. View of the Sandy Mountain stock showing exploration trenches.

Figure 10. Brecciated metagreywacke near the eastern edge of the Rattlesnake Hills greenstone belt.

Conclusions

The Rattlesnake Hills represent a fragment of a partially exposed Archean greenstone belt intruded by Tertiary alkalic volcanic rocks within the Wyoming craton. Based on mapping, the greenstone belt continues under the adjacent sedimentary rocks.

The supracrustal belt has been subjected to multiphase deformation during the Archean and later brittle deformation during the Laramide orogeny. Ductile deformation during the Archean produced foliation and at least two episodes of folding. During regional metamorphism the greenstone belt was subjected to lower amphibolite facies conditions. Later brittle deformation associated with the Laramide orogeny produced several cross-cutting and some foliation-parallel faults. Early in the Laramide orogeny, the metamorphic rocks were disrupted by volcanism.

At least three episodes of gold mineralization are recognized in the district. These include syngenetic stratabound exhalitive gold (Archean) mineralization, epigenetic gold mineralization (Archean), and disseminated epithermal gold (Tertiary). The presence of anomalous gold associated with exhalites and with the later Tertiary volcanism suggests that this region represents a favorable exploration target for gold. In particular, the possibility of low-grade, large-tonnage gold mineralization associated with some volcanics and with nearby hydrothermally altered zones and brittle breccias, is considered to be good.

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Appendix A – Descriptions of rock samples, by formation, from the Rattlesnake Hills

See **Plate 1** for sample locations. Information in parentheses indicates the table and page number on which chemical analyses or assays of the samples appear in this report.

UT Creek Formation

RH1-92 (**Table 5**, p. 17): Pyritiferous quartz with rare galena and chalcopyrite associated with milky quartz pods in gray cherty quartz from the Lost Muffler prospect. Sample contains abundant granular pyrite and pyrite cubes. Typically, the cubes average 1 mm in diameter with rare cubes up to 14 mm across.

RH2-92 (**Table 5**, p. 17): Same as RH2-92.

RH3-92 (**Table 5**, p. 17): Banded jasperoid collected 100 yards west of the Lost Muffler adit. Black jasperoid with tawny, red, and yellow bands with some translucent secondary quartz lenses. Some surfaces are pitted, but the source of the pits is unknown. Isoclinal fold closures occur in some bands.

RH4-92 (**Table 4**, p. 13): Metagabbro. Sample of the host rock at the Lost Muffler prospect.

RH5-92 (**Table 3**, p. 12): Metagreywacke.

RH6-92 (**Table 4**, p. 13): Gray foliated felsite porphyry (pink on weathered surface) with 0.25-inch euhedral to subhedral white feldspar phenocrysts in gray aphanitic matrix. Microscopically, the sample consists of K-feldspar phenocrysts partially replaced by chlorite and sericite with some quartz "eyes" in a matrix of quartz, biotite, uncommon microcline and opaques in a porphyroblastic texture.

RH7-92 (**Table 4**, p. 13): Black, fine-grained metabasalt. Microscopically contains abundant hornblende, common opaques and feldspar in allotropic granular texture. Geochemically, the sample is an iron-tholeiite.

RH8-92 (**Table 3**, p. 12): Fine-grained metagreywacke. The whole rock chemistry is similar to metagreywackes reported by Condie (1967) and Hausel (1987, 1991) at South Pass. The rock chemistry lies between basaltic to quartz dioritic.

RH9-92 (**Table 5**, p. 17): Brecciated and carbonated graphitic schist with quartz breccia and jasper collected from prospect pit.

RH10-92 (**Table 3**, p. 12): Metagreywacke. The whole rock chemistry is similar to metagreywackes reported by Condie (1967) and Hausel (1987, 1991) at South Pass. The rock chemistry lies between basaltic to quartz dioritic.

RH16-92: Porphyroblastic schist. Metagreywacke with 1-mm-size almandine grains and altered porphyroblasts of mica and quartz after cordierite(?).

RH34-92 (**Table 3**, p. 12): Metagreywacke.

RH35-92 (**Table 5**, p. 17): Sample of milky quartz with hematite blebs from dump adjacent to a 20-foot-deep shaft sunk in narrow 0.5- to 1.0-foot-wide gouge vein in metagreywacke.

RH38-92 (**Table 4**, p. 13): Metagabbro with ophitic texture. Microscopically contains amphibole with oligioclase. Whole rock chemistry places sample within high-magnesian tholeiite field.

RH39-92 (**Table 4**, p. 13): Metabasalt with subophitic texture. Composed primarily of amphibole and oligioclase. Geochemically in the high-iron tholeiite field.

RH43-92 (**Table 5**, p. 17): Metagabbroic(?) breccia.

RH44-92 (**Table 5**, p. 17): Gossan in metagabbroic(?) breccia. The texture is destroyed and the rock contains abundant limonite, boxwork limonite, kaolinized lithic clasts, and minor secondary quartz.

RH45-92 (**Table 4**, p. 13): Talc schist. Microscopically the sample is a talc-tremolite/actinolite-cummingtonite schist with whole rock chemistry comparable to peridotitic komatiite.

RH46-92 (**Table 4**, p. 13): Chlorite schist with whole rock chemistry comparable to a high-magnesian tholeiite.

RH47-92 (**Table 4**, p. 13): Metagabbro with whole rock chemistry comparable to tholeiitic basalt.

RH48-92 (**Table 4**, p. 13): Metadacite porphyry. Microscopically consists of labrodorite phenocrysts with chlorite+epidote pseudomorphic phenocrysts in a groundmass of quartz, feldspar, and chlorite. Whole rock chemistry is comparable to dacite.

RH1-93 (**Table 3**, p. 12): Metagreywacke.

RH2-93 (**Table 3**, p. 12): Cherty exhalitive. Fine-grained, greenish rock with reddish-tan weathered surface; finely laminated. The whole rock chemistry suggests the sample is comparable to calc-alkaline andesite.

RH3-93 (**Table 3**, p. 12): Dark gray metagreywacke.

RH3-93A (**Table 5**, p. 17): Brecciated metagreywacke. Lithic fragments coated with hematite and limonite.

RH4-93 (**Table 3**, p. 12): Light gray metagreywacke.

RH10-93 (**Table 4**, p. 13): Metapyroxenite(?). Microscopically consists of tremolite/actinolite-talc-chlorite schist with chemistry comparable to peridotitic komatiite.

RH11-93 (**Table 4**, p. 13): Metabasalt with possible pillow texture; chemistry is comparable to high-iron tholeiitic basalt.

RH12-93 (**Table 4**, p. 13): Metagabbro collected adjacent to RH11-93; comparable to high-iron tholeiitic basalt.

RH21-93 (**Table 6**, p. 18): Gossaniferous zone exposed in shallow 2-foot-deep pit. Contains some gray limonitic quartz similar to the Lost Muffler mineralized zone. Hosted by metagabbro.

RH22-93 (**Table 6**, p. 18): Sample collected in shallow cut along Lost Muffler tholeiites and metagreywacke contact with graphite schist. Includes 10- to 15-foot-wide limonite-stained quartz vein, which may be entirely enclosed by graphite schist.

RH23-93 (**Table 6**, p. 18): Grab sample of limonite-stained quartz from mine dump; the vein is 2-3 feet wide at this point.

RH24-93A: Porphyroblastic almandine pelitic schist.

McDougal Gulch Formation

RH11-92 (**Table 5**, p. 17): Hematitic quartz breccia vein.

RH13-92 (**Table 5**, p. 17): Contact quartz breccia vein between McDougal Gulch and UT Creek Formations. Sample is highly leached with quartz, hematite, and limonite hosted by metabasalt.

RH14-92 (**Table 2**, p. 10): Hematitic quartz breccia vein. Jasperized quartz breccia in metabasalt contains abundant jasper, milky quartz, and some hematite. Whole rock analysis shows the sample to contain 65.83% SiO_2 and 25.77% Fe_2O_3.

RH15-92 (**Table 5**, p. 17): Sample of cupriferous quartz vein taken at the eastern extension of the hematitic quartz breccia vein.

RH19-92 (**Table 2**, p. 10): Talc-chlorite schist. This sample has high magnesian content; whole rock chemistry places it within the basaltic komatiite field.

RH20-92 (**Table 5**, p. 17): Scorodite-stained quartz with primary arsenopyrite. Rock is pervasively kaolinized.

RH21-92 (**Table 2**, p. 10): Amphibolite (metabasalt) collected from pillow outcrop. Microscopically, sample consists of amphibole (hornblende) and oligioclase. Whole rock analyses places sample within the tholeiitic basalt field.

RH23-92 (**Table 5**, p. 17): Banded metachert. Consists of bands of gray quartz, green quartz, and graphitic schist. Yellowish mineral in schist identified as jarosite (alunite) on XRD.

RH31-92 (**Table 5**, p. 17): Quartz breccia vein from mine dump. Sample contains strongly iron-stained breccia with some boxworks, kaolinite, and jasper with some disseminated pyrite. Portions of the mine dump yield strong sulfur odor.

RH32-92 (**Table 5**, p. 17): Quartz breccia collected from prospect pit. The quartz is stained with scorodite and limonite and contains some primary arsenopyrite.

RH33-92 (**Table 5**, p. 17): Iron-stained breccia from prospect pit.

RH41-92: Vesicular metabasalt. Black fine-grained foliated metabasalt with common quartz-filled vesicles stretched in the plane of foliation.

RH6-93 (**Table 6**, p. 18): Composite chip sample collected over a 30-foot width in hematite quartz breccia vein.

RH7-93: Breccia quartz breccia vein. In thin section, sample consists of quartz, limonite, and minor sericite with rare lithic iron formation fragments.

RH13-93 (**Table 6**, p. 18): Hematitic-limonitic-quartz vein hosted by altered metagreywacke. Cross-cutting fractures are filled with hematite.

RH14-93 (**Table 6**, p. 18): Disrupted metabasalt breccia collected adjacent to Tertiary volcanics. The rock contains limonite, some quartz, and a trace of copper carbonate.

RH16-93 (**Table 2**, p. 10): Bleached aphanitic, tuffaceous metagreywacke(?).

RH17-93 (**Table 2**, p. 10): Gabbroic gneiss. Contains pink feldspar in gabboric matrix. Whole rock chemistry shows rock to have dacitic affinity.

RH18-93 (**Table 2**, p. 10): Similar to RH17-93. Sample contains clots of quartz and feldspar in mafic matrix.

RH19-93 (**Table 2**, p. 10): Metatuff (?). Whole rock chemistry shows rock to have basaltic affinity.

RH25-93: Hematitic-quartz breccia vein.

Barlow Springs Formation

RH12-92 (**Table 1**, p. 8): Foliated greenish banded metarhyolite (tan on weathered surface). In thin section, consists of minor chlorite, abundant quartz, minor clinozoisite, and accessory carbonate. The whole rock chemistry indicates the sample is felsic and has tholeiitic rhyolite chemistry.

RH24-92 (**Table 1**, p. 8): Low-grade quartz-grunerite-magnetite taconite.

RH25-92 (**Table 1**, p. 8): Low-grade quartz-grunerite-magnetite taconite.

RH26-92 (**Table 1**, p. 8): Talc-chlorite schist. Whole rock chemistry places sample within basaltic komatiite field.

RH28-92 (**Table 1**, p. 8): Actinolite schist. Whole rock chemistry places rock in peridotitic komatiite field.

RH29-92 (**Table 5**, p. 17): Iron-stained quartz breccia with milky quartz and foliated schist clasts.

RH30-92 (**Table 5**, p. 17): Banded iron formation and iron formation breccia from prospect pit.

RH37-92 (**Table 5**, p. 17): Brecciated and oxidized, banded iron formation collected from prospect pit.

RH40-92 (**Table 5**, p. 17): Reddish brown hematite-biotite schist.

RH9-93 (**Table 5**, p. 17): Limonitic grunerite-quartz-magnetite banded iron formation breccia.

Border gneiss complex

RH36-92 (**Table 5**, p. 17): Iron-stained, stockwork-like breccia with numerous intersecting specular hematite veinlets in ultramylonite(?) host.

RH42-92: Stockwork, felsic gneiss breccia.

Tertiary volcanics

RH17-92: Basaltic dike. Microporphyritic texture consists of plagioclase laths, with augite, andesite, and biotite in intersertal texture.

RH18-92 (**Table 5**, p. 17): Volcanic breccia.

RH22-92 (**Table 5**, p. 17): Volcanic contact breccia.

RH27-92: Latite.

RH8-93 (**Table 6**, p. 18): Tertiary dike containing breccia clasts of amphibolite schist.

RH15-93: Vesicular alkalic volcanic rock collected adjacent to Goat Mountain.

RH19-93A (**Table 6**, p. 18): Altered alkalic volcanic rocks collected from east flank of Sandy Mountain.

RH20-93 (**Table 6**, p. 18): Altered alkalic volcanic rocks collected from upper trench on Sandy Mountain.

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