WYOMING STATE GEOLOGICAL SURVEY Ronald C. Surdam, State Geologist



GUIDE TO PROSPECTING AND ROCK HUNTING IN WYOMING



by W. Dan Hausel

Information Pamphlet 11

LARAMIE, WYOMING 2004

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Front cover: This 34-ounce gold nugget was reportedly found at South Pass, Wyoming, during a past gold rush. The nugget measures about 2 1/2 inches across and includes some chalcedony nodules. Several large nuggets have been found at South Pass, including one boulder that reportedly contained as much as 630 ounces of gold (see Hausel, 1991). Photograph courtesy of the Natural History Museum of Los Angeles County, Los Angeles, California.

INTRODUCTION

Welcome to Wyoming! If you have come to our state to search for gold, diamonds, agates, or other precious metals or gemstones, you will find there is a wonderful opportunity to prospect or rock hound in the Cowboy State. Wyoming contains a large variety of minerals and rocks, and new discoveries are made every year.

Many people are under the erroneous impression that everything has already been found in the state, when in fact several gemstone and gold discoveries have been made in Wyoming during the past few decades. For instance, diamonds were accidentally discovered in 1975 south of Laramie and since then a number of diamond-bearing deposits have been identified in Wyoming and Colorado. More than 130,000 diamonds (including gems weighing more than 28 carats) have been recovered along the Colorado-Wyoming border south of Laramie. Geological and mineralogical evidence indicates that many more diamond discoveries will be made in the future.

Some gold was also found in Wyoming in recent years. One of the most impressive finds during the past 50 years was the author's 1981 discovery of an entire gold district west of Casper in the Rattlesnake Hills area (Hausel, 1998) (**Figure 1**). Following this discovery, some major mining companies and private consultants explored the district and located several other gold anomalies that led to drilling a significant, large-tonnage, low-grade gold resource at Sandy Mountain. There may be as much as 1 million ounces of gold at that site (Miller, 1999).

Several other gold discoveries were made by the Metals and Precious Stones Section at the Wyoming State Geological Survey (WSGS) during mapping projects in the historic mining districts at South Pass (Hausel, 1991), Seminoe Mountains (Hausel, 1994), Sierra Madre (Hausel, 1986), and Medicine Bow Mountains (Hausel, 1989; 1993) (**Figure 2**). In addition to the above lode discoveries, prospectors and treasure hunters have found many gold nuggets near some of these lodes with the use of metal detectors. A 7.5-ounce nugget was found at South Pass by a Wyoming prospector. Another treasure hunter from Fort Collins, Colorado found more than 100 nuggets at South Pass, and a prospector from Arizona recovered 399 nuggets in the Sierra Madre (Hausel and Sutherland, 2000).







Besides gold and diamonds, other metals and gemstones are also found in Wyoming. In 1995, a significant platinum, palladium, and nickel anomaly was identified in the Puzzler Hill area of the Sierra Madre near Saratoga (Hausel, 1997; 2000a). A few other areas in southeastern Wyoming also have the potential for discovery of platinum-group metal deposits.

Wyoming was known for its spectacular jade finds in the 1930s and 1950s, but in more recent years, other gemstones have been found. One of these was a beautiful, 1- to 2-foot long aquamarine from the Anderson Ridge area found by a prospector from Lander. In 1998, approximately 13,000 carats of gem-quality peridot and industrial olivine were recovered from two anthills near Black Rock in the Leucite Hills north of Rock Springs. Another attractive gemstone, known as iolite (gem-quality cordierite) was also found in 1998. This gem is transparent and changes from sapphire-blue to violet-blue depending on the direction from which it is viewed (Hausel and Sutherland, 2000). A group of iolite specimens weighing more than 1000 carats has been recovered by the WSGS. Some rubies and sapphires have also been found in the state. So kick a few rocks around and keep your eyes open—you may find a new mineral deposit or occurrence, maybe even a whole new district!

History of prospecting

The first prospectors in Wyoming were looking for gold. Spaniards may have found gold more than 200 years ago, but historical records indicate that gold was initially discovered in 1842. According to these records, fur trappers found gold in streams in the Wind River country, located in parts of both the Louisiana Purchase (1803) and the Oregon Territory (1846) that would later become Wyoming. In 1863, immigrants passing near Oregon Buttes along the Oregon Trail south of the Wind River area reported finding gold near the trail (**Figure 3**). Four years later, after the region had been made part of the Dakota Territory, prospectors discovered a rich lode along Willow Creek at the base of the Wind River Range. This led to the sinking of the Carissa shaft and South Pass City was built within sight of the gold mine.

Hundreds of prospectors rushed to South Pass. It is estimated that between 2000 and 10,000 gold seekers may have populated the South Pass area at the peak of the rush. Gold was soon discovered in several nearby lodes and placers in the region, and a few other towns rose from the dust. Hamilton City (near Miners Delight) and



Figure 3. Generalized map of the South Pass region, southern Wind River Range (modified from Hausel, 1991).

Atlantic City reported populations of 1500 and 500, respectively. Pacific City to the south claimed a population of 600. A few years later, after the region became part of the Wyoming Territory, gold discovered on Strawberry Creek led to establishing Lewis Town, which later became known as Lewiston.

Eventually many other gold discoveries would be recorded in the Seminoe Mountains, the Medicine Bow Mountains, the Sierra Madre, and in the Black Hills uplift (**Figure 2**). Gold has been found in every mountain range in the state; many streams draining the mountains also contain gold. During a recent investigation of placer deposits, the WSGS found gold in many streams draining the northern Medicine Bow Mountains and even found a historical gold mine within 100 yards of I-80. Gold was even found in an ancient stream channel in the Laramie City dump!

Gold was king until the end of the 19th Century, when the price of copper rose high enough for it to be considered a precious metal. The nation needed copper, and many people rushed to the Absaroka Range, Sierra Madre, and Medicine Bow, Owl Creek, and Laramie mountains of Wyoming. The greatest copper mine in Wyoming, the Ferris-Haggarty in the Sierra Madre, was discovered on a cupriferous gossan. To recover the rich ore, a 16.25-mile-long aerial tramway was constructed to haul ore from the mine west of the Continental Divide to the Boston-Wyoming mill and smelter complex at the town of Riverside east of the divide. The copper boom was followed by many other discoveries including platinum, palladium, asbestos, manganese, titanium, uranium, iron ore, coal, trona, bentonite, oil, gas, jade, and many other mineral commodities.

Mining and prospecting are important to Wyoming, and the State reaps tremendous benefits (taxes, jobs, etc.) from its mineral resources. We hope you enjoy our state and have a successful time hunting rocks and prospecting for gold and other minerals. When you find the mother lode, you will want to stake a claim.

Mining claims and leases

If you make a discovery while prospecting or rock hunting on public lands, the type and size of federal mining claims are the same in every state, as designated by Congress. Four types of mining claims can be staked on these lands: lode claims, placer claims, tunnel claims, and mill site claims. The most common claims are lode and placer.

Lode claims

A lode claim is reserved for mineralized veins or any high-value mineral or rock occurring in place, such as gold-bearing veins found in many mountains in Wyoming, or diamond-bearing kimberlites found in the southern Laramie Mountains. This also includes disseminated mineralized deposits such as the porphyry copper deposits in the Absaroka Range and roll-front uranium deposits in many Wyoming basins.

The size of a lode claim is limited to a maximum of 600 feet wide by 1500 feet long (**Figure 4**). If a lode claim is staked on a vein,



Figure 4. General diagrams for locating claims in Wyoming. a) Locating a lode mining claim. b) Locating a 20-acre placer mining claim by legal description.

the vein should divide the claim in half, with approximately 300 feet on either side. A discovery notice is required to be posted on the point of discovery. The claim notice should contain information about the claim including the name of the claim, the discoverer and locator, the date of discovery, the length of the claim along the vein measured each way from the center of the discovery shaft or point,

the general course of the vein, and a description of the claim by reference to natural or fixed objects. If the land is surveyed, a description by reference to section or quarter section corners should be noted. Six monuments or posts are required to mark the outline of the claim. The four-corners and the center of each side line are marked (**Figure 4a**). One side of each monument is marked to indicate which side of the monument faces the claim.

Placer claims

Placer claims are staked on detrital mineral deposits formed by the concentration of valuable minerals from weathered debris. The most common placer deposits are those found in river gravels of active streams such as the Sweetwater River and Rock Creek in the Atlantic City-South Pass mining districts, where gold was originally found in 1842.

A placer claim typically covers 20 acres, and is located by legal subdivisions giving quarter sections, township, and range (**Figure 4b**). If the discovery is on unsurveyed land, it is located by reference to a natural or fixed object. Larger placer claims can be located by an association of locators, and these are limited to 160 acres for a total of eight locators, or a maximum of 20 acres per individual in the association.

The claim must be marked with a securely fixed notice or sign containing the name of the claim (you must designate the claim as a placer claim, such as the Chicken-nugget Placer), the name of the locator or locators, the discovery date, the number of square feet or acres claimed, and a description of the claim with reference to fixed or natural objects. All four corners of the placer claim are required to be marked by substantial monuments or posts. After a discovery is made and marked with a notice, the claimant has up to 60 days to file their discovery with the appropriate County Clerk, and 90 days to file the claim with the U.S. Bureau of Land Management (BLM).

For additional information on staking of claims on public lands, you should contact the BLM State Office in Cheyenne (307/775-6256). The BLM also distributes informational pamphlets about rock hounding and fossil collecting on public lands. Information on mill site and tunnel site claims can also be obtained through the BLM.

If you make a discovery on State Land, you will need to apply for a lease from the Wyoming Office of State Lands and Investments in Cheyenne. If you have questions about mining claims in Wyoming, please refer to the Wyoming statutes regulating mining, specifically Title 30 (Mines and Mining) and Title 36 (Public Land). These can be found online at http://legisweb.state.wy.us/statutes/ statutes.htm.

ROCKS AND MINERALS: WHAT TO LOOK FOR

The most common rocks and minerals in Wyoming, along with some general localities in the state, are described below to get one started on prospecting, and a selected reading list is provided as **REFERENCES CITED** at the end of this pamphlet. A good addition to the list would be a descriptive rock and mineral reference book to help identify some of the more difficult minerals.

Agates, jasper, and petrified wood

Agate, jasper, and petrified wood are forms of chalcedony. Chalcedony is a compact or massive form of silica. Commonly, it forms by precipitation of silica-rich solutions as veins, cavity linings, or by replacement in a wide variety of rock types. By definition, agate imparts a distinct color banding resulting from impurities trapped in the silica as it crystallizes. Petrified wood results when the original woody material is replaced by silica-rich solutions, usually during rapid burial by silica-rich volcanic ash. Jasper is a brightly colored (red, brown, yellow) form of chalcedony.

Several distinctive varieties of chalcedony found in Wyoming have been given descriptive or geographical names by rock hunters. Some varieties are so distinctive that many rock hounds can give you the geographical location within a few miles of where the specimen was collected by merely looking at a hand-sized sample.

Banded and moss agate

Varieties of banded agate include *Rainbow agate*, which diffracts light into a rainbow spectrum of colors when thinly sliced. Rainbow agate is found in the Wiggins Formation in the southern Absaroka Range near Yellowstone National Park, and in gravels along the Wind River north of Riverton. A red and white banded agate known as *Dryhead agate* is found along the Bighorn River northeast of Lovell and in sediments eroded from the Hartville uplift northeast of Guernsey.

One of the more popular agates found in Wyoming is a very distinct and attractive agate, known as *youngite*. This is a pink silificified breccia cemented and coated with gray to blue-gray banded chalcedony (see the cover photograph of WSGS Bulletin 71 by Hausel and Sutherland, 2000). Youngite agates have only been found in eastern Wyoming in the Hartville uplift near Guernsey.

Moss agates have a distinct dendritic pattern from iron oxide or manganese oxide in white to blue chalcedony. A distinct agate known as *Sweetwater agate* contains manganese oxide dendrites in dark-blue to dark gray-blue chalcedony. Sweetwater agates are found along the Sweetwater River and Sage Hen Creek west and northeast of Jeffrey City, respectively.

Goniobasis agate

Goniobasis agate is a rock composed of dark-gray to black silicified fossil snails known as *Goniobasis* gastropods. These rock agates are found in the Green River-Granger area north of Interstate 80 in Sweetwater County. Many other specimens have been found along Delany Rim near Tipton and Red Desert just south of Interstate 80. The better samples are dark-brown to black in color, which is due in part to silicification.

Jasper

Jasper is reddish to tawny chalcedony, and is mineralogically and chemically identical to agate, with the exception of trace metals which impart the distinctive color. Many jaspers have been found in the state, but some of the better known localities are in the Granite Mountains, central Wyoming. Two extraordinary localities occur in the Tin Cup (**Figure 5**) and Rattlesnake Hills districts.

Petrified wood

Some of the better localities for petrified wood include the southern Absaroka Range; an area 35 miles north of Medicine Bow; along State Highway 130 between Saratoga and Walcott; and northeast of Farson. The most coveted samples are those collected near Farson, which are known as the *Blue Forest wood*. These contain cores of silicified wood enclosed by a light-blue to sapphire-blue chalcedony. In this same region, rock hunters used to find stumps of petrified trees standing more than 6 to 8 feet tall only a century ago (**Figure 6**).



Figure 5. Map of the Tin Cup district in the Granite Mountains (from Hausel, 1996a). Several jade, jasper, pyrite, and a few sapphire and ruby occurrences are known in the Tin Cup district. The jasper localities lie along the three parallel faults in the northern part of the district.

Copper and copper minerals

Deep green to blue stains on many rocks on old mine dumps may be copper carbonates known as malachite and azurite. A bronze-colored metallic mineral with a patina of purple and blue, known as *chalcopyrite*, is a common copper mineral in many of Wyoming's historic mining districts. When the copper deposits weather, they often produce a copper-stained



Figure 6. Historical photograph of large fossilized tree stumps found in the Whiskey Basin area (photograph courtesy of Donald A. Eastman).

gossan that is a good place to look for visible gold (**Figure 7**). Some gossans cap copper-enriched zones at shallow depths where the water table is encountered. Gold, silver, lead, zinc, and molybde-num may be found in association with copper.

About 30 million pounds of copper have been mined in Wyoming. Most of the production was from the Encampment District in the Sierra Madre, where several mines (including the famous Ferris-Haggarty) were developed to support the Boston-Wyoming smelter and mill complex at Riverside. Some high-grade ore from the Ferris-Haggarty mine was incredibly rich, containing 30 to 40% copper. For comparison, some of the major copper mines of today produce ore that has only 0.7% copper.

Copper is also found in many other places in the state includ-



Figure 7. Schematic diagram illustrating the gossan cap overlying an ore-bearing vein.

ing the Absaroka Range in northwestern Wyoming. Here, several giant copper deposits contain millions of tons of lowgrade copper, with silver, gold, zinc, lead, molybdenum, and titanium.

Chalcopyrite (copper-iron sulfide) is a brassy-orange, brittle, metallic mineral that weathers to limonite and a variety of copper minerals including malachite, black tenorite, and earthyred cuprite. *Malachite*, a light- to dark-green copper carbonate, will react with dilute (10%) hydrochloric acid (Muranic acid, a very weak form of hydrochloric acid, will also work) emitting bubbles of carbon dioxide, similar to the fizz in soda pop. If you place the same acid on tenorite or cuprite, and rub a well-used rock hammer in the acid, a thin plate of native copper will appear on the surface of the iron hammer.

Diamonds

Diamonds are some of the most valuable gemstones on the surface of the earth. Some rare faceted diamonds have been valued at 200,000 to 500,000 times an equivalent weight in gold! Thus for their size, diamonds can be an extremely valuable commodity. Diamonds are mined from two rare rock types—kimberlite (**Figure 8**) and lamproite, both of which are abundant in Wyoming. Wyoming hosts the two largest known fields of kimberlite in the U.S. and the largest lamproite field in North America. Geological and mineralogical evidence indicates that many more kimberlites and lamproites may be found in Wyoming. To date, most of the kimberlites that have been tested from Wyoming have either yielded diamonds or exhibit favorable chemistry for diamonds.

Although the first kimberlite pipe in Wyoming was found in 1960, diamonds themselves were not found until 1975. Since then, more than 130,000 diamonds have been mined in the State Line District, a region south of Laramie extending from Tie Siding, Wyoming to Prairie Divide, Colorado (**Figure 9**). A large percentage of the diamonds have been high-quality gemstones (**Figure 10**). A few diamonds larger than 28 carats were recovered from the Kelsey Lake diamond mine (**Figure 11**) just over the border in Colorado. The largest verified diamond found in Wyoming weighed more than 6 carats, although larger diamonds have been described.

The Metals and Precious Stones Section at the WSGS has identified several regions in the state where diamonds, or their host rocks are expected to be found. These areas include most of Wyoming with the exception of the Yellowstone region (**Figure 9**).

Jade

Jade is the gemologist's designation applied to two distinct and unrelated mineral species, *nephrite* and *jadeite*. Of the two, only nephrite has been found in Wyoming. However, it has been found in such abundance that nephrite jade is often synonymous with



Figure 8. Model of a kimberlite pipe showing different facies of kimberlite (not to scale) originating from a root zone at depth (from Mitchell, 1986).

"Wyoming Jade," even though it is found elsewhere in the world. *Nephrite* is an amphibole formed of extremely dense and compact fibrous tremolite-actinolite. Jadeite is a pyroxene of the augite series. Nephrite and jadeite are indistinguishable in hand specimen, and require x-ray diffraction analysis to identify.

Many similar-appearing rocks are mistaken for nephrite, such as rounded, stream-worn or wind-polished cobbles of dark-gray to green amphibolite, metadiabase, epidotite, quartzite, serpentinite, and leucocratic (white) granite. These rocks can be distinguished



▲ Cryptovolcanic structures

Figure 9. Locations of kimberlites, lamproites, and related occurrences in the Wyoming-Montana-Colorado region. Heavy dashed line indicates the extent of the Wyoming Archean Province. The shaded area indicates the Colorado-Wyoming kimberlite province.

from jade by any number of tests including some simple field observations. For example, amphibolite, metadiabase, and leucocratic granite typically have a granular texture that is lacking in jade; the freshly broken surface of quartzite tends to sparkle in sunlight due to the reflection of light off individual quartz grains; epidotite has a distinct pistachio green color and perfect cleavage; and serpentinite is relatively soft and often can be easily scratched with a pocket



Figure10. High-quality, 14.2-carat uncut octahedral diamond from the Kelsey Lake mine, Colorado (photograph courtesy of Redaurum Ltd. and Howard G. Coopersmith).



Figure 11. Highwall in one of the pits at the Kelsey Lake diamond mine, Colorado.

knife. In addition, serpentinite contains pockets of magnetite and is weakly to moderately magnetic, unlike jade.

Nephrite jade is extremely tough and resistant to fracturing. As a result, rounded boulders of nephrite are nearly impossible to break with a hammer. Because of its toughness and attractive appearance, nephrite, which has been termed the "*axe stone*," has been prized since prehistoric times.

Only *carbonado*, a black, granular to compact industrial form of diamond, is tougher than jade. However, gem-quality diamond, the hardest known mineral found in nature, lacks the toughness of jade and is easily smashed with a hammer. It is the toughness of jade, combined with its hardness that makes the gemstone carvable and durable.

Its hardness ranges from 6 to 6.5 on Mohs hardness scale (or about the same hardness as a steel file). The green color in nephrite jade is the result of iron within the crystal lattice. The amount of iron in the crystal lattice determines the various shades of green, including emerald-green imperial, apple-green, olive-green, leafgreen, black, and snowflake (mottled) jade (Bauer, 1968). When iron is absent, the mineral is practically colorless to cloudy white, resulting in a variety known as muttonfat jade. Greater commercial values are attached to the lighter green, translucent varieties.

Deposits of nephrite jade are accompanied by a distinct alteration mineral assemblage that can be used to help locate hidden jade deposits. Where found in place, jade is accompanied by a distinct, mottled pink and white granite-gneiss with secondary green clinozoisite, pink zoisite, pistachio green epidote, green chlorite, as well as white plagioclase which is pervasively altered to white mica.

When found, jade may be covered with a cream to reddishbrown weathered rind. But when it has been naturally polished, it exhibits high-gloss waxy surfaces known as *slicks*, and the jade is usually recognizable.

Large volumes of jade were found in central Wyoming a few decades ago (**Figure 12**). Jade has been reported as far west as the Wind River Mountains (McFall, 1976), and as far east as Guernsey and the Laramie Mountains. Jade has been reported in the Wind River Basin, the Rawlins golf course near Interstate 80 (Hagner, 1945), and even farther south in the Sage Creek Basin near the Sierra Madre.



Figure 12. The Rhodes boulder of apple-green jade found near Crooks Gap is about 4 feet long and 2 feet wide and weighs 3200 pounds (photograph by J. David Love).

Sapphire and ruby

Sapphire and ruby are gem varieties of corundum, the second hardest known naturally occurring mineral. It can be recognized because it can only be scratched by diamond, and is usually found as hexagonal prisms with distinct rhombohedral cleavage.

The deep red variety of corundum is termed *ruby*. All other colors of gem-quality corundum are known as sapphires, thus sapphire can be blue, green, pink, yellow, and white. Some rare varieties of corundum may contain small mineral inclusions of rutile aligned in specific, crystallographic directions forming three lines oriented 120° to one another. These will produce a star effect when light is reflected from the mineral, and are known as star rubies or star sapphires.

Gem-quality sapphires and rubies are found in Wyoming. Several (including star rubies) have been reported from the Granite Mountains north of Jeffrey City as well as elsewhere in the Granite and Wind River mountains. Many rubies and sapphires have been found west of Wheatland in the Palmer Canyon area of the Laramie Mountains along with the gemstone iolite and gem-quality kyanite. Some gem quality rubies have also been found near Encampment.

Gold

Gold occurs as a heavy, malleable, warm-colored metal. When scratched with a knife, the yellow flake or nugget will have a distinct gold-colored indentation. Gold is very heavy—15 to 19 times heavier than water. For comparison, quartz is only about 2.8 to 2.9 times heavier than water.

In general, gold is found in lodes and placers. The term *lode* simply describes an *in situ* mineralized vein or fault as opposed to a *placer*, which consists of reworked, detrital, heavy minerals concentrated in active or inactive stream gravels (**Figure 13**). Veins generally form narrow sheets of quartz, whereas most faults consist of vertical to near-vertical sheets of intensely deformed rock that often contain quartz veinlets and boudins (lenses). When mineralized, the gold values in lodes are typically erratic along much of the length of the structure and random sampling may yield only trace amounts of gold. However, periodic ore shoots (enriched zones) are sometimes encountered. Some of these zones may average more than 1 ounce of gold per ton (Hausel, 1999b). At such high grades, the gold will often be visible to the naked eye and individual pieces of rock may produce specimen-grade samples, especially when ore grades run higher than 1 ounce per ton.

In lodes, gold is often found with sulfide minerals. These may include pyrite (iron sulfide), also known as *fool's gold; arsenopyrite* (iron-arsenic sulfide); and *chalcopyrite* (copper-iron sulfide). Pyrite is often mistaken for gold; however, it is much lighter and forms brass-colored, brittle crystals that often have cubic (6-sided) or pyritohedral (12-sided) habit. Unlike gold, pyrite is not malleable and can be easily crushed to a dark greenish-gray powder by striking the mineral with a rock hammer. Scratching a streak plate (a rough, white piece of tile) with pyrite will also leave a distinct black streak of powder.

Sometimes pyrite contains hidden gold within its crystal structure. It can hide as much as 2000 parts per million (ppm) gold (this would be equivalent to a ton of pyrite containing about 60 ounces of gold) (Boyle, 1979). The gold in the pyrite would only be visible if some of the pyrite mineral had been oxidized and was replaced by



Figure 13. Schematic diagram showing the development of a placer deposit (stippled areas) in a meandering stream (from Hausel, 2002). Heavy minerals, possibly including gold, concentrate where the water velocity decreases on the inside of meander bends.

limonite (a hydrated iron oxide that is essentially rust), producing what is known as gossan, or boxworks.

A *gossan* is a reddish- to yellowish-brown, iron-rich mass found in some veins and faults. Gossans provide excellent places to search for gold since limonite, produced by the oxidation of gold-bearing pyrite, may contain specs, rods, or masses of visible gold. The better places to look for visible gold in gossans are in web-like, honeycomb, vuggy zones known as *boxworks*. Boxworks result from oxidation and removal of the pyrite, leaving behind silicified ridges, or outlines of the former crystals. Gold, being relatively inert, does not oxidize and will remain in place. Gold can sometimes be found on the boxwork ridges.

Other sulfides found with gold include arsenopyrite and chalcopyrite. Arsenopyrite, a brittle, silver-metallic mineral, will oxidize to a greenish-yellow limonite known as *scorodite*. When arsenopyrite is struck with a rock hammer, a garlic odor will be detected. This is due to arsenic in the sulfide. Some arsenopyrite can potentially hide as much as 1000 ppm gold in its crystal lattice (Boyle, 1979). One mineral that is more often mistaken for gold than pyrite is mica. Mica is often found in both lodes and placers. Each year dozens of people bring samples of mica to the WSGS believing they have found the "mother lode" (Hausel, 1999a).

Gold has been found in all of Wyoming's mountain ranges in the form of lode and/or placer deposits. Some of the better places to search for gold in Wyoming include the Wind River Range, Medicine Bow Mountains, Seminoe Mountains, Mineral Hill, and Sierra Madre. The South Pass and Lewiston districts are the most interesting areas in the Wind River Range, Douglas Creek and Gold Hill are the most interesting areas in the Medicine Bow Mountains, and the Seminoe district is of interest in the Seminoe Mountains. These mining districts are described in more detail below.

South Pass-Atlantic City district

The best place to search for specimen-grade gold samples (**Figure 14**) in Wyoming is the South Pass greenstone belt along the southeastern margin of the Wind River Range (**Figure 2**). The South Pass-Atlantic City district (**Figure 3**) encloses several gold-bearing faults (shear zones) and some veins. Many of these are located on maps published by the WSGS (see especially Hausel, 1991), and thousands of feet of gold-bearing shears in this region have never been seriously prospected!

Some ore recovered from the Carissa mine in 1908 assayed as high as 260 ounces per ton gold (Hausel, 1999c). The Miners Delight mine at South Pass was also a fairly good source of gold.

Downslope from the latter mine, historical reports indicate that water was pumped from the shaft and used to placer mine Spring Gulch. Several nuggets were found in the Spring Gulch gravels including one 6-ounce nugget, but most weighed 1 or 2 ounces. One lump of specimen-grade quartz found in 1873 was as large as a water bucket. According to one witness, it looked as if it contained a pound of gold. In nearby Yankee Gulch, northeast of the Miners Delight



Figure 14. Gold recovered from Stout placer operation on Rock Creek in the South Pass-Atlantic City district. Gold pan base is 6 inches in diameter.

mine, 8 to 15 ounces of gold were mined per day including one nugget that weighed nearly 5 ounces (Hausel, 2001).

In the central part of the district, the Rock Creek placer produced one fist-size chunk of quartz filled with an estimated 24 ounces of gold. A boulder found nearby in 1905 contained an estimated 630 ounces of gold! In recent years, hundreds of nuggets that range from less than 0.1 ounce to 7.6 ounces have been found by treasure hunters.

Lewiston district

Within the South Pass region is the Lewiston district, located east of the South Pass district (**Figures 3** and **15**). In the 1890s, a 500-foot strip of gravel that was mined at Wilson Bar along the Sweetwater River yielded 370 ounces of gold. The gold was traced upstream to a lode named the Burr. In 1893, a pocket of ore intersected at the Burr lode yielded 3000 ounces of gold. Some samples from this pocket were claimed to have assayed as much as 1690 ounces per ton of gold. To the northeast, another lode named the Hidden Hand produced an ore shoot that yielded several sacks of specimen-grade ore containing 75 to 3100 ounces of gold per ton. In recent years, some samples collected to the northeast of the Hidden Hand at the Mint-Gold Leaf lode assayed 1.29 and 3.05 ounces of gold per ton.

West of the Mint-Gold Leaf lode is a short drainage known as Giblin Gulch. The gulch cuts across the western end of the Mint-Gold Leaf shear zone, and drains into Strawberry Creek. In 1932, several nuggets were found in the gulch including some that weighed 5.2 and 5.3 ounces. Nuggets found in Two Johns Gulch in 1905 weighed 3 and 4.5 ounces. Another report indicated that five "good-size" nuggets were found in the Big Nugget placer in 1944. The exact locations of Big Nugget and Two Johns gulches are unknown, but they could be the same as Giblin Gulch.

Douglas Creek district

A popular place for placer mining is Douglas Creek in the Medicine Bow Mountains (near the Keystone area on **Figure 2**). Many nuggets found in the creek and its tributaries are typically coarse and jagged, suggesting they had been derived from nearby lodes (the largest reported nugget weighed 3.4 ounces). In recent years, several nuggets (0.5- to 1-inch long) were reported from nearby Bear



Figure 15. Geologic map of the Lewiston district (modified from Hausel, 1989).

Creek which drains into Douglas Creek. Nearly 40% of the gold recovered in Spring Creek, along the eastern edge of the district, was in the form of coarse nuggets (a 2.5-ounce nugget was found here in recent years). If you prospect in this district, you should also keep an eye out for diamonds and platinum nuggets, as they have both been found in nearby streams.

Gold Hill district

The Gold Hill district in the Medicine Bow Mountains (**Figure 2**) is located north of Douglas Creek. Some specimen-grade ore samples have been reported in this district. Samples collected from the Acme mine reportedly assayed as high as 2100 ounces per ton. Specimen-grade ore samples from the nearby Mohawk mine reportedly assayed as high as 1450 ounces per ton.

Seminoe Mountains district

The Seminoe Mountains lie near the central part of the state northeast of Rawlins and north of Sinclair (**Figure 2**). On Bradley Peak, at the western end of the range, a small group of mines were dug on narrow quartz veins. Several specimen-grade samples of gold-bearing quartz were found on the mine dumps by the author in 1981 (Hausel, 1994). Deweese Creek, which drains the Penn mines, shows very little evidence of placer mining. Based on the number of samples containing visible gold on the mine dumps, this creek should contain considerable gold.

Platinum-group metals

Platinum-group metals (PGMs) are closely associated with ultramafic rocks with high magnesium content, particularly those enriched in olivine, such as peridotites. A peridotite is a dark-greenish rock composed almost entirely of olivine with lesser pyroxene. Peridotites alter to serpentine; thus, when prospecting for platinum, the prospector should investigate rocks described as ultramafic, peridotite, or serpentinite.

PGMs have been mined from peridotites, nickel-copper deposits in alkaline igneous rocks, and in thick gabbros. However, the major PGM deposits are found in layered, mafic complexes such as the Bushveld complex in South Africa and the Stillwater complex in southern Montana. PGMs have been found in both placers and lodes in Wyoming. Platinum found in the Douglas Creek district occurs as grains or flakes. Platinum in nature has a specific gravity in the range of 14 to 17. One common impurity is iron: when present in sufficient amounts, it may cause the platinum to be weakly magnetic. Platinum is a malleable, tough, bluish-gray (steel-colored) metal with a very high melting point. It is not affected by an ordinary blowtorch. Platinum has a hardness of 4 to 4.5, and produces a shining silver streak on a streak plate or when scratched by a knife.

Platinum and palladium may be found as nuggets, grains, or flakes; they can be found in certain sulfide minerals such as sperrylite (palladium sulfide) or they may occur as impurities in some copper-sulfide minerals such as covellite. Platinum and palladium may also occur as impurities in gold, producing what is known as white gold. This may have a similar appearance to amalgamated gold, however white gold will have a consistent color throughout the metal. Amalgamated gold has a bright silver rind produced by mercury, and is distinctly gold-colored on the interior of a nugget.

Lode deposits of PGMs are often found in layered mafic complexes. Currently, several platinum, palladium, and nickel anomalies have been recognized in southeastern Wyoming. The anomalies occur in an extensive region covering three mountain ranges that parallel a major fault zone known as the Mullen Creek-Nash Fork shear zone, also known as the Cheyenne Belt.

Some of the better anomalies have been identified in the Lake Owen and Mullen Creek layered complexes (Hausel, 2000c) and the Centennial Ridge district (Hausel, 2000b) in the Medicine Bow Mountains. Anomalies were also identified in the Puzzler Hill area of the Sierra Madre to the west (Hausel, 2000c), when the author discovered significant palladium-nickel-gold-platinum-copper mineralization. Prior to the discovery, only copper was reported in this area.

The New Rambler mine, located along the northeastern edge of the Mullen Creek complex (**Figure 2**), was one of the only known mines in North America that produced platinum and palladium during the early 1900s. A cupriferous gossan was discovered here around the turn of the 19th Century and the New Rambler shaft was sunk on the gossan. Ore from the mine included many copper minerals including platinum-bearing *covellite* (CuS) and *chalcocite* (Cu₂S), with some veins containing a rare mineral known as sper-

rylite (PtAs₂). A search of nearby mines resulted in other PGM discoveries.

CONCLUSIONS

Wyoming is a vast region of spectacular geology that remains an exploration frontier. During the past three decades, the WSGS has made several interesting mineral discoveries and has mapped several mining districts. The discoveries include several gold occurrences, a gold district, silver anomalies, some diamond deposits, other gemstones (peridot, sapphire, ruby, iolite, kyanite, opal, garnet, diopside, aquamarine), a variety of lapidary minerals (agates, jasper, jasperoid), nickel, palladium, platinum, iron ore, and others. In addition, there is evidence that Wyoming has been intruded by a major swarm of kimberlites and related rocks. This is significant as kimberlite is one of two host rocks for commercial diamond deposits, and Wyoming could someday be a significant source for gem-quality diamonds.

The Metals and Precious Stone Section of the WSGS is currently working on a number of projects of interest to the prospector. A major opal deposit found by a prospector from Riverton is being mapped. The deposit covers parts of 3 square miles and may be as much as 100 feet thick locally. The Section is tracing a new discovery of iolite found near Laramie and searching for additional ruby and sapphire deposits. The Section is also sampling large to giant gold deposits around the state. Wyoming is a prospector's dream!

REFERENCES CITED

- Bauer, M., 1968, Precious stones, Volume 2: Dover Publications, Inc., New York, New York, p. 261-627.
- Boyle, R.W., 1979, The geochemistry of gold and its deposits: Geological Survey of Canada Bulletin 280, 584 p.
- Hagner, A.F., 1945, Diehl-Branham jade: Wyoming State Geological Survey Mineral Report MR45-7, 2 p.
- Hausel, W.D., 1986, Mineral deposits of the Encampment mining district, Sierra Madre, Colorado-Wyoming: Wyoming State Geological Survey Report of Investigations 37, 31 p.

- Hausel, W.D., 1989, The geology of Wyoming's precious metal lode and placer deposits: Wyoming State Geological Survey Bulletin 68, 248 p.
- Hausel, W.D., 1991, Economic geology of the South Pass granitegreenstone belt, southern Wind River Range, western Wyoming: Wyoming State Geological Survey Report of Investigations 44, 129 p., includes 1:48,000-scale color geologic map.
- Hausel, W.D., 1993, Guide to the geology, mining districts, and ghost towns of the Medicine Bow Mountains and Snowy Range Scenic Byway: Wyoming State Geological Survey Public Information Circular 32, 53 p., includes 1:100,000-scale map of selected localities.
- Hausel, W.D., 1994, Economic geology of the Seminoe Mountains mining district, Carbon County, Wyoming: Wyoming State Geological Survey Report of Investigations 50, 31 p.
- Hausel, W.D., 1996a, The Tin Cup district, central Wyoming—a rock hound's paradise: International California Mining Journal, v. 65, no. 8, p. 65-68.
- Hausel, W.D., 1996b, Geology and gold mineralization of the Rattlesnake Hills, Granite Mountains, Wyoming: Wyoming State Geological Survey Report of Investigations 52, 31 p.
- Hausel, W.D., 1997, Copper, lead, zinc, molybdenum, and associated metal deposits of Wyoming: Wyoming State Geological Survey Bulletin 70, 229 p.
- Hausel, W.D., 1998, The Rattlesnake Hills—Wyoming's little known gold district: International California Mining Journal, v. 68, no. 4, p. 44-46.
- Hausel, W.D., 1999a, Gold fever: International California Mining Journal, v. 68, no. 12, p. 17-19.
- Hausel, W.D., 1999b, Prospecting ore shoots and hidden veins for specimen-grade gold samples: International California Mining Journal, v. 68, no. 10, p. 7-28.
- Hausel, W.D., 1999c, The Carissa gold mine, South Pass, Wyoming– a sleeper?: International California Mining Journal, v. 68, no. 11, p. 14-16.

- Hausel, W.D., 2000a, The Wyoming platinum-palladium-nickel province: geology and mineralization: Wyoming Geological Association 51st Field Conference Guidebook, p. 15-27.
- Hausel, W.D., 2000b, The Centennial lode and the Centennial Ridge district, Wyoming: International California Mining Journal, v. 70, no. 2, p. 14-22.
- Hausel, W.D., 2000c, Prospecting for platinum in Wyoming: International California Mining Journal, v. 70, no. 4, p. 19-34.
- Hausel, W.D., 2001, The South Pass gold placers, western Wyoming: International California Mining Journal, v. 70, no. 8, p. 29-35 and 41-42.
- Hausel, W.D., and Sutherland, W.M., 2000, Gemstones and other unique minerals and rocks of Wyoming—a field guide for collectors: Wyoming State Geological Survey Bulletin 71, 268 p.
- McFall, R.P., 1976, Wyoming jade: Lapidary Journal, v. 30, no. 1, p. 182-194.
- Miller, D.R., 1999, Geology, gold mineralization, and economic potential of the Rattlesnake project, Natrona County, Wyoming, in Geology and Mineralization of Wyoming and surrounding regions: Wyoming State Geological Survey-University of Wyoming-Wyoming Geological Association 1999 Joint Conference Program and Abstracts, p. 16-17.

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