MINING HISTORY OF WYOMING'S GOLD, COPPER, IRON, AND DIAMOND RESOURCES

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Introduction

IT'S DIFFICULT TO determine when the region we now know as Wyoming was first explored by prospectors seeking gold and other valuable metals. The historical literature alludes to Spanish prospectors entering this region in the 18th century, although the evidence is not conclusive. By the early 1800s, gold was found by fur trappers in a few regions of Wyoming. Even Father DeSmet reported gold in the hands of Indians and whites in the Bighorn Mountains possibly in the 1840s. But by far the most important early discovery was the finding of gold in the South Pass region by a trapper from Georgia in 1842. This eventually led to the development of Wyoming's most important gold district.

The discovery of gold at Sutters Mill in California in 1848, set our early nation on fire with gold fever. The discovery probably resulted in an influx of Forty-Niners through the Wyoming-Dakota Territory on their way to the west coast, but the results of their endeavors went essentially unrecorded. If any of these prospectors took time to sample the streams from the northern flank of the Medicine Bow Mountains on their way to California, most likely they would have found gold. For, in a recent study of this area, gold was identified in nearly every drainage sampled (Hausel and others, 1992, 1993).

The 1860s were high-lighted by several gold discoveries throughout the territory. In 1863, placer gold was discovered in the vicinity of Oregon Buttes along the Oregon Trail near the southern tip of the Wind River Mountains. Two years later, a rich deposit known as the Lost Cabin, was found in the Bighorn Mountains. In 1867, gold was discovered along Willow Creek in the South Pass region near the Oregon Trail several miles north of Oregon Buttes. The news of this latter discovery attracted hundreds of prospectors to the southern tip of the Wind River Mountains and within a short time the towns of South Pass City, Atlantic City, and Hamilton City were established. In the following year (1868), gold was discovered on Douglas Creek in the Medicine Bow Mountains.

In 1871, the discovery of diamonds commanded attention in the West. The site was originally reported in Arizona, but kept secret. However, by late 1872, the location south of the Union Pacific railroad along the Colorado-Wyoming border was proven to be a hoax. This notorious scam left its scar in history that may have affected any serious prospecting ventures for diamonds in North America for many decades.

Gold continued to attract attention in Wyoming, but in 1881, rich copper deposits were discovered in the Sierra Madre. This led to the first important copper mine in the Territory, and soon copper was being mined and shipped from the Doane-Rambler mine. Sixteen years later, in 1897, a spectacular copper deposit was discovered northeast of the Doane-Rambler mine and developed into the Ferris-Haggarty mine.

Near the turn-of-the-century, our evolving industrialized nation needed iron for steel to fuel its growing economy. Wyoming had plenty of iron ore, but most was too low-grade to manufacture Bessemer steel and had to wait for technology to produce blast furnaces. However, some ore in the Hartville complex of eastern Wyoming was of sufficient quality to mine. In 1899, iron ore was shipped from the Sunrise mine after several years of copper shipments. Mining continued at the

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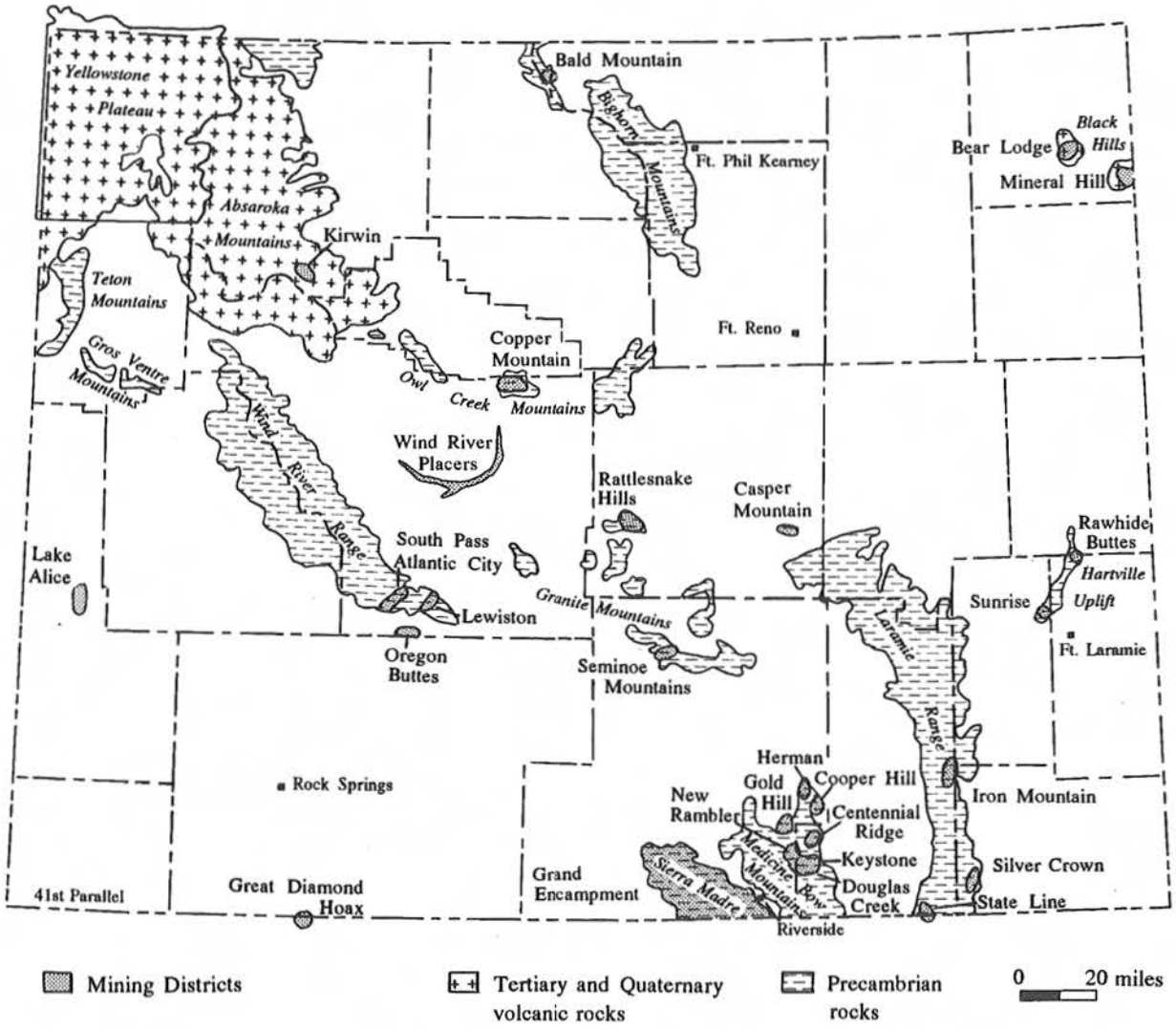

Historic Hardrock Mining Districts of Wyoming

Sunrise until the recession of the 1980s when operations terminated in 1981.

Wyoming never became a powerhouse hardrock mining state like some of its surrounding neighbors. However, based on the geology of the region, one would expect more interest in Wyoming in the future.

Bighorn Mountains

In 1865, General P. Edward Connor's expedition to the Bighorn Mountains discovered foundations of old stone houses along the shore of Lake DeSmet that were believed to be more than a century old. In the following year of 1866, the decayed remains of an arrastra (believed to be of Spanish origin) were discovered fifty miles southwest of Fort Phil Kearney (Strahorn, 1877).

Seeing many large nuggets in the hands of Indians, Father DeSmet claimed that the Bighorn Mountains contained the richest gold field in the world. Some early reports also described Indians trading gold dust and nuggets for supplies at Fort Phil Kearney along the eastern flank of the Bighorn Mountains (*American Journal of Mining* [AJM], 18 April 1865, 245).

Trappers working the Bighorn Mountains also reported gold. One trapper by the name of La Pondre with the American Fur Company claimed to have found many nuggets in the Bighorn Mountains. Years later, in July 1859, Captain Reynolds of the Corps of Topographic Engineers also reported gold in the Bighorn Mountains (Strahorn, 1877).

Sporadic discoveries continued to attract attention to this region. Strahorn (1877) reported several small

shipments of very coarse gold with nuggets of 0.02 to 0.5 ounces. Soon, nearly 3,000 prospectors were working the streams of the Bighorns.

Possibly, no other gold deposit stimulated the imaginations of gold hunters in Wyoming more than the Lost Cabin prospect. Legend claims this deposit was discovered in 1865 in the Bighorn (or possibly the Owl Creek) Mountains, and within three to six days, seven prospectors recovered nearly twenty-two pounds of gold prior to being attacked by Indians. Two prospectors escaped and traveled three nights on foot to Fort Reno east of the Bighorns. During the following spring, they organized another group of prospectors and were killed on the return trip. The location of the deposit was apparently known by some prospectors in the late 1800s, for Warren (1885) reported the Lost Cabin mine was situated near the Bighorn River, and samples from the prospect assayed 3.0 opt (ounce per ton) gold and a trace of silver. However, through time, the location has been forgotten.

At the turn-of-the-century, the Bighorn Mountains were the site of a short-lived gold rush. Gold was discovered along the western flank of the range and the town of Bald Mountain was organized to support as many as 1,500 prospectors. Three stamp mills were ordered, and the Bald Mountain district was organized west of present-day Burgess Junction (Figure 1). Gold was discovered in modern stream placers and in basal Middle Cambrian Flathead conglomerates, but the values were too low to support extended commercial operations.

These same conglomerates incited interest in the 1950s. Instead of gold, interest was for a rare-earth and thorium-phosphate known as monazite. Portions of Bald Mountain were drilled by the U.S. Bureau of Mines and a low grade zone of 20 million tons of conglomerate with an average grade of 2.5 lbs/ton of monazite was outlined. A smaller, high-grade zone was outlined that contained 675,000 tons averaging 13.2 lbs/ton of monazite. The average gold content of the rare-earth deposit was reported at 0.003 opt; however, only a small number of samples were tested and the drilling methods used were inefficient for gold recovery (King and Hausel, 1991).

It is interesting that the Bighorn Mountains commanded so much attention for gold. The geology of the Bighorns, a complex of Archean felsic gneiss and granite, is not favorable for major metal deposits. To date, with the exception of the Bald Mountain deposit, only small, localized, metal deposits have been found.

Medicine Bow Mountains

The Medicine Bow Mountains in southeastern Wyoming also attracted the attention of early explorers. Following a discovery of gold flakes and thumbnail-size nuggets in the northern Medicine Bow Mountains, Mullison (1909) became interested in the Brush Creek-Mullison Park area. According to Mullison, some Ute Indians described several ancient prospects in the upper North Brush Creek Basin to him in 1870. In 1886, Mullison investigated these and found prospects on North Brush Creek, Cortez Creek, and Mullison Creek which he interpreted to be of Spanish origin. At one of these prospects, a sixty-seven foot deep shaft sunk near the mouth of Cortez Creek cut older mine workings that contained a tunnel and a four-foot diameter shaft of unknown origin. The older workings were in very poor condition and an artifact found on the mine floor consisted of carved "elk's ivory" (Mullison, 1909).

In the same general area, Mullison found a group of prospect pits and the remains of a stone wall constructed to keep a steep bank along Mullison Creek from caving. A short distance from these prospects, Mullison found a six-foot diameter circular shaft sunk in the old creek bed. Trees growing on the mine tailings were estimated at more than 175 years suggesting the mine may have been of Spanish origin (Mullison, 1909, p. 32).

Douglas Creek District. In the early spring of 1868, rumors were circulating that gold had been discovered on the Little and Big Laramie rivers exiting the Medicine Bow Mountains on the east. A short time later, gold was discovered by Ira Moore about ten miles to the southwest in the interior of the Medicine Bow range along a tributary of Douglas Creek known as Moore's Gulch. Soon the Last Chance gold camp was established at the site. But there was evidence of earlier explorers in this region: one tree trunk found along Douglas Creek had the words "Antonia 1830" carved in it (Duncan, 1900).

Following the 1868 gold discovery, the Douglas Creek district was organized. During the first year of heavy prospecting (1869) about 400 ounces of gold were recovered. The district continued to expand and by 1876 an elaborate system of ditches for hydraulic mining had been completed (Hausel, 1993a).

Commercial gold deposits were reported in several tributaries of Douglas Creek. One company reported digging a 15 x 48 x 7-foot test pit on Muddy Creek which yielded 9.75 ounces of gold including nuggets weighing 0.2 to 0.4 ounce. The company also dug 1,000 feet of bedrock flume, 4,500 feet of ditches, with 600 feet of fluming (*Engineering & Mining Journal* [E&MJ], 28 November 1896, 519). An E&MJ article in its 27 July 1896 issue, (p. 87), reported a partial cleanup from nearby Spring Creek produced fifty ounces of gold. Much of the gold from Spring Creek was coarse with nuggets weighing 0.05 to 1.0 ounce. Quartz was still

attached to some nuggets.

Henry Beeler, State Geologist, visited the district in 1906. Beeler reported gravels with values ranging from 0.017 to 0.085 oz/yd^3, with gold ranging from flour to coarse nuggets. Some of the nuggets had considerable quartz attached indicating a proximal source. As much as 25% of the gold was coarse and jagged with nuggets weighing five to twenty pennyweights (1 ounce = 20 pennyweights). One nugget found early in the history of the district weighed 3.4 ounces (Beeler, 1906). The gold ranged from 0.890 to 0.960 fine (1.000 fine = pure gold). Impurities included as much as 10% silver with traces of platinum. The gravels were three to twenty feet thick with an average thickness of five feet. Gold was sparsely distributed throughout the gravel and concentrated on bedrock.

Decades later (1935-1946), the Medicine Bow Mining Corporation operated a dragline with floating washing plants south of Keystone on Douglas Creek. In 1935, the firm processed 48,176 yds^3 of gravel and recovered 286.84 ounces of gold and thirty-four ounces of silver (Hausel, 1989). Total gold production from the district is not known, although Currey (1965) estimated 4,000 ounces was recovered.

Centennial Ridge District. Gold was discovered along the eastern flank of the Medicine Bow Mountains in 1874. In early 1875, the first claim staked in this area was named the Centennial. A sample taken from the Centennial vein assayed forty-seven opt Au (Au = gold) (Duncan, 1990). After the assay results became public, a rush followed. By 1876, the Centennial Ridge district was established (Strahorn, 1877).

The Centennial mine began operating in 1875. A ten-stamp mill was ordered and by early fall, a 425-foot tramway was constructed to transport ore from the adit downslope to the mill (Duncan, 1990). In 1876 a sample of specimen-grade ore shipped to the Denver Mint was reported to assay 2,263.02 opt Au and 209.98 opt Ag! (Ag = silver) (Duncan, 1990). Another sample of specimen-grade ore won first prize at the 1878 Paris Mining Exposition a few years later (Dart, 1929).

Work continued until the summer of 1877 when the mine workings cut into fault gouge and lost the vein. The vein was offset by the fault and the extension of the vein could not be found. Operations terminated with total production of about 4,500 ounces.

Keystone district. A few years after the discovery of the Centennial lode, the Keystone district was established. The Keystone lode was staked on October 31, 1876, by Fletcher Dunham along the bank of Douglas Creek (Duncan, 1990).

The Keystone lode occurred as an ore shoot in quartz biotite schist at the northwestern end of a well-defined shear zone. The shear was traced more than a mile to the southeast where it cut across the Keystone quartz diorite. At the southeastern end of the shear, a second ore shoot was developed into the Florence mine.

In 1877, a five-stamp mill was moved from the Centennial Ridge district to the Keystone mine (Duncan, 1990). In 1878, a ten-stamp mill was constructed and by 1890, a forty tpd (tons per day) mill was operating on the property.

E&MJ's 25 January 1890 issue (p. 118) reported the Keystone mine produced about 10,000 ounces of gold from ore that averaged 0.84 opt Au. Several months later, the 22 November 1890 issue (p. 607) stated the Keystone produced only 3,750 ounces of gold up to 1889. The 18 April 1891 issue (p. 480) credited the Otras Mining Company with about fifty ounces of gold per week from their milling operations at the Keystone. The shaft was sunk to a depth of 365 feet with 5,000 feet of drifts. The ore averaged 1.2 opt Au (Currey, 1965).

In 1893, mining operations ceased with 6,000 tons of ore on the dump and another 100,000 tons of reserves identified underground (Currey, 1965). During the field examination of this property in 1990, I found that ore samples were very rare on the dump indicating the ore stockpile had been beneficiated sometime after the mine closure. Total gold production from the mine is unknown, although Currey (1965) estimated production at 5,000 ounces. In the 1950s the mill was dismantled and the shaft sealed.

The Florence shaft was sunk in Keystone quartz diorite near the southeastern extent of the Keystone shear. By 1878, thirty miners resided in the Florence camp. Ore from the Florence was reported to average 0.82 opt Au (E&MJ, 25 January 1890, 118). The ore consisted of low-grade mineralized rock with sporadic pockets of pyrrhotite. These pyrrhotite pockets were typically rich in gold, and some pockets were reported to carry sixteen to thirty ounces of gold (Currey, 1965). Some of the best auriferous boxwork specimens that I've found in Wyoming were collected from the Florence mine. Total gold production from the mine was estimated by Currey (1965) at 2,500 ounces.

Herman district. About the same time that gold was discovered in the Keystone district, gold was found along the northern edge of the Medicine Bow Mountains in the early part of 1876. The precious metal was discovered in loose dirt of the Overland Trail. In May, 1877, ditches were constructed to supply water for hydraulic mining operations to the Emigrant Gulch placer west of Rock Creek, but according to the *Wyoming Industrial Journal* [WIJ], 9(no. 4, 1907): 4, the activity subsided within a few years.

Twenty years later in 1897, placer operations began

again in the Rock Creek area. By June of 1897, the Overland Gold Mining Company had constructed at least three miles of ditches with 800 feet of flume with iron riffles that led from Foote and Wagon Hound creeks to Rock Creek. The placer gravel was four-to-nine feet deep with widely-dispersed and granular gold (E&MJ, 5 June 1897, 583). Hydraulic operations were also reported on Strawberry and Emigrant gulches (E&MJ, 7 March 1897, 315).

Later in June of 1897, an additional 500 feet of flume had been added to accommodate the large quantity of gravel being mined. Two giants (hydraulic monitors) were operating day and night washing 20,000yds^3 of gravel in a twenty-foot face in the east bank of Emigrant Gulch. The gravel reportedly averaged 0.036 oz/yd^3 Au, and additional giants were planned (E&MJ, 26 June 1897, 673). Samples recently panned by the Wyoming Geological Survey on Rock, Wagonhound, and Foote creeks, and Emigrant Gulch verified the presence of anomalous gold (Hausel and others, 1992, 1993).

Some lode deposits were also developed in the region. The Laramie Mining and Stock Exchange in 1896 reported considerable work was being done on Threemile Creek a few miles east of Rock Creek. The ore bodies were described as strong and well defined, carrying gold and silver and hosted by granite.

Cooper Hill district. Placer gold may have been found in Cooper Creek, a few miles southeast of the Herman district, as early as 1854. In 1877, the King Survey of the 41st Parallel also reported rumors of gold in Cooper Creek, but no apparent verification was made. In 1893, claims were staked following the discovery of gossans on Cooper Hill and lode mining began. Three years later (1896) several thousand acres of placer ground were staked along the North and South forks of Cooper Creek and on the East(?) Fork of Dutton Creek (E&MJ, 4 July 1896, 15).

Over the next few years, high-grade ore was mined and stockpiled on Cooper Hill in anticipation of construction of a mill and smelter. In 1896, E&MJ (21 November 1896, 495) reported that the Carbon County and Gold Coin Mining Company had contracted for a ten-stamp mill to be built with concentrating tables, a large boiler, and a five-ton jacket smelter. In the following year, the stamp mill was delivered and placed at the south end of Cooper Hill and 300 tons of the stockpiled ore from the Albion and Emma G mines were processed yielding an average of $17.50 per ton (Duncan, 1990). According to Duncan (1990), the smelter was not delivered, thus the base metals and refractory precious metals could not have been recovered unless the concentrates had been shipped.

In 1906, Henry Beeler, Wyoming State Geologist, visited Cooper Hill. His report noted that the Emma G mine produced the richest float, the Albion mine produced the greatest body of gold and galena, the Richmond mine produced the greatest amount of free-milling gold, and the Cooper Hill mine produced the greatest amount of copper in the district (Beeler, 1906). Beeler also mentions some ore (undoubtedly selected specimen-grade material) assayed as high as $84,000 per ton.

Activity in the district subsided after a few years. Unfortunately, the veins on Cooper Hill were typically narrow with no possibility of extending minable reserves at depth. This is because Cooper Hill is an allochtonous block of layered Proterozoic metamorphic rock thrust over much younger unmineralized Cretaceous sedimentary rock. Therefore, the Proterozoic-age veins can have no appreciable depth. Mineral deposits in the district include veins, breccia veins, replacement veins, and skarns (Hausel, 1992). Minor amounts of gold, silver, copper, and lead were recovered from the district.

Gold Hill district. In 1889, narrow, rich, quartz veins were discovered in the Medicine Bow Mountains between Douglas Creek and the North Brush Creek Basin. The first claim was staked in what was originally called the Brush Creek camp. Soon the camp became known as the Gold Hill district. Some spectacular specimen-grade material from this area assayed as high as 2,100 opt Au!

Plans were made to extend a railroad spur to the district. By 1891 a ten-stamp mill was under construction to handle ore from the Leviathan, Little Giant, and Wyoming mines (initial tests showed the ore averaged 1.5 opt Au). A twenty-stamp mill was arranged for the Niagara claim (E&MJ, 31 October 1891, 514). Unfortunately, the veins were narrow and the gold localized in pods. At $20.67 per ounce, the ore was not feasible to mine.

LaPlata district. The LaPlata district was developed from a small group of copper, silver, and gold prospects and mines immediately east of Gold Hill in the Snowy Range--none of which yielded much ore. E&MJ's 17 October 1891 issue (p. 463) reported 1,000 pounds of shipped ore from the Big Strike prospect yielded 40% Pb (lead), 31.7 opt Ag, and 0.9 opt Au. Other properties included Telephone, North American, Brooklyn, Red Bird, and Gray Copper.

The LaPlata district lies at the top of the Snowy Range in the Medicine Bow Mountains and is underlain by metacarbonates and quartzites. Many of the mines and prospect pits were developed on shears with traces of silver and copper. The known mineral deposits are typically weakly mineralized with the possible exception of the Billie Class gold deposit. The Billie Class consists

of an impressive gossaniferous shear zone, 100 to 200 feet wide, with strike length of 2,000. Recent samples yielded 0.063 ppm to 4.8 ppm Au (Dersch, 1991; Hausel, 1991a).

New Rambler district. The New Rambler deposit was discovered west of Douglas Creek near Moore's Gulch. The town of Holmes, adjacent to the New Rambler deposit, was established about 1893. From 1900 to 1918, the New Rambler produced at least 6,100 tons of copper ore with credits in Au, Ag, Pt (platinum), and Pd (palladium) (McCallum and Orback, 1968). Contained metals included 1.75 million lbs of Cu, 170 oz Au, 7,350 oz Ag, 16,870 oz Pd, and 910 oz Pt (Hausel, 1989).

The New Rambler district lies along the northeastern edge of the Mullen Creek layered mafic complex which is a sixty mi^2, highly deformed, 1.8 Ga (billion year old), tholeiitic intrusive. The complex includes twenty-one cyclic units (Loucks and others, 1988).

Jelm Mountain district. In the 1870s, copper and gold were discovered in the hills near the Laramie River along the southeastern flank of the Medicine Bow Mountains in what became known as the Jelm Mountain district. The district gained much reputation through various mining frauds (Duncan, 1990). Actual production was minimal.

The South Pass Area

Records suggest gold may have been found in the South Pass region near the southern tip of the Wind River Mountains of western Wyoming as early as 1842 by a trapper from the American Fur Company. According to Hale (1883), the discovery was made along Strawberry Creek probably in the area presently known as the Lewiston district. Conflicting reports suggest that the discoverer was either killed by Indians during his return to Georgia, or that he was part of a later group of forty prospectors that entered the South Pass Region in 1855.

This group of prospectors traveled to Fort Laramie in eastern Wyoming during the winter and was arrested there for some unknown reason. Three years later, in 1858, one member of the group returned to the South Pass region, and in 1860 he and eight others commenced mining along Strawberry Creek. The decayed remains of their sluice boxes were found in 1870 (Anonymous, 1870). In the fall of 1861, another group of fifty-two prospectors was reported mining gold on Willow Creek, but they were attacked by Shoshone Indians and driven out (Anonymous, 1870).

In 1863, placer gold was discovered in the vicinity of Oregon Buttes along the Overland Trail a few miles south of Willow Creek. Greene (1896) reported the discovery was rich enough to attract a "colony of prospectors". These prospectors worked the placers for three months before being attacked and massacred by Indians. Because of the increased Indian hostilities, the Overland Trail was abandoned for a safer route farther to the south (Greene, 1896).

In 1866, another group of prospectors entered the South Pass region, and in the following summer on June 8, 1867, lode gold was discovered along Willow Creek six to eight miles north of the Oregon Buttes placers. The lode was named the Carissa. The discovery was credited to Henry S. Reedall (AMJ, 22 February 1868, 16). Reedall and his partners worked the Carissa and were soon attacked by Indians. Three prospectors were killed and the remaining men fled, but later returned on July 28 (Anonymous, 1870).

During the ensuing winter, the handful of prospectors worked the lode with primitive hand tools and mortars and recovered more than 400 ounces of gold. An additional four tons of ore was hauled to Springville, Utah, which yielded $28,000 in gold (about 1,400 oz) (AJM, 10 August 1867, 83). And the development of the district seemed to be imminent following the pronouncement by Brigham Young from his pulpit in Salt Lake City of the richness of the gold deposits. The AJM issue of 10 August 1867, (p. 83) stated, "On Sunday last, Brigham Young in the course of his discourse is said to have declared his belief in their richness, and of all men who have not been there he is the most competent to pronounce an opinion on the matter". The news of the discovery spread and hundreds of people rushed to the region.

The district surrounding the Carissa was initially named the Shoshone district. To the northeast, the area surrounding Rock Creek was called the California district (AJM, 23 November 1867, 324). Four towns sprang from nothing in 1868. South Pass City in the Shoshone district grew to a population of 2,000 and was selected as the county seat of Carter County, Dakota Territory, although the *Kemmerer Gazette* (August 11, 1933) later reported the population of South Pass City had actually been around 5,000. Other reports inflated this number to 10,000.

Hamilton City (Miners Delight) and Atlantic City in the California district were reported to have populations of 1,500 (*Kemmerer Gazette,* 11 August 1933) and 500 (AJM, 22 February 1868, 117), respectively. Pacific City in the Pacific district to the south had a population of 600 (AJM, 22 February 1868, 117). Another district organized in 1868 northeast of the Carissa mine was known as the Kentucky Gold and Silver Mining district (AJM, 21 March 1868, 181). In 1869 the AJM of 2 January 1869 (p. 4) reported South Pass City included about 100 houses, three stores, and a brewery; and

Atlantic City and Hamilton each had about seventy-five houses and numerous tents. The variations in population statistics were undoubtedly due to the constant influx and turn-over of prospectors in the area.

By July 1869, several arrastras and three mills with a total of twenty-six stamps were operating in the region. In 1870, ten mills were operating with a total of 126 stamps (Raymond, 1873). In 1871, twelve mills were operating in the South Pass region with a total of 121 stamps, and in 1872, twelve mills with a total of 161 stamps were crushing ore. The Caribou mine near Atlantic City was producing ore averaging 0.5 to 1.5 opt Au. A short distance to the west, the Buckeye (Garfield) shaft had been in continual operation since 1868 (Raymond, 1873). At the bottom of the shaft, the vein was ten feet wide and yielded ore that averaged $9 per ton (0.4 opt): milling and mining costs averaged $6 per ton. By 1870 the mine was producing 2,500 ounces annually.

Ore processed in the Miners Delight mill to the east was estimated to average 1.0 opt Au. The western extension of the Miners Delight lode known as the Hartley mine processed thirty tons of ore in a new twenty-stamp mill which yielded an average of 1.5 opt Au. The eastern extension of the Miners Delight also operated a twenty-stamp mill and processed ore that yielded 0.4 to 0.75 opt Au. The nearby placers employed about 100 miners (Raymond, 1873).

From 1872 to 1875, interest in the South Pass region began to decline until the district was nearly deserted. After 1875, the region showed several moderate resurges followed by hiatuses. The reason for the decline in interest in South Pass is probably complex since none of the mines were ever mined out. In fact, recent studies indicated lode gold mineralization in the region is relatively widespread (Hausel, 1991b).

Many factors affected the progress of the camps. Most notable was the continued hostilities between miners and Indians. Few prospectors dared to stray far from the established gold camps and prospecting generally required a large group of associates. The AJM issue of 26 October 1867 (p. 261) reported, "...the Indians were so bad that we were compelled to prospect in large parties". Typically, many persons in the prospecting parties were required to stand guard while the rest of the partners dug for gold. In an early report following several Indian raids, it was stated by Raymond (1873), "Miners cannot work and at the same time watch and fight Indians". By 1870, the U.S. Army had established Camp Stambaugh along Smith Gulch between Atlantic City and Hamilton City. The fort was abandoned eight years later, but the army continued to patrol South Pass.

The camps of South Pass had many other problems. The gold mills were poorly designed. The E&MJ (8 March 1870, 149) reported, "Our quartz mills have been another great drawback. Many of them were bought by inexperienced men; the mills being old and useless...frequently failing to save a color of gold when the same rock crushed in an arrastra would yield forty dollars to the ton...". Another problem reported by E&MJ was the abundant frauds in the district,"...certain men have gone East and sold ledges that had no value."

Water was another problem. Many lode mines were developed in highly-permeable shear zones that provided good access for water; in some cases the workings were flooded just a few feet below the surface. Just the opposite was true for many of the placer mines where many gulches could only be worked in the spring when runoff was plentiful. But in one case, the water problem of one operation turned out to be a blessing for another. In Spring Gulch below the Miners Delight mine, placer miners used water pumped from the shaft to work their claims. Several one and two-ounce nuggets were recovered from these gravels including a six-ounce nugget. One lump of quartz as large as a water bucket was found filled with gold. According to Raymond (1873) "it looked as if it would contain a pound of gold".

The gulches were reported to be every bit as rich as the famous Dutch Flat diggings in California, although the potential volume of South Pass auriferous gravels was comparatively miniscule. Nearly every gulch in the district yielded gold. Some gulches contained extremely rich pay streaks and gold fever struck thousands of miners looking for bonanzas. These people with their wild expectations soon drifted away because the rich placers soon played out (Strahorn, 1877), or were too small to accommodate but a few miners.

Still, successes were reported. The AJM (8 August 1868, 84) reported one company shipped $20,000 in gold dust in one week (about 2,000 ounces). On March 22, 1869 W.C. Erwin arrived in Cheyenne from South Pass with sixty-five pounds of gold dust (Strahorn, 1877). The Wilson Company on Yankee Gulch near Miners Delight was taking out eight-to-fifteen ounces of gold per day including one nugget that weighed a little less than five ounces (AJM, 19 September 1868, p. 180).

Some impressive pieces of gold were also found in Rock Creek in the middle of the district. One fist-size chunk of quartz was filled with an estimated twenty-four ounces of gold. A boulder found nearby possibly contained as much as 630 ounces of gold (WIJ, 6, no. 12, 1905: 18). Other nuggets (three and four-and-a-half ounces) were recovered from Two Johns Gulch near Strawberry Gulch (Hausel, 1989, p. 164).

Several years later, in 1884, a French company managed by Emile Granier obtained large blocks of claims on Willow, Rock, and Strawberry creeks. To resolve the water shortage problems, the company plan-

ned a major undertaking to transport water for hydraulic mining to the South Pass area from Christina Lake more than twelve miles away. Ditches and flumes were built. The ditch on Rock Creek alone was nearly seven miles long. Flumes built across valleys were seventy feet high with lengths up to 500 feet. Plans were made for an 1888 start up, but production was apparently delayed until 1890.

E&MJ (28 January 1893, 87) reported gold production from the first year's (1890) operation of the Christina Lake placers amounted to about 1,500 ounces. In the following year, gold production from the placers amounted to more than 6,720 ounces (E&MJ, 10 October 1891, 436), but it appeared the Christina Lake operation had been a failure. In 1895, the E&MJ (12 October 1895, 355) reported more than $900,000 had been spent to put the Christina Lake placers in operation, and by 1895, the property had been leased to the Rock Springs Placer Company. The gold produced from 1890 and 1891 was worth only about $170,000. Unless there had been significant production from 1892 to 1895, the operations would have been a financial failure.

Two lode mines that continued to attract attention were the Carissa and the Miners Delight. The Carissa was developed on a narrow shear ranging from one-to-fifty feet wide enclosed by an envelope of 100 to 200 feet of highly fractured and rehealed wallrock (Hausel, 1991b).

Some of the ore from the Carissa mine was refractory. Anthony (1872) reported large quantities of pyritiferous rock on the tailings was assumed to be valueless. Analysis of some of the waste yielded 3.5 opt Au. The sulfides were then run through stamps and amalgamators and only 0.75 opt Au was recovered, the rest reported to the tailings.

From 1902 to 1906, the Federal Gold Mining Company extended the Carissa mine workings to five levels. In 1947 the mine was equipped with a seventy-ton amalgamation-cyanide mill, and was later operated in 1954 by the Pioneer Carissa Gold Mines. In the 1970s, Anaconda Mining Company optioned the property, but the option was dropped in the 1980s following bankruptcy of the mining giant.

The Miners Delight mine, several miles to the east, began operations in 1868. On February 15, 1869 gold shipped to the Denver Mint from a week's run of the Miners Delight mill totaled 157 pounds and three ounces of gold bullion (AJM, 17 April 1869, 245). The mine operated from 1868 to 1874 and idled until 1880. Operations began again from 1880 to 1882. In 1887 Warren (1887) reported the Miners Delight mine was sitting idle principally because of the high cost of living in Wyoming. E&MJ (10 January 1891, 74) reported a new ten-stamp mill was constructed at Miners Delight in 1891.

Lewiston district. The region known as the Lewiston district, twelve miles southeast of Atlantic City, began to receive some interest in the 1870s. The date when the district was established is unclear. Weis (1974) reported Lewiston was founded in 1879. Pfaff (1978) noted that Martin Lewis discovered placer gold on Strawberry Creek in 1875, which led to the establishment of Lewis Town (later known as Lewiston).

Gold was found south of Strawberry Creek at Wilson Bar in 1878. According to early reports, some pockets in this placer were extremely rich. The Wilson Bar placer lies at the mouth of Burr Gulch where it intersects the Sweetwater River. Gold from Wilson Bar was traced upstream to the Burr lode, which may have been found as late as 1886 (*Lewiston Gold Miner,* 1 (no. 1, 1894). In 1893 E&MJ (14 October 1893, 406) reported a pocket of ore had been intersected at the Burr mine that yielded 3,000 ounces of gold. The lode was reported to be seven-to-ten feet thick and to average 2.0 to 3.5 opt Au.

The Hidden Hand lode north of the Burr was probably discovered shortly after the Burr. Many years later, in the 1930s, miners at the Hidden Hand intersected a rich shoot that produced several sacks of specimen-grade ore with seventy-five to 1,650 opt Au, and a few that reportedly contained 10% Au (3,100 opt) (Pfaff, 1978).

During the Great Depression, people turned to mining to make a living. In 1932 it was reported that many people were panning gold in the South Pass region. From 1933 to 1941 to E.T. Fisher Company dredged six miles of Rock Creek using a dragline (Ross and Gardner, 1935). This operation was continuous until the United States entered World War II. A minimum of 11,500 ounces (possible as much as 30,000 ounces) including nuggets up to 3.4 ounces were recovered (Hausel, 1991b).

After the Second World War, only minor amounts of gold were mined as the main focus shifted from gold to iron. Serious exploration of banded iron formations began in 1954 north of Atlantic City. In August 1962, U.S. Steel Corporation shipped the first iron pellets from its Atlantic City open pit to Geneva, Utah (Bayley, 1968). From 1962 until operations ceased in 1983, more than ninety million tons of iron ore were mined.

Gold mining activities were minimal during much of this time. But when Congress eliminated the gold standard in 1969, gold prices were free to rise; by early 1980, gold prices were the highest in history and continued to rise, stimulating exploration. A few small placer mines began production, but by the early-to-mid 1980s, the worldwide recession crippled the U.S. mining industry as well as interest in South Pass. In 1986,

interest in South Pass picked up again with nearly a dozen companies exploring for gold, but this was soon attenuated by the 1987 stock market panic.

Total gold production from the South Pass region is unknown and few statistics were ever recorded. E&MJ (28 January 1893, 87) reported gold production totalled 600,000 to 700,000 ounces. The U.S. Geological Survey later estimated production amounted to only about 70,000 ounces (Koschmann and Bergendahl, 1968). Later work in the district produced a figure of 348,000 ounces based on production statistics and historical estimates (Hausel, 1991b).

Very generally, the South Pass area is interpreted as a greenstone belt floored by ultramafic and mafic metaigneous rocks that include primitive, alkali-poor, ultramafic lavas and subvolcanics and tholeiitic lavas and sills. This lower unit is overlain by a thin metasedimentary-metavolcanic unit of metatholeiite, metapelite, quartzite, and banded iron formation, which is overlain by a metatholeiite unit. The youngest supracrustal unit includes ultramafic, tholeiitic, and calc-alkaline metaigneous rocks capped by a fining-upward metasedimentary sequence. These rocks are intruded by granite, granodiorite, and tonalite, and are intercalated with augen gneiss (gneiss complex) along the northern margin of the belt (Hausel, 1991b).

Today, we recognize two mining districts at South Pass: the South Pass-Atlantic City district along the northwestern flank of the South Pass synclinorium, and the Lewiston district along the southeastern flank. Auriferous paleoplacers eroded from the greenstone belt occur in Tertiary conglomerates and fanglomerates in the Oregon Buttes area south of the Greenstone belt and in the McGraw Flats area northeast of the greenstone belt. Paleoplacers are also present within the greenstone terrane.

Seminoe Mountains

The Seminoe Mountains of central Wyoming were explored for gold several years after the South Pass region. These mountains were named in honor of one of General John C. Fremont's guides, Basil Cimineau Lajeunesse. Lajeunesse, a French trapper, was responsible for leading Fremont's expedition out of the Sweetwater Valley through Seminoe Pass, twenty miles west of the Seminoe Mountains near the western edge of the Ferris Mountains (Reed, 1872). Lajeunesse's middle name, Cimineau, is pronounced "Seminoe" in English. Seminoe Pass was renamed Whiskey Gap following the destruction of a load of 'bootleg' whiskey by Captain Brown of the 11th Ohio cavalry at a spring in the gap in July of 1862 (Ferry, 1871).

Nine years later in June 1871, troops under the command of generals Bradley of Fort Sanders and Thayer of Nebraska, set out on an expedition to the Seminoe Mountains to search for reported rich deposits of argentiferous galena (Ferry, 1871). One report by Lt. R.H. Young of Fort Steele in 1869, described three prospectors returning from the Seminoe Mountains with samples of quartz assaying $2,000 a ton in silver (Morrow, 1871)(about 1,500 opt Ag).

Instead of finding silver (which probably came from the Ferris Mountains to the west of the Seminoes), gold-quartz veins were discovered by Mr. Ernest, a prospector from Laramie who accompanied the 1871 expedition. Ernest's discovery was made along the flank of Bradley Peak (named in honor of General Bradley) about one-half mile west of Deweese Pass. Deweese Pass was named for Captain Deweese who was the first military officer to drive through the pass with wagons (Ferry, 1871). Shortly after General Bradley's expedition, a second expedition led by General Morrow with Captain Deweese of Fort Steele, was accompanied by E.P. Ferry (surveyor).

Several gold prospects were staked following these historic expeditions. Most of the prospects were located on well-defined gold-quartz veins along the flank of Bradley Peak in what was initially known as the Ernst mining district. In several instances, the ore was reported to assay as high as $100 per ton in gold (5 opt), and in one case ran as high $250 per ton (12 opt) (Morrow, 1871). In 1873, everything appeared propitious following the erection of a stamp mill by the owners of the Ernst gold mine (Reed, 1873), but in the following year, all prospecting and mining came to an abrupt halt. According to an 1874 congressional report, many fatalities resulted from an Indian raid on the mining camp, and the few survivors were driven from the district (Reed, 1874). A cavalry expedition to the district shortly after the attack reported that all thirty cabins and the stamp mill were vacated (*Rawlins Sentinel,* 11 September 1874).

The Seminoe district was avoided by miners and prospectors for the next few years. As many as four years after the conflict, an 1878 congressional report stated, "A visit to the Seminoe Mountains found the mining camp for the most part deserted." A sample collected from the Ernst tunnel at this time assayed $106.20 in gold per ton (5.14 opt). The report went on to say, "Other prospects in this locality afford quite good indications; and, now that the Indians are no longer to be feared there, I shall expect a revival of interest in it on the return of more prosperous times" (Reed, 1878).

This optimistic report apparently did not hold true, for in an 1881 congressional report it was written that the "...shafts went down to a little depth and tunnels had been ambitiously started when this camp too was broken up by a band of hostiles...." It's not

clear if this report is referring to the earlier 1874 raid or a later raid in 1881. In any case, if hostile attacks were not enough, the mining properties were also held in litigation, for it was also stated "...this property, long in litigation, has just been fully cleared as to its title, and the present undisputed owners are preparing to commence work the next season..." (Corey, 1881).

According to E&MJ (18 April 1885, 269), some of the mines were purchased by the Penn Mining Company in 1885. The company, based out of Wilkes-Barre, Pennsylvania, was incorporated on May 5th, 1885 with a capital stock of $100,000. Five company trustees were named including Samuel Aughey, the Wyoming Territorial Geologist, who would later be accused of fraud in the Silver Crown district in eastern Wyoming.

Aughey (1886) reported that the company extended the Deserted Treasure tunnel (possibly the original Ernst mine) to a length of 200 feet. The ore was described as having free-milling gold in quartz associated with pyrite and chalcopyrite. The vein averaged four feet thick. The company constructed a ten-stamp mill with concentrator that successfully handle about twenty-two tons of ore per day (Warren, 1885; Aughey, 1886). Plans were made to construct another stamp mill after the Penn Mining Company struck a six-foot gold-bearing vein (E&MJ, 9 October 1886, 265).

A document published ten years later in 1895 disagreed as to the success of the mill and reported the ten-stamp mill erected by the Penn Mining Company proved to be a failure due to bad management (and possibly due to the lack of oxidized ore and abundant sulfides). Three clean-ups from the mill gave $8, $12, and $16 in gold per ton (E&MJ, 18 May 1895, 472).

Another mine operated by the Penn Mining Company, the King mine, ran almost parallel to the Deserted Treasure. In 1886, improvements in the King mine included a 120-foot drift with a fifty-four foot deep winze. At the bottom of a winze, the ore was five feet thick. Seventy tons of the ore reduced by the mill yielded $700 in gold, but the sulfides were not saved. The East King mine shaft encountered a streak of very high-grade, gold-bearing quartz.

In 1894, the Penn Mining Company resumed work after a six-year shutdown (E&MJ, 29 December 1894, 615). The King mine was extended from 120 feet in 1886 to 700 feet in 1896. The vein was one-to-four feet wide with an average width of thirty inches. Assays of the quartz averaged $25 in gold per ton (1.2 opt)(E&MJ, 8 August 1896, 135). The "Penn mine" tunnel was extended to 165 feet with a 135-foot deep winze on a three-to-five foot wide vein. Drifts were driven along the ore body for a distance of 100 feet in each direction. The ore averaged $20 in gold per ton (1.0 opt) and carried some copper. The stamp mill, however, recovered only three-to-four dollars per ton due to the refractory nature of the ore (E&MJ, 8 August 1896, 135).

In 1902, some interest was expressed for iron in the district when Hendricks (1902) examined high-grade iron deposits in the Pattison Basin area along the southern flank of Bradley Peak for the Lake Superior iron company. The Pattison Basin deposits were estimated to include one million tons of ore at an average grade of 60% iron. In 1906, more interest was shown for the extensive iron deposits in the Seminoe Mountains after the Western Iron Ore Company acquired claims in the district. At about the same time, Dickman (1906) reported some of the iron contained precious metals.

The first detailed description of the iron deposits was made by Lovering (1929). Another detailed investigation was made thirty-seven years later by the U.S. Bureau of Mines (Harrer, 1966). Harrer estimated about 100 million tons of taconite (banded iron formation) occurred in the vicinity of Bradley Peak.

In 1979 and 1980, gold prices rose to their highest levels in history. In the following year (1981), the author visited the Seminoe district and recovered several quartz vein samples with visible gold that assayed a maximum of 2.87 opt. A sample of altered iron formation recovered at this time assayed more than 1.0 opt Au (Hausel, 1993c). Following this discovery, a gold rush occurred, and Timberline Minerals Company and Kerr McGee Corporation obtained favorable land positions.

Geologically, the Seminoe Mountains lie along the southeastern margin of the Wyoming Province and form an uplifted Laramide thrust wedge cored by Precambrian metamorphic and plutonic rock. The core consists of Archean metasedimentary and metavolcanic rock (> 2.6 Ga, Snyder and others, 1989) exposed in a broad, vertically plunging, fold. The rocks are of lower amphibolite grade and were intruded and folded by syntectonic granodiorite (> 2.6 Ga, Snyder and others, 1989, p. 27).

The crystalline rocks are interpreted as a fragment of an Archean greenstone belt with metavolcanic rock ranging in composition from tholeiites to komatiites (Klein, 1981; Hausel, 1993c). Interlayered metasedimentary rocks include thick bands of quartz-magnetite-grunerite iron formation, some chlorite schist, metagreywacke, and metapelite. Metavolcanics include metabasalt and crystal and lithic metatuffs and felsic schists.

Diamonds

The Great Diamond Hoax. In 1870, the diamond fields of South Africa had eclipsed diamond production from India and Brazil. But no commercial diamond source had yet been found in North America. One

enterprising prospector, Philip Arnold, decided to correct this problem. Arnold had been employed by the Diamond Drill Company of San Francisco from 1869 to 1871 and attempted to learn as much as possible about diamonds from his employer. In 1871, Arnold left the company to prospect with his old friend John Slack, and returned with a handful of diamonds, sapphires, and rubies that he claimed he had found in Arizona. Actually, Arnold had journeyed to London where he purchased $12,000 worth of gems (Liebling, 1940). Arnold realized that the time was ripe for a swindle: information on the host rock for diamonds was virtually nonexistent and essentially no one knew anything about diamonds or their mineral associations in North America.

To finance their scam, Arnold and Slack took their gems to some prominent businessmen in San Francisco. At this time in history, North American jewelers were inexperienced in uncut gems. The lack of experience showed when the $12,000 worth of gems had been appraised by a San Francisco jeweler at $100,000. These jewels were later appraised by Tiffany's of New York at a value of $150,000 (Liebling, 1940). The financiers gave the prospectors $200,000 towards the final purchasing price of $650,000 for the diamond fields. Arnold and Slack immediately went prospecting in London where they purchased another $50,000 in uncut gems.

After their shopping spree, they returned to North America to plant the salt. They selected an inconspicuous ferruginous sandstone outcrop fifty miles south of Rock Springs near the 41st Parallel. The site was two miles south of the Wyoming border in Colorado near what is now known as Diamond Field Draw in Moffat County, and 180 miles due west of what today is known as the State Line diamond district. Over the next few months, Arnold guided representatives of the investors including a professional mining engineer by the name of Janin to the deposit. These people were blindfolded throughout much of the journey, and after digging several gems from the salted outcrop, they were all convinced of the validity of the discovery.

The deposit was salted with ruby, sapphire, pyrope garnet, emerald (possibly chromian diopside), and diamond. The site was so well-salted with gemstones that in 1986, I was able to still pan seventeen rubies, twenty-four pyrope garnets, and four diamonds from the site in one afternoon. The presence of pyrope garnet in the salt was an unbelievable coincidence in that this is a heavy mineral commonly associated with diamonds; a fact that was unknown to Arnold and Slack in 1871. The garnets (and possibly chromian diopside) were acquired in northern Arizona as rubies and emeralds (Lowel Hilpert, pers. comm., 1986). The diamond deposit received so much attention between 1871 and 1872, that congressman Ben Butler, a stockholder in the diamond property, engineered an amendment through congress known as the Placer Mining Act designed to protect his investment in the diamond lands (Liebling, 1940).

At this time in history, Clarence King and his staff had been surveying the 41st Parallel. Two members of the Survey ran into Janin and others after a return trip from the diamond fields. Emmons and Gardner of the King Survey began questioning Janin and his associates about the geography in the vicinity of the diamond deposit. Based on this information, they were able to determine its location within fifteen square miles.

In late October of 1872, accompanied by Clarence King, they searched the suspected area and discovered several claim notices and the diamond site. After searching for a considerable time, it was realized that the only place diamonds and rubies could be found was where the ground had been disturbed. Digging a ten-foot deep trench, they also discovered that the precious stones did not continue below the surface. The property was shortly exposed as a salt (Emmons, 1872).

State Line diamond district. The effects of this swindle may have delayed the discovery of diamonds 180 miles to the east. For nobody in their right mind would have believed diamonds could have been found anywhere in this region for many decades. However, more than 100 years later, diamonds were actually discovered *in situ* in Wyoming and Colorado along the 41st Parallel. This event began in 1960 and 1961 when two unusual oval-shaped 'outliers' of Cambrian, Ordovician, and Silurian sandstone and limestone were discovered south of Tie Siding in southeastern Wyoming a few miles north of the Colorado-Wyoming border (Chronic and Ferris, 1963). The structures were highly enigmatic, in that they were only about 250 feet across, completely surrounded by 1.4 Ga Sherman Granite, and no similar outcrops of Silurian and Ordovician rock were known within many miles of this locality. In 1964, the origin of these outliers was solved by M. E. McCallum at Colorado State University after a third outlier was found in Colorado that not only contained Silurian and Ordovician sediments, but it also contained kimberlite.

Several additional kimberlite intrusives were discovered in the subsequent years. Then in 1975, a serpentinized garnet peridotite nodule collected from a Wyoming kimberlite by Dr. McCallum scratched a carborundum grinding wheel during thin section preparation at the U.S. Geological Survey lab in Denver (carborundum has a hardness of 9.5 compared to 10 for diamond). Suspecting the presence of diamond, the nodule was dissolved in hydrofluoric acid and several microdiamonds were recovered (McCallum and Mabarak, 1976).

For the next few years, this diamond occurrence remained an interesting geologic phenomenon. However, in 1977, Dr. Daniel N. Miller, Jr., State Geologist of the Wyoming Geological Survey, recognized that the diamond deposits had potential commercial possibilities and worked with the State Land Commissioner's office and Rocky Mountain Energy Company (Union Pacific) to attract mining companies to test the deposits. In 1979, Cominco America Incorporated was granted a permit to explore for diamonds on state and Union Pacific land in the State Line district of Wyoming. Within a short time, exploration was also initiated by Superior Minerals Company in Colorado.

Diamond recovery plants were constructed by Cominco American in Ft. Collins, Colorado, and by Superior Minerals in the Prairie Divide area, Colorado. Testing by Cominco American, Superior Minerals, and later by Mobile Diamond Company, N.L., and Lac Minerals yielded grades from 0.005 to 1.351 carats per ton and more than 112,000 diamonds (South African pipes typically average about 0.1 carat per ton)(McCallum and Waldman, 1991; McCallum, 1991). The largest diamond recovered to date is a 6.2 carat gemstone (Howard Coopersmith, pers. comm., 1993).

To date, only kimberlite in the State Line district has yielded diamonds. Another district to the north of the State Line district in Wyoming known as the Iron Mountain district was explored by Cominco American Incorporated in the early 1980s. However, the mineral chemistry of kimberlite from Iron Mountain suggest low probability of diamond preservation (McCallum and Waldman, 1991).

Elsewhere, Superior Minerals, Cominco American, and Lime Creek conducted reconnaissance surveys of the Cortez Creek area in the northern Medicine Bow Mountains where a prospector found two diamonds in 1977. Another area that has received attention is located northwest of the diamond hoax in the Green River Basin of Wyoming. This area is covered with anthills containing pyrope garnet and chromian diopside from an unknown source (McCandless, 1984).

Additionally, north of Rock Springs in the Green River Basin is a large lamproite field known as the Leucite Hills that contains several 1.0 million year-old lamproitic volcanoes similar to the diamondiferous lamproites in the Kimberly region of Western Australia (Carmichael, 1967). This area has only received minor attention. Limited testing of the lamproites has not produced any diamonds.

Grand Encampment Area

Wyoming was subject to a copper boom that began in 1874 following the discoveries of rich copper deposits in the Sierra Madre of southeastern Wyoming. This led to the development of a cupriferous gossan on the western flank of the range named the Doane-Rambler deposit.

The development of the mine was relatively slow due to the harsh environment: the copper ore was loaded in wagons, transported across the Sierra Madre on a narrow and rocky trail cut through the forest, and loaded at Walcott Junction more than fifty miles away to be shipped to smelters in the East.

In 1897, Ed Haggarty found another cupriferous gossan in quartzite along a creek later to bear his name. This was even more impressive than the Doane-Rambler. In the following year, a shaft was sunk on the gossan and intersected massive copper at a depth of thirty feet. The ore was hauled by wagon to the nearest Union Pacific rail junction and shipped to the Copper Refining smelter at Chicago. The first fourteen-ton shipment averaged 33.18% Cu! This led to the development of the greatest copper mine in Wyoming. According to Houston (1992), this was also one of the most important copper mines in the West at this time in history and at one time ranked as the 27th largest producer in the world.

E&MJ (4 February 1899,'155) reported ore from the Ferris-Haggarty was mixed chalcocite and bornite, and shipments often yielded more than 35% Cu. In 1899, the Ferris-Haggarty was shipping forty tons of ore daily (E&MJ, 12 August 1899, 199). By 1900, the Ferris-Haggarty mine was averaging about 550,000 pounds of copper per month (E&MJ, 12 May 1900, 570).

In 1902, a mill and smelter were constructed at Riverside adjacent to the town of Encampment along the eastern flank of the Sierra Madre. But to get the ore to the smelter complex, a major engineering feat had to be accomplished. This involved the construction of a more than sixteen-mile-long tramway from Riverside at an elevation of less than 7,200 feet, across the eastern flank of the Sierra Madre over the Continental Divide at more than 10,600 feet above sea level, and down the western slope to the Ferris-Haggarty mine at an elevation of 9,700 feet.

The Boston-Wyoming smelter at Riverside operated from 1902 to 1907. But in 1908, mine operations terminated following a series of financial disasters. The mill was partially destroyed by fire in 1906 followed by destruction of the smelter in the following year. The final nail in the coffin occurred in 1908 when copper prices dropped 35% (Hausel, 1993b). Production records indicated more than twenty-one million pounds of copper were mined from the district with credits in gold and silver--most of which was produced by the Ferris-Haggarty (Hausel, 1989).

Black Hills

An expedition into the Black Hills in 1875 by the U.S. Army under the command of General George Armstrong Custer gave the western prospector a brief look at this mineral-rich terrain. Soon the region was invaded by hundreds of prospectors. Today, the region hosts several mines including the Homestake mine and several open-pit gold mines east of the Wyoming border. The geology in the Black Hills uplift in Wyoming is similar to South Dakota which suggests the possibility of the discovery of similar gold deposits in Wyoming. Three regions received some interest in the past--Mineral Hill, the Bear Lodge Mountains, and Black Butte. Only the Mineral Hill area was heavily prospected.

Mineral Hill district. The Mineral Hill district southeast of Sundance, lies along the Wyoming-South Dakota border. The district was explored for gold and tin in the late 1800s and early 1900s. Placers generated much of the first interest, and by 1882, construction of a forty(?) mile ditch was reported to be underway to supply water to the placers. (E&MJ, 23 June 1883, 369). In 1883, a twenty-stamp mill was ordered (E&MJ, 5 May 1883, 259).

Several gold nuggets were recovered from the Mineral Hill placers including a 2.45 ounce nugget (E&MJ, 1890, 555). The gold on Sand Creek, one of the principal placers in the district, was reported to be mostly coarse with nuggets from 0.25 to 0.5 ounce in weight. Prior to 1893, more than 9,000 ounces of gold were recovered from the Mineral Hill placers (Knight, 1893).

In 1900, a twenty-stamp mill was constructed at the site of Welcome along Sand Creek and on the western flank of Mineral Hill. In addition to gold, tantalite and cassiterite were recovered. In 1936 and 1937, the Fansteel Mining Corporation placered Mallory Gulch and reported the gravel averaged 1.7 pounds cassiterite, 0.31 pounds tantalite, and from 0.07 to 0.21 oz/yd^3 Au (Johnson, 1958).

The Mineral Hill Tertiary alkalic ring complex consists of multiple intrusions emplaced in Precambrian biotite-quartz schist and Paleozoic sedimentary rocks. This district adjoins the Tinton district of South Dakota on the east.

Silver Crown District

The Silver Crown district in the Laramie Range of southeastern Wyoming, was organized on April 4, 1879 following the discovery of Cu-Au-Ag, and Cu-Zn lodes. A few years later in 1885, a smelter was constructed which ran successfully for one-and-a-half years until the water supply ran out. Overall, the district was slow to develop: the effects of a salting scheme in the mid-1880s probably did irreprable damage to the reputation of the district and may have kept it from developing to its full potential.

According to the WIJ 1(no. 5, 1899): 98-9, "one of the most memorable attempts at mine salting in the West occurred in 1885". The fraud involved the Carbonate Belle prospect. According to the *Journal,* Professor Samuel Aughey, the Wyoming Territorial Geologist, claimed to have developed a unique process for extracting gold from the refractory ore of the Carbonate Belle which would yield not less than 10 opt Au. Other assayers could only extract traces of gold from the ore.

Some wealthy cattlemen were taken into Aughey's confidence, and a large block of claims were staked along a twenty-mile belt along the edge of the Silver Crown district in 1886. When assayers were consulted in the East and even in England on how to extract gold from the refractory ore, no more than a trace of gold could be recovered. To unravel the mystery, A. H. Swan of the Swan Land and Cattle Company (regarded as one of the wealthiest stockmen in the West) sent Aughey to the Hartzfeld Smelter in Kentucky with a carload of Carbonate Belle ore to refine the process of gold extraction. Upon returning to the Territory, Aughey desposited his formula in a safety deposit box in the First National Bank of Cheyenne. While at the smelter in Kentucky, Aughey was apparently poisoned by antimony and arsenic from the ore. It was arranged that a large sum of money would be paid to his family in case of his untimely death prior to anyone opening the envelope containing the formula.

The owners of the Carbonate Belle sent Aughey to Arkansas for his health. Upon returning, A. H. Swan and others insisted that Aughey demonstrate the value of the Carbonate Belle ore. A test was arranged in which a committee of cattlemen would observe Professor Wilbur C. Knight apply the "Aughey process" to the Carbonate Belle ore. The test was conducted such that neither Aughey nor anyone else interested in the Carbonate Belle would be allowed into the assay office, and all instructions would be given to Knight by Aughey from the adjoining office.

Aughey insisted that some ore in his possession be tested. Knight refused and instead used some samples he had previously collected in the presence of Thomas Swan. Aughey then stated that his process required the ore to be roasted in an air-tight crucible. Since Knight didn't have any fire clay in the office, he had to leave for a short period to get the clay. Upon returning, the test was made in duplicate and Knight recovered two gold buttons equivalent to 250 and 300 opt Au.

The committee was ecstatic, but Knight knew the samples had somehow been compromised. Knight infor-

med Mr. Davis, one of the committee members, that he had been tricked but he did not know how. At that point, Mr. Davis remembered Aughey entered the assay office when Knight left to get the fire clay under the pretext that he needed some water to take some medicine.

Knight spent the next two hours working through the samples until he found evidence of the salt. Gold filings from a coin had been thrown into the sample. Davis then demanded Aughey's resignation as Territorial Geologist and told him to leave town. Subsequently, it was discovered that Aughey and associates had obtained bonds on a number of claims in the Carbonate Belle trend and were ready to sell them had the scheme been successful. According to the WIJ, Aughey later traveled to Missouri where he was accused of another scam involving the salting of a mine with graphite.

This unfortunate incident checked the development of the district. Several potentially commercial deposits were found, but none were developed to any great extent. For example, in 1885, Warren reported that the Metcalf prospect was opened on a two-to-three foot wide vein. A sample of the vein yielded 30% Cu, 9.8 opt Ag, and 0.5 opt Au. Another assay performed by the Denver Mint gave 46% Cu, and 19.1 opt Ag.

The two most promising properties in the district in the late 1800s were the Copper King (Arizona) and the Comstock (King David). The Comstock lode was located in 1882 a few miles north of the Copper King. The shaft was sunk 126 feet and several hundred tons of copper, gold, and silver ore were recovered including one large mass of chalcocite about the size of a cook stove. From 1914 to 1917 the Comstock shaft was extended to a depth of 240 feet and drifts driven on two levels. In 1956, the Good Venture Mining Company produced some high-grade copper ore from the mine (Ferguson, 1965).

The mine was developed on narrow veins and mineralized fracture intersections in quartz monzonite and granodiorite. The shaft was sunk on the northernmost intersection and levels were established at 172 and 205 feet. Samples of the Comstock ore reported by Ferguson (1965) yielded from 0.74% to 66.6% Cu, none to 21.8 opt Ag, and none to 3.75 opt Au.

Another property which showed potential in the late 1800s and still shows promise is the Copper King. This property was explored and drilled by several groups. According to Ferguson (1965), the Copper King was located in 1881 and developed by the Adams Copper Mining Company. A high-grade streak of ore intersected in the shaft was reported to yield 14% Cu and 3.0 opt Au. In 1883, the E&MJ (8 September 1883, 156) reported the deposit was 5,000 to 6,000 feet long, and forty feet wide. Sometime later, the property was explored by the Hecla Consolidated Mining Company. In 1937, the American Smelting and Refining Company drilled five holes on the property for a total of 1,400 feet. In 1952, the Copper King Mining Company was formed and drilled a total of 2,630 feet outlining a six million ton, low-grade ore body with a high-grade core that averaged 0.76% Cu, 0.14 opt Au, and 0.43 opt Ag.

Following a drilling program by the U.S. Bureau of Mines, Soule (1955) reported the Copper King ore body continued to a depth of at least 1,024 feet and had an oxidized and leached zone which extended to a depth of 100-to-150 feet below the surface. Later, Henrietta Mines outlined a substantial low-grade copper-gold ore body in 1973 and reported the following reserves (after Nevin, 1973):

Tons (millions)	Gold (oz/ton)	Copper (%)	Stripping Ratio (waste/ore)
2.8	0.044	0.36	0.5
6.0	0.038	0.32	1.2
13.5	0.028	0.26	1.8
35.0	0.022	0.21	2.0

The results showed a substantial orebody of thirty-five million tons of low-grade Cu-Au mineralization with the possibility of extending the reserves laterally and at depth.

In 1987, Calidonia Resources optioned the property and explored the higher-grade core. The results of their drilling program outlined gold reserves on the order of 4.5 million tons of ore averaging 0.044 opt (or about 200,000 ounces of contained gold). In 1989, Royle Gold Inc., optioned the property and reported reserves of 3.6 million tons of ore averaging 0.4% Cu and 0.04 opt Au.

The Copper King is a dissected, Proterozoic-age porphyry with disseminated Cu-Au mineralization localized in an area 300 feet wide by 600 to 700 feet long. The mineralization occurs in quartz monzonite and foliated granodiorite and shows strong correlation with K-silicate alteration and hydrothermal propylitic alteration. Sulfides include chalcopyrite and pyrite with minor bornite (Nevin, 1973; Hausel, 1989). Similar anomalies have been reported in the area (Nevin, 1973).

The porphyry lies within a narrow belt of northeast-trending, foliated, calc-alkaline metaigneous rocks between the Happy Jack road and I-80 west of Cheyenne. The eastern edge of this belt is marked by steeply-dipping Phanerozoic sedimentary rocks unconformably overlain by Tertiary Chadron Formation. The western margin is marked by exposures of the Sherman Granite (1,390 to 1,450 Ga). The oldest rocks in the district are quartzite, quartz-biotite schist, and amphibolite which are fragments of a Proterozoic volcanosedimentary terrain. These were intruded by granodiorite (locally known as the Copper King grano-

diorite).

The entire succession was metamorphosed to amphibolite grade at about 1.7 Ga (Peterman and others, 1968). The emplacement of the Sherman Granite along the west, the intrusion of quartz monzonite dikes and pegmatites, and the development of shear zone cataclastics and faults were all controlled by gneissic foliation in the granodiorite (Klein, 1974). Mineral deposits in the district are structurally controlled and parallel regional foliation or occur in tensional fractures. Regional retrogressive greenschist metamorphism overprinted amphibolite facies rocks producing secondary chlorite and epidote.

Hartville Uplift

The Hartville uplift in eastern Wyoming began to attract early attention because of copper, iron, and onyx deposits. Some interest for precious metals was also stimulated by reports of rich silver discoveries. In 1880, for example, the E&MJ issue of 20 March 1880 (p. 205) reported ore near Rawhide Buttes yielded 125 opt Ag and 0.4 opt Au.

But copper seemed to dominate much of the early attention. A smelter was ordered to reduce the ore mined by the Platte Canyon district south of Rawhide Buttes. The smelter was erected on the north bank of the North Platte River at the mouth of the canyon, and on December 1, 1882, the first run was made. Up to October 1, 1883, over one million pounds of copper bricks had been produced and shipped by the Wyoming Copper Company (Warren, 1885). Copper ore from the Michigan and Sunrise mines was reported to net $150 per ton (E&MJ, 19 August 1882, 100). By 1883, regular shipments of copper matte were reported from the Hartville mines (E&MJ, 8 September 1883, 156).

In 1884, E&MJ (19 January 1884, 50) reported 4,000 tons of ore with an average grade of 15% Cu had been mined from Sunrise, and 3,500 tons had been smelted. In 1888, the E&MJ (24 March 1888, 222) reported the Sunrise smelter had a maximum capacity of thirty tons of ore per day and that a new 120 ton-per-day smelter was planned. In that same year, it was reported that the Michigan Copper Mining Company in Muskrat Canyon had contracted to furnish the smelter at Fairbanks (Sunrise?) located twenty-five miles away with fifty tons of ore per day (E&MJ, 4 August 1888, 93).

In 1899, with the copper deposits near depletion, massive hematite deposits associated with some of the copper mineralization became of interest. Warren (1890) reported that the Sunrise mine had been worked for copper in irregular pockets entirely surrounded by hematite, and the hematite had only been partially developed. For many subsequent decades, the hematite was mined by Colorado Fuel & Iron Corporation at the Sunrise, Good Fortune, and Chicago mines in the Sunrise district until operations ceased eighty-two years later in 1981. The hematite is interpreted to be secondary in origin and to have originated from groundwater oxidation and enrichment of originally ferruginous beds (Bayley and James, 1973; Snyder and others, 1989).

The Hartville uplift is interpreted as an Archean eugeoclinal terrain formed of a succession of hematite schist, metadolomite, metabasalt, and pelitic schist unconformably overlain by Paleozoic carbonates. Past production amounted to more than forty-five million tons of iron ore, more than five million pounds of copper, and some silver, uranium, and onyx.

Kirwin District

In 1890, claims were staked following the discovery of veins with gold, silver, copper, lead, and zinc along the North Fork of the Wood River in the southern Absaroka Mountains of northwestern Wyoming by Will Kirwin. After considerable prospecting and some development work, most properties in the Kirwin district were consolidated into two ownerships: the Galena Ridge Mining Company (organized in 1902), and the Shoshone Mountain Mining Company (organized in 1903).

Between 1903 and 1907, the Galena Ridge Mining Company drove a 2,327-foot crosscut at the base of Galena Ridge north of the Kirwin townsite to explore veins at depth found higher on Galena Ridge. The crosscut intersected the Little Johnnie, Mendota, and Manilla veins, stopping short of the Oregon vein. The Shoshone Mountain Mining Company concentrated on the Bryan and Pickwick veins south of Kerwin. Most exploration and development terminated in the district in 1907, following an avalanche that killed three people and destroyed several buildings.

A hiatus followed and very little work was done for many years until Charles F. Wolf leased some patented property near the base of Bald Mountain and sunk the Wolf shaft in 1942. Rock recovered from the mine contained bleached and altered porphyry with stockwork molybdenite and chalcopyrite veinlets. Wolf dropped his lease option in 1947, and between 1948 and 1953 some other properties were leased by the Anaconda Lead and Silver Company. However, no significant work was done.

From 1951 to 1953, William H. Wilson of the Wyoming Geological Survey mapped the district and recognized stockwork-type mineralization and the potential for a porphyry-type, copper-molybdenum deposit. A few years later in 1960, R. J. Wright, the Western United States exploration manager for AMAX Exploration, asked W. H. Wilson about molybdenum

resources in Wyoming. Wilson described Kirwin as the most promising prospect in the state. As a result of this discussion, Ora Rostad and Jon Browne, geologists with AMAX visited the property in the Fall of 1960, and Rostad recommended further study of the district. Thus the porphyry was found by follow-up of public information obtained from the Wyoming Geological Survey and could not be described as either a geochemical or geophysical discovery (Rostad, 1985).

AMAX began drilling at Kirwin in 1963, and significant secondary-enriched porphyry-copper mineralization was intersected (Rostand, 1983a). Drilling over the next several years proved a significant porphyry deposit. AMAX's drilling program resulted in 150 holes totalling 86,861 feet. The project outlined geologic reserves totalling 196 million tons of ore averaging 0.505% Cu and 0.022% MoS^2 at a 0.3% Cu cutoff grade with by-product credits in silver and gold. Pitable reserves were calculated at 160.8 million short tons with a very favorable stripping ratio of 0.57:1 of waste to ore (Rostad, 1983b). Feasibility studies indicated the deposit to be amenable to *in situ* leaching. A recent 1991 study on *in situ* leaching indicated possible recovery at $0.309/pound Cu (Ora Rostad, pers. comm., 1992).

The feasibility studies led to the possibility of developing an open-pit mine in 1980. But depressed copper prices led to the cancellation of mining operations by AMAX. AMAX later sold the property to the Mellon Foundation which in turn donated the property to the U.S. Forest Service.

Conclusions

During the early mining and prospecting history of Wyoming, conditions were very primitive. The weather in the high Wyoming plains and mountains was (and still is) a deterrent, as many people froze to death. While the neighboring territories and states were being tamed, Wyoming was still a wilderness where people succumbed to the weather, Indian raids, and attacks by outlaws. Additionally, poorly-funded mining ventures and inexperienced prospectors made Wyoming a scam artist's dream.

The literature is particularly filled with the hopelessness of operating mining ventures in the Wyoming-Dakota territory and provides many reports of raids on the camps. Strahorn (1877) wrote, "such hope and opinion received a sharp check by the unfriendly action of the United States government in its persistent, though tacit sanction and support of American savages in their hostile incursions upon the miners in established camps. These marauders compelled not only the abandonment of work begun, but also total cessation of all prospecting...The mining interests of Wyoming have been crippled for more than a decade."

Strahorn (1877) additionally wrote about South Pass, "Constant Indian depredations frightened away both miners and capital until the once noted region was almost unheard of." Emmons and Becker (1885) wrote that Wyoming's "...resources have as yet, however, been scarcely developed partly because the broad plain areas offer little inducement to the prospector, and partly because he has hitherto been debarred from the nothern mountain areas by the Indian tribes to whose reservation they belonged."

In 1875, General Custer's military expedition trespassed on Indian lands of the Black Hills which signaled a change in the U.S. policy toward the Indian nations. This expedition gave the American public a glimpse of rich gold deposits on sacred Indian lands, and triggered more widespread violence and problems for both the Indians and the western prospectors.

Besides Indian confrontations, the early prospectors experienced other problems. The cost of living in the 1800s was very high in Wyoming because of the lack of support by a well-developed agriculture and transportation industry (Warren, 1887). Promoters, swindlers, and bad press practices were also prevalent. In an article about problems in the Encampment district, the E&MJ (4 December 1897, 679) reported that, "...articles refer to numerous veins of gold ore of great width assaying from few to many thousand dollars per ton. Nothing so unfortunate could have befallen this new camp. These articles may induce the unsophisticated to visit it and spend a small amount of money. On the other hand, how foolish it is for a man to pose before the mining world and say that he has a large vein of ore that will average $2,000 or $3,000 per ton, and in the same breath state that capital is needed to develop it. In fact, such ore can be mined, hauled to the railroad, freighted to Denver and smelter for $50 per ton, in which case the $2,000 ore would net the owner not less than $19,500 per car of 10 tons. The press has made such extravagant statements that mining men understanding their business would not even visit the district."

The geology of Wyoming has also added to the complexity of the problem. Much of Wyoming is underlain by an Archean craton that is dissimilar to much of the remaining U.S. and few economic geologists in this country have been trained to work in this type of terrain. As a result, many companies have avoided this region.

There is no question that Wyoming had and still has some important ore and mineral deposits and has the potential for the discovery of others. But Wyoming has never been developed into a powerhouse hard-rock mining state like its neighbors. Many historians have suggested this is simply because Wyoming lacks ore

deposits and that all of the historic mines have been mined out. Such conjectures are based solely on opinion completely unsupported by scientific fact. The fact is that Wyoming has several potential ore deposits including some very large metal resources and there is little evidence to support that more than a handful of historic metal mines were ever mined out.

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I found a fair amount of data base exists on the history of the state's mining districts, but unfortunately because of time constraints, I was able to research only a small portion of this data. I would like to thank Jon K. King and Laura L. Larsen for helping me locate this information.

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