MINING IDAHO'S HISTORY

METAL MINING IN IDAHO 1860–1960



A Mining Context for Idaho



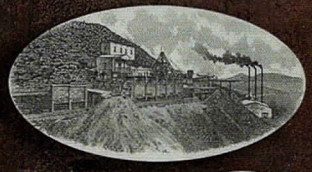
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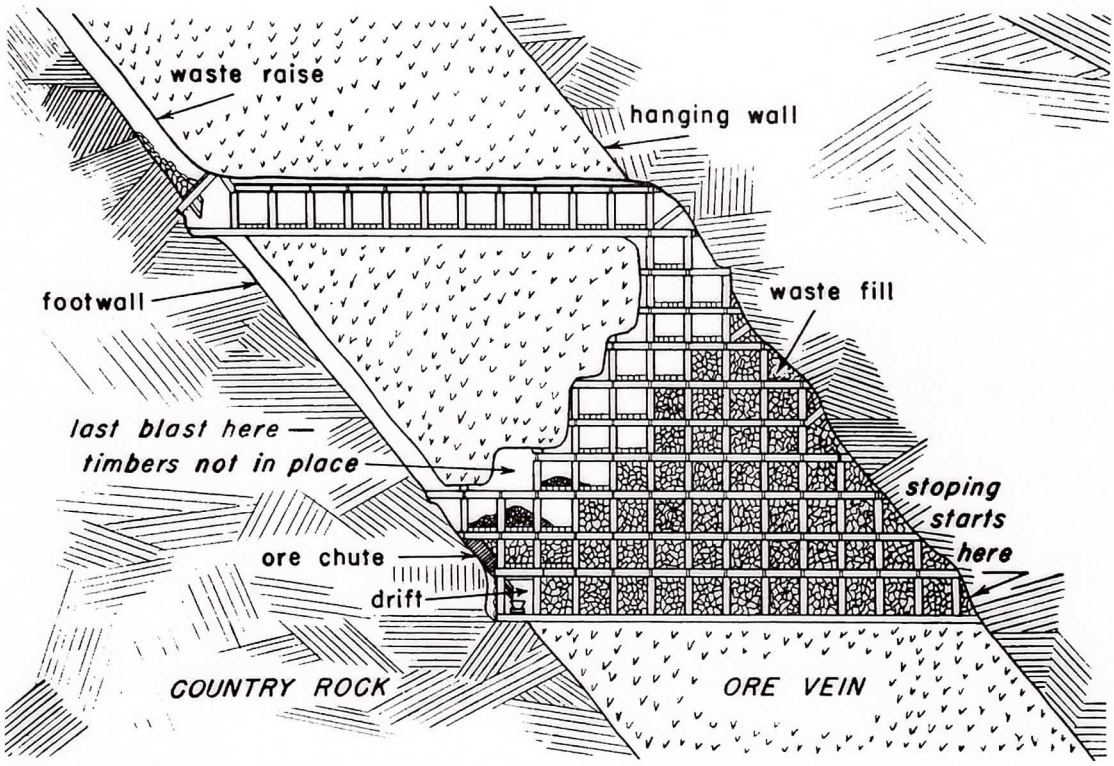






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Underground workings at a mine using the timbered cut-and-fill method. (Teske, *Idaho's Mineral Industry*, 29)

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Preface

This report has been prepared in order to help cultural resource specialists and other interested people identify, evaluate, and manage Idaho's historic precious- and base-metal mining properties dating from 1860 to 1960. The remains of historic placer and lode mines, mills, and smelters range from isolated collapsed adits to extensive industrial complexes. They were built for temporary use and have often deteriorated due to salvaging of machinery and materials, periodic re-use and remodeling, severe weather, vandalism, and neglect. Such sites present a challenge to those evaluating their significance and integrity.

The National Register of Historic Places plays a key role in evaluating the significance of cultural resources in the United States. The National Register lists historic properties that are considered significant to the country's historic, archaeological, architectural, engineering, or cultural heritage. Regulations found in 36 CFR 60 list the criteria, integrity, levels of significance, age, and exceptions that must be present to evaluate and nominate properties to the National Register. Regulations in 36 CFR 63 and 36 CFR 800 detail the process for determinations of eligibility. The federal Section 106 process requires an assessment of the significance of historic sites within the framework provided by historic contexts. Historic contexts are defined in terms of common theme, common geographic area, and common time period. For a property to qualify for the National Register of Historic Places, it must meet significance criteria by representing an important aspect of an area's historic context, and it must retain certain qualities of physical integrity.

The historic context for metal mining in Idaho presented in the first part of this report is based primarily on the documentary record, including site forms for historic mining sites that have been recorded in the state. As new information is discovered and more mining properties are identified and evaluated, the context may be revised. It provides an analytic framework within which the importance of a particular historic site can be evaluated.

The second section of this report describes mining-related property types and discusses the eligibility requirements for these property types. The property types that have been developed link the theoretical material in the historic context with the actual historic resources that illustrate those ideas. This section also outlines threats to historic mining sites, known information gaps, and suggested goals and objectives for identifying, evaluating, managing, and treating historic mining properties in Idaho.

Idaho experienced extraordinary growth and transformation as its mining wealth was explored, prospected, assayed, mapped, mined, milled, and exported to the country's manufacturing and financial centers between the Civil War and the Cold War. It is a dramatic story, and though presented here in a management context rather than as a historical narrative, we suspect that many audiences will find Idaho's mining heritage as fascinating as we have.

Terms defined in the glossary are printed in **bold** the first time they are used in the text.

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Figure 1–Morning Mine. Women played many roles in mining districts. The occupations most commonly associated with women in the industry from the first gold rush in California through the mid-twentieth century include work as cooks, laundresses, teachers, saloon girls, and prostitutes. Yet some women hungered for adventure and chose mining as a career. In Idaho, for example, M.A. Rice, who in 1902 joined her father and his prospecting party bound for the state's gold fields, became known as the "Queen of Thunder Mountain" for her expertise and negotiating skills. The other prospectors entrusted her with marketing the district's gold mining claims.[1]

Historic Context • Section One

INTRODUCTION

This historic mining context provides an overview rather than a definitive scholarly history. It outlines a basic framework for managing and preserving Idaho's important metal mining sites. Much remains to be done to correlate this statewide historic context with more local contexts and with particular mining properties. In any event, the historic mining activities as they unfolded and continued to develop over time created the characteristic landscape and features that attach a specific sense of place to larger geographical areas in the state of Idaho. This sense of place derived from the interaction of humans involved in the mining industry with the landscape, and in turn, human adaptation to the area through material culture as the specific landscape and geology demanded. The very nature of mining, especially in wilderness or rugged mountain areas, created distinctly recognizable patterns of landscape modification and built environments.[3]

It takes a gold mine to develop a silver mine; it takes a bank to develop a gold mine.

–Mexican proverb[2]

Only the metals mining industry is covered in this historic context. Other materials that have been mined in Idaho, such as phosphate, fluorspar, crushed rock, and opals, are not included. Mining-related settlement patterns, other than company towns, are also outside the scope of this report. Note also that mining districts *not* mentioned in the historic context nevertheless have associations with the historic themes and may be significant. (For a listing of Idaho's mining districts, see Idaho mining district maps Figs. 31, 70, and Appendix A.)[4]

Idaho's precious and base metal **mining districts**, like most in the West, generally went through several phases: discovery, **development**, maturity, and decline. These phases sometimes recurred when circumstances changed. The value of **ore** varied over time depending on markets, characteristics of the ore, current extraction and **ore beneficiation** technology, production costs, and transportation networks. Generally, miners first worked the higher-grade **placer** deposits and ores that were easier to extract and more efficient to process. They mined lower-grade deposits later using larger-scale, capital-intensive methods. Eventually, the ores were no longer economical to work. The Coeur d'Alenes region of northern Idaho has proved to be an outstanding exception to this rule: its **veins** continue at great depth, and many have been worked profitably for decades. This area has been the leading producer of metals in Idaho by a wide margin since 1890.

Idaho's initial gold rushes began in 1860, and the focus was on exploiting rich placer gold deposits. By 1869, most of the known significant placer deposits, as well as many **lode deposits**, had been found. When gold mining declined at the end of the 1870s, rich lead-silver deposits were discovered in several areas. **Base metal** mining soon dominated Idaho's mineral industry. The coming of railroads and the development of successful new methods and technology to recover metals from these **complex ores** helped this shift to occur. The total production of gold from Idaho, up to 1965, was about 9.3 million ounces, compared to 307.2 million ounces for the United States as a whole.[5] Silver, lead, and zinc, however, have been Idaho's most important minerals for decades.

Idaho's mineral production peaked during World War I, as has been true in many other states. World War II, the Korean War, and the government's strategic metals program have also led to periods of high production due to the resulting higher prices for metals considered important in the defense effort.[6] Idaho led the nation in the production of strategic metals such as cobalt, tungsten, and antimony in certain years during the 1940s and 1950s.

GEOLOGY

Most of the gold and silver deposits in the western United States are distributed around the edges of large granite **intrusive** bodies of rock called **batholiths**, like the one in Idaho, which consists of two large expanses of granite, recognizable in the field by its salt and pepper appearance. This **igneous** intrusion, covering 15,400 square miles, originated in the late Cretaceous period during the **faulting** and folding of central Idaho's ancient **sedimentary beds**. The Idaho batholith was formed as a great body of fluid **igneous rock** (magma) that carried metals and other minerals in solution. The molten rock rose towards the surface along channels such as fracture zones and then cooled to solid rock, precipitating minerals as a variety of compounds along the walls of the fractures. Later, **dikes** formed from a variety of rocks cut the altered sediments, granitic rocks, and veins, and intruded into the batholith itself. Volcanic eruptions were followed by dikes and stocks of comparatively young igneous intrusions. After this geologic activity, valuable metal deposits were contained either in the granitic rocks or in intruded rocks consisting of sedimentary, metasedimentary, and volcanic rocks. **Contact metamorphism** (the changes that happen when cold host or **country rock** comes into contact with a hot body of magma) also occurred in some areas of the Idaho batholith, such as in the South Mountain district of Owyhee County and the Alder Creek district in Custer County.[8]

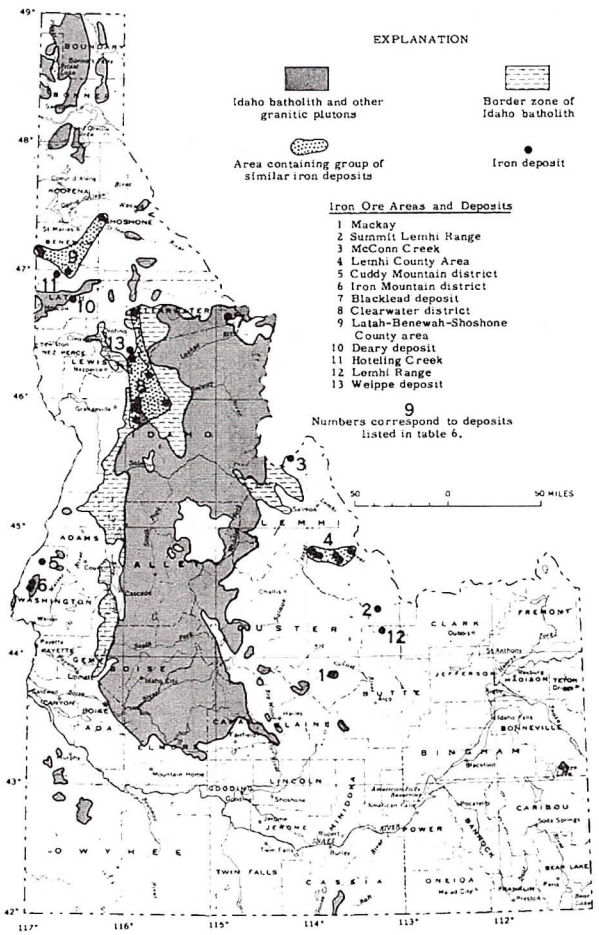


Figure 2–Idaho batholith. Most gold deposits occur in the mountainous and semi-mountainous areas of the West and the sites of most mining settlements differed only in detail. Typically, the primary consideration in site selection consisted of proximity to mining operations.[7]

Ore deposition in the Idaho batholith occurred within a mile of the contact between the granite and the invaded rocks. The cooling and solidifying of the intruding magma and the escape of gases and vapors caused distortion of the surrounding rocks and of the igneous rock at the contact. The rock was brecciated, jointed, fractured, fissured, and faulted, and **shear** zones formed. In the resulting open spaces, the mineralizing solutions circulated, depositing their gold and other valuable metals.[9]

The classification of Idaho's gold deposits encompasses placers, **fissure veins**, and replacement deposits. Fissure veins, or cracks in rocks infilled by fluid-borne minerals, include all open-space fillings. Individual veins range from less than an inch up to several miles in length. Sometimes they pinch out and narrow, or they may bulge or split or go very deep. Gold and silver lode deposits are tabular in shape and occur between definite boundaries. They may consist of several veins close to each other. When hot ore-bearing solutions penetrate solid rock and dissolve it, substituting new minerals for the original rock, they form "replacement deposits." Generally not a major source of gold, these types of deposits were mined chiefly for lead, silver, copper, and cobalt, with gold as a byproduct.[10]

Gold-silver quartz veins are worked primarily for gold, but they also yield silver as a byproduct. Most of these types of deposits occur in certain districts of the Boise Basin and in the Warren, Marshall Lake, Florence, and Elk City districts. For the most part these deposits lie along highly fractured zones in granitic rocks of the Idaho batholith; however, genetically they relate to younger Tertiary dikes and stocks. Characteristically, the ore shoots within the veins are small to moderate in size and discontinuous, few going more than five hundred feet below the surface. Deposits in places like Silver City and Yankee Fork have more silver than gold, but since gold has a higher value than silver, many of these are known as gold mines even though they produce more silver.[11]

Many of Idaho's rich **ore deposits**, such as those in the Coeur d'Alenes, contain relatively little gold. The deposits in this mining region are mostly fissure veins along minor fractures and faults, along with some replacement deposits. In many cases, Tertiary igneous rocks have intruded rocks of the Idaho batholith and other rocks. The rocks were forced into several large, asymmetrical folds, which were then extensively dislocated by faulting. Many crop out at the surface, but others apex several thousand feet below the surface. Unlike many other lode deposits in Idaho, depth has had little effect on the occurrence or type of ore.

Veins and replacement deposits of silver, lead, and zinc found in Precambrian metamorphosed rocks, like those typified by deposits in the Lakeview, Pend Oreille, Clark Fork, Porthill and other districts in northern Idaho, are the most productive type of deposit in the state.[12]

MINING LAW

The mining of metal deposits falls into two basic classifications: placer or **lode** (also hard rock mining). Mining laws recognize placers as ore found on the ground surface or under a thin cover of soil; lodes as mineral deposits lying "in place" or within the walls of neighboring rock. Lode claims, then, are staked on veins or lodes of quartz or other rock containing deposits of gold, silver, copper, or other valuable ore. Placer claims cover all other types of deposits except those found in veins of quartz or other rock bounded by wall rock.

Soon after the gold rushes to California, Montana, and Idaho, U.S. government policy aimed to stimulate prospecting and development of the country's mineral resources. Accordingly, the General Mining Law of 1872 provided relatively easy private access to mineral resources on federal lands. This law permits U.S. citizens and businesses to freely prospect for minerals on federal lands; to mine the land if an economic deposit is found; to sell the extracted minerals; to establish a **millsite**; and to obtain legal title to the land (surface and minerals) by obtaining a **patent**. A claimant obtained title to minerals on public lands by proving the presence of minerals, staking a claim, and reporting the location to county officials. Placer claims were limited to 20 acres per person, up to a maximum of 160 acres for a group of eight. For lode claims, miners could claim fifteen hundred feet along the assumed course of the vein and up to three hundred feet on either side of the center of the ledge. The discoverer of a placer deposit or **ore body** had to put up a discovery monument at once, with a notice of **location** posted on the monument, and do specified initial work on the claim. To keep the claim, he had to do at least one hundred dollars worth of **assessment work** on it each year (this requirement has since been replaced by the requirement of an annual maintenance fee of one hundred dollars). If the work was not done annually and affidavits of work performed were not recorded, the claim would be regarded as abandoned and subject to location by anyone who wished to claim it.[14] The General Mining Law of 1872 continues to regulate much of western mineral development on federal lands.

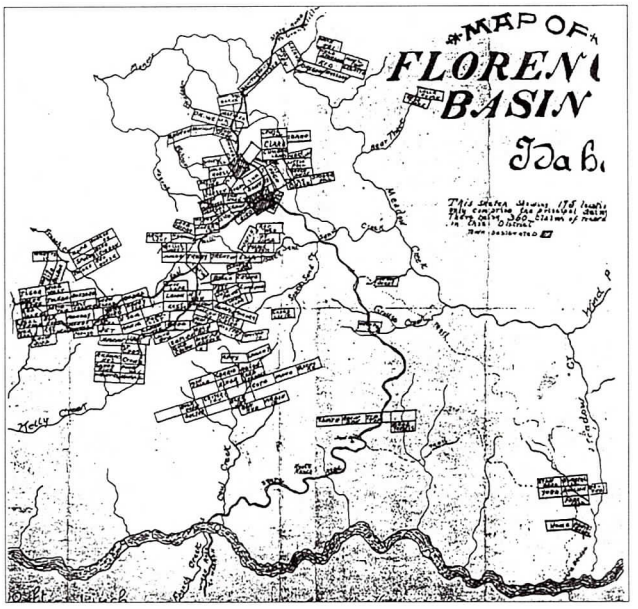


Figure 3–Map of 175 of the 360 lode claims of record in the Florence mining district in 1897. Placer miners usually worked along streams and gulches, washing gravel through their sluice boxes and similar devices to extract free gold; lode ("hardrock") miners drilled and blasted into solid rock to obtain ore from which gold, silver, or base metals could be extracted through costly reduction and smelting processes.[13]

Miners staking claims in a particular geographic area established legal and administrative units known as mining districts. These geographic units, sometimes loosely defined, formed the basis for local government and for the recording of placer and lode claims. Although the boundaries and names of some of the districts in Idaho changed over the decades, the districts retained their importance as identifying the location of particular claims and associated settlements.

A miner's right to a **mining claim** depended on discovery and development. A miner did not own a

claim; he owned only the right to mine and extract minerals from the property. The mining codes of placer districts were designed to allow an individual to hold only enough ground for himself and one or two others to work. Some of Idaho's mining districts allowed individual miners to hold several types of mining claims. In Boise Basin, for example, each man could hold five claims: creek, wet gulch, dry gulch, hill or bar, and quartz. This allowed the miners to work as much of the year as possible, since certain types of claims could only be worked for a short season when water was plentiful.[15]

The ownership of the upper part of a vein gave the claimant the right to follow the vein underground, even if it ran underneath an adjacent claim. This provision became quite confusing with discontinuous veins, sometimes resulting in litigation. Under the "apex law," the claimant had to fix the surface boundaries so that they included the vein's **apex** (the top of the vein emerging from the ground). The claimant could follow the vein down the **dip** past the side lines of the claim, if the side lines were parallel to the vein.[16]

To obtain patent for the claim (a deed from the government), which was desirable for valuable claims, the miner had to complete at least $500 in assessment work, have the claim surveyed, file appropriate notices, and then pay $5 per acre for a lode claim or $2.50 per acre for placer ground. The claim then became private property and could be sold, inherited, or mortgaged and was subject to lien or judgment.[17]

To supplement federal legislation, Idaho developed general mining codes that stipulated more specific requirements. One of these involved the location of mining claims. Idaho law required locators to mark their claims within ten days of making the discovery and post the location at the point of discovery. The notice served to disclose the evidence of discovery, and the locator had to mark the boundaries at each corner or angle using a substantial and conspicuous marker. If made of timber or posts, the markers had to measure at least four inches in diameter and project four feet above the surface. In a timber-poor area, however, the locator often stacked rocks and placed a can, frequently a tobacco tin, which held the mandatory claim notice. Other markers might be iron posts embedded in soil, rock, or concrete. Regardless of the marker type, the claim notices required the locator to supply specific information, including locator name, the type of claim (placer or lode), the date of location, the mining district, and the county. If the discovery occurred outside of a known mining district, then the locator stated the claim as "unorganized district."[18]

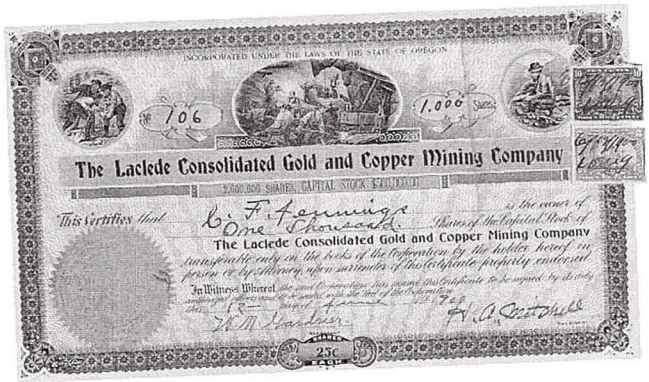


Figure 4–Tobacco tin claim marker.

MINING METHODS AND TECHNOLOGY

Prospecting and Locating Claims

Prospectors in search of ore deposits concentrated their efforts in highly mineralized country, which was often characterized by quartz outcroppings.



Following the foot of a mountain range, they examined the sand and gravel in streambeds. Gold-bearing fissure veins, the object of a prospector's search, are usually only a few feet in width. In areas with few outcrops, prospectors were guided by streaks that they found in the wash; following these, they found seams that widened as they got deeper. Prospectors also searched for surface anomalies that indicated that the rock they were examining was either harder or softer than country rock, one name for the rock that surrounds a lode or vein. A strip of earth that



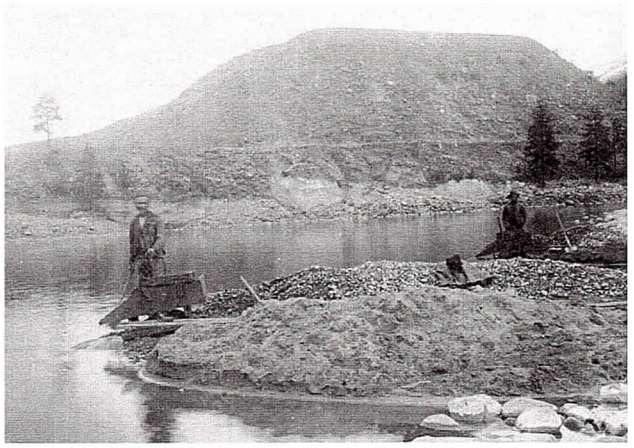


Figure 5–Primitive mining with rocker on Horseshoe Bend near Freedom (Slate Creek), Idaho County. ISHS 1268 Chinese J. A. Hansen photo, Grangeville

was a different color from the surrounding earth might indicate the presence of a metalliferous vein beneath it, like the rust-brown color of hematite, regarded as a reliable indicator of gold.[19] A blossom of mineral salts on a ledge or an outcrop was also a good sign.

In the 1860s, a typical prospecting party was composed of two to twelve men (the larger number was favored if the group expected to encounter hostile Indians). As they traveled they would examine streambeds, focusing on wide spots where the water slowed down, larger boulders, and bedrock crevices. If a location looked promising, the prospector first tested it by **panning**. Next, he might dig a **prospect pit** or a bore hole all the way down to bedrock, pan the contents of the pit, and then estimate the amount of gold present in a given volume of sand and gravel (in cents per cubic yard). The prospector could then delineate the depth, width, geological character, and value per cubic yard of the pay channel by excavating a series of prospect holes on a grid across the entire alluvial terrace down to bedrock in foot-deep increments. If the gold was large, rough, and not too rounded by stream action, the source of the gold might be relatively close. If the gold was flour-like and flattened, it had probably been transported a long distance.[20]

Nuggets and large flakes of gold could be picked out of a pan by hand, but recovery of the rest required **amalgamation**. To do this, the prospector stirred mercury in with the sand and gold. After the gold amalgamated or combined with the mercury, the prospector placed the resulting **amalgam**, the consistency of soft putty, in a chamois cloth and squeezed most of the mercury out through the skin. If the mercury-gold ball that remained was small, he could heat it on a shovel over a campfire to vaporize the mercury, thus separating out the gold; otherwise, he used an iron **retort**. Weighing the resulting gold on scales determined whether the diggings were rich enough to pay well. At $16 per ounce (a typical value in the 1860s), five- to twenty-five-cent gravels would be profitable to work.[21]

When a prospector found a lode that appeared to be mineralized, he would knock off a chip, lick it to remove dust and highlight the contents, and examine it visually. If the results looked good, he conducted a rough field **assay** by pulverizing the ore sample in a hand mortar. He then panned the crushed ore, and tested it with acid, or created a mercury amalgam. Next the prospector determined the width of the vein and estimated the quantity of ore it would yield (veins had to be at least four inches thick to be worth working, because the miner had to excavate a four-foot-wide opening to allow working room) and traced the vein on the surface as far as possible. If still promising, he took the next step to develop the mine by uncovering the outcrop at a number of points and **sinking** a prospect **shaft** on the dip of the vein at the place of the best surface showing. By shipping some of the best ore out, the prospector might be able to raise the money to bring in better equipment. Eventually, after doing some underground work and identifying a good amount of ore, he could afford to hire experts to design a mining plan and a **mill** to treat both the oxidized and sulphide ores. Or, more likely, he might sell his prospect/mine at any of these stages for others to develop.[22]

Ores found close to the surface, in the **oxidized** zone, are generally not extensive. Miners always hoped for ores that stayed rich at depth, but the **sulphide** ores–those minerals, such as cadmium, cobalt, copper, lead, silver, and zinc, which when combined with sulfur make metal sulphides–below the oxidized zone turned out to be complex and low-grade and, thus, often could not be handled by the methods and equipment available in the 1860s. Many of the extremely rich surface ores found in Idaho, such as those in Bayhorse and Silver City, had been **enriched** by weathering. Metals dissolved near the surface from the oxidized zone moved down the vein in solution with surface water and then redeposited just below the water table (this is called supergene enrichment). These types of ores never persist at depth. Many of the early lode miners did not understand this process. Oxidized deposits of enriched lead and silver ores generally are found together, and these accounted for much of the early production in the Wood River, Bayhorse, Nicholia, and other mining districts. Oxidized silver minerals formed the rich ores in the DeLamar, Carson, Lava Creek, Yankee Fork, Mineral, and other districts.[23]

Exploration to determine the probable value of a deposit is more extensive and often more systematic than prospecting. Early methods included hand-digging surface trenches, adits, and shafts to expose underground rock, particularly if the overburden was shallow. Until the adoption of dynamite in 1868, the cost of drilling was quite high so mine developers could not afford to explore to any great depth. By the early 1900s, churn drilling and diamond drilling provided deep samples of rock. Diamond drilling worked particularly well in ground that was fairly homogeneous; it produced a drill core that showed the actual geologic section of the formation.

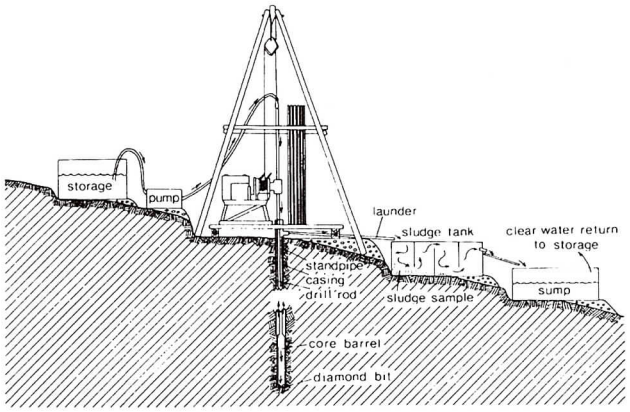


Figure 6–Diagram of diamond drilling rig.

Sixty years later, preferred methods included diamond drilling, percussion drilling, and rotary drilling. Deposits were often drilled with vertical or angled holes arranged in careful patterns. Bulldozers, backhoes, and mechanical or hydraulic rippers have been used to dig prospecting trenches, and pneumatic drills or dynamite aid in sinking prospecting shafts. In addition, geochemical and geophysical techniques have been developed that allow for more cost-effective testing and sampling. Delicate instruments, chemical tests, controlled explosions (seismic methods), and deep drilling can identify hidden ore bodies. Most lode claims did not have enough ore of sufficient value to warrant further development beyond the exploration stage.[24]

Prospectors had a more difficult time identifying silver ores than gold ores. Silver and lead usually were found together, often also associated with zinc and at depth with sulphur. Black nuggets found at the surface of a lode outcrop, caused by weathering of silver sulphurets and galena, often led to discoveries of silver-lead deposits.[25] If the prospector discovered silver ore rather than gold, he took samples to an assayer for evaluation of its metal content. Assaying provided a means of monitoring mining, **milling**, and **smelting** processes. Professional assayers tested the ore by chemical or by fire assay. They reported the types and quantity of metallic elements in the sample. Mining companies often employed resident assayers, particularly when the difference between valuable ore and **waste rock** was not obvious visually. Prospective buyers of a claim took their own samples and got an independent assay report.[26]

The process of assaying silver and gold ore began by **crushing** the ore to a powder, weighing it, and mixing it with a **flux** in a fire clay or porcelain **crucible**. The mixture was melted in a furnace and poured into a cast-iron button mold. After cooling, the assayer chipped off the outer surface (a glassy **slag**), leaving a silver-gold-lead button. The button was placed in a bone-ash cupel and heated in a muffle furnace. As it melted, the lead was absorbed by the bone-ash, leaving free silver and/or gold. Nitric acid dissolved the silver, thus separating the precious metals so they could be weighed separately.[27]

Placer Deposits and Mining Methods

Due to relatively easy access to gold in the form of eroded surface material, placer mines made up the earliest mining districts developed in the American West. Easier to prospect and develop, placer sites required few tools and little initial capital outlay. Beginning in the 1860s, local trade stores stocked mining supplies like gold-washing pans, buckets, picks, and shovels–tools that miners could transport by horse or mule to remote diggings. A resourceful miner could construct rockers, sluice boxes, and **long toms** (mining equipment used to separate gold from sand and gravel) from timber available on site.

The name placer (pronounced "plasser") derives from the Spanish word *placera* meaning "alluvial sand". This term is applied to the mining of **precious metals** like gold found in the beds of streams or former streams into which metal has been washed due to a long process of erosion. The sources include gold-bearing veins or lodes, pre-existing placer deposits that have been reworked by running water, alluvial material with no placer concentration, and sedimentary rocks. About 90 percent of all the gold in a placer deposit is concentrated within one foot of bedrock.

The gold in placers was originally deposited in igneous rock in finely **disseminated** particles or in quartz veins cutting through other rocks. Various erosional processes–like changes of temperature, wind, rain, earth movements, and chemical action–break the

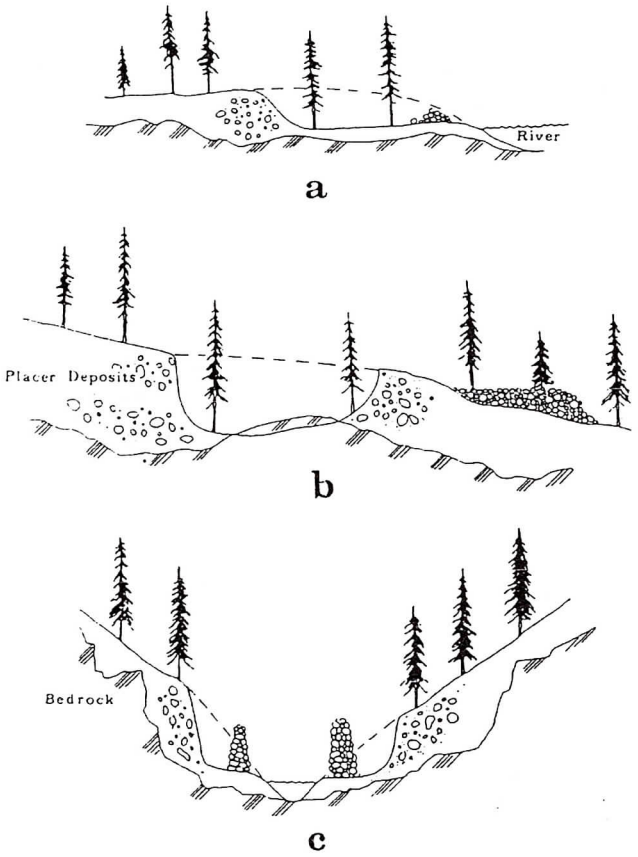


Figure 7–Cross-section views of typical tailings and washing pits resulting from working three types of placer deposits: a) bar placer, b) bench placer, and c) stream placer. (LaLande, "Sojourners," 1985: 49)

rock containing the lode or vein of gold and free the precious metal. Gold is chemically inert, and therefore does not change as erosion releases it out of the surrounding rock and moving water transports it away from its source. A placer district generally expands upstream, as prospectors find the sources of the stream deposits.[28]

Placer deposits are classified based on how far the gold has been transported from its source and sorted by erosion and by the form in which the deposit settles. There are several different types:

1. Stream placers represent gold that has been transported by a stream and reconcentrated. The gold works towards the bottom of the streambed and lodges in crevices and cracks. The coarse gold is deposited in the upper part of the stream and the finer gold in the lower. These deposits, also known as **alluvial deposits**, have been the main source of placer gold in the West.[29]
2. **Bench placers** are those in which the released gold is deposited in benches or terraces when a stream occupied a higher level than at present (they are usually located high above the valley floor). Bench deposits can be as much as 500 feet above the present stream. These are found, for example, in Elk City.
3. River bar placers are bars of sand or gravel that are exposed between high and low water; fine gold is usually distributed throughout the bar, and the deposits are usually very low grade. These types of placers occur along the Salmon River.[30]
4. Residual deposits are those in which the gold has been released from the rock through weathering but has not been transported far from its original location. Residual gold is angular rather than rounded like most other placer gold. Some of Florence's rich placers were residual deposits.

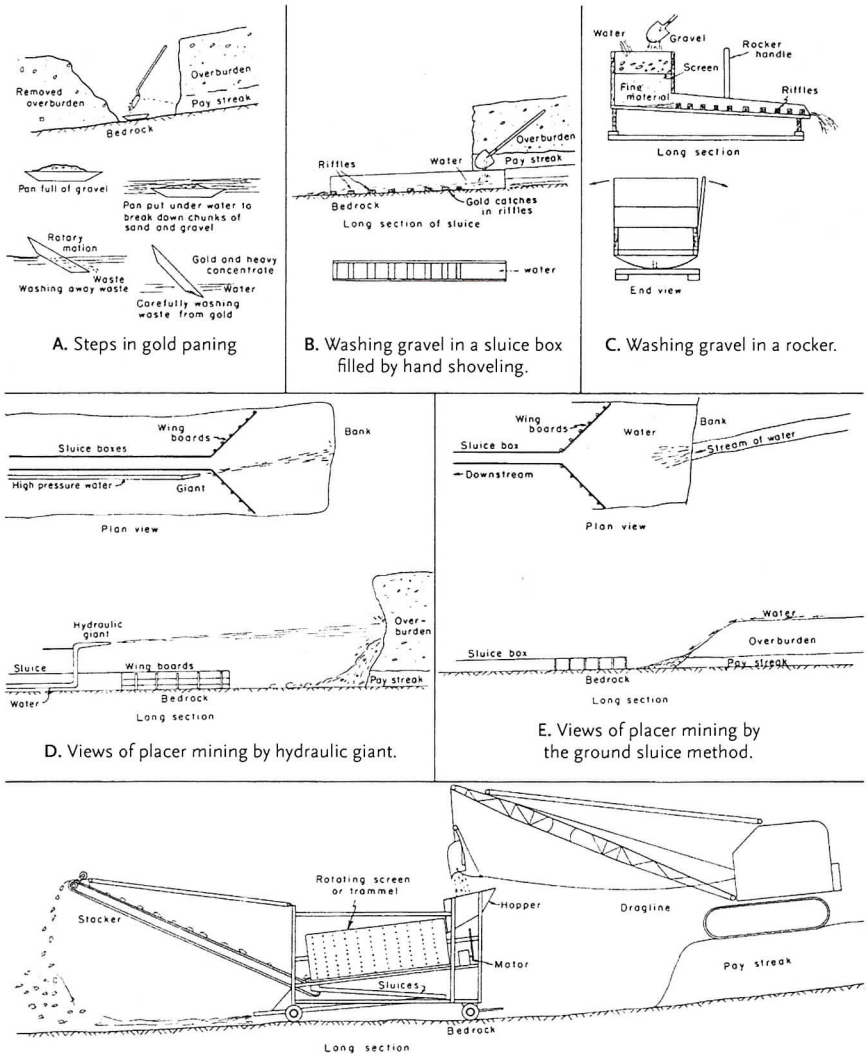
Traditional Hand Methods of Placer Mining



The various methods of placer mining range from those requiring little capital and the cooperation of only a few partners to large-scale, capital-intensive operations. Miners selected their mining method based on water availability, terrain, depth of overburden, depth of deposit, richness of gravel, availability of sawed lumber for **flumes**, and availability of ground for **tailings**. Miners who came to Idaho from California in the early 1860s were experienced placer miners, which led to a certain similarity in methods throughout the territory.

Placer mining essentially entails the process of washing gold, nineteen times heavier than water and about eleven times more than sand when submerged in water, away from gravel, clay, and boulders. The various methods of washing placer gravels required different amounts of capital investment and water supply and had very different efficiencies. A miner selected the method that would maximize his returns, depending on his financial resources.[31] The simplest method, one frequently used by prospectors, of separating nuggets and heavier gold particles from water is panning. (See Fig. 8 A) Using a gold pan, a miner could only wash less than one cubic yard a day. With a **rocker**, three yards could be washed, and with a **sluice box**, about ten yards.

A rocker was a wooden box with a handle, generally about six feet long and two feet high, which rested on a slight incline. (See Fig. 8 C and "rocker" in glossary) The bottom of the rocker was covered with a piece of carpet or burlap and held a frame of riffles,



A. Steps in gold paning

B. Washing gravel in a sluice box filled by hand shoveling.

C. Washing gravel in a rocker.

D. Views of placer mining by hydraulic giant.

E. Views of placer mining by the ground sluice method.

F. Sketch of a dry-land dredge or washing plant. A dragline or power shovel fills the hopper with gravel. The rotating trommel separates the coarse and fine gravel; only the fine gravel is sluiced. Water must be brought to the plant.

Figure 8–Placer Mining Methods. (Stout, *Mining Methods*, 51)

which were usually square wooden bars. The sharp, jerking motion of the rocker and the constant flow of sufficient water, fed from the upper end, washed the lighter materials over the riffles, while the gold and fine sands were caught behind the riffles or in the carpet or burlap. At the rear, the hopper, equipped with a piece of perforated sheet metal or a mesh screen known as a "**grizzly**," allowed the water and the ore below a certain size to fall through to a slanted canvas apron and then into the rocker itself. The material left behind was washed in a pan as concentrates. Mercury might be placed on a copper sheet in the bottom of the rocker to create amalgam, which then had to be retorted.[32]

One man could operate a rocker, but often two men dug gravel and a fourth dumped the pay sand and then buckets of water into the hopper. Every once in a while the miners removed the hopper and dumped its gravel to one side so that the canvas apron and the riffles could be cleaned for gold. In some areas, miners worked claims in the winter; they had to thaw dirt with fire and heat water to run through the rockers.[33]

The long tom was basically a compact sluice box with a screen that separated out coarse gravel. A long tom was much more efficient than a rocker. Built of lumber, it was generally a 10- to 30-foot-long box, 1.5 feet wide at the lower end. Like the rocker, it had cleats across the bottom that sometimes had mercury behind them. The bottom of the lower end was perforated or screened by a grizzly and had a shallow, flat riffle box below it, 4 to 5 feet long, that caught most of the remaining gold.[34]

The sluice box, a line of long, narrow, open troughs, constituted the most complicated and efficient method used by small-scale placer miners. It usually rested on a wooden trestle that controlled the slope of the boxes. Sluicing took the labor of many men simultaneously shoveling in sand and gravel while a large stream of water washed the lighter material through the riffles, made of wooden blocks, angle iron, poles, cobblestones, or other materials. Like long toms, a catch blanket made of corduroy or carpet at the lower end of the riffle-bar deck helped capture gold particles.

To operate a typical sluice box (See Fig 8 B), two men shoveled the gravel into the upper end, a third man stood on top with a shovel or sluice-fork and fished out the rocks and debris, and a fourth man stood in the pool of water at the lower end and threw the waste sand and gravel as far away as possible. A fifth man poured mercury into the moving mass of gravel. Two other men removed sod and loam down to the gravel to prepare a new spot for the washing process. Every few days the crew would shut the water off and clean the boxes thoroughly to recover the gold. As they operated the sluice box, water flowed out through a long and narrow **ditch** known as the tail race. A bedrock

drain, sometimes dug through sod, loam and gravel, even into the bedrock, allowed seepage water in the pit to flow from the claim to a nearby creek. Miners worked the gravels upstream on the claim; they brought boxes from the discharge end to the head, so that waste material could be deposited on top of previously worked ground. Placer mining with a sluice box disturbed the land for miles along the streams and in the valleys below, where the tailings and debris settled.[35]

Sluice boxes were typically introduced into placer gold districts within a year of the discovery of gold. Sluices worked well when there was a sufficient water supply to run through the sluice, when the gradient below the sluice allowed for the easy removal of tailings, and when the gold was not too fine (the stream of water might wash away finer flakes). Because sluicing required a great deal of water, the length of the season depended on the rain and snow levels of the previous winter and spring. The short high-water season of many of Idaho's districts, as little as only a few weeks in many gulches, resulted in a feverish haste, which inevitably led to much gold escaping from the sluices.[36] Eighty percent of the gold was trapped in the first two boxes of a **string**. The finer the gold, the more boxes were needed.[37] If sand was shoveled by hand into the sluice, the process was sluicing; if washed into the sluice by water, it was called **ground sluicing**.

Ground sluicing, a productive method used in mining districts, eliminated some of the hand labor needed in excavating and transporting gravels to sluices. This method required relatively shallow gravels, sufficient grade for the water to carry the soil, sufficient water, and room for tailings to be diverted at the lower end of the sluice. Water from a ditch or flume washed down a bank and carried the gravels through a narrow trench cut down to bedrock into a sluice. The bottom of the trench was riffled with holes, riffle bars, cobblestones, gravel, or other materials. Rocks too large to go through the sluice boxes were stacked in piles or windrows on barren or previously mined ground. The concentrated fine material was then washed in a rocker or sluice box to obtain the gold. Sometimes miners would hand shovel the gold-bearing gravels into the trench or directly into sluices. Small plank or earth **dams** might direct the water to undercut banks during the **stripping** operation. Ground sluicing was also used for stripping overburden off a hillside.[38] (See Fig. 8 E)

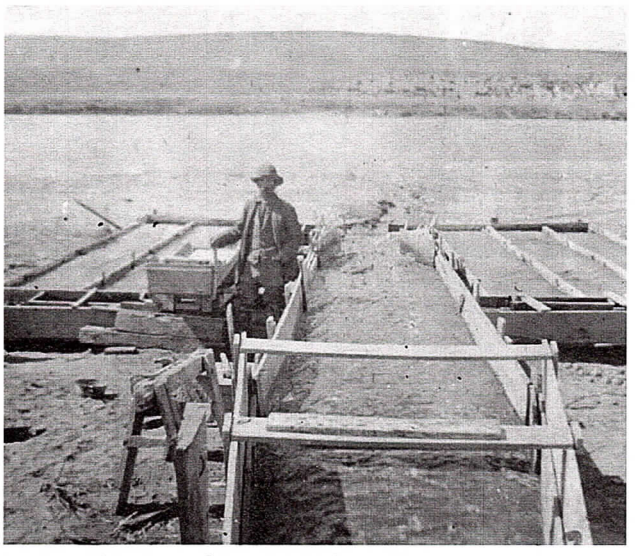


Figure 9–Sluice boxes for recovering fine gold on Snake River. (ISHS GR 62-50.19)

Miners turned to **booming** where the water supply was inadequate for steady ground sluicing. They impounded water above the deposits and released it at intervals, often through an automatic gate, to carry the gravel through sluices. While the reservoir refilled, miners piled boulders in windrows on barren ground. Once the paystreak was exposed, the operation continued as a shoveling-in or ground-sluicing operation. This was also a good method for stripping light overburden.[39]

Rockers, long toms, and sluice boxes all work on basically the same principle of using water to separate the heavier materials (gold) from the lighter materials (those without value). One of several types of barriers, such as **riffles**, trapped the gold, and the waste materials were discharged. Using a gold pan, a miner could only wash less than one cubic yard a day. With a rocker, three yards could be washed, and with a sluice box, about ten yards. **Hydraulicking**, on the other hand, was vastly more productive, since five hundred yards a day could be knocked down and washed through a sluice; gravel worth only five cents a yard was worth hydraulicking. A miner selected the method that would maximize his returns, depending on his financial resources.[40]

Hydraulic Mining

For an individual miner or a small group, use of rockers or sluice boxes remained productive and financially feasible with high grade ores. Lower grades of ore, however, required a more efficient placer mining method to reap the kind of financial return the high-grade ores produced. Hydraulic mining, a large-scale method for placer mining low-grade bench gravels, was

developed in California in 1853. Hydraulicking entailed aiming water under pressure against stream banks and hillsides, knocking down large volumes of gravel, dirt, sand, and boulders to expose and wash the gold-bearing material beneath the surface, and direct it through sluice boxes or bedrock channels.



Figure 10–Hydraulic Mining, Granite Creek, Boise Basin, ca. 1905. (ISHS 70-80.20)

As a result productivity rose from the three yards washed by rocker or ten yards washed with a sluice box to five hundred yards a day that hydraulicking accomplished. Hydraulic mining greatly reduced the cost of handling gravel per ton, but this level of efficiency came at a price. It required a relatively large capital outlay, consolidation of claims, plentiful water, and terrain with hills to give enough fall to the water to create high pressures. Men who had mined in California generally brought hydraulicking to other mining areas, often within a few years of the discovery of gold. In Idaho both Euroamerican and Chinese miners quickly adopted hydraulicking.[41] However, mining districts without much water, such as Owyhee, or with mostly flat ground, such as Florence, relied instead on sluicing to work their placer deposits.

The promoters of a hydraulic operation had to do much preliminary work. First, they evaluated the probable financial returns by determining the depth of the deposit to bedrock, its length and width, and the value per cubic yard. They bought up adjacent placer claims along a drainage, consolidating ownership for efficient working. Next, they built reservoirs, ditches, and flumes, purchased the necessary equipment, constructed shops and other camp buildings, and provided phone communications and illumination for night operations. Finally, they hired crews and began mining.[42]

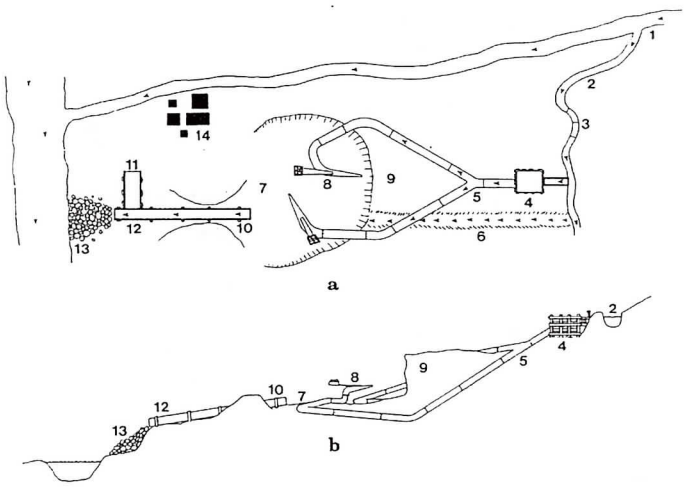


Figure 11–Plan view (a) and cross-section (b) of typical hydraulic mining operation: 1) ditch intake, 2) lateral ditch, 3) flume across steep draw, 4) headbox, 5) penstock in inclined ditch, 6) sluice water channel, 7) floor of washing pit, 8) feeder pipe and nozzle, 9) headwall of washing pit, 10) sluice boxes, 11) undercurrent sluice, 12) tailings sluice, 13) tailings pile, 14) camp, including supply sheds and shops.

Hydraulicking required the conduction of water under enormous pressure through riveted iron pipes (metal pipes replaced the less satisfactory canvas hose in the 1870s). To achieve sufficient water pressure, a high stream was dammed and its waters brought to the mining site by a flume or a ditch. At the highest point above the site, the water was directed through a pressure box (also called a **headbox**). The pressure box, generally a rectangular wooden box, measured and controlled water at its pressure or head, removed air bubbles in the water, and kept sand and debris out of the pipes by the use of traps. The main feeder pipe, also known as a **penstock**, went from the pressure box downslope to the **washing pit** and on through to the monitors or hydraulic giants (iron nozzles, essentially water cannons, in general use by 1870) that aimed the water jet at the bank that was being worked. Water shot out of the monitor against the base of a gravel bank, and the force of the jet caused the bank to collapse. Operators pivoted the monitors horizontally and vertically, and they could wash out tons of sand and gravel in an hour. The loosened sand, gravel, and cobbles were then run through sluice boxes or channels excavated into the bedrock to extract the gold. Due to the force of the water, the penstock often required bracing with boulders or wooden **cages** to keep it in place; smaller pipes were braced within ditches. Periodic cleanups at a hydraulic operation involved removing the amalgam of mercury and gold from the sluice box riffles and separating them by distilling the mercury.[43] (see Fig. 8 D)

A hydraulic **elevator** sometimes lifted gravel as much as seventy feet to provide sufficient fall for sluicing or to place tailings on higher ground. The device worked by directing a pressurized jet of water through an orifice, creating a vacuum and drawing

in the gravels through a tail or feed pipe. The process was similar to modern suction **dredges**, although it was on a much larger scale.[44] Hydraulic elevators were later replaced by power equipment. After about 1920, welded stovepipe-style mining pipe came into use in hydraulics.

The disposal of huge volumes of tailings, totaling up to hundreds of cubic yards per day, presented the greatest dilemma in hydraulic mining. Miners carried away large boulders to keep them from going into the sluices, sometimes stacking them by hand into high rock walls. A grizzly separated out the smaller cobbles moving through the sluice boxes, which were carried by water to a separate moveable tailings sluice or flume, then washed out the end into a pile in a previously excavated area. When the **dumps** became full, the sluices were extended to a new area. In some areas where streams became choked with tailings, miners constructed bedrock tunnels that led from a shaft at the bottom of the washing pit and discharged the tailings into adjacent ravines and valleys. The coarser materials often remained in the gulches near the mines, but much of the finer material passed into the streams, and the sediments caused problems downstream. This occurred as early as 1868 in the Boise Basin where tailings, sand, and gravel from hydraulic mining operations accumulated to average depths of six to ten feet in the main creek channel. The North Fork of the Coeur d'Alene River, too, was muddy certain times of the year due to tailings from hydraulic operations and dredging.[45]

A typical hydraulic mine employed twenty-five to thirty miners, including the pipemen who worked the monitors, a watchman who kept the dump at the end of the sluices clear of obstructions and prevented theft, men who watched the unstable embankments for slides, and ditch tenders who kept the ditches and flumes working well. Hydraulic mining companies often ran both night and day during the high-water season, lighting their operations with huge fires, oil-burning locomotive headlights, benzene lamps, or electric lights. Due to its high cost, urban manufacturers and outside investors financed hydraulic mining, as it required both a greater work force and expensive machinery like nozzles, valves, iron pipe, and wrought iron, for its operations.[46]

Water Conveyance Systems

The success of a placer mine depended largely on an abundant supply of water. In some placer districts, water had to be brought from great distances to the gold-bearing gravels. Sluicing and hydraulicking operations often necessitated the construction of a complex system of ditches or flumes. These water conveyance systems required intensive labor and thus were often quite expensive to build and maintain.

Of the various water transportation systems, ditches were the most durable and easiest to repair. Built on a slight but steady grade (in mountainous areas, grades of sixteen to twenty feet per mile were common), they were dug by men with hand tools or by a team of horses that plowed the course, turning the earth from the upper side to the lower embankment to form a semi-circular contour. Once completed, the main ditch transported water to a set of claims through a series of smaller feeder ditches. Where necessary, **cribbing** shored up the sides of ditches to keep them from collapsing. Waste gates, installed to protect ditches from erosive rushes of water, also allowed the ditch to be emptied when a break occurred; snow guards protected the ditch from snow slides. Once the ground was saturated, compacted, and layered with sediment, the water ran with little leakage (although water was lost to evaporation). Good maintenance helped to prevent breaches. The term "**miners' inch**" was used to measure the volume of water a ditch could carry; one miner's inch generally equaled 11.25 gallons of water per minute.[47]

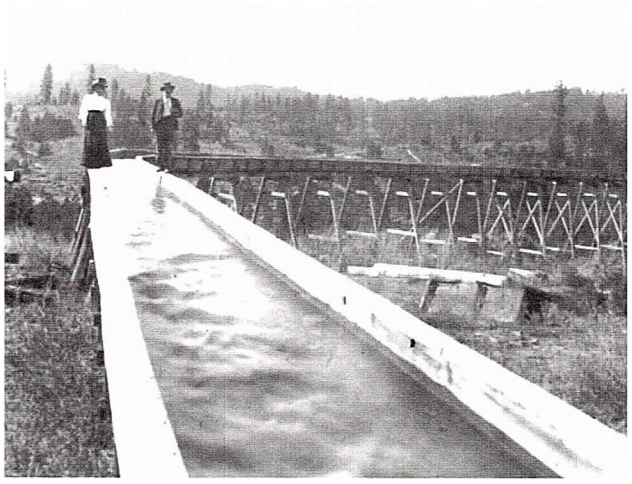


Figure 12–Flume in Boise Basin, ca. 1905. (ISHS 70-80.5)

Wooden flumes, more expensive to build than ditches, carried water across rocky terrain, drainages, or areas subject to washout. They were generally wooden boxes, open on the top, and sealed with battens, tar paper, or canvas. Flumes were either supported on trestles or were bracketed along cliffs. Flumes could handle a steeper grade than ditches, and like them, flumes required waste gates to drain off excess water. They generally did not last more than ten years; natural decay, fires, floods, wind, and snow took their toll. Pipelines,

siphons, and **tunnels** were also used to convey water in certain areas. In Twin Springs, a bridge carried a siphon across the Boise River to a hydraulicking operation.[48]

Dam construction varied according to the needs of miners and the topography. **Head dams** collected water from a drainage and directed it into the ditch system. Retaining dams, built to create a storage reservoir, guaranteed a water supply during the dry season. Most retaining dams were earthen, with cribbed timber bases filled with stones, earth, gravel, and sand. This kind of dam worked well to feed the penstock pipe used in hydraulicking. These dams, built by human labor or by horses and slipscrapers (also called fresnos), required a twice-a-day trip to the head of the ditch to open the headgate to release the impounded water, then close it to allow the dam to refill. On the other hand, splash dams, constructed just above the diggings, had trip-release gates that discharged the accumulated water in a powerful flood onto ground that had been stripped of its overburden for booming or ground sluicing purposes. Distributing reservoirs conveyed water to individual claims and retained surplus water, generally only enough for a few days of work.[49]

The supply of water to a placer mine was critical to the success of the operation. The construction of mining ditches was generally necessary to bring water by gravity to the mine. In some of Idaho's placer districts, water had to be brought from great distances to the gold-bearing gravels. Water conveyance systems required much labor and expense both to build and to maintain. Ditch companies sometimes were formed to construct the ditches for an area and then sell water to miners.

Dredges and Draglines

Dredges and dragline operations were designed to dig the gravel of a relatively flat placer deposit and raise it high enough so that gold could be recovered in sluice boxes. They typically operated in stream gravels that were too low-grade or too flat to permit profitable mining by hand or by hydraulic methods. The key to their success lay in careful testing of the dredge grounds, continuous operation, and bulk processing.

The dredge, essentially a flat-bottomed boat equipped with excavating, screening, and gold-washing machinery, evolved from small, steam-driven wooden machines with 3.25-cubic-foot buckets to large, all-steel, electric-driven machines with 16-cubic-foot buckets within nearly two decades. By 1912, some dredges could handle over ten thousand cubic yards of gravel daily. Dredges were often moved from one placer deposit to another; some used in Idaho were brought in from other states and reassembled on-site.[50]

The bucket-elevator dredge (used first in Bannack, Montana in the latter 1890s and considered the most popular, successful, and expensive dredge in the West) consisted of a wood- or steel-hulled barge outfitted with a continuous chain of buckets; a screening and washing plant to save the gold; and ore conveyor belts for removing tailings. The processing plant washed and screened the gravel, ran fine material through a sluice, and discharged tailings off the stern. Steel-pointed spuds provided a pivot around which the dredge swung as it worked. Basically a monstrous vacuum cleaner scooping up finer particles, the dredge worked the length of a river channel, redepositing the debris behind it as it moved through the water channel. As work progressed, and the dredge moved forward, it created a large artificial pond several feet deep. Work had to stop if the grade increased too much or if rock ridges blocked the dredge.[51]

Dragline dredges, essentially washing plants floating on pontoons, were equipped with a **trommel** or cylindrical sorting screen, sluice boxes, and perhaps other machinery such as a **jig**, which further agitated the material being worked. Dragline shovels, **power shovels**, or front-end loaders dug the gravel and deposited it in the washing plant.

Draglines became popular beginning in 1933 in California and other western states for the following reasons: they cost less than bucket-line dredges; they could work deposits that were small, discontiguous, or otherwise unsuitable for floating dredges; they could be moved easily; and they cleaned ordinary bedrock relatively efficiently. Draglines, however, had some disadvantages: they could not dig up the gravels continuously, and they did not work as well as bucket dredges in hard, compacted gravel.

To prepare the area for dredging, a caterpillar tractor with a scraper or bulldozer blade in front and a winch in back cleared the land of brush and trees and leveled the ground ahead of the dragline shovel. The caterpillar also removed overburden and built dams to form dredge ponds, if needed. Either the dragline shovel removed the tailings from the washing plant and deposited them on the streambank, or the washing plant was equipped with a stacker for discarding the tailings.[52]

On **clean-up** days, the materials caught in the sluice's riffles were generally processed in jigs. The resulting amalgam was then retorted, resulting in a sponge of free gold and a small amount of mercury. This sponge was sent to an assay office or for final processing. At some dredges, such as the one at Yankee Fork, the company processed the molten gold further



Figure 13–Dredge near Centerville, 1899. (ISHS 1246)

by heating it to a higher temperature and adding a flux. This resulted in relatively pure gold that was poured into bricks.[53]

The dryland dredge, generally a smaller and more mobile variant of a dragline dredge, could be used on smaller deposits or in narrow areas. The washing plant of a dryland dredge was mounted on wide, iron tires, tractor treads, or metal tracks, and it usually consisted of a hopper, a rotary screen or trommel, a sluice beneath the trommel, and a stacker. A dragline shovel or a tractor pulled the washing plant forward.[54]

Some of the problems encountered by dredging operations included irregular distribution of gold, lack of power, scarcity of water, large boulders, very hard bedrock, narrow valleys, and rugged terrain. Blocks of claims needed to be obtained so a dredge could work a large area.



Figure 14–Dragline and washing plant on Jordan Creek, 1947. (ISHS 72-201.97/B)

River Bar Mining

River mining is a technique brought to Idaho from California for use on some placer deposits, particularly along the Salmon River. Miners built a **wing dam**, ditches, flumes, canals, or even tunnels to divert rivers or streams from their natural streambeds, allowing them to extract the gold from the exposed gravel using rockers, sluices, or other traditional hand methods. Chinese miners often built wing dams, and they also introduced sump pumps to drain the water. Overshot or undershot **water wheels** that powered a chain of bailing buckets were also used to raise water for sluicing gravels located on high benches along the Salmon and Snake rivers.[55]

In Idaho, miners worked the sand bars along the shores of the Salmon and Snake rivers in the winter when the river was low. Mining along the river continued for many decades, starting with rich gravel-bar deposits, which could be replenished after every high water. In the early days, miners found deposits of fine "**skim gold**" on the inside curves of sand bars. This precious metal accumulated on the sand bars on the inside of bends and at the mouths of larger tributaries and often was found in deposits several dozen feet deep. Rockers and sluice boxes generally caught the gold. Once those placers were exhausted, miners moved on to high benches, former river channels where gold deposits also appeared. The coarser gold found in the higher bars and bench gravel sometimes reached more than two hundred feet above the present level of the river. The mouths of tributaries that come from

gold-bearing regions also contained gold deposits.[56] Obtaining gold from benches above the river was more difficult due to the problem of getting water to the claims. Hydraulicking or adits dug into riverbank terraces were later methods used to work some of these bench deposits; the higher deposits required hydraulic mining fed by ditches.[57] Driving adits into bench gravels and high bars–the method employed in later years–required even more development work and investment in water conveyance systems than working the deposits of skim gold in the sand bars along the river.[58]

Traditional recovery methods often allowed the very fine gold to float away. Although miners tried many devices for recovering the specks of gold, none ever succeeded entirely. The most successful was a suction dredge in the early 1900s, on which **concentrates** from burlap tables were amalgamated in barrels. Dragline scrapers, dragline shovels, and other methods were also used.[59] Recovery methods focused on first, separating the fine gold from the gravels and **black sands** and then using amalgamation and/or **cyanidation** to recover it. Separation methods included rockers with copper plates coated with mercury, burlap-lined sluice boxes and **tables**, **undercurrents** (a very wide, shallow sluice set below the main sluice), and magnets that removed the iron.[60]

Before turning our attention to the less water-intensive alternatives of drift and lode mining, we might pause for a moment and ask where all this water was coming from? Maritime circulation combined with orography are the determining factors. Idaho's mean elevation is nearly a mile above sea level. The state counts 352 peaks reaching heights of 10,000 feet or more, scattered among more than seventy named ranges and sub-ranges. Melting winter snowpack provided a crucial resource for placer mining from late spring through mid-summer, with the local situation varying with latitude, elevation, rain shadow effects and periodic seasonal rain-on-snow events.

The state is studded with more than two thousand lakes and has a total water surface area of 880 square miles. The largest and deepest lakes are in the silver-mining uplands of the northern Panhandle (Boundary, Bonner, and Benewah counties). Lakes control the base level of running water in streams and constrain channel erosion in ways that make locating placer deposits more predictable.

The longest stream in the state is the Snake River, which originates on the Yellowstone Plateau and arcs 880 miles across the entire width of Idaho like the belt on a potbellied prospector. Along its middle reach, the Snake gains additional replenishment from the porous lavas of an aquifer which stores another hundred million acre-feet in its upper levels.

The Salmon and Clearwater are the second and third most important streams in the state's placering history. The Salmon River drains 14,000 square miles of Idaho's interior batholith, and drops more than 7,000 feet in 425 miles. The Clearwater River originates on the west slope of the Bitterroot range and drains 9,645 square miles. Its relative accessibility by comparison to the Salmon accounts for the early start of placering at Pierce and Orofino (see Transportation to Idaho's Mines, below).

Annual precipitation varies considerably across this orographic mosaic, from less than ten to more than fifty inches. A one-statistic perspective on the state's water-wealth emerges from a comparison of annual stream inflow to outflow. An average of 37 million acre-feet of water enter the state annually, while 75 million acre-feet flow out.[61]

Heaviest annual precipitation occurs in the northern panhandle, followed by the prairies, mountains, and canyons in the center of the state. Southern and eastern Idaho are significantly drier, due to the combined affects of rain shadows and circulation patterns. The southwestern valleys and highlands receive less than half as much moisture as the central interior. The plains along the Snake River are drier still, as are the rainshadowed northeastern basin-and-range valleys.

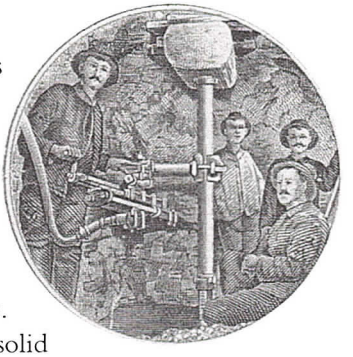
Finally, these geographic regularities must also be viewed from the perspective of our changing climatic history. Idaho was much moister when the Little Ice Age ended in the 1860s than it is today[62], or will be for the foreseeable future.

Drift Mining

Where water for hydraulicking was not easily available, or where conditions were unsuitable for dredging, underground work known as **drift mining** was sometimes required. In areas with deep overburden layers, miners chose this method of gold recovery, a more hazardous, highly speculative, and less efficient one than hydraulicking, to reach bedrock. Miners sank shafts into the gravel or peat or drove **adits** into the bank or hillside. Often, due to the dangerous or unstable conditions, adits required **timbering** for structural support, and wooden timbers or planks were installed along the top and sides of the mine opening to keep it from collapsing or caving in. Using wheelbarrows, **ore cars**, or windlass and **buckets** to remove ore-bearing gravel from the adit, miners hauled the gravel to a rocker, long tom, or sluice box for processing. In many areas, drift mining was one of the first mining methods employed.

In Idaho, small-scale drifting began in the Boise Basin by 1863, and soon some adits were three hundred feet deep.[63]

Lode Mining Methods



In contrast to placer mining, lode mining refers to the mineral deposit still contained in the surrounding rock found in a vein or lode; erosion has not freed it from solid rock or subsequently deposited it in stream beds. The ore is extracted from solid rock in underground workings or in surface pits. While placer mining, particularly in the early years, was often conducted by solitary or small groups of miners requiring few tools, little initial capital, and the ability to identify the type of landscape where precious metals were likely to appear, lode mining involved a large group of miners requiring more complex and expensive machinery, large capital investments, and a knowledge of geology to extract precious metals from tunnels drilled into the earth or into mountainsides. Profitable development of lode mines depended on a number of factors, including the richness of the deposits, the technical difficulties of recovering the gold from the ore, the distance to the nearest shipping point, the topography, and the climate.[64]

Upon discovering lodes that led underground, miners in the American West found the contemporary methods adapted from the Spanish and Allegheny coal miners of working refractory ores unsatisfactory. So, in the mid-1800s, American mine owners began importing Cornish miners, known for their knowledge and expertise in underground mining, to run the mines. Cornish mine "captains," skilled in obtaining optimal work from the miner while simultaneously maximizing the amount of ore recovered at the most economically feasible price, supervised the mine or mining districts' day-to-day activities. Under him, Cornish "shifters" or shift bosses "knew better than anyone how to break rock, how to timber bad ground, and how to make the other fellow shovel it, tram it, and hoist it."[65] Cornish miners not only taught their American counterparts the techniques of hard rock mining, but also introduced efficient equipment and left a wealth of old mining terms, a specific vocabulary including the words stope, winze, raises, and drifting, used then and now to describe underground mining practices.[66]

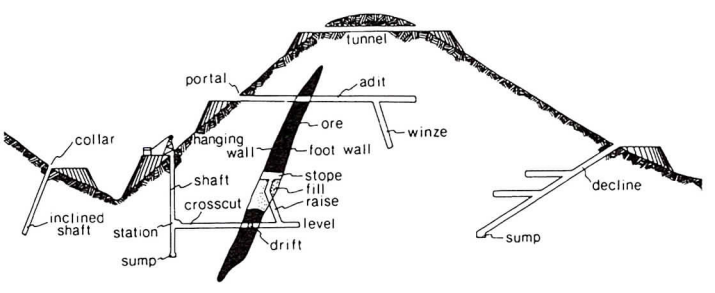


Figure 15–Diagram of lode mine [underground mining terms & great map]. (USFS, *Anatomy of a Mine*, 44)

The various methods of **lode mining** were designed to mine the mineralized cracks, fissures, and replacement bodies of ore on site. The technology was determined partly by the geology of the ore body and partly by the means of gaining access to and removing the ore body and of ventilating the mine. If the vein was narrow and dipped steeply, underground work was needed. Otherwise, since about 1900, surface mining could be done much more cheaply, especially on large, low-grade deposits.

Historic underground mining methods varied somewhat depending on local conditions such as configuration of the ore body, value of ore, distribution of pay ore, strength and physical character of ore and wall rock, and availability of timber. Veins typically were fairly close to vertical. Lodes ranged from an inch or less to many feet thick, and all of the lode was removed. The classification of a **stope** (a cavity wide enough to contain a miner) generally depended on the type of support it required. Stopes usually had to be timbered (concrete and steel began to replace wood in part about 1915) so that they would not cave in. **Drifts** about eight-feet-square would be driven along the ore-bearing vein, and crosscuts would be driven at right angles to the vein. **Raises** were driven upward on the vein to block out the ore for mining. Adits went into a mountain on the level, with only enough slope for water to drain out and to let ore cars run by gravity. Stopes were backfilled with waste rock or mill tailings mixed with water, or they were allowed to cave.[67]

Two general methods of underground excavation in western mines have been used over the years: the "rat-hole" system and planned mining. The first was an early method that continued to be used in some small mining operations. Access to and removal of the ore body was done by a single shaft or an adit. When the terrain allowed, adits were preferred because they were less costly to construct and operate and because they drained water from the workings above. The mining followed the ore body with a maze-like network of drifts excavated in or around and parallel to the long

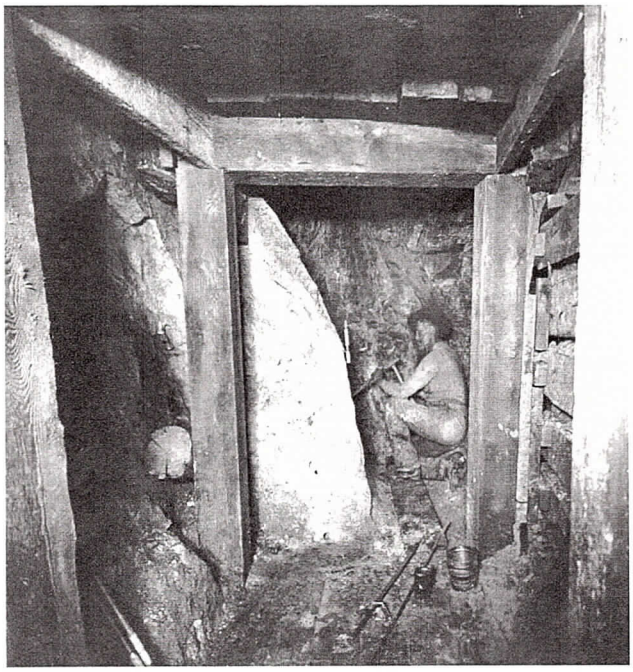
axis of the ore body, with **cross-cuts**, **winzes**, and raises connecting the different **levels**. This was the primary method used when the ore body was relatively shallow. Miners learned how to mine at great depth on the Comstock Lode in Nevada; by 1881, shafts had been sunk there three thousand feet below the surface. Planned mining, the second underground method used in the excavation of deep ore bodies (and the primary method used in the Coeur d'Alene district), required exploratory drifts to determine the shape of the ore body, and planning to provide access and ventilation. The various innovations of the late 1800s in mining methods allowed for much deeper operations. Deep workings, in turn, led to problems with ventilation, heat, cave-ins, sanitation, and fire.[68]

Most larger mines were part of an engineer-designed system. Every component was designed to work together to maximize profits and take advantage of economies of scale. In the years after the 1890s, when big business rose to power in America, mining engineers developed standard systems for mine operation. A relatively small number of companies manufactured mining equipment and shipped it to widely scattered mining districts. Sometimes, however, special conditions at a mine would make unique technologies adapted to the particular environment more cost-effective than a standardized industrial technology. Successful innovations spread fairly rapidly once they were proven in the field.[69]

Small-scale mines or mines in the exploration stage used manpower or animal power for hoisting men, supplies, and ore up and down a mine shaft. Miners accessed the underground workings by climbing down a ladder or by riding in an ore bucket or in a cage. Alternatively, a hand-operated winch, called a windlass, lowered and raised workers, ore, waste rock, and supplies (the **whim** was a horse-powered version of this). The **headframe**, a hoisting system that featured a gallows-like wood or steel structure over the mine shaft, greatly increased the capacity and flexibility of hoisting. A wire cable or belt passed over a drum at its apex, and an engine pulled the cable to raise and lower the miners, supplies, and ore. Small mines with fewer financial resources generally drove slightly sloping tunnel adits, since they were self-draining and did not require the expensive hoisting equipment that drilling shafts did. Well-financed mines generally had steam-powered **hoists** that lifted large tonnages of ore and waste rock up the shafts or **inclines**. Eventually, hoists were powered by compressed air, diesel, or electricity.[70]

The purpose of underground work was to locate or reach the vein and then to extract the ore from it. The work that miners conducted on the lode between levels is called **stoping**. (see *Underground workings at a mine using the timbered cut-and-fill method*, inside front cover) The actual mining occurred in the drifts that followed the lode. Miners had to support the underground workings with mine timbers, remove the accumulated ore and waste rock, and do exploratory work. They sorted the waste from the ore and transported the latter to the mill. Waste rock was generally dumped right outside the **shaft collar** or just below the adit **portal**. By the beginning of the twentieth century the "shrinkage" system of stoping was used, which involved excavating a drift just below the ore body to serve as a floor upon which ore cars ran, followed by tunneling raises at each end of the ore body, then hollowing out more raises (chute raises) parallel to the manway raises at twenty-four-foot intervals. The latter were used to drop mined ore loosened by **blasting** into the cars waiting on the floor below. The miners excavated the working drifts about fifteen feet above the ore car floor.[71]

Figure 16–Single jacking at ore face, Lincoln Mine, Pearl, 1909. (ISHS 71-85.27)



Underground mining required hammers and rock drills; dynamite for blasting; and picks and shovels for **mucking out** the loosened ore. The actual drilling of the ore **face** could either be done by **single jacking** (one man holding and turning the steel for drilling with his left hand while striking with the sledge with his right hand) or by **double jacking** (one man turning

the steel while one or two others pounded on it.) The stopes were always driven up, both for ease in drilling the rock and for removing the ore by gravity. More efficient compressed-air drills, invented in 1869, replaced these hand drilling methods soon after their introduction. Compressed air continued to provide power to underground drills, even after electricity was introduced, because compressed-air drills were safer and easier to maintain. Beginning as early as 1868 in the Owyhee mines, dynamite replaced the more hazardous black powder. When a crew arrived at its work level, it mucked out the ore and waste left by the blasting of the preceding shift. The shift boss marked the new drill-hole locations on the ore face, and drilling began. At the end of the shift, the miners carefully packed the holes with dynamite and added a cap or detonating device. They then detonated the explosive, counting the shots so that the muckers would not run into a live round. The next shift then descended, sorted and mucked the ore and waste, and loaded each in individual cars to be taken to the surface.[72]

Air circulation was a major concern in underground mines both for cooling the air and for removing smoke, gas, and dust from the workings. Driving openings to the surface at intervals provided natural ventilation. Lighter warm air from inside the mine would rise out of one shaft, drawing down through another shaft the heavier cool air from outside. Generally the hoist shaft served as the outlet, since it was the longest continuous raise in the mine; this resulted in a heavy white column of steam rising from the shaft on cold days. This method was dependent on weather conditions, however. In some mines, air compressors and air blowers forced air throughout the workings.[73]

The flooding of underground workings was a common problem in many mines. The simplest solution was to dig inclined adits into the hillside below the mine. Iron buckets on windlasses or whims could bail out the mine, as could a water skip pulled up an inclined ramp. By 1859, steam-powered pumps were used to dewater mines; the most common was the **Cornish pump**. Electric pumps supplanted steam-powered ones in later years. The expense of these pumps, however, caused many miners to drive adits instead. Problems arose when development work was suspended for too long at a mine–the untended shafts and adits filled with water and the timbers supporting the stopes rotted, making the workings inaccessible.[74]

Ore and waste rock were generally removed in ore buckets lifted up the shaft by a whim or windlass, or in small, one-ton ore cars that could be used singly or

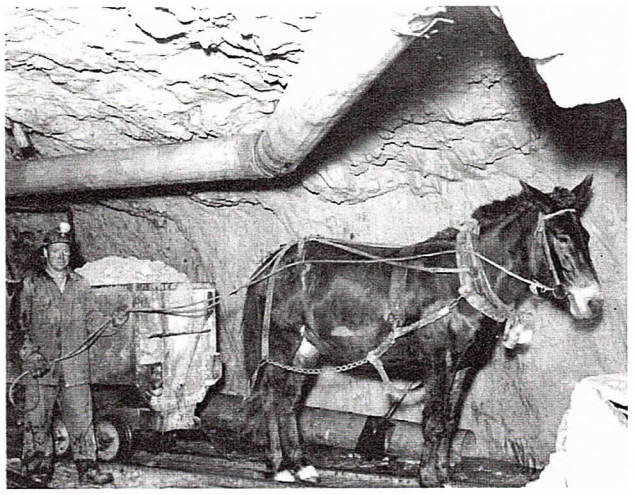


Figure 17–Mule hauling mine car. (ISHS F 152.Sh1 63-160.174 Mines–Coeur d'Alene, Silver Dollar Mine.

linked by chains and hooks at the corners and run on tracks in the inclined adits. The ore cars, powered by humans or by mules in the early days, had four closely set flanged wheels that ran on rails laid down about eighteen inches apart. In larger mines, the tramming levels could be double-tracked. At the surface, a worker known as the "top lander" pulled the cars off the cage levels, replacing them with empty cars. He spilled the waste out over the dump and took the ore to the sorting shed or to ore bins. Contract freighters or mine employees collected the ore in wagons and transported it to the mill, or the ore was hauled to the mill in ore carts that ran on a system of rails or in buckets suspended from an aerial tramway.[75]

Power sources varied at lode mines depending on the available technology at the time, the environmental conditions, and finances. Humans, animals, steam, hydroelectric power, compressed air, electricity, and gasoline or diesel engines all provided power for various aspects of lode mining. In the hauling of ore, for



Figure 18–"Ready to shoot–big low-grade stope, De Lamar Mine" *Annual report of the mining industry of Idaho.* (TN 24. I2 A2 1912)

example, machinery driven by steam, compressed air, or electricity replaced human and mule power.

In mines with high-grade ore, some workers succumbed to temptation and carried rich ore home with them. To counter such theft, mining companies built change houses–locker rooms where the men were required to change out of their work clothes–both to allow employees to shower and change clothes and to prevent this kind of **high-grading**.

By the end of the nineteenth century, a great many new technologies had been introduced to hard-rock mining that allowed the working of relatively low-grade ore deposits. Cages replaced ore buckets; wire cable replaced rope; dynamite replaced gunpowder and nitroglycerin; machine drills replaced hammers and hand drills; and electricity replaced steam plants and human and animal labor. Although new technology reduced the costs and the physical labor required for many tasks, it also replaced human laborers, made the extraction of the ore less systematic and thorough, and created new problems and dangers for underground miners. For example, when a mine converted to pneumatic drills run on compressed air, it might lay off three quarters of its double-jack drilling teams and still hoist more tons of ore and waste rock than ever before. The new drills created a dust that caused the deadly disease known as silicosis, which scarified and altered lung tissue until the miner literally could not breathe. The invention, in approximately 1890, of a water-flushed drill that wetted down the flying clouds of dust eliminated this safety hazard.[76]

Surface Mining

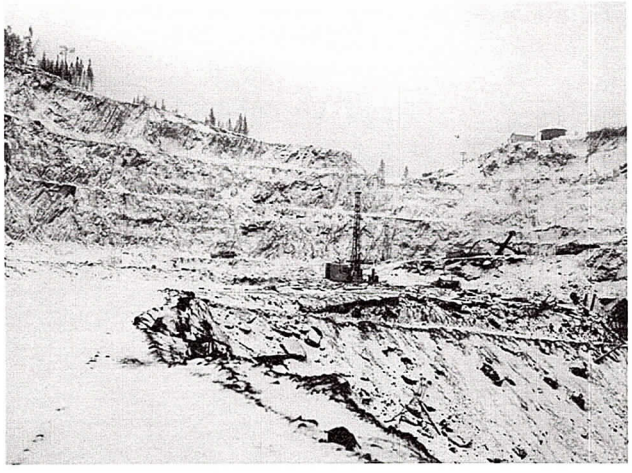


Figure 19–Blackbird Mine near Salmon. (ISHS 63-160.257a Winter scene: surface mining)

The development of surface mining operations in the twentieth century reflected the need to reduce labor costs by replacing manpower with the use of heavy equipment. The factors determining whether to use surface or underground methods to work a lode deposit included the extent and value of ore reserves, topography, mining equipment, operating and capital costs, cut-off grade, availability of dump area, stripping ratio (the ratio of waste to ore), the ore's metallurgical characteristics, marketing considerations, and other factors. The three types of surface mining that have been tried in Idaho are **open cuts**, **glory holes**, and **open-pit** mining.

Open cuts, a relatively simple method of lode mining, could only be used on deposits that outcropped or those with a shallow overburden. Often used on a series of hillside **benches**, this method could only go to a limited depth, however, due to the danger of falling rock.[77] Miners removed the waste overburden by stripping, then loosened, loaded, and transported the rock and earth. Loading was done by hand or by mechanical excavators. Hydraulicking or blasting was sometimes used to break down unconsolidated material. Open-cut mining was often a way that a small-scale mine operator could obtain capital for subsequent work.

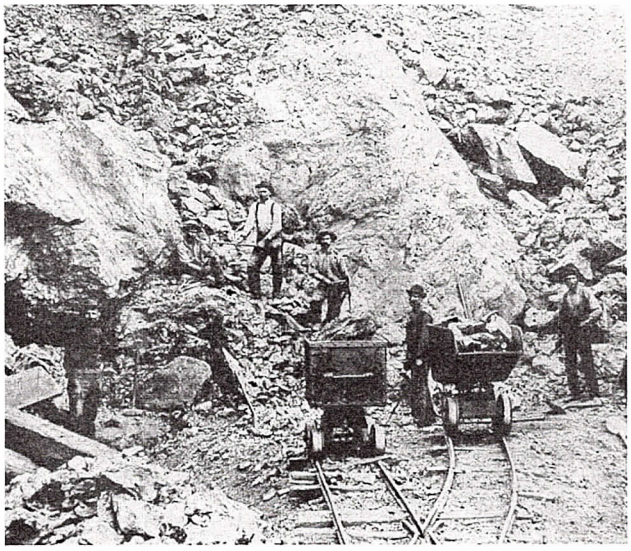


Figure 20–Early open cut mining, Bunker Hill, 1887. (*Mining Salutes Idaho's 50 years*, p. 4. TN 24.12 I3 1940)

Glory-hole mining consisted of a funnel-shaped excavation connected to a raise driven from an underground haulage level. The ore was broken by drilling and blasting around the periphery of the funnel. The broken ore slid into the raise, where an ore car or some other mechanized means hauled it out. The benches were excavated as the work descended to the bottom of the deposit.[78]

Open-pit mining developed early in the twentieth century as an economical means of mining large,

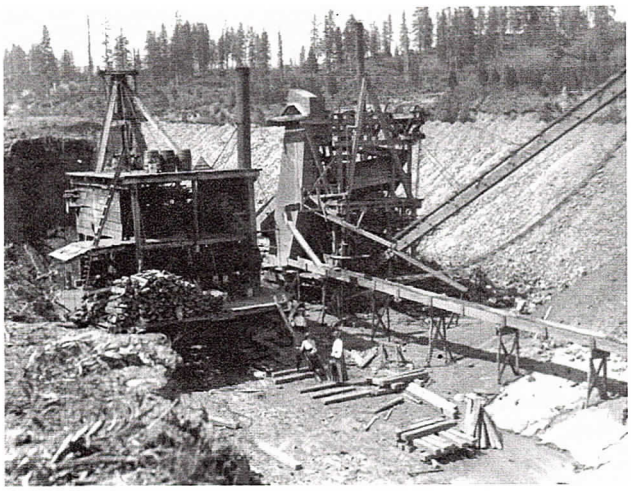


Figure 21–Power shovel and washing plant at placer mining operation, Boise Basin, ca. 1905. (ISHS 70-80.32)

low-grade ore deposits. This method, combined with new sampling and prospecting techniques, allowed the mining of ore that had previously been considered worthless ground. Open-pit mining removed both the ore body and the overburden covering it (sometimes relatively high-grade ore was left unmined, however, if it was located deep beneath the overburden). Mining engineers at open-pit mines endeavored to minimize the overall ratio of stripped material to ore by keeping the slopes of the pit as steep as possible. Stripping equipment included shovels, trucks, draglines, bucket-wheel excavators, and scrapers. Drilling and blasting teams did the mining, followed by the loading and hauling crews. As the pit deepened it created a series of benches with widths ranging from twenty-five to sixty feet. The overburden and ore was hauled out by a variety of means, including railcars, conveyor belts, trucks, bulldozers, and inclined skips. If trucks were used to haul the ore, an inclined **haul road** spiraled or hairpinned out of the mine. Belt conveyors were mostly used to convey overburden to dumps and to take the crushed product to an ore bin, a mill, or to railroad cars for shipping. By the 1960s, open-pit mining had almost completely replaced glory-hole mining. Improved excavating and haulage machinery such as dragline shovels, tractor loaders, inclined rails, conveyor belt or pipeline transport systems, ammonium nitrate for blasting, power shovels, and large trucks made this method possible.[79]

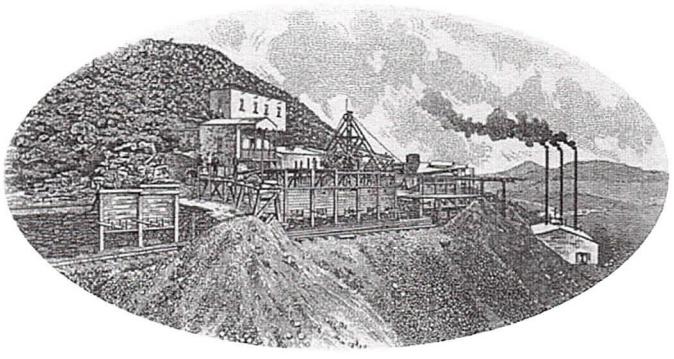
The power shovel is a critical component of open-pit mining. Mining operations used a few small revolving shovels by the early 1900s. In 1925, the technology advanced with the development of a heavy-duty, full revolving shovel powered by electricity. Its digging element, a dipper attached to a handle, had a hinged door with a latch at its bottom for dumping the contents. The shovel was usually mounted on a system of crawlers.[80]

Since World War II, open-cut mining has been characterized by increased productivity of labor, decline in grade of the ore, larger capacities of trucks and excavating equipment, more efficient drilling, and increased production. At the same time, the cost of underground mining has risen steadily. In the late 1960s, over 90 percent of the metal produced in the United States came from open-pit operations.[81]

ORE BENEFICIATION

The Reduction and Refining Process

Ores bearing valuable metals require more complicated and varied processes to recover their values than do placer gravels. Ore beneficiation upgrades the value of precious metals extracted from the earth. It separates the **gangue**, or worthless minerals, from the valuable ones in an ore. There are two stages: crushing and classifying, and concentration: classification sorts the ore by size; **concentration** reduces the volume of the ore and increases its metallic content. The machinery that accomplishes these two stages is usually housed in the same mill or ore-processing building.



As mills relied on gravity feed to move the crushed rock through its various parts, they were located, whenever possible, on hillsides downslope from the mine portal. The roofline followed the same downhill gradient as the entire building, which was built on a stepped foundation. The machinery required plentiful water for washing the crushed rock, so mills were always located near a dependable water source or access

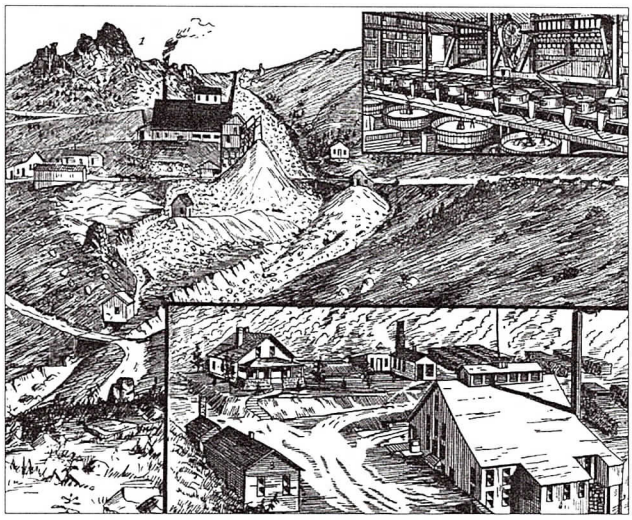


Figure 22–Drawing of Oro Fino Mine, mill interior, and supporting buildings (blacksmith shop, store house and dwelling, office, and mill), 1890. (ISHS 78-89.6)

to water. (Dry milling, or ore beneficiation without the use of water, was primarily used in the American Southwest; most of Idaho's mining districts had seasonal or year-round water sources.) Mills and other ore processing buildings were designed around the machinery, not the reverse.

After milling, the high-grade ore or concentrate then goes through a recovery process to separate the metal(s) from the impurities. The three broad categories of recovery processes are amalgamation, chemical methods, and smelting. Smelting reduces both high-grade ores and the concentrates from mills. Refining enhances the value of the ore or metal even further until it reaches a nearly pure state. The recovery processes tried in Idaho for various kinds of ore include: stamp milling combined with mercury amalgamation for gold ore; **Freiberg** and **Washoe processes** (with or without **roasting**) for silver ore; **blast furnace** smelting for lead-silver and copper ores; and, among others, cyanidation, **flotation**, **chlorination** and **leaching**.[82]

Hand sorting constituted the earliest form of concentration. Rich ore could be hand sorted and then shipped directly to a large-scale smelter, often located outside the area. Most ores, however, required additional concentrating to reduce shipping charges. Precious minerals were not terribly bulky, but ores bearing base metals such as lead, copper, and zinc were; so many isolated districts needed railroads to transport ore in order for base metal mines to become producers.[83]

The various reduction methods always began with the mechanical crushing and grinding of the ore, whether by an **arrastra**, **stamp mill**, **jaw crusher**, or another device. Next, the crushed rock was concentrated, reducing the volume and increasing the metallic content of the ore. The amalgamation process collected free-milling gold particles relatively easily, using devices such as copper plates or tables covered with a thin film of mercury to separate the gold from rock containing no ore. Free-milling gold made up most of the ore in Idaho's early mining days, so most of the milling occurred in stamp mills combined with straight amalgamation. Gold **bullion** resulting from this amalgamation process was sent to an assay office or to the mint. As the ore became more base with depth, the milling process expanded to include table concentration and cyanidation in order to recover more of the values (in the 1910s, stamp milling alone was saving only about fifty percent of the values). Much of this milling-grade ore ended up in stopes and on **waste rock dumps**; some of which was later reworked at a profit.[84]

More complex **refractory ores**, those in chemical combination with sulphides, would not amalgamate with mercury and thus were lost in the tailings when only the gravity concentration and amalgamation were used. These ores generally required additional crushing and grinding, chemical processes such as cyanidation or flotation to concentrate them, and smelting of the resulting concentrates. Smelting heated the ore in the presence of fluxes in order to chemically separate the metals and the waste rock. The **matte** resulting from the smelting process was then shipped to other plants for refining either into bullion suitable for commercial exchange or into metals or alloys for industrial use.[85] Smelters accepted high-grade ore directly from a mine or concentrates from a mill. Smelters generally operated as independent corporations that bought ore from several producers or as part of an integrated system of mine, mill, and smelter.

Each mine owner had to determine the most efficient and cost-effective method of concentrating and recovering the values from his or her particular ores. The characteristics of the ore, available materials, and power sources combined to produce idiosyncratic milling processes that reflected local conditions. With each new technological development, the amount of skilled labor required for each ton of ore processed tended to decline. **Custom mills** were sometimes established in districts where no single mine supplied enough ore to support a separate mill of its own. The mineralization in any given area was generally similar, so the types of ore mined and the milling and concentrating processes best suited to the ores were also likely to be similar. General similarities in the mineralization

in types of ore mined in any given area meant that the milling and concentrating processes best suited to those ores were also likely to be essentially the same. These independent mills bought the ore at a price based on the assay value and then sold the concentrates to a smelter.

The new recovery processes of cyanidation and flotation allowed mining companies in the twentieth century to rework old mill tailings and to recover metal from low-grade deposits in waste rock dumps. By the 1920s, power shovels rather than hand laborers loaded the rock or tailings into trucks or rail cars that hauled material to a mill for processing.[86]

Sorting and Crushing Ore

Ore was always sorted to separate out high-grade ore and then ship it directly to a smelter instead of sending it to the mill. First, miners broke the ore with sledges. When sorting happened underground, some of the waste rock went immediately to fill the stope. Alternatively, when the separation of ore occurred above ground, it could be done in a sorting ground either on a stationary table or on a belt conveyor or other moving surface, where the waste rock ended up in a dump pile.[87]

After sorting, ore destined for treatment in a mill would be crushed and ground to a uniform size by one or several pieces of machinery, either in the mine, in a building near the mill, or at the top level of the mill. The fineness of the crushing depended on the particle size needed in the rest of the milling process. The simplest method was crushing rock in a hand mortar; this prohibitively slow and labor-intensive process, however, was done only in the early stages of a rich mine's development. In the early years, crushers were primarily arrastras and stamp mills, and to a lesser degree **Chilean mills**. (See Fig. 80) Later, size reduction involved several stages. Jaw and gyratory crushers and reduction gyratories, cone crushers, and rollers prepared ore for the grinding mill; these began to replace stamp mills by the late 1800s. By 1910, ball, rod, or tube mills had become the standard fine grinding mills because they produced the **slimes** (smaller particles) required by cyanidation and flotation. At each stage of size reduction, grizzlies (grates), vibrating screens, trommels (cylindrical screens), or **classifiers** sorted the ore for size to ensure a uniform size fed to the mill, returning the oversize back to the crushers and allowing the fines to be carried by water to the concentrators.

The least costly device for crushing quartz was the arrastra, built almost entirely of local materials. The technique, brought north from Mexico, required low capital and overhead investments, and only one or two operators. As a result, many arrastras were operating in Idaho by 1864. An arrastra consisted of an eight- to twenty-foot circular stone-lined pit that held mercury, water, and crushed ore. Pairs or quads of 150-200-pound drag stones of any fine-grained igneous rock that burrs rather than polishes with continued use were loosely hung from the horizontal beam(s). A wooden post in the center had one or two beams set horizontally on the pivot. If animal-powered, the end of one beam had a harness for a horse or mule; if water-powered, the center post was attached to gears turned by a water wheel. The arrastra was shallowly filled with ore broken into walnut-sized pieces. When the ore had been ground to the size of medium sand grains, water and mercury were added before further grinding. The addition of more water sent the mixture, by then a thin **pulp** or slime, out through one or more outlet troughs, where it would be panned, run through a sluice, or screened. The arrastra operator collected amalgam from the arrastra floor and retorted it to separate the gold from the mercury. Then the gold was cast into ingots. The operator generally dismantled the arrastra after processing the ore to recover any gold that had seeped through. Some miners earned additional money by leasing their arrastras at either a fixed rate or, more commonly, for a percentage of the gold recovered.

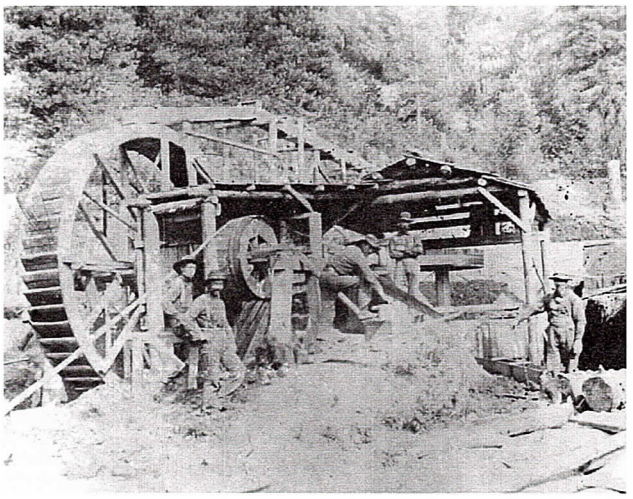


Figure 23–Water-powered arrastra on Silver Creek near Pierce, 1892. (ISHS 608-A-1)

Arrastras crushed a low tonnage of ores at any one time, so they usually required relatively high-grade ore. Over the decades small-scale operations without much capital continued to use arrastras, which in later years might be powered by gasoline engines or even electricity. Since the amalgamation process seldom achieved more than 70 percent recovery, tailings piles from arrastras (and stamp mills) were often profitably

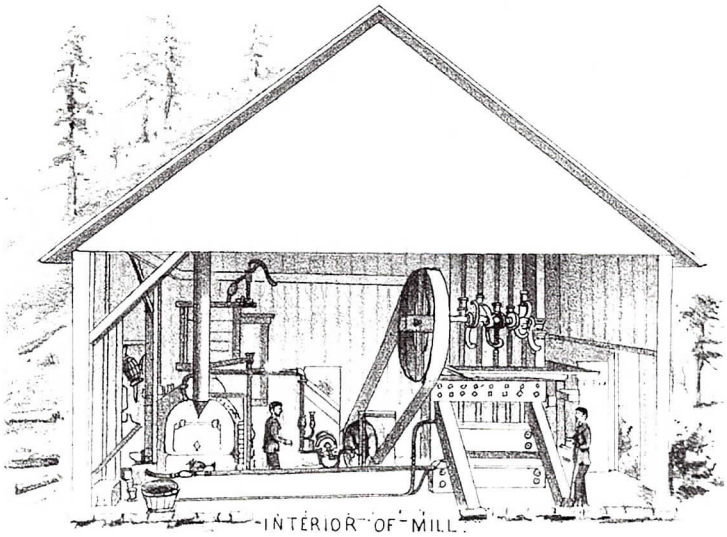


Figure 24–Drawing of stamp mill interior, Marion F. Waldron Mine, Centerville, 1884. (ISHS 76-37.49 Interior of stamp mill, Marion F. Waldron Mine, Centerville, 1884 [Source: W. Elliott, History of Idaho] ISHS 76-37.49, or Elliott, *History of Idaho Territory*)

re-treated later by cyanidation or flotation.[88] In the early days Idaho miners also used a variant of the arrastra, the Chilean roller mill, which could be operated by animal or water power, and instead of drag stones used large stone or cast-iron wheels set on edge that revolved around a horizontal axle and crushed the ore.[89] The Chilean roller mill generally held up better than an arrastra because the drag stones wore out in roughly six to eight weeks and the floors in approximately six months with continuous use.[90]

Many miners, dissatisfied with the slow workings of an arrastra, substituted a stamp mill to crush their ore. The stamp mill, a more complicated and heavy piece of machinery, could not be built locally but had to be shipped in from outside, generally from Chicago or San Francisco. Stamp mills were readily transportable over wagon roads, relatively easy to erect and to operate, and were repairable. The number of stamps determined the milling capacity: a two-stamp mill was considered the equivalent of one arrastra. Stamp mills required steam power and, thus, much fuel to operate. The great expense resulted in the formation of mining companies to finance mills.

Rock breakers–most commonly a jaw crusher or a gyratory crusher located near the top level of the mill–below the ore bin (see *Flow sheet, Little Pittsburgh Mill*, inside back cover), smashed the ore into pieces about the size of apples before it was fed to the stamps. Each stamp consisted of a vertical steel stem with an iron foot or shoe on the bottom that was lifted by a cam and dropped onto coarsely crushed ore. The stamps, which averaged five to seven hundred pounds each, raised and dropped approximately one foot onto the die with every turning of a horizontal shaft, falling with a loud bang approximately sixty times a minute. A heavy iron trough, called the battery, ran around and under the shoes of the stamps, enclosing them all. The blows of the stamps caused the water covering the ore and the die to explode, discharging the ore in a pulverized slurry, which then passed through sluice boxes or flowed over inclined tables that had an amalgam plate (a copper plate coated with mercury) to catch the gold. The gold was then extracted from the amalgam by **retorting** or distillation, as in an arrastra. If the ore contained silver sulphides, it underwent an additional roasting before or after going through the stamps.[91]

Rock breakers and stamp mills were the industry standard throughout the second half of the nineteenth century. By the 1910s, however, ball, tube, and **rod mills** began to replace stamp mills. These new mechanisms produced the smaller and more uniform particle sizes required by cyanidation and flotation, the methods to recover gold from low-grade ores. The less satisfactory arrastras and stamp mills combined with the amalgamation process worked best on free-milling ores. Sometimes used in combination with amalgamation alone, a **ball mill** and a few square feet of mercury-covered copper plate could recover the gold from high-grade ores. As the percentage of unoxidized sulphides increased, however, the recovery of gold by plate amalgamation decreased rapidly.[92]

The ball mill consisted of a large steel cylinder or drum that rotated slowly about its long axis by means of a gear train. Inside, many five-to-six-pound forged-iron balls, up to three inches in diameter, rode up the inside and then fell back as the cylinder turned, pulverizing the ore and mixing it with water. Cleaner and more efficient than stamp mills, ball mills worked continuously rather than by batches. The crushed ore emerged from the ball mill as a slurry or clay-like slime. Rod mills functioned in a similar manner, only their grinding elements–full-length steel rods–crushed the largest pieces first, resulting in ore ground to a uniform size. Tube mills also produced a finely ground ore.[93]

Amalgamation and Gravity Concentration

Although amalgamation was the most common nineteenth century recovery process used for free-milling gold and silver ores, it seldom yielded more than 70 percent recovery. The crushed ore, in the form of a thin pulp, left the stamp mill or ball mill and passed over a mercury-covered copper or silver-coated plate.

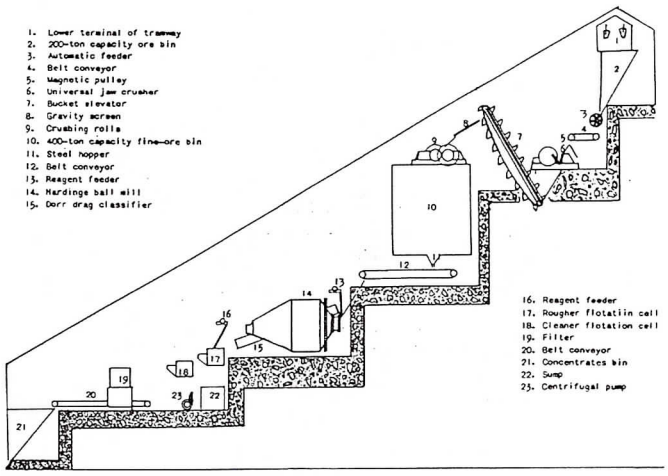


Figure 25–Side view of mill at Harmony Mines, Baker, 1930. (Gardner, Harmony Mines)

The mercury absorbed the free metal liberated by the crushing process, forming an amalgam that remained on the plates. The amalgam was removed at regular intervals and the mercury was retorted, recovering nearly pure gold and silver. In the twentieth century, the ore went from the amalgamation plates in the mill to cyanidation or flotation or table concentration for better recovery.[94]

Gravity concentration separated valuable minerals from gangue on the basis of differences in specific gravity. Gravity concentration was often, but not always, combined with other methods of concentration in a mill. The process yielded three products: concentrates, middlings, and tailings, and the middlings were re-treated. A variety of gravity concentrators–jigs, **buddles**, **vanners**, and, by the early 1900s, **Wilfley tables**–were used to separate out gold, silver, lead, zinc, and copper ores prior to the introduction of flotation. These devices, generally located at the bottom of the mill, all made shaking, vibrating motions that separated heavier metal-bearing ores from waste rock. The jig, a sieve-like cone that vibrated up and down in water, caused the crushed ore to stratify. The buddle was a circular table swept by brushes that rotated around a center pivot. As the pulp flowed onto the table, the heavier metals sank to the bottom. A vanner was a table-mounted continuous belt that shook or vibrated from side to side, vertically separating the pulp and washing away the lighter materials. Wilfley and other similar tables were covered with linoleum and a series of shallow cleats. Tilted at slight angles, these tables gently shook the pulp as it washed across them; light materials swept over the cleats to tailings disposal, and small heavy particles rode high to the end where they were collected as concentrates.[95]

Lixiviation/Leaching

Lixiviation, also known as leaching, involves the treatment of crushed silver ore by roasting and chlorination followed by leaching with water and chemicals to create silver **chlorides** and precipitate the final product. Vat leaching, a method in use in some western mills by the 1880s, percolated crushed ore bedded in large rectangular or circular vats. The silver chlorides were dissolved in a solution of sodium or calcium hyposulfite. The silver was then precipitated from the solution by adding an alkaline sulphide, after which the resulting silver sulphide was roasted, leaving a metallic mass that was refined and cast into bullion bars. Lixiviation did not have high recovery, nor did it work on ores with significant amounts of lead. The **Russell process** solved both these problems by adding additional chemicals to the precipitation tanks and the leaching vats that removed the lead from the silver solution and improved silver recovery.[96]

Some highly refractory silver ores required salt roasting followed by either the Washoe or Freiberg process. In some cases, however, the silver particles resulting from the salt roasting proved too small to amalgamate. In that case, the Von Patera lixiviation process followed salt roasting. In this process, silver chloride was dissolved with hypo solution and precipitated as a pure sulphide. The silver sulphide was roasted without salt to drive out the sulphur, leaving pure silver.

A more recent chemical method developed to recover the values in low-grade minerals at open-pit gold and copper mines is in-place or **heap leaching**. Similar to leaching done at waste rock dumps, this method involves stacking the waste rock in heaps on impervious pads, and percolating a solvent through the heap to dissolve selected metal values.[97]

Chlorination

One of the early chemical methods for treating ores was chlorination, introduced to California in 1858. This process was expensive and required finely ground ores. After roasting and cooling, the ore was dumped into chlorination barrels or vats, where the precious metals were leached out in a chlorine solution and then precipitated from the solution. Inexperienced operators who did not understand the chemistry involved often lost much of the value in the stack or the tailings. The arrival of railroads in a mining district allowed large chlorination plants to work ores from many mines.

Cyanidation

The efficient cyanide process eventually replaced other chemical methods such as pan amalgamation, chlorination, and Von Patera or Russell lixiviation. Invented in Australia in 1887, its introduction led to a revival of many of Idaho's lode districts in the early 1900s. Cyanidation, a technical process that necessitated the help of an experienced metallurgist, used a compound of cyanide in solution to dissolve gold and silver in the crushed ore. Zinc shavings were added to precipitate a silver-gold sludge, which was then refined into bullion. The process involved the following steps: 1) crushing the ore and adding cyanide to the ore-water pulp, 2) agitating the pulp to dissolve the gold content of the pulverized ore, 3) separating the gold-containing cyanide solution from the pulverized ore by washing it over Wilfley tables or riffles and blankets, 4) precipitating the dissolved gold and silver from the cyanide solution by passing it over zinc shavings or agitating it with zinc dust, 5) refining the gold-zinc precipitate in a furnace, resulting in gold bullion (if silver is present, dissolving the silver with sulfuric or nitric acid), and 6) melting and casting the gold bullion into bars for shipment to the mint. Presses, filters, agitators, **thickeners**, and other devices helped the process work by introducing water and oxygen and drying the products.[98]

After 1893, Idaho's mills used cyanidation to recover gold and silver from low-grade ores and from old tailings. The process slowly grew in popularity as miners exhausted the oxidized ores and began mining sulphide ores out of necessity. Although some stamp mills incorporated cyanidation, the process required finely ground ores, and many of the early mills did not grind the ore sufficiently fine to liberate all the metal from sulphide ores. The process worked best with coarser free-milling ores and with placer sands. Gold ores with constituents such as copper required flotation, and arsenical and antimonial ores required a preliminary roasting.

Flotation

The concentration method known as flotation recovers various minerals from low-grade and complex ores more effectively than gravity methods. Using this process valuable materials are isolated through the surface tension of liquids and the ability of minerals to attach to air bubbles in liquids. The flotation process used in the early 1900s created air bubbles in a liquid solution of finely ground ore. The ore was "frothed" with air and pine oil or other **reagents**. The metal

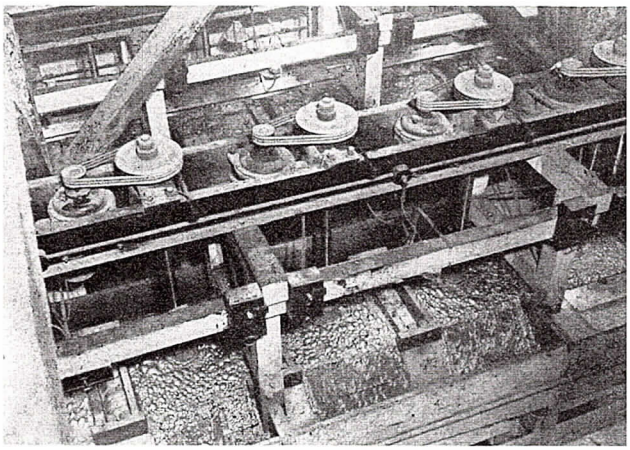


Figure 26–Flotation. Battery of flotation cells, in *Mining Salutes Idaho's 50 years*. (PARL TN 24.12 I3 1940, p. 33 [credit ISHS])

compounds floated to the surface with the air bubbles, were collected by the oil and removed by mechanical paddles, and the gangue sank. The concentrates produced by flotation usually were dewatered (dried) in Dorr-type thickeners, then filtered before shipment to the smelter. Gold recovered by flotation resulted in a high-grade concentrate that, after drying, could be treated with cyanide solution or used to produce gold bullion. Most often, however, the concentrate was shipped to a smelter. Differential or selective flotation, a later development, separated the various sulphides, resulting in separate high-grade lead, copper, and zinc concentrates.

The world's first commercial flotation mill was established in Australia in 1905. Flotation, combined with improved grinding treatment in ball and rod mills, allowed cost-effective concentration of gold, silver, lead, and copper in complex and low-grade sulphide ores for the first time. For example, finely disseminated lead-zinc ores not amenable to gravity concentration could be concentrated by flotation.[99] By 1930, flotation was considered the best method to recover gold from sulphide ores. Flotation followed by cyanidation worked well for gold ores with very fine gold that was intimately associated with sulphide or arsenide minerals. Losses of gold were generally due to poor operating practices or to the failure of gold in oxidized or partly oxidized minerals to float with ordinary reagents, a problem later overcome through use of amalgamating plates or corduroy blankets prior to flotation. In Idaho, mills had begun to use this relatively cheap and simple process by the 1910s; flotation replaced gravity concentration in the Coeur d'Alenes, for example, around 1916. By 1930, flotation was considered the best method to recover gold from sulphide ores, and Wood River, Stibnite, Atlanta, and other Idaho districts found

success in employing this method. Further, at Atlanta, where recovery of the valuable metals had been a challenge for decades, the combination of an amalgamation jig with a Washoe pan followed by flotation resolved the problem.[100]

Washoe Pan Process and Related Processes

The Washoe pan amalgamation process, invented at the Comstock Lode in Nevada and in use by 1862 as the final step in the process of separating out gold and silver in ores, provided another method for processing silver ores that were not too refractory. Ground silver ore, when placed in pans or tubs along with mercury, salt, and copper sulfate, converted silver sulphides to silver chlorides subject to amalgamation. Steam heat speeded up the process, and made it more efficient than the traditional Mexican method, known as the patio process, which used the sun to provide the heat. The pulp then went to settlers (large tubs with rotating stirring arms that separated the amalgam from the pulp). The mercury was separated from the amalgam in a retort, and the silver bullion was refined and cast into bars.[101]

A variant of the Washoe process, the Reese River process, differed in that this method involved roasting the crushed ore in a furnace, thus converting it to a more easily worked silver chloride before amalgamation. If combined with lixiviation, the Reese River process could treat refractory ores.

Smelting

Most of the world's silver occurs in association with base metals such as lead and zinc and can be separated from them only by smelting. It is especially difficult to recover metals from lead-silver ores. High-grade ore was shipped directly to **smelters**, but low-grade ores were first treated by gravity concentration to avoid high transportation costs to distant smelters. To be successful, smelters required a source of cheap fuel, lead ore (necessary for processing ores containing silver), flux to enhance fusion, and relatively close sources of appropriate ore or cheap railroad transportation of ore.[102]

Smelting, a method of concentrating ores by fire, relies on heat and chemicals to first convert the ore to a fluid state, then separate the metallic ingredients by means of their specific gravity. The high cost of smelting meant that only high-grade ores or concentrates could be considered for this method, and the process had to be tailored to local ores. Such large-scale operations necessitated a constant supply of ore, and smelters depended on railroad transportation and nearby timber for charcoal production; large smelters well located in relation to both ores and fuel soon proved more successful than small, local smelters.[103]



Figure 27–Lead smelter, Bunker Hill & Sullivan, 1940, in *Mining Salutes Idaho's 50 years*, (TN 24.12 I3 1940, p. 33 [credit ISHS])

Smelting silver-lead ores, the most difficult to recover, involved the following method, known as the Washoe process. First, the ore might be roasted in a **reverberatory furnace** to remove volatile byproducts. Workers then put the ore or concentrate, fuel (often charcoal), and flux (generally lime) into a blast furnace, and forced air was blown into the interior through openings near the bottom. The charcoal provided the necessary intense heat and also caused important chemical reactions in the metal-bearing ore. Once the furnace had heated the ores to a molten state, the metals drained into a sump at the bottom of the furnace. The slag (iron oxide and sand) formed on top and was skimmed off and taken to the slag pile. Sulfur and carbon dioxide gases off-gassed in the process and were released through an exhaust stack. The remaining precious metal bullion was then poured into ingots and shipped to market. Byproducts such as flue dust and **baghouse** fumes might be treated to recover metals.[104]

An expensive alternative to the Washoe process, the Freiberg barrel process, used amalgamation to process moderate- to high-grade and highly refractory silver-lead ores. This gave extremely high silver but poor gold recovery. The ore was crushed, then mixed with common salt. Roasting in a reverberatory furnace drove off the sulphur and arsenic and converted the sulphurets to chlorides. The resulting charge then went into a Freiberg amalgamator, which reduced the charge to a paste while mixing it with mercury, copper, and iron salts. The amalgam was drained off and retorted to recover the silver sponge, which was melted and poured

into bars for delivery to a refinery. The waste then made another pass over a Wilfley table to recover any remaining amalgam.[105]

Custom smelters purchased ore outright; basing the price on an analysis determined by sampling and assaying. Certain elements–such as arsenic, antimony, and high concentrations of zinc–increased the cost of smelting or adversely affected the refined product and were subject to a penalty by the smelter, whereas lead, a necessary ingredient in the smelting process, was not. Smelters that could mix ores from many different mines to obtain essential chemical reactions did best. For example, in 1884 after four years of operation, the smelter at Bayhorse ran out of lead from the ores it was extracting and had to haul in lead-silver ore by railroad and wagon.[106]

Smelters, roasters, and boilers across the West relied on charcoal produced in earthen pits or beehive kilns. Charcoal is produced by burning huge amounts of wood within an enclosed environment under controlled conditions to drive moisture and volatile chemicals from the wood. Standardized brick **charcoal kilns** were introduced in the late 1860s, and both they and the more traditional earthen-pit method of charring wood often supplied the same smelters. Coal, oil, and then electricity began to replace charcoal as a fuel for blast furnaces in the early twentieth century.

Refining

The metals produced from smelting contains impurities that usually must be removed before the metal can be used, a process known as refining. Various methods of refining include 1) fire refining, or removal of impurities by selective oxidation, 2) **electrolytic refining**, or the deposition of a pure metal by electrolysis leaving the impurities undissolved or undeposited, 3) chemical refining, or the solution of impurities by chemical reagents, and 4) distillation. At times, the first three may be used successively on one metal.[107]

TRANSPORTATION TO IDAHO'S MINES



Figure 28–Idaho's railroads, 1915. (Robertson, Western Railroad History, 196)

Transportation–actually, the difficulties of transportation–played a significant role in the development of Idaho's mining districts. Placer and lode mining led directly to the construction of trails that were upgraded to wagon roads and then to automobile roads. The slow development of improved transportation typically limited lode mining activity, however. Roads for hauling heavy mining machinery in and ore out were necessary to keep costs down in developing and working lode mines (early placer gold operations were less dependent on good roads). The introduction of wagon roads reduced freight rates greatly and often revitalized declining districts. **Ore wagons** pulled by teams of horses or mules could haul as much as three tons each.[108]

Idaho's mining districts of the 1860s were handicapped by rugged terrain removed from well-established lines of travel. When the rush to Idaho began in 1861, San Francisco was the primary market center, with Portland a secondary distributing point and Walla Walla a transportation hub. Miners generally traveled by Oregon Steam Navigation Company steamboats up the Columbia River and then continued on to the mines by foot, horse, stagecoach, or wagon. To reach Idaho County's Warren mining district, one of the most isolated in Idaho, mule pack trains had to travel some 170 miles by trail to and from the nearest trade center.[109]

The most popular route to the mines of northern and north-central Idaho was as follows: by sea to San Francisco, by sea and the Columbia River to Portland, up the Columbia and Snake rivers to Lewiston by steamboat, and then on foot or by horse to the mines. Some people traveled overland from the east to reach the north-central Idaho mines, but this was a much slower route. They traveled by steamer to Fort Benton, Montana, and then followed the Mullan Road to Idaho, or came by land from the south or north. Those traveling to southern Idaho often took a steamboat to

Umatilla, Wallula, or Walla Walla and then headed east by foot, horse, or stagecoach across the Blue Mountains and on to the mining districts. Some came from California ports to the Oregon Trail, from points along the Missouri River, or from Salt Lake City. Ferries and bridges were built along the main routes to aid travelers, and toll roads provided routes through rough terrain.[110]



Figure 29–W. H. Dewey's freight team (ISHS 73.075.0012 Wells, *Gold Camps and Silver Cities*, p. 47; PARL: QE 103.B8 no. 22 1983)

Pack trains of the 1860s averaged fifteen to twenty mules–sometimes the number of pack animals could total up to one hundred–in addition to the horses of the cook and packers. Each mule carried at least a couple of hundred pounds of supplies, and pack trains generally traveled fifteen to thirty miles a day. Most of the packers in Idaho in the 1860s were Mexicans who seldom owned the business, but provided the animals, packing system, knowledge, and labor. Some packers were independent traders who packed in their own goods and sold the merchandise themselves on Sunday out-of-doors or through commission houses. Miners and prospectors who hauled in their own supplies used horses, mules, hand-pulled sleds, and their own backs. Heavy machinery was generally taken in over packed snow by horses and mules. On steep slopes, the machinery was lowered by cables on sledges, with donkey engines providing the power.[111]

The coming of the transcontinental railroad to Utah in 1869 shifted Idaho's supply routes significantly. From then until railroads came to the interior of Idaho itself in the early 1880s, freight was brought from east and west by the Central Pacific Railroad to various points such as Kelton or Corinne, Utah, or Winnemucca, Nevada, and then transferred to freight wagons and hauled north to Idaho. The coming of the Oregon Short Line to the Snake River plain in 1882 and its progress across the territory immediately expanded many mining districts. But the real improvement in Idaho's transportation picture came in the early 1880s, when two transcontinental railroads crossed Idaho (one along the route of the Oregon Trail and the other across the panhandle). The Utah and Northern Railroad was built north through Idaho to connect with the Northern Pacific Railroad at Garrison, Montana, in 1884. Reduced freight rates allowed low-grade ore from many districts to be profitably shipped to distant smelters. The railroads also made the hauling of heavy machinery needed for extracting and processing ores more affordable. Of course railroads never reached some mining districts; in these places stagecoaches, freight wagons, and even pack animals continued to haul people and equipment until the arrival of automobiles.[112]

The Northern Pacific Railroad crossed northern Idaho in 1882; the transcontinental line was completed just in time for the mid-1880s rush to the Coeur d'Alenes. Rail access to Spokane was critical, since this city was the center of capital and transportation for the region, but the town of Coeur d'Alene was established to serve as a closer supply center for the mines. The first railroad that reached the Coeur d'Alene mines was a narrow-**gauge** line built by the Coeur d'Alene Railway & Navigation Company in 1887 (this line was dismantled in 1898). This line ran from Cataldo Mission at the head of steamboat navigation on the Coeur d'Alene River to Wallace, and it required a costly transfer of freight (including sacked ore) and passengers between rail cars and steamboats. In 1889, a rail line built around the southern end of Coeur d'Alene Lake allowed ore and other freight to be hauled without reloading. The Union Pacific reached Wallace in 1888, and two years later the Northern Pacific built a line from Missoula. Both railroad companies built tributary lines to outlying mines and communities. The railroads gradually abandoned these feeder lines as the region's mining and logging activities decreased.[113]

The Great Northern Railway completed its transcontinental line across the Idaho Panhandle, north of the Coeur d'Alenes, in 1893. And yet another transcontinental line, the Chicago, Milwaukee, St. Paul, and Pacific Railroad, crossed northern Idaho in 1909. Branches of the transcontinental lines served other parts of Idaho, too, and many of these helped outlying mining districts. For example, a branch of the Northern Pacific reached Moscow in 1890 and Lewiston in 1898.[114]

The construction of roads suitable for automobile traffic in the twentieth century helped many of Idaho's mining districts. Beginning in 1933, the Forest Service and the CCC built many miles of roads that served

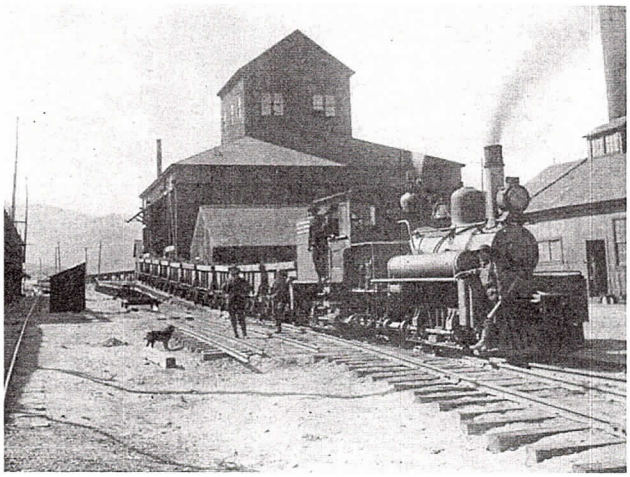


Figure 30–Shay-geared locomotive and ore cars at White Knob Smelter, Custer County, *Annual report of the mining industry of Idaho.* (TN24.I2 A2, 1906, p. 53)

Idaho's mining districts. Some were overlaid along the basic route of earlier wagon roads, but others followed new routes. The Elk City Wagon Road, for example, served many north-central Idaho mining districts from 1895 until 1932, and it crossed two mountain summits along its route. In the 1930s, a road along the South Fork of the Clearwater from Grangeville to Elk City greatly revived the lode mines of the various districts it accessed and also helped Depression-era placer miners reach the placer deposits.[115]

A good example of the typical evolution of transportation networks serving a particular mining district is the Leesburg area, which is west of Salmon in Lemhi County. In 1866, when gold was discovered there, supply pack trains ran from Bannack, Montana, to Leesburg until the arrival of deep snow. Throughout the winter, snowshoes were the only means of reaching Salmon. In fact, a shoveling company was organized to dig out the trail to Salmon in February 1867 to relieve miners suffering from a shortage of supplies. Soon, a foot and pack bridge was built across the Salmon River, and a ferry was established. The construction of a wagon bridge followed. Goods were freighted in from Bannack and Virginia City, Montana, and from Salt Lake City, Boise, and Walla Walla. In 1869, the transcontinental railroad made available new sources of cheaper supplies from northern Utah, and this became the major shipping point for goods destined for eastern Idaho. The arrival of a railroad in Red Rock, Montana, in 1882 reduced the wagon haul to about one hundred miles. In 1910, a railroad came to Salmon. Originally constructed to haul silver and lead ore from mines in the Gilmore area, it also hauled agricultural and other supplies. A motor vehicle carrying freight first reached Leesburg in 1919. The Gilmore & Pittsburgh Railroad closed in 1939, due to improved roads for motorized vehicles and the nation-wide Depression.[116]

METAL MINING IN IDAHO

In general, first gold, then silver, and then lead-silver, zinc, and copper were found in Idaho. Gold placer and lode deposits were much easier to **prospect** than base metal outcrops. Most of Idaho's **placer mining** areas expanded to include lode mines. But some significant placer camps, along with the Salmon River bars and Snake River fine gold deposits, had no significant lodes to develop. A number of lead-silver, copper, and other base metal districts had no gold placers.

Mining development in Idaho usually progressed in four stages, often in temporal sequence in the sense that one often led to the next. The fourth generally is quite recent, although the first and the last, or the last three, or two or three may be carried on in the same operation.

1. *Placer mining, primarily of gold.* Gold discoveries in any district usually commenced with placers; and in a number of areas, not much else of consequence ever was found.
2. *Quartz mining of gold and silver.* Quartz discoveries in any district usually commenced with placers; and in a number of areas, not much else of consequence ever was found.
3. *Base metal mining.* Early attempts at quartz mining bridged the gap between the beginnings of mining operation (placers) and the really large-scale lead-silver-zinc operations, which constitute the major mining activity in Idaho. The latter had to await railroads and advances in management and technology, many of which were pioneered in early attempts to exploit quartz properties.
4. *Mining of metals that lacked a market or did not attract interest until recently*: antimony, tungsten, cobalt, columbium, tantalum, and any number of other newly exploited metals.

Some of these developed out of earlier stage operations; others are new.[117]

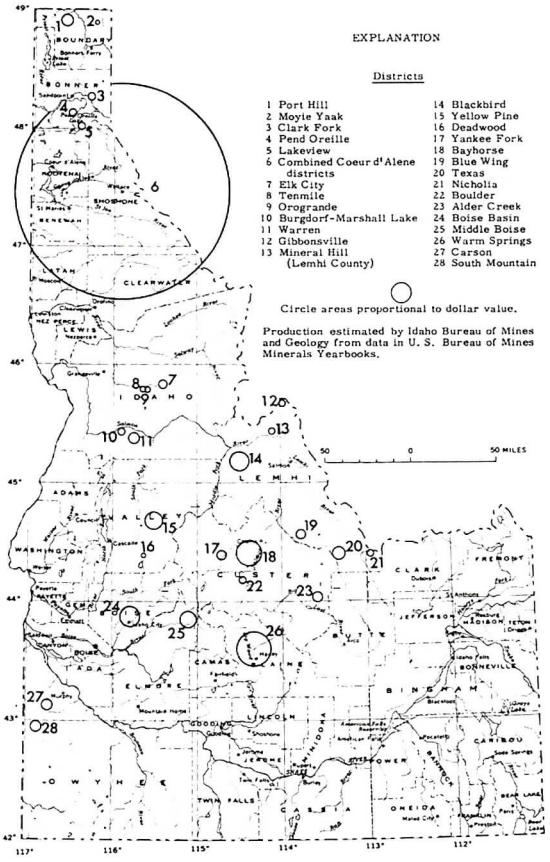


Figure 31–Gold, silver, lead, zinc, and copper production in Idaho by mining district, 1905-ca. 1964. (USGS, *Mineral and Water Resources*, 18)

Early Placer Mining in Idaho

The California gold rush began in 1848, attracting some two hundred thousand people from North America and abroad. Fueled by widespread publication and an abundant and mobile labor force, people headed to the west coast hoping for a better life. Experienced miners from Georgia, North Carolina, Mexico, Cornwall, Wales, and other areas of the world shared their skills with thousands of inexperienced men. As a result, the United States went from a minor gold-producing nation in 1851 to a producer of nearly 45 percent of the total world output.[118]

Many Americans enthusiastically joined gold rushes in the mid-1800s. A restless folk, they dreamed of easy riches, had little working capital, wanted to live with fewer restraints, or were fleeing difficult situations such as war-related destruction. Placer gold, easy to recognize and to extract without large investments of capital, started the early rushes. Miners moved from frontier to frontier as new discoveries of precious metals were made. They brought with them mining techniques and methods for organizing society. Miners established "island colonies," communities separated by undeveloped wilderness that participated in world systems of transportation, communications, and commerce. Thus, the remote mining camps of the West were closely linked to the urban centers of America, Europe, and Asia. The world system provided a market for raw materials, including metals, produced in the remote regions of western North America.[119]

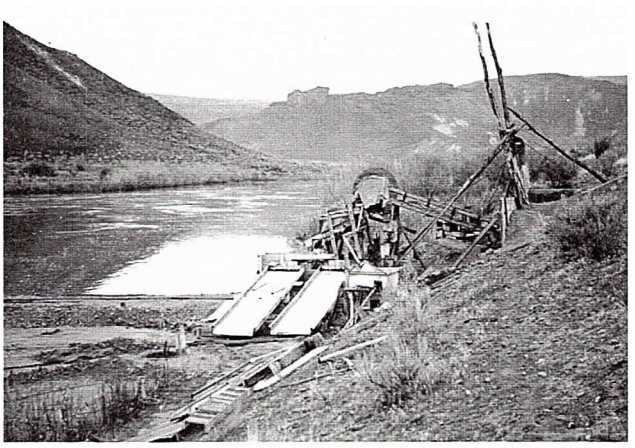


Figure 32–Placer mining on the Snake River, 1940.

Prospectors and miners moved northward and eastward from California and spearheaded the development of the rest of the mountain West. A rush to eastern Washington (the Colville area) began in 1855 and soon spread to the Upper Fraser River of British Columbia, Canada. In California, by this time, the surface placers had been exhausted, and working the deep diggings required new methods and much capital. Soon the frontier expanded to Colorado (1859), Nevada (1859), Idaho (1860), Montana (1861), and elsewhere. The rush to Idaho peaked in 1862 and 1863, with some twenty-five to thirty thousand people reaching the Boise Basin alone in 1863.[120]

Many of the men who participated in the early 1860s placer rushes to today's Idaho were veteran miners from the old California camps; at the same time, inexperienced miners came in from Missouri and other areas, fleeing the devastation of the Civil War. Of these footloose, independent entrepreneurs, many were drifters, and all were people living under extremely unstable and volatile conditions as over and over again, inevitably, each new discovery led to a rush from established camps to the new diggings. Many moved around between camps in British Columbia, Idaho, and Montana.[121]

Gold had been discovered in today's Idaho by the early 1850s, but the scattered early finds were kept quiet and did not result in a rush to the area. The establishment of Fort Walla Walla in 1856 encouraged people to move in despite the resistance of Indians living

in the area. The Stevens Treaty of 1855 prohibited Euroamericans from entering the reservation assigned to the Nez Perce; the tribe had exclusive use and benefit of the lands within its boundaries. All of the Idaho mines discovered up to 1862, however, lay within the Nez Perce Reservation.[122]

American Indians and the Gold Rush

The initial development of the Idaho mining frontier was not without conflict between native occupants and the intruding miners. American Indians had lived in the region that is now Idaho for some fourteen thousand years before the first Euroamericans arrived. Members of the Lewis and Clark expedition traveled through northern Idaho via the Lolo Trail on their way to and from the Pacific coast in 1805 and 1806. British and American fur traders came next, along with a few missionaries. Travelers heading west on the Oregon Trail in the 1840s and 1850s journeyed across the Snake River plain. In 1860, a group of Mormons settled in southeastern Idaho, establishing Idaho's first town.[123]

Some Nez Perce bands remained opposed to the occupancy of their reservation by Euroamericans, including people who lived along the trails to Elk City, Florence, the Salmon River country, and the Bitterroot Valley. These bands sometimes ordered miners to leave, but prospectors typically traveled in large, armed groups and often evaded hostile Indians.[124]

Nez Perce chief Lawyer signed a new treaty between the U.S. government and the Nez Perce, against the wishes of other chiefs such as Joseph and White Bird. The treaty, when ratified in 1867, drastically reduced the size of the Nez Perce Reservation

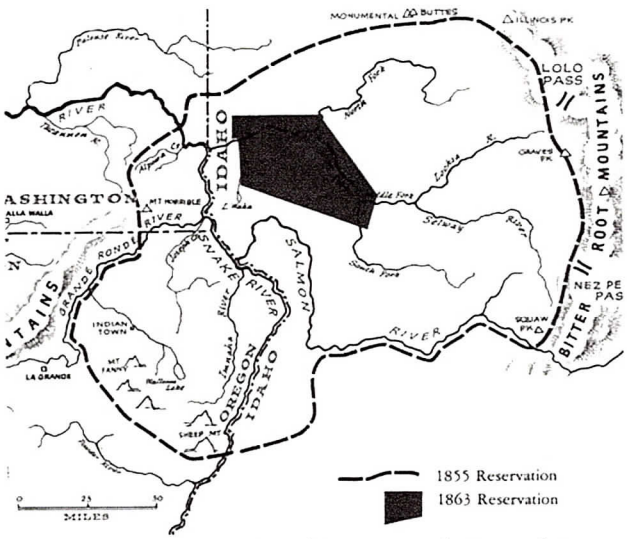


Figure 33–Reservation Boundary of the Nez Perce by Treaty of 1855 from Bill Gulick, *Chief Joseph Country*, p. 110, courtesy of The Caxton Printers, Caldwell, Idaho.

from approximately ten thousand square miles to just twelve hundred. Florence, Elk City, and other mining areas no longer lay within the reservation boundaries. All of the bands of the Nez Perce were required to move onto the new reservation within one year of ratification. In exchange, the tribe was to receive $265,000 for the land, be reimbursed for improvements on relinquished lands, and be paid the money promised by the 1855 treaty.[125]

In 1877, a few weeks before the deadline for all Nez Perce bands to move onto the Nez Perce reservation, a few young Nez Perce men killed some Salmon River settlers in retribution for past wrongs and captured a freight wagon headed for Florence. After a series of battles, about eight hundred Nez Perce left the area and began a long flight across Idaho and Montana. Forced to surrender that fall, many were exiled to Kansas and then Oklahoma and were not allowed to return to the Pacific Northwest until 1885, when they were moved onto the Colville Reservation in north-central Washington. The conclusion of the Nez Perce "War" of 1877 was seen by Euroamerican miners as the end of the Nez Perce challenge to their right to mine in north-central Idaho.[126]

In northern Idaho the hostility of the Spokane, Coeur d'Alene, and other Indian tribes kept Euroamerican miners out of the area until these tribes were defeated in 1858. The Walla Walla valley subsequently opened to settlement, which gave prospectors a base near Nez Perce lands. Restless miners moving out from the Similkameen, Fraser River, and Colville districts sought new gold fields, and northern Idaho appeared promising.[127]

Southern Idaho was the traditional homeland of the Boise and Bruneau Shoshone, particularly the drainages of the Snake, Bruneau, and Boise rivers. Indian resistance did not slow prospectors and miners down for long. The miners severely damaged the environment of the upland traditional areas. Mining altered or destroyed fisheries, riparian vegetation, game habitat, and meadowlands. Fort Boise, a U.S. military post, was established in the summer of 1863 at the crossroads of the Oregon Trail and the new road to the Boise Basin and Owyhee mines. Hostilities continued until 1867, when the U.S. government established a reservation at Fort Hall. Several hundred Indians regularly returned to the Boise area until the Bannock War of 1878 had ended. After this and the Sheepeater War of 1879, the native peoples were held more closely to the reservations.[128]

The Rush to Idaho

The man credited with starting Idaho's first gold rush was Elias D. Pierce, a California miner who came



Figure 34–Unidentified miners in front of mine portal. (ISHS 3069)

to the Nez Perce country for the first time in 1852 as a trader. Pierce and a group of prospectors secretly traveled to the North Fork of the Clearwater in August 1860, and they found gold at Oro Fino Creek. When this party returned to Walla Walla the next spring bearing gold dust, the great rush to the Clearwater began. Men and women poured into the region, at first mostly from Oregon and Washington, but soon from other parts of the United States as well as from Mexico, Canada, Europe, and elsewhere.[129]

The initial mining in the Clearwater region–labor-intensive placering–required little start-up capital and equipment that miners could build themselves. Groups of two to four men generally worked the claims. They used rockers extensively because of their effectiveness even when the water supply was limited. Long toms and sluice boxes became practical if there was plenty of water and the gradient was steep enough to allow for the easy removal of tailings. Ditches and dams, and particularly hydraulic mining operations, required larger cooperative ventures and much capital to succeed. All of these methods were wasteful in varying degrees; with low gold recovery rates, even after several reworkings of the gravel. Many miners did not reach bedrock, where the richest ground lay. In fact, the tailings from sluice boxes often covered valuable beds of gravel.[130]

Settlers soon established the trading town of Lewiston at the confluence of the Snake and Clearwater rivers, in flagrant violation of the treaty with the Nez Perce. By July 1861, some twenty-five hundred miners were working in the area, with several thousand more scattered throughout the region. Prospectors continued to push up the Clearwater and its tributaries. When Idaho Territory was created in 1863, Lewiston was named territorial capital even though it was located within the Nez Perce Reservation.[131]

Miners believed that they would find a much richer, central deposit of gold ore near the Clearwater region. With the coming of warm weather in the spring of 1861, prospectors fanned out over the region to look for gold. Prospectors soon found rich deposits in Elk City on the South Fork of the Clearwater River, 125 miles south of Pierce. Gold was first discovered in the Florence basin, also known as the "Salmon River mines," in August of 1861. The discovery of these fabulously rich placer grounds received international attention by the following spring, and thousands of men laboriously made their way to this remote part of north-central Idaho with hopes of striking it rich. This was the kind of mining district men dreamt about: a place where small groups of miners could recover thousands of dollars in just a short time.

Since the discovery of this district happened so late in the season, it took until the summer of 1862 to realize how extensive or deep the deposits really were. The boom was short-lived because the rich ground turned out to be shallow and not very extensive, and the earliest arrivals had already claimed all the high-paying ground. In fact, many people could not even "make their grub," so by fall 1863, the boom at Florence had ended.[132]

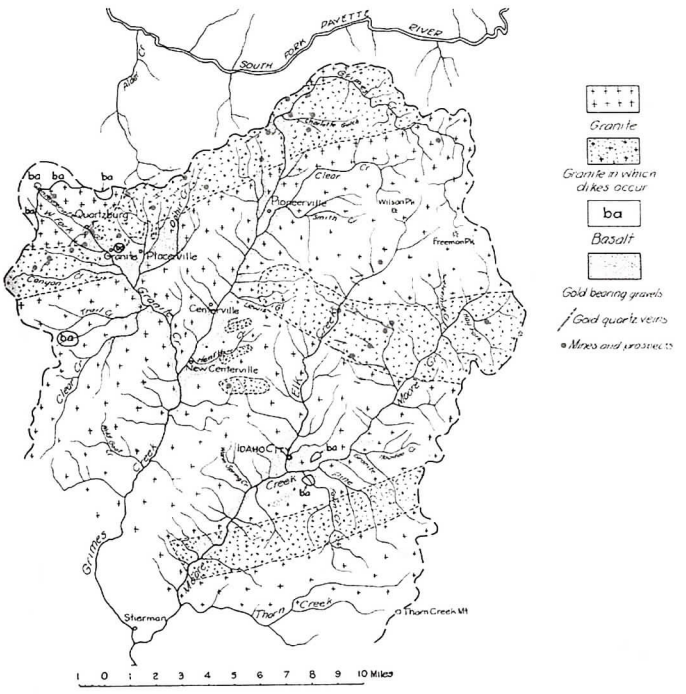


Figure 35–Geologic map of the Boise Basin, Boise County. (TN 24.12 A3 n. 68 c.3 W.W. Staley. *Gold in Idaho*, 1946. [map follows p. 14, Fig. # 11])

During the summer of 1862, many men left Florence to try their luck in new gold fields. Men moving out from Florence in search of rich new **strikes** discovered many of these new districts–notably Warren, the Boise Basin, and Bannack, Montana. James Warren and a party of prospectors discovered the diggings, later known as Warren, in the spring of 1862. The placers there proved deeper and much more extensive than those at Florence. Within two months, over two thousand people had reached the area, including many from Florence.[133]

By the summer of 1862, discouraged miners leaving Florence had many possible destinations to choose from, including Warren to the south; Cariboo in British Columbia; Powder and John Day rivers in eastern Oregon; and Bannack, Montana. But the biggest discovery of all in the Pacific Northwest came in August 1862, when prospectors fanning out from Florence discovered extraordinarily rich and extensive placer deposits in southern Idaho: the Boise Basin, one of the state's most important early 1860s discoveries. Through 1870, the production of gold from its placers and lodes far exceeded those from any other district. For two decades, most of Idaho's miners worked in southern Idaho.[134]

The Boise Basin placer deposits were located in a sink about fifteen miles in diameter. In the early years, miners worked the rich and shallow gravels found in many of the streambeds. For a short time, Idaho City in the Boise Basin was the largest community in the Pacific Northwest, outranking even Portland. The important trading center of Boise was founded in 1863 to serve the nearby mines, and the Boise Valley soon attracted settlers.

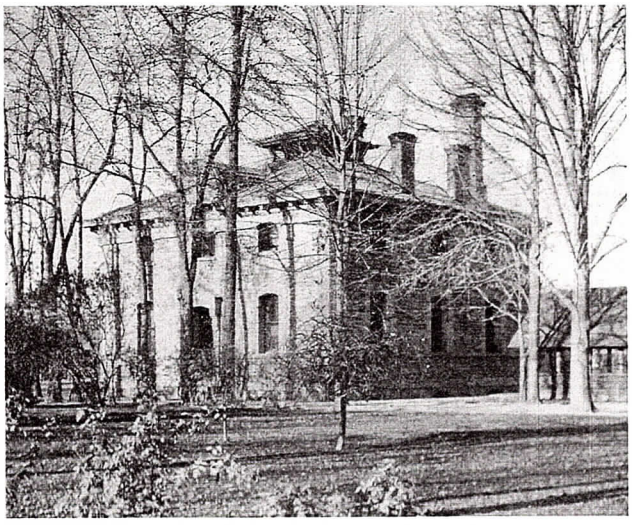


Figure 36–Boise Assay Office, 1900. Home of the Idaho State Historic Preservation Office since 1974.

A year later Boise replaced Lewiston as territorial capital. The U.S. government built a branch assay office in Boise in 1870-1871. This reflected the importance that mining had attained by that time in the territory as well as federal encouragement of mining in the territory. Miners welcomed the facility because its location within the territory made it easier for them to sell their gold bullion.[135]

Miners and prospectors spread out from the Boise Basin to other parts of southern Idaho. In addition to more placer deposits, they also discovered gold and silver lode mines, which led to the establishment of new mining districts in the Owyhees, South Boise (Rocky Bar), Atlanta, and other places. Rushes to other areas in the 1860s, such as Montana, British Columbia, and Nevada, also drew restless miners away from the southern Idaho mines.

As miners fanned out over a vast geographical region in the 1860s, some came together briefly at particular camps and then moved on. For example, Ralph Bledsoe–a prospector, miner, and merchant–mined in the California gold fields in 1850, and in Oregon in 1854, before arriving in Idaho where he worked as a merchant in Elk City in 1861, participated in the rush to Florence, worked the first pan of dirt in the Placerville area of the Boise Basin, and in 1870 had a claim on the Snake River near the Twin Falls. The community of miners as a whole persisted, evolving its own traditions that transcended the experience of any single camp.[136]

While it is nearly impossible to determine the value of the gold taken from the early 1860s placer districts, most of the prospectors and miners who labored hard in the gold fields made little more than wages. Miners had to deduct from their gross production the expenses of travel, prospecting, stripping the claim, water conveyance, labor and supplies, and living expenses. In Florence and Pierce, for instance, miners realized a profit on only about 12 percent of the total gold produced.[137]

Idaho's mines produced 19 percent of the United States gold production during the Civil War. Gold from Idaho, thus, helped finance the war and increased the currency in circulation. Between 1860 and 1869, some twenty thousand miners extracted about $57 million in minerals from the territory, mostly gold and silver. About half of this came from placer deposits and the rest from lode deposits.[138] The following figures (in millions) give some idea of the relative production of gold in Idaho's mining districts between 1860 and 1866:

Boise Basin	$24.0 million
Florence	9.6
Warren	6.0
Silver City	4.0
Elk City	3.6
Pierce	3.4
South Boise, Atlanta	0.8
Salmon River bars	0.8
Clearwater Station	0.6
Newsome	0.4[139]

Leesburg in Lemhi County was discovered in 1866 by a group of miners coming over from Montana. Despite difficulties due to boulders and large rocks in the placer deposits and the need for extensive ditch and drainage systems, these mines were paying fairly well by 1868, and the relatively high wages had attracted a few thousand people to the area. As prospectors fanned out over central Idaho, they made more discoveries at Stanley, Yankee Fork, Bay Horse, Clayton and other areas. The service community of Salmon was founded to serve these areas.[140]

Idaho's last placer gold rushes of the 1860s, to Loon Creek on the Middle Fork of the Salmon River in 1869, and to Cariboo Mountain in eastern Idaho in 1870, temporarily reversed the trend of miners leaving Idaho's mining districts. Due to its remote location and short seasons, large-scale lode mining at Cariboo was unfeasible, but the district produced gold for a relatively long time because of its deeply buried placers.[141]

Later placer gold rushes of the 1870s occurred in northern Idaho in places such as the Snake River and the North Fork of the Coeur d'Alene River. In 1879, A. J. Prichard discovered gold on Prichard Creek, and the resulting placer gold rush helped develop the region that soon would become famous for its fabulously rich lead-silver ore deposits along the South Fork of the Coeur d'Alene.[142]

Production in most of Idaho's placer mining districts was on the decline by the end of the 1860s. Most of the Boise Basin miners, for example, had left for other gold fields in Idaho or moved on to new finds in Montana and Nevada. In 1870, the population of Boise Basin was approximately thirty-five hundred, of which nearly half were Chinese. Despite new discoveries at Loon Creek and Cariboo Mountain between 1866 and 1870, and those to the north in the late 1870s, placer mining in Idaho otherwise continued to decline in the 1870s, especially after the failure of the Bank of California in 1875 led to a nation-wide depression.[143]

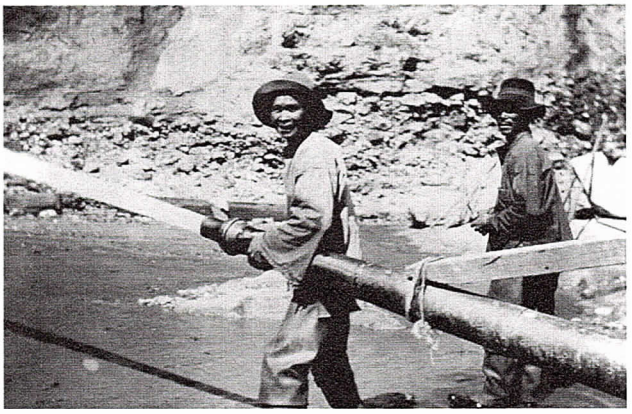


Figure 37-Chinese miners operating a giant at Rocky Bar. (ISHS 103.B8 #22, 1983)

Chinese Placer Miners

Chinese miners played a significant role in Idaho's placer gold districts from the late 1860s until approximately 1890. They reached areas such as Orofino, the Snake River, Boise Basin, and the South Fork of the Clearwater early on. Euroamerican miners generally admitted Chinese to a particular mining camp by a majority vote. They were glad to have buyers for their placer claims; merchants and others had a new market; and the Chinese provided a relatively low-cost but hard-working labor force. The Chinese typically purchased, leased, or paid royalties on the claims of Euroamerican miners who were abandoning a district, and then through hard work, frugal living, and persistence were able to make wages or better from the high-graded grounds.[144]

Close to 50 percent of the Chinese in the West in 1868, or about fifteen thousand people, were estimated to be miners. In Idaho, the Warren mining district in 1872, had twelve hundred Chinese in the camp; by 1880, the ratio of Chinese to Euroamericans among the general population was higher in Idaho than in any other state or territory in the United States. Their numbers declined in the 1880s, and by 1890, only about two thousand Chinese still lived in Idaho. The Chinese left Idaho's mining districts in the late nineteenth century as a result of continued declining values of placer deposits and legal restrictions that prevented them from becoming citizens or from owning mining ground. Those who left generally returned to China or settled in large American coastal cities.[145]

Many early mining districts had laws that excluded Chinese miners. At least one district with a chronic labor shortage, Cariboo Mountain, welcomed Chinese miners from the very beginning, and Euroamericans and Chinese sluiced and hydraulicked adjacent claims

in those years of placer mining activity most placers were active. On the other hand, the Coeur d'Alene-area mines, more repressive than any others in Idaho, completely banned the Chinese.[146]

In 1864, the Idaho territorial legislature passed a law that allowed Chinese to work in Idaho mines but required them to pay a monthly tax of $4 per person. Half of the taxes collected went to the territory, the other half to the county in which the taxpayer lived. When the Idaho tax increased to $5 per month in 1866, this had little effect on Chinese immigration to the territory due to a similar tax set at $1 higher in California. The Idaho legislature declared this law unconstitutional in 1870.[147]

Congress passed the Chinese Exclusion Act in 1882, the first of several national restrictions on Chinese immigration that were not fully repealed until 1943. So, Chinese wishing to enter the United States after 1882 had to cross the borders from Mexico and Canada illegally. This act, combined with a depressed national economy and the willingness of Chinese to work for lower wages than Euroamericans would accept, led to the formation of anti-Chinese societies throughout the West. Euroamerican hostility to the Chinese took the forms of violence and of challenges to the legal status of the Chinese. One of the worst incidents of violence in Idaho occurred in 1887, when Euroamericans killed over thirty Chinese miners on the Snake River in an unprovoked attack.[148]

Euroamericans sometimes "jumped" Chinese claims–took possession of a claim without paying for it. Some Chinese responded by hiring Euroamerican men to jump their claims back for them or to assert ownership of the property. The most important civil case involving the jumping of Chinese claims resulted from an Elk City case. In 1887, four Euroamerican men ejected Chinese leaseholders from their claim. In the resulting court case, the district court judge ruled that Chinese could not acquire mining claims under U.S. mining laws. This decision may have led some Chinese to leave the state, but others simply leased the ground and water rights from Euroamerican owners. In 1897, the legislature restricted mining activity to U.S. citizens or those who had declared their intent to become citizens.[149]

Idaho's Chinese miners almost always worked placer deposits, not lode mines, perhaps because few wanted to invest in heavy equipment and because Chinese, Mexicans, and African-Americans were traditionally excluded from lode mines. Euroamerican lode miners saw the Chinese as cheap competition for jobs and generally prevented Chinese from working in underground mines (sometimes, however, Chinese men did work on the surface in jobs such as dumping ore cars, breaking ore, and surface excavation).[150]

Chinese miners assimilated with the dominant Euroamerican society more in terms of housing. They generally lived in small, crowded dwellings, either cabins they purchased from Euroamericans or ones they built (log cabins, walled canvas tents on dugout platforms, or huts with brush, mud, or cobble walls). In China, the principles of feng shui determined the arrangement of residences based on spiritual and physiographic elements. For example, traditional Chinese residences always opened to the south. These principles may have influenced the selection and layout of some Chinese residential sites in Idaho.[151] Chinese living in the United States generally maintained their traditional diet and methods of food preparation. Some Chinese had commercial gardens in or near mining camps, such as Warren and Pierce, and used cookware imported from their homeland to cook with.[152]

Like many Euroamericans, the Chinese who immigrated to the United States generally were not experienced miners. They, therefore, readily adopted Euroamerican tools such as shovels, picks, pans, rockers, sluice boxes, and hydraulic equipment. Most worked in groups of ten to fifteen people, all partners in a claim. They also worked with Euroamerican miners as partners or employees. Their wages were lower than the prevailing rates, generally about one to two dollars per day.[153]

Chinese sometimes favored rockers over more efficient washing devices because rockers were cheap and portable. The Chinese became accomplished hydraulic miners, although in some places they were assigned unskilled tasks such as carrying away large boulders. They were very skilled in designing and managing water systems due to their earlier experience with irrigated agriculture in their native Guangdong. Where possible, they used "**China pumps**" and wing dams (L-shaped coffer dams) to divert the courses of rivers and creeks. Their work methods were generally labor intensive and meticulous. In Warren, for example, Euroamerican men worked the **hillside placer** claims, where there was plenty of water and space for dumping tailings. The Chinese, however, were relegated to the flatter meadows, where water and dumping grounds were more of a challenge and where a deep overburden had to be removed before the gold-bearing gravel could be worked.[154]

Chinese miners who moved in to declining or abandoned mining districts slowed the decline of population and production, put more gold into circulation, and increased the tax base. They provided a market for Euroamerican miners who wanted to leave a district and a low-cost, hard-working labor pool for those who remained. The mining revenues of Chinese miners is largely unknown.

Placer Mining in the 1930s

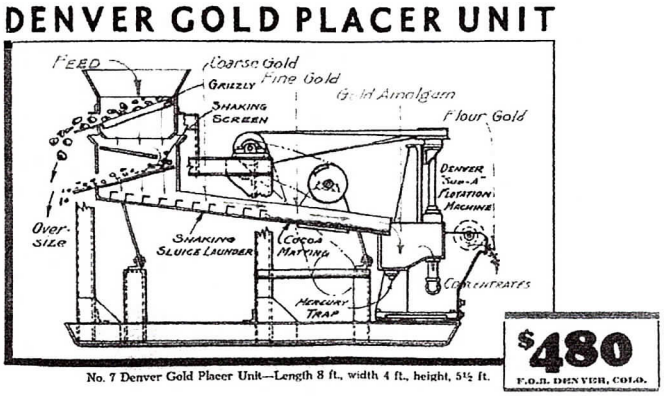


Figure 38–Diagram of the Denver Gold Saver, popular during the 1930s. (Miller, *Automobile Gold Rushes*, 44)

The price of gold has a tremendous effect on the potential profits recovered from any particular deposit. Beginning in 1834, the United States government maintained an official price of gold, tied to coinage, of $20.67 per **troy ounce**. In April 1933, the United States went off the gold standard, and the market price of gold rose to just over $34.00 per ounce. The Gold Reserve Act, passed at the end of January 1934, removed gold from coinage and restricted private ownership of the metal. The next month, the government set the price at $35.00 per ounce, and this remained the prevailing price into the 1960s. Small-scale miners could sell their gold to the U.S. Mint, to the assay office at Boise, or to private buyers licensed by the mint, and the previous government-imposed two-ounce minimum was no longer enforced. Small-scale and large-scale placer operations across the state, as well as lode mines, increased production in response to the Gold Reserve Act.[155]

The higher price of gold led many unemployed people to try mining when Government agencies actively encouraged placer gold mining as an alternative to relief in the 1930s. The new miners required relatively little equipment to remove marketable gold from streams and dry gravels. They often owned automobiles, and by then roads built at the time made it easy to reach the previously inaccessible mining districts. Popular equipment included rockers, long toms, sluice boxes, and new devices such as small suction dredges and mechanical sluices powered by gasoline motors. The Idaho Bureau of Mines and Geology, like other state agencies in the West, responded to numerous inquiries from hopeful prospectors and miners by issuing small publications full of practical advice for novice placer miners. The University of Idaho, the Northwest Mining Association, and other organizations offered classes in placer mining that several thousand people attended. Despite high hopes and much hard work, placer mining did not reliably provide the needed income; in 1935, most of the small-scale placer miners in the West earned less than two dollars per day.[156]

During these Depression years, hundreds of prospectors and miners worked the Salmon River bar placers below French Creek, especially between Riggins and Whitebird. Unlike many in the high mountains, these deposits could be worked most of the year. There, miners worked with relatively inexpensive rockers, sluice boxes, hydraulics, power shovels, and washing plants, and to keep their living expenses low, most lived in tents. Although new roads in the area improved access, some "floating miners" chose to prospect along the rivers in rafts.[157]

Hydraulicking revived in a number of placer districts in the 1930s. Its use in Idaho continued through at least the 1930s, even in some of the oldest districts such as Elk City, Warren, and Leesburg. Some operations of this period may have combined methods by using mechanized earth movers such as tractors pulling scrapers to remove the overburden and then monitors to break down the paying gravels and feed them into the sluices.[158]

Regardless of the mining method, between 1930 and 1942, Idaho's gold mines produced some 1.1 million ounces of gold; and placer gold accounted for about 42 percent of this total. The War Production Board Order L-208 of 1942 suspended gold mining in the United States for the duration of World War II. When the order was rescinded, many placer and lode gold mines in Idaho did not resume operations; they remained closed due to the high costs of labor, supplies, and equipment.[159]

Lode Mining in Idaho

Lode mining could rarely be conducted by an individual, independent miner. Even the relatively capital-intensive methods of placer mining such as hydraulicking and dredges did not require the capital investment nor the advanced technology that lode miners had to provide



Figure 39–Miners, Quartzburg Mine Engine Room, ca. 1914. (ISHS 71-185.30)

from the beginning. Since lode mine development and production was not as seasonal as placer mining (which was brought to a halt when creeks ran low on water), and since it often took long-term planning and investment to succeed, lode mining helped establish stable and permanent settlements in Idaho.

Concurrent with the discovery of extensive placer deposits in Idaho, prospectors began looking for lode deposits, but lode mining in the state got off to a slow start due to the complexities of the recovery process. In some districts the sources of the gold proved difficult to find, but in others, such as Rocky Bar, Silver City, or parts of the Boise Basin, the important lodes were identified fairly early on. The silver-bearing veins in the Silver City area, rated as Idaho's most important find of 1863, had grown into the state's highest producing lode mines by 1869; in the following decade the Atlanta and Yankee Fork districts numbered among the most productive. In these early years, primarily due to the lack of railroads and of efficient milling for processing the complex base ores, the productive lode mines chose to work the higher paying precious metal deposits instead.[160]

In most Idaho mining districts, finding efficient methods of concentrating the ore and recovering the values from it presented the greatest challenge. Arrastras were used widely in the early years because they were the only rock-crushing devices available at the time. Stamp mills followed, brought into many districts at great expense and effort. In general, they proved financially unsatisfactory because the mines did not have enough ore to keep them in constant operation. Dramatic failures of a number of lode mines in South Boise (Elmore County) and Owyhee County in 1866 and 1867, gave lode mining in Idaho a bad reputation that it did not overcome for many years.[161]

Profitable development of lode mines depended on a number of factors, including the richness of the deposits, the technical difficulties of recovering the metals from the ore, the distance to the nearest shipping point, the topography, and the climate. Mine managers, especially in the early years, failed to test

the ore's quality and extent before installing a mill, and sometimes they sank great amounts of capital into processes that did not work on their ores. Many mistakenly assumed that rich values extended to great depths, as they did on the Comstock silver lode in Nevada, but this was not the case with most Idaho properties. Other contributing development problems included the inability to consolidate claims into mines of reasonable operating size, mines that operated long after they should have shut down, or those properties that were hurt by title litigation, stock manipulation, or absentee ownership. During the 1860s and 1870s, lode mine superintendents generally tried to meet all costs from current production. This, along with a system of compensating superintendents with a percentage of production, led to high-grading or working only the richest parts of mines.[162]

The Panic of 1873 slowed mining efforts in Idaho appreciably for several years, and the failure of the Bank of California two years later badly hurt even the highly productive mines in the Silver City area. Since the San Francisco exchange carried the stock of some of the area's rich mines in the area, these Owyhee investments crashed. This discouraged investments in Idaho's mines for the rest of the decade.[163]

Some of Idaho's most noteworthy silver mines include the Owyhee mines, which were second only to Nevada's Comstock Lode in silver output after 1863. After a decline in activity there and elsewhere in the 1870s, production revived in the early 1880s with the discovery of lead-silver ores in Blaine County. The mines of the Coeur d'Alenes became major producers after the mid-1880s. This district in northern Idaho has had a huge impact on the state's economy. The exceedingly rich lode deposits in northern Idaho have made Idaho the leading state in silver production in the United States, and the Sunshine Mine the top single producer of silver.[164]

Lode mining in Idaho finally took off after 1880, when improved management, rail transportation, and technology for processing lead-silver ores enabled many companies to work their claims profitably. The coming of railroads to Idaho allowed base ore concentrates to be hauled to faraway smelters for processing. Some of the older gold mines that had been high-graded since the late 1860s became efficient producers. At this time, however, interest in lead-silver properties stimulated mining, which in the 1880s caused the revival of some older lode mines and the development of new ones. The Wood River district began production in 1884, the same year that lead ore was first discovered in the Coeur d'Alenes. By 1888, the production of gold in Idaho lagged far behind lead and silver in value. However, some gold- and copper-producing lode mining districts, such as the Seven Devils district in Adams County and the Blackbird and Indian Creek districts in Lemhi County, opened in the 1890s.[165]

After about 1884, miners had discovered most of the major free-milling gold and silver deposits that are known today, so subsequent gold rushes in Idaho were often misguided.[166] Around the turn of the century, for example, well-publicized discoveries in the Buffalo Hump and Thunder Mountain mining districts brought many people into these remote areas of north-central Idaho and generally increased activity in the surrounding areas for a few years. As it turned out, however, the mines' potential turned out to be wildly exaggerated.

A financial panic in 1893 brought an end to the mining prosperity of the 1880s. The nationwide depression caused railroads to go into receivership, mines to shut down, and banks and businesses to go bankrupt. Idaho's highly productive lode mines in the Coeur d'Alenes curtailed operations, and mines in Custer County closed down.[167]

Many of the gold and silver lode mines developed in Idaho were neither extensive nor more than a few hundred feet deep. The main method of ore treatment used at the turn of the century–crushing the ore in stamp mills followed by plate amalgamation–resulted in the recovery of only about 50 or 60 percent of the gold. Many of these mines shut down in the 1890s or early 1900s once the oxidized ore or the richer shoots were exhausted or as a result of financial instability due to the panic of 1907. With the development of better milling processes that could treat complex sulphide ores, some mines reopened. Atlanta, for example, did not have an effective recovery process until 1932.[168]

In the twentieth century some of Idaho's lode mines, particularly those with shallow overburden, introduced surface mining in the form of glory holes and open pits. Two mining methods, open pit and underground, are sometimes combined in the same location. Today, due to the expense, underground methods are generally used to mine deep deposits with fairly high-grade ore, such as in the Coeur d'Alenes.

Lode mining, like placer mining, experienced a revival in the 1930s in many Idaho districts due to the increased price of gold and also improved transportation. The price of silver, which had dropped in the early 1930s, also rose in 1934, and led to many old

mines reopening. Guaranteed prices for both gold and silver, set in 1934, boosted the industry. New mills were built with more up-to-date processes.[169]

The War Production Board Order L-208 of 1942 shut down most of the nation's gold mines for the duration of World War II. After the war, high production costs prevented many lode mining companies from resuming operations.[170] During and after World War II, however, Idaho became a leading producer of several strategic metals such as tungsten, quicksilver, antimony, and cobalt.

With the development of the base metal industry, many of Idaho's mining districts could be characterized as industrial islands, isolated in the mountains but connected to the world market by railroad. The mining and milling industry, like others in the West, became large-scale and corporate–one in which highly capitalized ventures with international investors displaced small or modest operations run by entrepreneurs. Wage workers and managers clashed in some of Idaho's mining districts as the classes became more stratified; the distinctions between laborers, supervisors, and financiers increased. Mine operators were subject to forces beyond their control, such as international market price fluctuations and transportation costs. To allow for these uncertainties and to maintain solid business practices, some companies tried to control all aspects of production by integrating mining and the processing of ores.[171]

Financing Lode Mining

Some of Idaho's early lode prospectors worked part of the year as employees at mines and used their wage work to support prospecting. Prospectors could also be "**grubstaked**" by someone who supplied the money for food and equipment in exchange for an interest in any minerals discovered. Some miners prospected for gold-bearing ore during the summer when the placer season ended and then worked in the adits or shafts of their lode mines in the winter when deep snow made placer mining difficult.

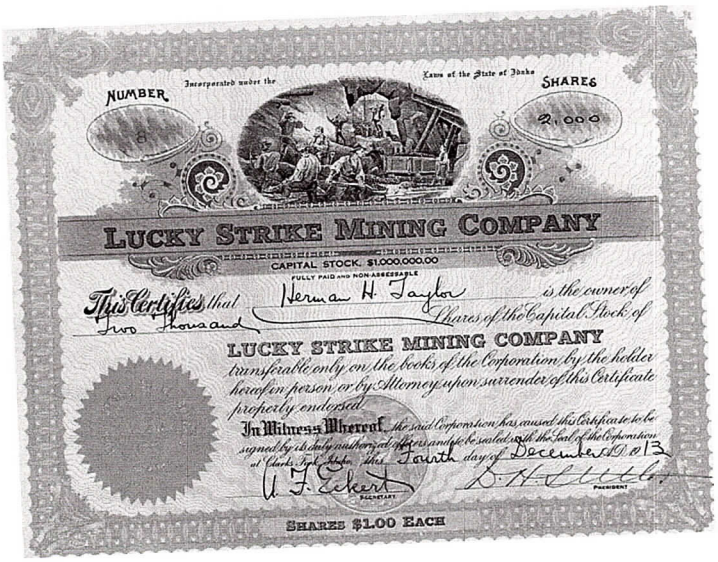


Figure 40–Stock Certificate: Lucky Strike Mining Company. (ISHS MS 2-1219b)

Lode mining required heavy machinery, extensive tunneling and timbering, and mills and other above-ground buildings, among them machine and assay shops, company stores, bunkhouses, cookhouses, and dwellings, for successful operation. Such extensive operations necessitated large investments of capital and corporate methods. So when a prospector located a good gold vein, he might option to sell the property outright for cash or trade, or he might speculate on its worth and accept, in lieu of cash, an interest in the corporation organized to develop and operate the property. Profits from placer operations financed some lode mines; the sale of stock to the public, often with the help of a professional promoter or broker, financed others. In only a few cases, such as the Charles Dickens Mine in Yankee Fork in the 1870s, did rich surface deposits meet the heavy expenses of developing a major mine and allow the miner to develop without having to sell or bring in outside capital. In many cases, profits were made by the selling of mining company stock to promote the mines rather than by the production of ore. [172]

Companies of stockholders or large corporations generally bought out individual miners or partnerships. Absentee ownership by large companies became more common, and mining expertise became more and more critical to success as the industry developed. As mining engineers with formal training challenged the dominance of experienced amateurs, individual small operators became outmoded in many areas, and most who stayed in the business focused on earning wages rather than finding wealth through rich strikes. The mining districts were linked in a national and international transportation, communications, demographic, and economic network. Capital came to Idaho's lode mines from the east, from other western states, and from England. The largest single American investment in Idaho occurred when Simon G. Reed of Portland purchased the Bunker Hill property in 1887, reportedly for over $700,000.[173]

Between 1860 and 1901, the British dominated European investment in mines west of the Rockies. Investors who had dropped capital into Idaho's mines after the end of the Civil War noted the failure of

so many lode mines in South Boise in the mid-1860s and soon became wary of investing in Idaho lode mines. Investment declined dramatically in the 1870s as a result of the national depression of 1873, followed by the failure of the Bank of California in 1875. The arrival of railroads in the mid-1880s resulted in a significant expansion of British investment in Idaho's mines. For all the British capital poured into Idaho mines, only the DeLamar Mining Company in the Silver City area paid any dividends at all. Luckily, the returns from this property, owned by British investors from 1890 until World War I, were so large that it probably offset much of the British losses in the rest of Idaho and even in the Northwest.[174]



Figure 41–Miner cooking under a canvas lean-to in the Boise Basin area, ca. 1900. (ISHS 76-119.6)
The main street...made up of a double row of compact buildings almost a mile in length, contained, in addition to many other businesses, eight hotels, two churches, six billiard halls, four or five elegant gambling houses, three hurdy-gurdies or dance-halls, several bawdy houses, and innumerable saloons. The other businesses referred to probably included a restaurant or two, a blacksmith shop, a stage office, a livery stable, an assay office, some groceries, a laundry and a bank. Varied patterns of these establishments formed the basic business district of a mining settlement.
(Council Bluffs Eagle, 14 September 1864)[176]

The demonetization of silver in 1873 depressed world silver prices and hurt rich producers such as mines in the Silver City district of Owyhee County. As more and more countries went off the silver standard, declining silver prices cut production in Wood River in 1888, and the price collapse of 1893 proved disastrous for several of Idaho's major districts. The new Populist Party, formed in Idaho in 1892, supported free and unlimited coinage of silver. Idaho did not climb out of the 1890s depression until late in the decade when conditions grew more favorable: when gold was discovered in the Yukon, new methods of processing precious metals began to yield more gold, and the Spanish-American War stimulated business.[175]

Working and Living Conditions at Placer and Lode Mines

In the 1860s, miners lived at first under trees, among rocks, or in other protected spots. Some groups brought tents with them. The first houses were small log cabins with shake roofs covered with dirt and with dirt or hide floors. The beds were piles of pine needles or fir boughs, and boxes served as tables, chairs, and cupboards. A fireplace both provided heat and cooked meals. Miners seldom left their cabins locked; travelers could enter and make a meal and stay overnight if needed.[177]

Many miners working in remote mountain districts would come out for the winter and stay in nearby towns. Placer miners who stayed in the mining district during the winters kept busy with tasks such as making sluices, whipsawing lumber, building flumes, and digging ditches.

Idaho's placer mining settlements of the 1860s all looked somewhat similar despite being separated physically. Typically, the camps were located as close as possible to the mining operations, often alongside and parallel to a stream with placer deposits. The buildings were generally laid out at first along one long main street. Dwellings ranged from brush huts to canvas tents to log structures. Business buildings often had wooden false fronts and eventually lap siding. Many of Idaho's earliest placer camps, such as Old Florence, Rocky Bar, Centerville, and Murray, disappeared when later gold processing obliterated the ground on which they stood.[178]

Some of the placer mining camps established in the 1860s never moved from small-scale hand methods into extensive capital-intensive lode mining. Others never developed into productive mining districts. For example, the Hoodoo mining district on the headwaters of the Palouse River had small production over the years, but many of the area settlers found ranching, farming, and logging to be more profitable endeavors than mining.[179]



Figure 42–"Discovery crosscut tunnel entrance, Franklin Bonanza, Pine Grove" in *Annual report of the mining industry of Idaho.* (TN24.I2 A2, 1903, p. 57)

Conditions at lode mines differed from placer settlements. Small lode mines were, by nature, labor intensive and often provided a varied work experience to the employees, owners, or lessees. Lode miners might work for an existing mining operation that hired employees, locate their own claim and develop it, work as contract miners, or buy an existing claim and begin mining. Miners at small-scale lode mines generally had partners in order to share capital expenses, reduce labor costs, have help with jobs that one man could not do alone, and enjoy the companionship. The job requiring the least skill was tramming out the ore (pushing the ore cars). Mucking or shoveling was next, but during hard times, such as the 1930s, skilled miners worked as muckers if nothing else was available. In small mines the men sharpened their own drills and refurbished other tools, but the larger mines had blacksmiths and tool tenders. The hoist operator worked at the headframe at the top of the shaft, and the top lander removed cars of ore and waste from the cage, pushing each to its appropriate destination and loading materials into the cage. Other jobs included replenishing underground supplies, grading the surface around the shafts, lowering material into the shaft, raising ore, constructing surface buildings, sawing lumber, logging, serving as watchmen, working as stationary engineers, and excavating prospect pits.[180]

Miners put in a six- to seven-day work week, and shifts in underground mines ranged from eight to twelve hours, depending on the success of the mine, the presence of unions, state legislation, and local practice. The passage of an eight-hour law in Idaho in 1907 came only after the labor shortage of 1906 to 1907 forced mine owners to raise wages and shorten the workday to maintain an adequate labor force. Most miners worked for wages, although some did contract to do specific jobs for set fees. Many men turned to hard-rock mining because it paid substantially higher wages than other industries. Miners generally spent much of their free time prospecting. In high-elevation districts, snow levels curtailed winter-time prospecting, so miners kept busy constructing buildings or doing underground work. In wintertime some left the mining districts altogether, living in Lewiston, Boise, along the Salmon River, or a west-coast city during the cold months.[181]

For many years, Cornish miners formed a nucleus of skilled hard-rock miners in the American West. They passed on techniques, equipment, terminology, and even the system of contract work and of leasing a mine and working it on a royalty basis.[182] When miners leased a mine, they passed a percentage of the gross receipts on to the owners rather than working on a contract basis or for hourly wages. The owners considered leasing a mine a safe investment: they did not have to pay expenses; less ore was lost through stealing or carelessness; and the lessee was responsible for damage to the property and for employee accidents. The lessees assumed greater risks but expected greater dividends without a heavy initial outlay for machinery or expensive development work. Lessees were not held liable by lien laws for their employees' unpaid wages, however, so some miners did not get paid for their work; their only recourse was to file an injunction to collect wages from the clean-up of gold, if any. Leasing was most common in young camps or in declining districts. Lessees could make good profits if they had a favorable agreement and encountered a solid pocket of high-grade ore; this was the main way working miners accumulated small fortunes. When leasing an undeveloped property, the owner and the lessee gambled that paying ore would be found. Miners rarely reopened closed mines: due to their rapid deterioration it was too costly and dangerous.[183]

Underground work at lode mines is extremely dangerous. Many miners suffer work-related injuries, illnesses,–even death–from hazards like falling objects, drilling and loading holes and handling explosives, cage and bucket accidents, falls, bad air, cave-ins, floods, mine fires, and silicosis. In the mid-1890s, the Idaho legislature created the office of inspector of mines, which prepared annual reports on the state's mining industry. However, since these mining inspectors generally showed more concern for the health

of the industry than for the health and safety of the state's miners, by 1910 territorial and state legislatures had passed a wide range of legislation in Idaho to help protect underground miners. A 1909 bill placed liability with the employer for accidents caused by defects in machinery, passageways, and other workplace conditions, by the negligence of managers, or by the actions of an employee following the employer's rules. Regulations related to safety concerns such as fire protection, cage operation, and the storage and use of dynamite were also passed. Beginning in 1917, the law mandated that Idaho mine owners pay into the state workmen's compensation fund. Early miners' unions in Idaho concerned themselves primarily with wage issues, not health and safety; since 1966, the federal government rather than the state has regulated the safety of lode mines.[184]



Figure 43–Coeur d'Alene Mining District mine rescue car in *Annual report of the mining industry of Idaho.* (TN24.I2 A2, 1954, p. 17)

Large mining and milling companies established company towns near Idaho's isolated mines, mills, and smelters that employed many workers. Ostensibly organized simply to provide needed services to employees, they also created a company-imposed social order. The settlement patterns of these planned towns reflected a fairly rigid class structure. They included company-owned facilities such as a general store, hospital, school, hotel, boardinghouse, bunkhouses, and private dwellings. The company stores and boardinghouses were often run by the mine superintendent. Boarding houses, typically occupied by single men, provided each employee with a small room and hot meals in a common dining area. Some employee quarters were quite large; for example, in 1907, the Snowstorm Mine in the Coeur d'Alenes built a bunkhouse, complete with electric lights and steam heat that could house 240 workers. A 1911 Idaho law prohibited companies from requiring workers to shop only at the company store; although some of the stores remained in business after this, miners and their families then could shop at competing stores. Many smaller mines provided room and board for some or all of their workers, for which they deducted a monthly charge for wages. These facilities were generally arranged more haphazardly and might be mixed with privately owned buildings near the mine or mill.[185]

Labor Unions at Idaho's Lode Mines

Idaho mining camps of the 1800s maintained law and order by miners' meetings and by electing a Justice of the Peace, a deputy sheriff, and a recorder. Disputes between conflicting claimants of mining ground were settled by a miners' meeting, where witnesses could be introduced and a majority vote determined the verdict. This local method of resolving disputes was especially important in the 1860s gold rush, because until May of 1863, the seat of government for the area that is now Idaho was at Olympia, four hundred miles to the west. Some early communities, such as Florence, Elk City, and Lewiston, formed vigilance committees to deal with criminals.[186]

Early placer miners generally did not organize labor unions because small groups of owners could work the deposits efficiently. Lode mines, however, often required hundreds of employees who worked for absentee owners. Miners at the Comstock Lode in Nevada organized a union in 1863 and spread the concept throughout the mining West. In 1867, a few months after the Comstock union experienced some success, miners in Idaho's Silver City organized their own union. As managers implemented wage reductions, employees responded by forming unions and organizing strikes. Wage and hour concerns dominated western mining unions.[187]

The Silver City union experienced only limited success in increasing the prevailing wage. The union also tried to get regular paydays instead of having to wait until a mine began producing to receive back pay. A strike in 1872 in Silver City resulted in the firing of an unpopular mine superintendent, and another strike in 1873 led to the banning of Chinese from surface work at the mines. This union became one of the most active outside of the Comstock. In the 1890s, Silver City miners formed a local of the Western Federation of Miners and bargained over issues such as wages, length of work day, and safe working conditions.[188]

Two miners' unions were organized in the Wood River area in the early 1880s with a combined membership of about 450. In 1884, they succeeded in holding



Figure 44–Miners' Union parade [2 miners carrying banner imprinted with word "UNION"]. (ISHS 78-156.0008 Ketchum–Parades, in Wells, *Gold Camp and Silver Cities*, p. 119 PARL: QE 103.B8 no. 22 1983)

wages at $4 a day. A year later this union held the longest strike ever in the history of western mining, but when it ended the mining companies in the area all cut wages.[189] Following these organized efforts to improve conditions in Silver City and Wood River, Idaho's organized miners regrouped and took their struggles to the Coeur d'Alenes.

The rapid rise of large-scale mining escalated the conflict between workers and owners in the Coeur d'Alene mines. The nature of mining was changing due to new technology such as the introduction of mechanized drills around 1887 and the working of lower-grade base metal deposits using more mechanized equipment and fewer skilled workers. Many miners were reduced to doing unskilled work and were paid less than drillers. Mine owners took control of hiring practices, pace of work, and wages.[190]

The miners in the Coeur d'Alenes organized in the late 1880s. Three years later, the mine owners formed a Mine Owners Association (MOA). Citing increasing freight rates and declining metal prices, the owners shut down the region's major mines in 1892 after the workers refused to accept a reduction in pay. This put about two thousand people out of work. When the mines reopened, the owners announced reduced wages and brought in non-union workers. The lengthy, bitter controversy ended with workers dynamiting an abandoned mill. Federal troops were called in, and martial law ruled in the Coeur d'Alenes for four months. Some six hundred union men suspected of participating in the uprising were held in an outdoor prison known as a bull-pen. At the end, the mines operated on the owners' terms but the unions had not been broken, even though union men were blacklisted throughout the West.[191]

Violence and class warfare erupted again in the Coeur d'Alenes in 1899 after owners refused the union's wage and hiring demands. Miners blew up the Bunker Hill & Sullivan mill because it was the only company not paying $3.50 per day to all mine workers. Again the troops arrived, and martial law was imposed for over a year. For many years after this incident, mine owners maintained a central hiring agency that screened potential employees.[192]

The 1892 labor struggle in the Coeur d'Alenes, combined with wage cuts and enthusiasm over the new Populist Party, resulted in the creation of the Western Federation of Miners. The militant and increasingly Socialist union soon opened its membership to all mine, mill, and smelter workers, but it only represented a minority of miners. Eventually, due partly to union efforts, state and federal legislation mandated minimum safety and health standards and inspections at mines and mills.[193]

Labor unionism revived in the Coeur d'Alenes during World War I due to the rising cost of living and the shortage of skilled workers. New unions organized in the area, including the International Workers of the World. After a 1919 strike, all the mining companies adopted the eight-hour workday for their surface employees. Unions reappeared in the area in the 1930s.[194]

After World War II, the Kellogg local of the International Union of Mine, Mill and Smelter Workers was targeted for having Communist affiliations and being too militant. The union organized a strike against the Bunker Hill Company in 1960. The community response centered on the question of whether the union's leadership was pro-Communist, and the local lost bargaining rights at Bunker Hill. This reflected the power of the anti-Communist movement during the 1950s and 1960s.[195]

PRECIOUS METAL LODE MINES IN IDAHO

The following discussion highlights a few of the most productive and well-known precious metal mining districts in Idaho. *Note:* This is an overview discussion; not all significant districts are mentioned. Please consult the Idaho mining district maps, Figs. 31 and 70, and Appendix A, for a listing of other Idaho mines and mining districts. (For a listing of Idaho's mining districts not mentioned in the text, consult "Mining Districts in Idaho," Idaho State Historical Society Reference Series # 472, April 1969. This document and other mining-related documents are available on-line at http://history.idaho.gov/reference_series.html)

Southern and Central Idaho

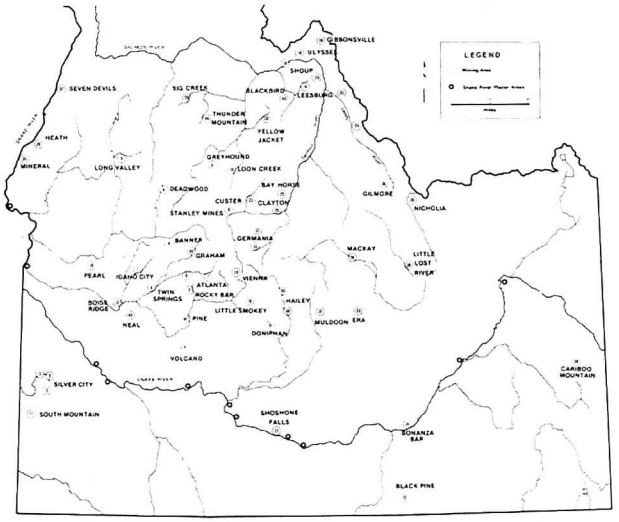


Figure 45–Map of Southern and Central Idaho mining regions. (Wells, *Gold Camps and Silver Cities*, p. 2 PARL: QE 103.B8 no. 22 1983)

Owyhee Mines

Miners in the Silver City area first worked placer deposits on Jordan Creek, but within a few years, they discovered very rich silver-and-gold-producing lode mines. The Owyhee mines soon produced an important share of the national output of silver. The initial mining period in the Silver City region of Owyhee County lasted from 1863 until 1876, when the mines closed due to declining silver prices and the failure of the Bank of California.[196]

In the 1860s claim wars, inadequate recovery methods and poor transportation created problems at the Owyhee lode mines. For example, at the Poorman, one of the early bonanza mines at Silver City, expensive litigation resulting from a claim war slowed production. Another claim war on War Eagle Mountain in 1868 led to armed conflict above and below ground. Troops from Fort Boise were called in and the dispute was eventually settled; but in the process, one of Idaho's leading miners, J. Marion More, was shot and killed.[197]

Arrastras at Silver City, and several stamp mills imported in 1864, made good initial returns on the easily mined oxidized high-grade ore, located mostly on War Eagle Mountain. Low-grade properties on Florida Mountain, however, required concentration by vanners to separate the sulphides that prevented silver recovery. These large deposits could not be developed until the Oregon Short Line offered transcontinental rail service in 1884 and technology, capital investment, and management had improved.[198]

Poor transportation to the Owyhee mines limited investment and development there for many years. Entrepreneurs built toll roads in the area in the 1860s and established a stage route between Boise and Silver City. Well-known passenger and bullion carriers such as the Oregon Steam Navigation Company and the Wells Fargo Company, and their competitors, served the area. But hauling heavy mine and mill machinery by freight wagon was extremely expensive. The construction of the Oregon Short Line across southern Idaho in the early 1880s eventually helped bring prosperity to Silver City. William H. Dewey built the thirty-mile Boise, Nampa & Owyhee Railroad in the late 1890s between Nampa and Murphy. This line was absorbed by the Oregon Short Line in 1913. But, due to reduced mining activity around Silver City, the last section from Murphy to the mines was never built.[199]

The Owyhee mines, which would soon have railroad service, saw renewed productivity starting in 1889 with the discovery of new large ore bodies and such technological advances as the introduction of power drills. These events opened a period of consolidation of ownership and systematic development. William H. Dewey began consolidating properties in the late 1870s by buying many Florida Mountain properties at low prices and raising capital in Pittsburgh for their development. The construction of a five-mile tunnel system connecting Silver City and Dewey allowed for serious production. Dewey's Trade Dollar Mining & Milling Company became one of the most successful mining enterprises in the West. When Joseph R. DeLamar brought in a mill with vanners to his DeLamar district, that eliminated the expense of hauling ore to Silver City for processing. In 1890, he sold his Owyhee property to British investors, and he and they profited greatly over

subsequent years. In 1914, after $23 million in precious metals were extracted from Silver City, exhausting the supply of known ore, mining ceased except for sporadic small-scale operations. This highly productive run marked the longest period of mining prosperity in Idaho outside of the Coeur d'Alenes.[200]

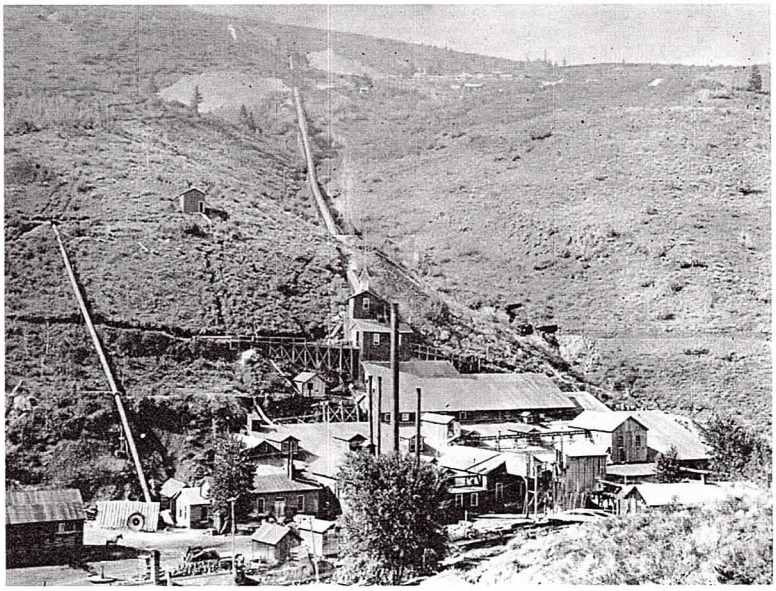


Figure 46–Delamar Mine and Mill ISHS 81.049.0001 Mines–Owyhee (Delamar) in Wells, *Gold Camps and Silver Cities*, p. 48 PARL: QE 103.B8 no. 22 1983)

The advent of electrical power in (1901, after the Trade Dollar Mining Company built the Swan Falls Dam, helped production at the Florida Mountain (and area communities). Electricity not only powered the hoisting works, ventilators, compressed-air drills, water pumps, electric haulage locomotives, lights, heat, and machine shop tools for the mines, this technological advance also provided some economic relief. [201] Previously, the mines had depended on seasonal water power and on steam, but this had consumed all the timber in the area, which resulted in prohibitive fuel costs.

South Boise

Prospectors discovered the first lode vein at South Boise in the spring of 1863, at about the same time as the placer rush to that area. Surface investigations (like the customary working a lode mine by following the vein rather than driving adits below the outcrop and working up after determining the amount of ore in the deposit) led to the mistaken belief that the veins were richer and deeper than was actually the case. This would result in the over-promotion of many properties, claim disputes and litigation in the district. Based on the promise of a deep, rich payload, however, over eighty locally built arrastras were operating by the fall of 1864, processing up to 1.5 tons per day. Simultaneously, the completion of a wagon road to Rocky Bar allowed shipment of the first of several stamp mills that same season. Unfortunately, events that followed eventually caused the mines to fail: miners underestimated the initial capital, labor costs, amount of ore, and management resources necessary to support steam-powered stamp mills. The veins turned out to be neither uniform nor deep, and the stamp mills recovered only half the gold from the ore at most. The most poorly managed mines were the first to shut down, and by 1867, most of the Rocky Bar mines had failed. The closure of these early lode mines in South Boise highlighted the problems faced by miners in shifting from simple placer mining to complex lode operations.[202]

After the failures in 1866 and 1867, several Boise companies began to block out the ore on their properties, which led to some stability. Many returned to small-scale milling with arrastras. The district, still suffering from high freight costs and limited capital, entered a period of gouging–extracting high-grade ore at the expense of systematic mining and good recovery. Nonetheless, many new developments around transportation and technology encouraged mining during this period, which included completion of the Union Pacific Railroad, invention of dynamite and single jacks, and improvements in pumps, engines, and hoisting works. The establishment of the U.S. Assay Office in Boise allowed South Boise miners to sell their product without delay, an important economic factor since each mill run typically only covered current operating costs.[203]

Rocky Bar's most productive period began in 1884, when the Oregon Short Line came within sixty-five miles of the South Boise mines. Properties were consolidated, and the larger companies did development work with modern equipment. Even so, until the known ore deposits were exhausted in 1892, the district supported successful large-scale mining and milling operations. A bedrock flume project designed in the late 1890s to recover amalgam lost from earlier stamp mills was never completed, which hastened the decline of the district. Dredging along the nearby Feather River in the 1910s and 1920s did recover much gold from placer deposits, however.[204]

Atlanta

Atlanta was only fourteen miles from Rocky Bar, but even so the miners in this district repeated some

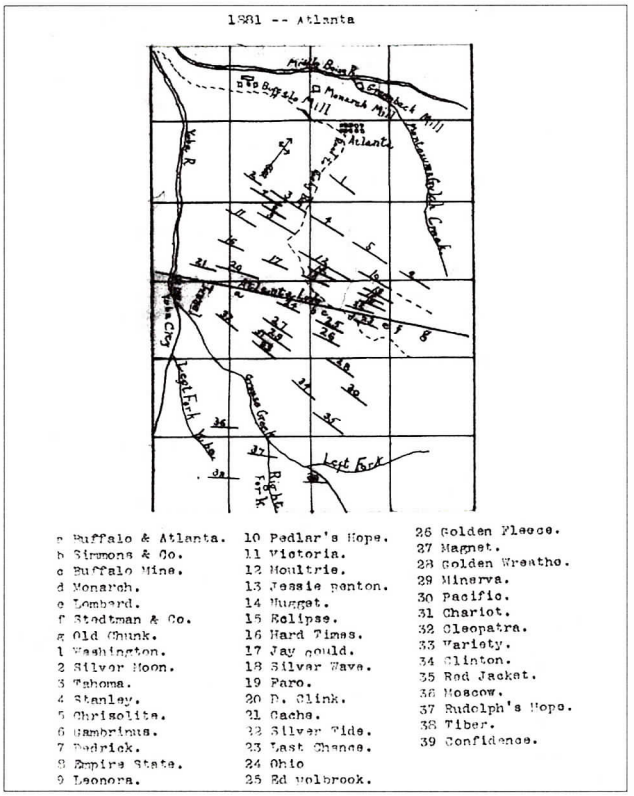


Figure 47–Historic mining operations at Atlanta, Alturas (now Elmore) County, Idaho, 1881. (PARL MS 2/54)

of their neighbors' mistakes. Silver ores were found in the district in 1864. Although small-scale development had begun, the refractory nature of the ores, which made it difficult to recover the silver values using the Washoe process, delayed major development. New York investors brought in a ten-stamp mill and a five-hearth furnace, and the Atlanta mills saw much activity until 1884 when the high-grade ore gave out. Even when ore was packed into Atlanta from Yankee Fork for processing, it was uneconomical to recover only the gold by stamp milling, so in the early 1900s, mills employing amalgamation, table concentration, and cyanidation were built, those too proved unsatisfactory.[205]

The Atlanta mines would not have an effective concentration process for their ores until 1932, when the St. Joseph Lead Company introduced flotation. Production from the company's Boise-Rochester Mine in the 1930s enabled the district to lead the state in gold production some of the years before World War II. Construction of the Middle Fork road from Boise to Atlanta in 1938 also helped the district. The commercial ores at the Boise-Rochester Mine were confined to relatively shallow shoots, however, and large-scale production ceased after the early 1950s.[206]

Yankee Fork

The Yankee Fork district in Custer County boasted rich silver-gold lode deposits, notably the Charles Dickens and General Custer mines, first discovered in 1875. Litigation and the lack of a wagon road for hauling in milling machinery delayed development of some of the mines. Finally, a thirty-stamp mill was brought to the district around 1880, and the Custer Mine alone produced about $8 million over the next decade. After very high yields, the district had started to decline in the 1890s; before it did, however, the installation of a cyanide plant to rework old tailings, and the installation of a tram to the Custer mill to work lower-grade ores, made further recovery possible. The district was hindered by poor management, the declining price of silver, gouging of high-grade ore, lack of a railroad, and systematic logging that had exhausted the timber supply. After the 1890s, Yankee Fork saw no further large-scale activity until extensive dredging of placer deposits in the 1940s and 1950s yielded some $2 million in gold.[207]

Other Nineteenth-Century Gold and Silver Lode Mining Districts

Gibbonsville, unlike most lode camps, was developed by its original discoverers. By working the outcrop, they paid for a ten-stamp mill in 1879. Gibbonsville became Lemhi County's major gold producer (mostly from lodes, but also from some placer production) after Leesburg declined. The district declined abruptly upon reaching sulphide ores in the late 1890s, although a mill was built later to handle these ores.[208]

In 1869, during the rush to Loon Creek, miners found old lode deposits at Yellowjacket. After installing a sixty-stamp mill with cyanide plant, sawmill, and aerial tramway, and building a wagon road, the value

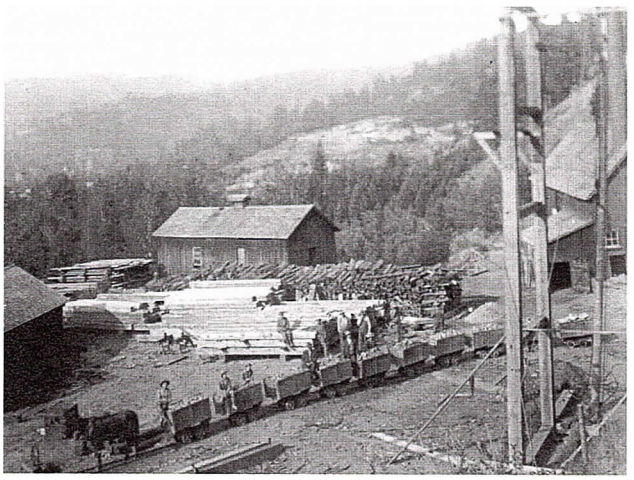


Figure 48–Gibbonsville mine cars, boiler room, and compressor plant, 1912. (ISHS 77-171-14/B Mines–Gibbonsville (AD&M) in Wells, *Gold Camps and Silver Cities*, p. 110 PARL: QE 103.B8 no. 22 1983)

of the gold turned out to be less than the cost of the improvements, and the stamp mill was hardly used. Lower costs of producing and processing ores in the 1930s allowed more development. Even when a flotation mill was installed in 1953, the ores still could not be treated economically.[209]

Gold was mined in the Cariboo district in the 1870s, although the first stamp mill did not arrive in the isolated area until 1890. Despite substantial development work on some mines, large-scale lode mining could not be accomplished in this district.[210]

Twentieth Century Precious Metal Mining Districts

At the turn of the century, many investors and fortune seekers sought adventure. While events of the latter 1890s–the Klondike gold rush and the Spanish-American War–drew many Idaho miners away from the state, others participated in the two big mining rushes at Buffalo Hump and Thunder Mountain.

Buffalo Hump

The first rush to Buffalo Hump occurred in 1862, when prospecting parties fanned out from Florence to the surrounding mountains and made a discovery in the area. Miners, too, rushed in, some of them temporarily abandoning rich claims in Florence. The excitement quickly died, however, when the lack of placer gold became clear, and the promising outcrops of veins were low grade and could not be profitably worked at that time. [211]

The big rush to Buffalo Hump began in 1898, after two Florence prospectors found a promising outcrop. Within two years Grangeville served as the outfitting point for the miners and prospectors, and that small town grew tremendously during 1898 and 1899 as a result of the rush. By June of 1899, five thousand people had reached Buffalo Hump, and many of them located claims. The influx soon led to the establishment of three more towns: Callender, Concord, and Hump.[212]

In 1900, Charles Sweeney of the Coeur d'Alenes bought the Big Buffalow Mine, put up a mill, and began development work in earnest. The Big Buffalow operated from 1900 until 1903. For a time, it and the Merrimac had a payroll of four or five hundred men, who were responsible for over twenty thousand feet of development work in the district in the early years. After the first year or so, five stamp mills (the largest a twenty-four-stamp mill on the Jumbo) were brought to the Hump to treat the ores. Most operations, however, had closed by the end of 1903 due to the lack of free-milling ore and the difficulty in extracting the values from the quartz. Other reasons for the decline included the withdrawal of Charles Sweeney from the district, high operating costs for shaft mining, over-capitalization, difficult and expensive transportation, deep snow in winter, scarcity of timber, and general disappointment in the size and value of the ore bodies. One mill ran intermittently for fifteen years; the last one shut down in 1915. Despite all the excitement, total production from the Hump amounted to only about $540,000.[213]

Thunder Mountain

The mining boom at Thunder Mountain–exaggerated wildly in the press–amounted to little more than a spectacular bubble. Although the first mining in the Thunder Mountain area occurred in the early 1860s, the area was not prospected much until the expulsion of the Sheepeater Indians from the region in 1879.



Figure 49–Dewey mill at Thunder Mountain, 1903. (ISHS 66-74. 158a Earl Willson Collection)

Still, not much happened there until the discovery of the gold deposit known as the Dewey Mine (named for owner William H. Dewey of the Owyhees) in the mid-1890s. Exaggerated accounts of the deposit's richness were spread around the country, and in 1902, two to three thousand people poured into the area. Development followed, largely with money from Pittsburgh investors between 1902 and 1906. Between the discovery and 1908, production of gold and silver was valued at approximately $400,000, almost all from the Dewey Mine. Business there came to an abrupt end in 1909 when a huge landslide backed up waters to form a new lake. This event caused flooding and subsequent evacuation of Roosevelt, the town which had been founded to serve the mines. Then in the 1930s, new

roads and the higher price of gold led to the reopening of some of the mines, including an open pit operation at the Dewey.[214]

When the Thunder Mountain rush started, a number of established communities–Boise, Ketchum, Mackay, Red Rock, Weiser, and Grangeville–vied to be the jumping-off point for the mines. In 1902, travelers could get to the area from any of these towns, and other routes opened later. The hopeful prospectors carried their gear on their backs, led loaded-down mules, or even dragged goods wrapped in elk and deer hides across the snow in the winter.[215]

Disappointingly, the deposits in the Hump and Thunder Mountain were only rich on the surface; the hoped-for profits did not materialize. After the collapse of these two booms, lode mining in Idaho's gold and silver districts, as in other western states, slid into a gradual recession.

Northern Idaho

Mining in the Coeur d'Alenes

The mines and associated industrial operations in the Coeur d'Alenes have played an extremely important role in shaping the history of Idaho. This region, an east-west mineralized belt covering about five hundred square miles, is one of the great mining districts in the world. It has produced nearly 45 percent of the nation's silver, 11 percent of the lead, and 9 percent of the zinc. The mines have yielded over 80 percent of all of Idaho's metal production. The first silver-lead lodes were discovered there in 1884, and by 1891 the production of Shoshone County exceeded that from all the rest of the state.[216]

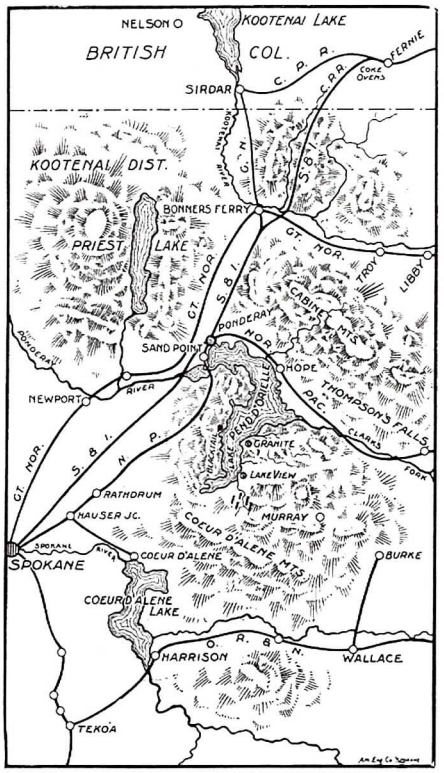


Figure 50–Map of [Bonner County?] northern Idaho, 1907 in *Annual report of the mining industry of Idaho.* (TN24.I2 A2, 1907, p. 47)

Most of the mines are located along the South Fork of the Coeur d'Alene River and in tributary gulches. Unlike many other areas of Idaho, the veins of ore persist at great depth, so that the district has remained in continuous production. In the late 1880s soon after the initial discoveries, railroads came to the Coeur d'Alenes, which was critical for the large-scale expansion of the district.

The ores of the Coeur d'Alenes are complex: sometimes lead, zinc, copper, gold, silver, and other metals occur in the same ore. Selective flotation revolutionized the milling process of the refractory ores after World War I, allowing profitable treatment of the lead-zinc ores. Nearly all the ore from the region was concentrated and then shipped to smelters. The construction of the Bunker Hill lead smelter in 1917 near Kellogg freed the company from its dependence on a near monopoly of American lead smelting. The building of an electrolytic zinc plant in 1928 by the Bunker Hill and Hecla companies gave zinc an equal place with lead and silver. The major companies employed professionally trained engineers, and the region became a leader in the industry. Eventually, large corporations owned all the major mines except the Hercules. So like other large corporations in the early 1900s, Bunker Hill & Sullivan, too, tried to become fully integrated, from mining to processing to marketing. Its research and development program introduced new technologies, and its managers came up with innovative business methods that helped the company become a leader in the industry.[217]

Placer gold rushes to the North Fork of the Coeur d'Alene River in the Murray and Eagle City vicinities constituted the initial mining activity in the Coeur d'Alenes. The Northern Pacific Railroad sponsored an advertising campaign that strengthened the rush of 1883 and 1884. By 1888, however, placer mining near Murray and Delta had greatly declined. Although some hydraulicking and dredging occurred later, by the late 1880s, the focus of activity had shifted to the lead-silver mines of the South Fork.[218]

Silver-lead mining is of necessity a large-scale operation. Instead of small cooperatives based on friendship, outside investors formed large companies to extract and process the ores of the Coeur d'Alenes. When these companies hired miners as employees, and not as entrepreneurs, miners' fear of competition led to the total banishment of Chinese miners from the Coeur d'Alenes, even from support occupations.[219]



Figure 51–Old South Mill at Bunker Hill, 1907. (ISHS 79-92.15)

The 1885 discovery of the lead-silver Bunker Hill & Sullivan claims marked the start of development of Idaho's largest mine. In 1887, this property sold to Portland industrialist Simeon G. Reed. By that year, several major mines in the area such as the Tiger, Bunker Hill & Sullivan, and the Poorman were shipping ore to out-of-state smelters. By 1890, ten concentrators in the region were each processing an average of one hundred tons per day. Eventually, over ninety major mines and many smaller ones were operated in the Coeur d'Alenes.[220]

Initially, water generated electricity, ran mills, and powered compressed air, and until the 1890s, seasonal water-powered generators limited mining and milling operations in the Coeur d'Alenes. Some electrification came to the area in 1892, which allowed mines like the Poorman to install Edison electric dynamos powered by water or by back-up steam engines that used coal. In 1903, ninety-mile transmission lines erected from the hydroelectric plant at Spokane Falls to the mining region provided the Coeur d'Alene mines and mills with cheaper and more dependable electric power. While hand drilling was still employed in some of the smaller mines and in exploration work until the early 1900s, the larger mines used machine drills to drill blast holes. The cost of mining, freight, and treatment of ore in the region in 1892 amounted to $25 to $28 per ton. At this time, most of the high-grade ore and concentrates were shipped to Denver or Omaha for smelting.[221]

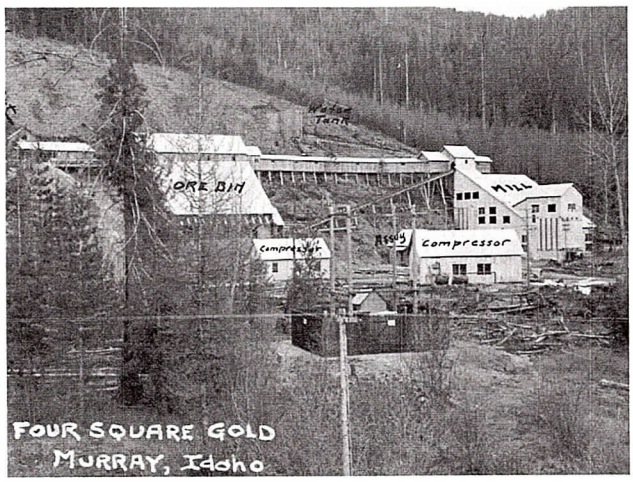


Figure 52–Four Square Gold Mine showing assay office and two compressor buildings, Murray. (ISHS 63-160.18 F752.5h7 Mines–Coeur d'Alene, Donor: State Inspector of Mines, O. T. Hansen)

As of the early 1900s, most of the ore was still extracted through adits rather than shafts, without hoisting or pumping. As mine workings reached the valley floor, the method changed to sinking shafts underground, when rich ore bodies were found at considerable depth. The major mines were worked by back stoping with timber supports. In the early 1900s, the development of electric hoists and other electrical devices and better drills reduced per-ton mining costs. As mining machinery improved, fewer men were needed to accomplish the same work. Even so, the mines and mills of the Coeur d'Alenes employed about three thousand men in 1906.[222]

Harry Day, one of the discoverers of the Hercules Mine, remained the primary figure throughout its history and for decades was one of the most influential men in the Coeur d'Alenes. This mine was unusual in that the locators and their associates developed and ran

its mining, milling, smelting, and refining operations. Moreover, for a number of years, the operators of the Hercules Mine resisted the move towards consolidation that swept the Coeur d'Alenes in the early 1900s. In 1901, the Hercules was found to be a very rich lead-silver-zinc mine. Between that year and 1924, the mine was developed to over one thousand feet below the surface. It grossed some $75 million, and during World War I, employed nine hundred underground workers. After the Hercules closed, the Days revitalized their company with new mining properties.[223]

The first concentrating mills in the Coeur d'Alenes were built in the mid-1880s in order to reduce the high costs of shipping ore to smelters. The early mills all hand sorted ore and used gravity processes such as jigs, tables, buddles, and vanners to separate the valuable metals from the gangue. The middlings from various processes were often recrushed or ground and re-treated; The tailings were discharged into nearby creeks. This process did not work very well with complex ores. The largest mill was the new Bunker Hill & Sullivan built at Wardner in 1891, which could treat five hundred tons per day (eight years later striking miners dynamited and destroyed this mill). Once it left the mine, the ore was handled almost completely by machine: a two-mile aerial tramway carried it in ore cars to the mill (a tunnel later replaced the tramway), and the ore went directly from the mill to a Union Pacific side track. This and the other early mills recovered about 75 percent (sometimes much less) of the silver and lead values, with a ratio of concentration of five to one. Over the years, mill employees toured other mills outside of the area and conducted extensive tests in their own mills in an effort to improve the yield.

The transition from reliance on gravity concentration to fine grinding followed by flotation took place during the 1910s and 1920s in the Coeur d'Alene mills. Each ore required a slightly different method of treatment except for the very similar ores of the Pine Creek district. To solve the problem of poor recovery of Coeur d'Alene ores, the U.S. Bureau of Mines, the University of Idaho, and mine operators worked cooperatively to develop the flotation method. The general process involved, first, fine grinding the ore in ball mills to a silt-like consistency and then treating the overflows and slimes by flotation. The concentrates from the flotation machines were dewatered in settling tanks or Dorr thickeners and then passed on to vacuum filters to reduce the moisture content. Flotation allowed mills to process disseminated ores effectively, and differential (selective) flotation proved to be the best way to recover zinc. By 1919, a few plants were using differential flotation to raise the lead and zinc sulphides separately. When flotation was added to the Bunker Hill mill in 1913, the mill produced very high-grade lead concentrates. Other modifications were made throughout the mill over the years. For example, in 1928, differential flotation to recover the small amount of zinc in the mill feed was added to the process. The tables at Bunker Hill were abandoned in 1938.[224]

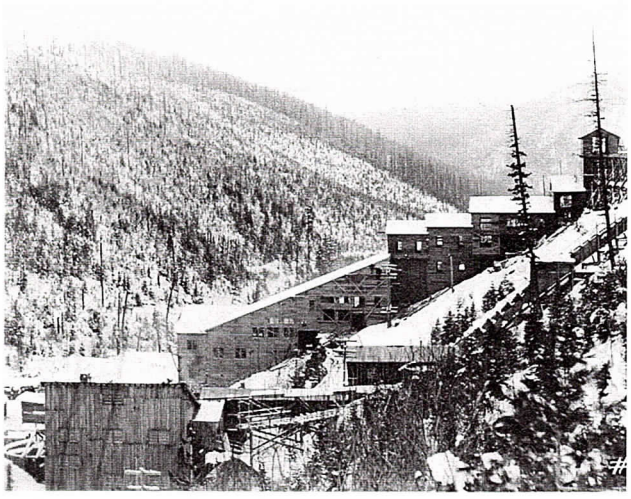


Figure 53–Jack Waite Mining Company mill, Coeur d'Alenes. (ISHS 63-160.145)

Early mining companies in the Coeur d'Alenes sold their high-grade ore and concentrates to a dozen or more smelters. These smelters eagerly sought ore from the Coeur d'Alenes because of its relatively high lead content–an important ingredient in smelting. The Bunker Hill owners purchased a smelter in Tacoma to smelt their ores from Idaho and Alaska. In 1899, the American Smelting and Refining Company (ASARCO) was organized. This consolidation, soon controlled by the Guggenheim brothers, combined eleven companies that owned smelters, refineries, and mines around the country in order to reduce competition and stabilize profits. Smelters that remained outside the "smelter trust" were not allowed to handle the output from the Coeur d'Alene district. In 1903, Charles Sweeney of Spokane purchased most of the major mines in the region (but not Bunker Hill & Sullivan) in an effort to establish economies of scale and ore production large enough to affect the smelter trust. As part of this consolidation, Sweeney formed the Federal Mining and Smelting Company. The Guggenheims bought stock control of Federal, however, and Federal signed a twenty-five-year contract with ASARCO, accepting the trust's quotas for production.[225]

During the early 1900s, ASARCO held a virtual monopoly on smelting in the United States, so the trust was able to influence the rates and schedules of

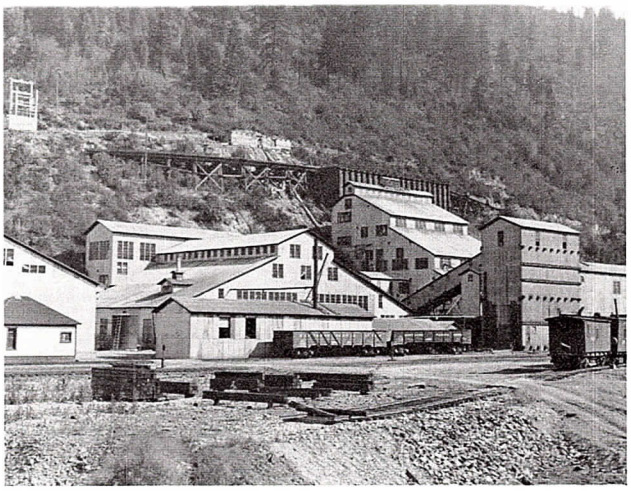


Figure 54–Hercules new mill near Wallace in *Annual report of the mining industry of Idaho.* (TN24.I2 A2, 1930, p. 231)

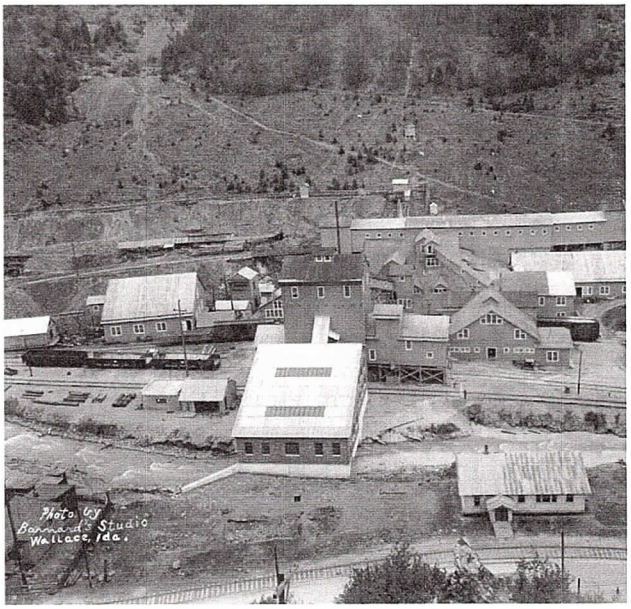


Figure 55–Hecla Mining Company mill, Gem, 1926. (ISHS 63-160.147 Ore Dressing–Coeur D'Alene (Hecla Mining Company mill) Gem, Idaho May 6, 1926 Barnard Studio Photo, Wallace)

railroads that competed for its freight business. Bunker Hill signed a twenty-five-year contract with ASARCO in 1905 after the trust bought the Tacoma smelter for a high price. This guaranteed ASARCO an adequate supply of high-grade lead ores for many years. By the end of 1908, however, Bunker Hill was sending all of its concentrates with more than a 75 percent lead content to a non-ASARCO smelter (their contract required concentrates containing 30-70 percent lead be treated in ASARCO plants). This reduced its dependence on the Tacoma smelter and led to lower smelting and freight rates.[226]

The Hercules Mine did not join the smelter trust until 1912 because it had access to independent smelters; but, Hercules finally did contract to sell its ore to the trust on very profitable terms. In 1916, however, Day Mines took the risk of breaking from the trust. The company purchased an abandoned smelter at Northport, Washington, to treat ores from the Hercules and two other mines and also bought an independent refinery in Pennsylvania.[227]

Bunker Hill & Sullivan built its own smelter near Kellogg in 1917.[228] This allowed the company to smelt its concentrates containing less than 30 and more than 70 percent lead and also to treat ores from other mines in the area. The construction of this smelter made the region's low-grade lead mines profitable. ASARCO sued, claiming a breach of contract, but Bunker Hill was essentially allowed to continue this practice after an out-of-court settlement. Having a smelter within the district reduced the costs of handling ore and gave Bunker Hill a second major source of income through its custom smelting operations. As one of only a few lead smelters in the Pacific Northwest, the smelter bought ore based on an analysis of the concentrates minus a treatment charge, and the profit was derived from a per-ton charge for treatment and marketing and from recovery of more metal than was contracted for.[229]

In 1917, the Bunker Hill lead smelter treated ore by crushing the concentrates from mills, roasting, blasting, **drossing**, processing in a reverberatory furnace, and other steps. A revolving cycle of treatment and retreatment gradually extracted all the metals contained in the smelter feed. Metals in the fumes were recovered and run back through the system. Slag was periodically tapped off, de-zinced (after 1943), and discharged. The lead refinery removed various impurities in the lead bullion through the processes of drossing, softening, and desilverizing, making it pure and, therefore, marketable. Besides lead, Bunker Hill smelter products included silver, gold, zinc, copper, antimony, and cadmium.[230]

From 1941 until 1951, Bunker Hill operated an iron plant that recovered the ferrous metal from the South Mill tailings to use as smelter flux. The company also opened an electrolytic zinc plant in 1928 (in combination with the Hecla Company), an ore preparation plant, a sulfuric-acid plant in 1954, and a phosphoric-acid plant in 1960. Other improvements included smoke and fume recovery, improved materials handling, and new mechanical and metallurgical processes. In the early 1960s, the plant feed consisted of Bunker Hill lead concentrate, Bunker Hill zinc plant lead residue, and custom ores and concentrates. Limerock and silica were used as fluxes, while coke, coal, natural gas, and fuel oil provided the energy sources for the operation. The

smelter had the following main divisions: receiving, crushing, and sampling; smelter ore or feed preparation; sintering; smelting; refining; and alloying, casting, and shipping.[231]

Lead and silver prices reached their highest levels in forty years during World War I, and the Coeur d'Alene mines yielded great profits during this period. Some new properties were developed, such as lead-zinc and antimony mines in the Pine Creek area (due to high metals prices and a new market for zinc). As had happened in 1893 with fluctuating silver prices, in the 1920s, mines opened and closed depending on lead prices.[232]

Although known to be associated with lead ores in Idaho early on, zinc was discarded in tailings for many years and was penalized by lead smelters because of increased processing costs. The first recorded zinc production occurred in 1904 or 1905. During World War I, higher prices led to a rapid increase in zinc production in the Coeur d'Alenes, largely as a byproduct of lead and silver smelting based on improved technology. After World War II, mines producing zinc ore made Idaho a major producer of this metal. During this period, reworking old mine tailings and dredging river channels for tailings became profitable. The Pine Creek area boomed, and for several years in the 1940s Idaho led the nation in zinc output. Only a few Idaho mines outside of the Coeur d'Alenes, such as the Triumph and the Clayton, produced significant amounts of zinc in the 1940s and 1950s.[233]

Initially, the lack of markets and uses for zinc and the difficulty of recovering the metal from lead-silver-zinc ores delayed the mining of zinc. Coeur d'Alene ore did not yield zinc oxides by roasting because it contained impurities such as silica, so the mines had to find a way to produce the metal itself rather than marketing zinc oxides. The development of selective flotation enabled mills to recover zinc sulphides effectively. The Bunker Hill & Sullivan and the Morning mining companies experimented with ways to treat zinc just before World War I and turned to flotation. During the 1910s and 1920s, much of the zinc produced was shipped to an electrolytic plant at Great Falls, Montana.[234]

The electrolytic process started with sulphide zinc concentrates milled from raw ore. These were roasted; leached with a sulfuric acid solution; the resulting liquor was purified; and the zinc was deposited electrolytically. The spent electrolyte was used to leach more ore. This method, based on low current density and a weak sulfuric acid, was favored in the Northwest as a result of the potential availability of hydroelectric energy.[235]

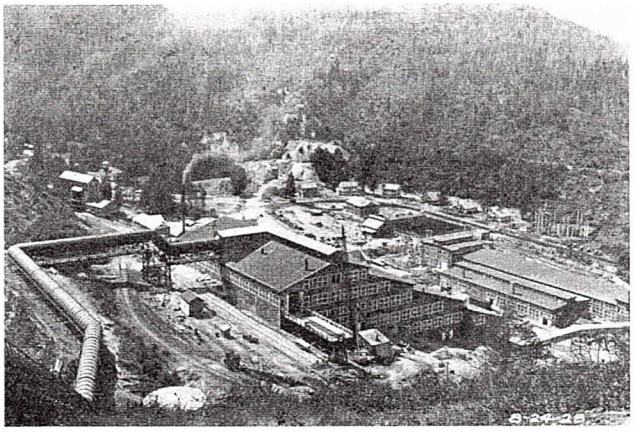


Figure 56–Zinc plant: Sullivan Mining Co. in *Annual report of the mining industry of Idaho.* (TN24.I2 A2, 1930, p. 44)

Bunker Hill & Sullivan began looking into building an electrolytic zinc plant by the 1910s. The company recruited U. C. Tainton, a metallurgist who had built a zinc pilot plant in California using high current density and a strong acid strength, a process that worked well with a variety of impurities. The company built the Sullivan zinc plant in 1928. It was the only one in the world that successfully operated on a high current density, strong acid basis. This plant produced high-purity zinc metal for zinc-base die casting alloys used in many industries, and for galvanizing sheet iron and iron wire. Over the years, the plant expanded and added new facilities, such as a cadmium plant that produced cadmium and copper as byproducts of the zinc recovery and a plant that produced marketable sulfuric acid. By 1972, the plant was producing over three hundred tons of zinc a day, and about half its concentrates came from mines that Bunker Hill did not own. A slag fuming plant built in 1943 recovered zinc in the blast furnace slag of the lead smelter. By 1963, the Bunker Hill Company was refining nearly 24 percent of special high-grade zinc and 20 percent of the primary refined lead in the United States.[236]

The Sunshine Mine in the Coeur d'Alenes began producing regularly in the late 1920s, and in 1931, a bonanza was found deep in the workings. As of 1937, the Sunshine Mine in the Coeur d'Alenes was the largest producer of silver in the world; by 1962, it had produced two hundred million ounces of silver. The ore from the Sunshine contained other metals such as copper, arsenic, and antimony that had to be removed before entering the lead smelter's system, so Bunker Hill built a dry ore plant in 1939 to pre-treat this "dry" ore and also converted a mill into an electrolytic antimony plant. The success at the Sunshine led other companies in the area to sink very deep shafts without prospecting,

and with such a deep development program, some of them found rich ore bodies. The Star Mine near Burke reached a depth of some 8,300 feet, making it in its time the deepest lead-zinc mine in the world.[237]

During the Depression the low metal prices of the 1930s caused the smaller producers in the Coeur d'Alenes to shut down or cut back on their operations. Only the Sunshine continued producing full time. Labor shortages made it difficult to produce during World War II, although the market for lead, zinc, and cadmium improved and the government paid a fixed price for silver between 1934 and 1963 that was twice the existing world price. The cadmium plant built by Bunker Hill in 1945 captured cadmium from baghouse dust, and this and the slag fuming plant that captured zinc sulfate helped offset production losses caused by the labor shortage. During the Korean War, however, area mines received record high prices for lead and zinc. From 1953 until 1962, lead and zinc prices declined, resulting in the closing of some of the area's base metal mines.[238]

By the early 1960s, the largest underground hoist in the world operated in the Bunker Hill mine, and fifteen giant fans pushed air throughout the extensive workings. Electric and air-operated slushers moved the broken ore from the face where it was drilled to the ore chute. Underground work at some of the mines in the Coeur d'Alenes, such as the Bunker Hill, had switched from waste-fill methods to a hydraulic sand-fill system. Underground cavities created by mining were backfilled by tailings; the rest went to tailings ponds. Another innovation being tested at this time was the replacement of timbered mine supports with precast reinforced concrete drift sets designed by the U.S. Bureau of Mines, University of Idaho, and Idaho mine operators.[239]

Copper Mines in Idaho

Idaho's copper deposits occur as mineralized shear zones, fissure veins, disseminated deposits (typically worked by open pit methods), and contact **metamorphic** masses. Most production has come from the latter. Many of the deposits are inaccessible, and many have low-grade, refractory ores and erratic occurrence.[240]

The new electrical and automotive industries of the early 1900s increased the nation's demand for copper. After World War I, however, prices for copper plummeted, and for two decades companies mined only the higher-grade ores. Copper was used to manufacture cartridge brass, and, therefore, considered one of the metals vital to the World War II effort.[241]

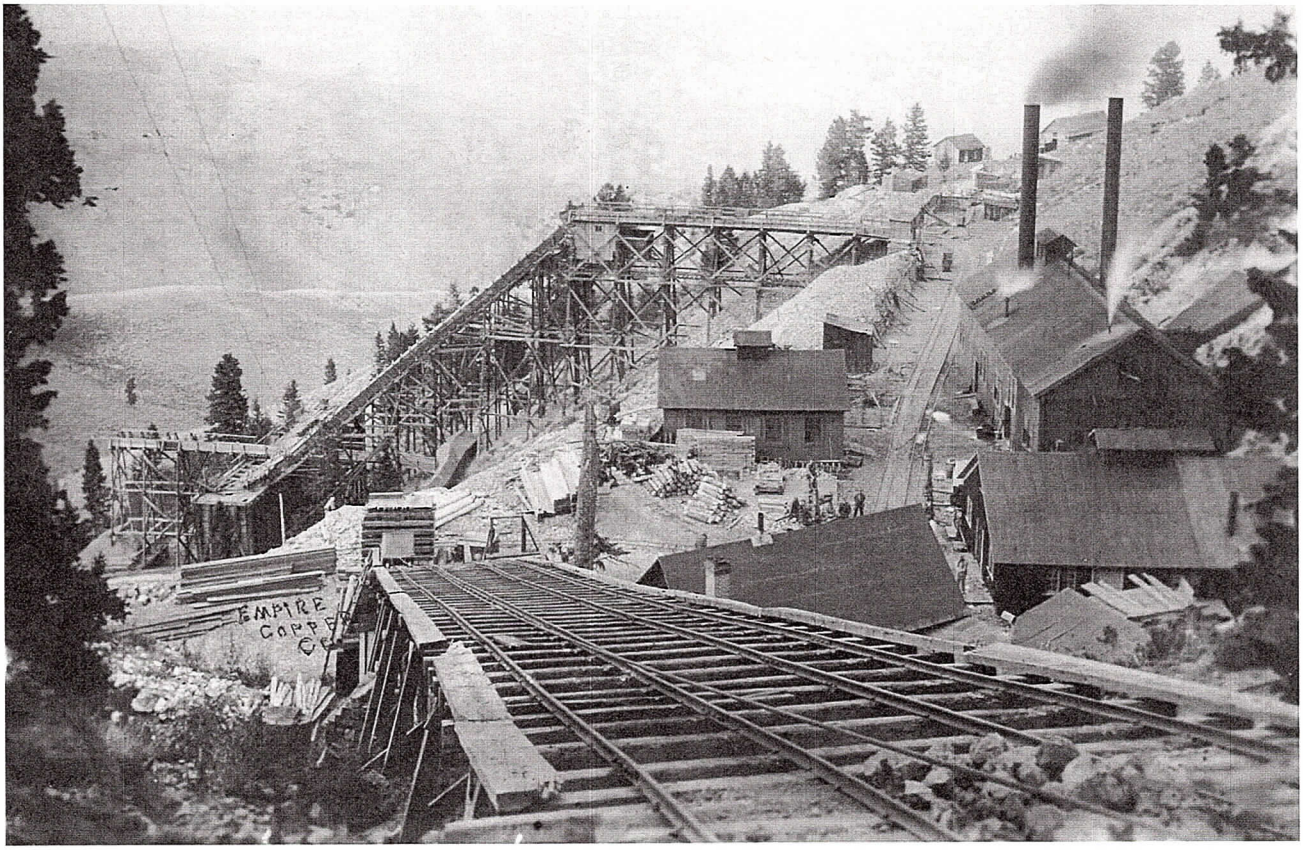


Figure 57–Empire Mine at White Knob. (ISHS 70-5.4 in Wells, *Gold Camps and Silver Cities*, p. 125, PARL: QE 103.B8 no. 22 1983)

Until 1907, almost all copper mined in the United States was obtained by underground methods. After open pit mining of low-grade ore on a large scale was demonstrated at a mine in Utah, the industry began to shift. Since World War II, almost all of the copper mines in the United States have been open pit operations. At the same time, the percentage of copper in low-grade deposits that were worked dropped from 5 to 2 percent or even lower. Since World War II, about eight major companies have produced around 75 percent of the copper mined in the United States.[242]

The production of copper in Idaho began around 1894, although little mining took place until 1911. About 65 percent of the copper was a byproduct of mining for other metals, primarily lead, zinc, and silver but also cobalt, gold, and tungsten. As of 1964, mines in the Coeur d'Alene district had yielded about 56 percent of the total copper in Idaho, with the exception of the Snowstorm Mine, which produced mainly copper. In 1904, a two-hundred-ton leaching plant was built to treat copper ore from the Snowstorm. Production peaked in the first two decades of the twentieth century. Alder Creek in Custer County (Empire Mine) and Blackbird in Lemhi County (Harmony and Pope-Shenon were the main producers) make up the other two relatively large copper-producing districts. These districts used overhead stoping as their main ore extraction method. Ore and concentrates were shipped to smelters in Utah and elsewhere. Other areas with some copper production included the Hoodoo and Volcano mining districts.[243] In the early 1900s, however, a few remote Idaho mining districts such as Yellow Jacket and the Lost Packer on Loon Creek imported copper blast furnaces, developed in Baltimore, to treat the ore.[244]

At first, copper was processed by crushing, grinding in ball mills and rod mills, and concentrating by gravity separation using jigs, tables, or vanners. The concentrate then was shipped to a smelter. But this process, used until shortly before World War I, only recovered about two-thirds of the copper values. A major breakthrough in the treatment of sulphide copper ores occurred in 1915 when froth flotation, which removed up to 93 percent of the copper in sulphide ore, replaced gravity concentration. Oxide ores were treated by leaching, a chemical process that usually involved sulfuric acid. In open pits, the ores were trucked to leaching dumps and treated by heap leaching in the dump or spread out and then treated.[245]

The Seven Devils copper deposits stretch for 120 miles in a band 2 to 40 miles wide. Although miners found copper lode deposits there in the early 1860s, for various reasons recovery efforts failed in the Seven Devils area over the ensuing decades. A smelter, built in response to the 1897 boom at the town of Cuprum, failed to work and the district closed down as a result of litigation among Montana investors in 1902. A cyanide mill built in the early 1900s shipped gold to the Denver mint until cyanide supplies from Germany were cut off due to World War I, which caused the mill to shut down. Copper companies that had pioneered large open pit mining in Utah considered moving into the Seven Devils, but their methods could not be used in the remote area. Even with the building of a new smelter at Landore in the early 1900s, and the construction of a bridge across the Snake River at the base of the Kleinschmidt grade (a twenty-two-mile road from the Peacock Mine down to the river), transportation



Figure 58–Hot blast pyritic copper furnace, Loon Creek, early 1900s in *Annual report of the mining industry of Idaho*. (TN24.I2 A2, 1905, p. 44)



Figure 59–Ladd Metal Company smelter, Landore, built 1904-1905. (ISHS 70-165.11 Mines–Seven Devils)

problems continued to deter large-scale mining in the area. The situation improved in more recent years, however, with the advent of open pit mining at the Silver King Mine.[246]

Rich copper ores were discovered in the Alder Creek district near Mackay in 1884. After spending about $3 million in unsuccessful development work, the mine finally did produce copper from 1905 until 1929, with some sporadic production through the late 1950s. The Empire Mine, with its approximately 120,000 feet of underground development, produced copper and byproduct gold. A 16,000-foot-long aerial tram located on a railroad siding conveyed ore from the mine to the mill. A spur line of the Oregon Short Line had reached Mackay in 1901, and soon a company-owned railroad served the Empire Mine. By the late 1910s, the ore went directly to a smelter in Utah instead of to the local smelter. Mines in this area helped Utah smelters recover copper ores by providing different ores than what the smelters could obtain elsewhere. In the 1920s, recovery at the Empire improved when the mine installed a 150-ton flotation plant.[247]

Base Metal Lode Mines in Idaho

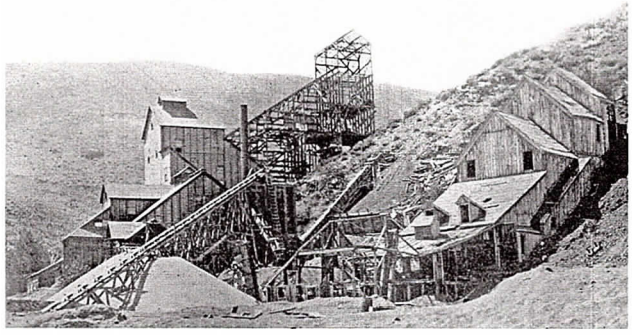


Figure 60–Minnie Moore mill, showing addition to mill in course of construction, Bellevue, Blaine Co. in *Annual report of the mining industry of Idaho.* (TN24.I2 A2, 1909, p. 29)

Precious metals produce bullion whose primary value is monetary. Base metals such as lead, zinc, and copper are needed to manufacture materials that support industry. Technological innovations, deep-pocket investors, and transportation improvements have largely determined the course of base metal mining in Idaho. The coming of railroads, which allowed shipping of ore to smelters, combined with improved technology for processing lead-silver ores, allowed Idaho's large-scale lead-silver-zinc operations to succeed and become the mainstay of the state's mining operations. As of 1880, Idaho's gold and silver lode mines, except for some very rich properties in the Silver City area, had not been profitably developed. Discoveries of silver-lead and silver-lead-zinc deposits along Wood River and in the Coeur d'Alenes in 1880 and 1884 redeemed the reputation of Idaho's lode mines and soon revolutionized Idaho's mining industry.[248]

The leading producer of lead since 1889 has been Shoshone County, followed by Blaine County with its significant lead production. Most lead-bearing ore contains some zinc. Very little zinc was recovered prior to 1905, however, because there was no market for it (in fact, smelters imposed a penalty on ores with a high concentration of zinc). Production grew dramatically during World War I as a result of an improved recovery process and a rise in price due to the use of zinc in shrapnel. By the 1950s, lead accounted for more than 40 percent of the value of the mineral output of the state. Silver production in Idaho peaked during World War I, the late 1930s (when the Sunshine Mine in the Coeur d'Alenes was brought into major production), and again in the late 1940s, due to production from the Galena and Lucky Friday mines in the Coeur d'Alenes.[249]

Silver-lead mining did not become important in Idaho until the late 1870s and early 1880s, when it took off in Wood River, Bay Horse, Clayton, and Nicholia (Blaine, Custer, and Lemhi counties). By then the Indian wars had ended and the effects of the panic of 1873 had lessened. Production from each of these central Idaho camps declined when many of the principal known ore shoots were exhausted (prior to the drop in the price of silver in 1893), but they revived after 1900.[250]

The discovery of lead-silver ores in Idaho began the state's rapid transition from isolated, small-scale mining to large-scale, capitalistic mining organized in a corporate form. Due to its low value per ton and need for complex smelting, silver-lead ore cannot be mined by modest operations. In the 1860s, Idaho miners had shipped rich ore to Swansea, Wales, for highly efficient smelting. When the United States began to build smelters, ores from Idaho territory were shipped to smelters in Utah, Colorado, the Pacific Coast, and other areas. Soon, Idaho mines producing large quantities of ores that were otherwise difficult to concentrate, began to construct their own small smelters. After the 1869 construction of one in Pioneer City to handle silver galena ores, others followed, like the lead smelter built to process deposits of lead-silver ores at South Mountain in Owyhee County.[251]

As a result of a rush from the Coeur d'Alenes, Bonner County's first mining claims were filed in the



Figure 61–Bay Horse. (ISHS 63-132.18 Bay Horse–Views in *Gold Camps and Silver Cities*, p. 103 PARL: QE 103.B8 no. 22 1983)

1880s. This region's mines were not nearly as rich as those lead-silver deposits of the Coeur d'Alenes. The earliest mining probably occurred in the Lakeview district on the southern end of Lake Pend Oreille. Lead-silver, copper, zinc, and some gold (lode and placer) constituted the ore found in this area. The Weber Mine shipped silver ore from an open pit operation to a smelter in Tacoma in the 1950s and 1960s.[252]

Boundary County's main ore producer was the Idaho Continental Mine in the Priest Lake mining district. Developed by Alfred Klockmann starting in 1915, this mine yielded significant amounts of silver, which were shipped to the Bunker Hill & Sullivan smelter.[253]

The following discussion highlights a few of the most productive and well-known base metal mining districts in Idaho. This is an overview; not all significant districts are mentioned.

Bayhorse

Until 1880, Idaho miners showed little interest in mining for metals other than gold and silver. An exception was the effort to develop lead-silver mines at Bayhorse in Custer County. Sparked by the earlier, successful production of lead-silver ore in Eureka, Nevada, and Leadville, Colorado, most of the over $10 million worth of ore produced at Bayhorse between 1877 and 1888 came from oxidized, high-grade silver-lead ore.[254] A smelter that used some of the lead contained in the ore was built in the district in 1880, along with charcoal kilns to produce the necessary fuel for smelting (**coke** was also used). The operations declined in the late 1880s due to a decline in silver prices and the importation of cheaper Mexican lead. In later years, sulphide rather than oxidized ores yielded some silver and lead. The demand for zinc during World War II revived the district, but later mining in the 1950s and 1960s was not successful.[255]

Wood River

Prospectors fanning out from Rocky Bar, Yankee Fork, the Sawtooth, and other mining areas in 1879 made rich strikes on the Wood River. A rush soon developed, fueled by improved smelting techniques and the anticipated coming of a railroad to the area. The main mine was the Minnie Moore. Within a year, several local smelters were processing the district's rich lead-silver ores. In 1882, one of the smelters put in Idaho's first electric light plant, and residents also enjoyed Idaho's earliest phone service. A branch of the Oregon Short Line was built into Hailey and Ketchum in 1883 even before the railroad had completed its main

line from Wyoming westward to the Boise Valley and Oregon. Coke brought in by railroad from Pennsylvania allowed roasting prior to smelting, reducing the costs of smelting. The smelted ore was then further refined out of state.[256]

By the summer of 1883, perhaps four thousand people lived along the Wood River. The silver boom ended in 1887 just a few years after it had started. Labor troubles over wages, the seasonal operation of the Philadelphia smelter and its inability to handle low-grade ores with a variety of impurities, the exhaustion of known ore shoots, and the 1893 drop in the price of silver, all contributed to the decline. Some of the district's major mines were allowed to fill with water.[257] The center of mining activity in Idaho had already moved northward to the Coeur d'Alenes.

The Triumph Mine was located in the early 1880s, but major production from its refractory ores did not begin there until 1927. After much testing to find the best way to separate the lead and zinc, the mine owners settled on selective flotation, the method that finally allowed profitable production. Beginning in 1939, the Triumph was worked as a single operating unit with two other mines, Independence and North Star. The Triumph continued to produce during World War II (due to the importance of lead and zinc to the defense effort) and to ship its concentrates, high-grade ores, and middlings to smelters. By 1949, total development of the Triumph Mine had reached over one hundred thousand feet. By the time it closed in 1957, the Triumph had produced an estimated $40 million, more than the product of all the early Wood River properties combined.[258]

Lemhi County Lead-Silver Mines

The rich lead ore of the Viola Mine in the Birch Creek Valley was discovered in 1881. A smelter was built in the mid-1880s, and a long aerial tramway connected the mine and the smelter. The hundred-ton smelter required a great deal of charcoal and coke for fuel. The charcoal was produced locally in beehive kilns, but the coke was brought in from Pennsylvania. The smelter closed down in 1887 when the ore from the Viola was exhausted. During this period, the Viola produced a high percentage of all the lead being mined in the United States.[259]

After the closure of the smelter, mining at nearby Gilmore did not become practical until the arrival of the Gilmore & Pittsburgh Railroad from Armstead, Montana, in 1910. Then Gilmore ranked as Idaho's largest lead-silver area outside of the Coeur d'Alenes until 1929, when Pittsburgh investors in area mines convinced the Northern Pacific Railroad to build the branch line. The rail line suffered because mining along its route did not boom as anticipated and because of competition from automobiles, trucks, and lower freight rates offered by competitors. The last train on the 120-mile line ran in 1940. The line operated at a deficit throughout its existence.[260]

Strategic Metals Mining in Idaho

During World War II, the federal government identified several metals as strategic and sought domestic sources. The government assigned production quotas to base metal mines based on 1941 production, with premiums paid for excess production. Idaho became a significant and even leading producer of a number of these metals, such as tungsten, mercury, antimony, and cobalt. The U.S. Bureau of Mines and the U.S. Geological Survey immediately began encouraging exploration, development, and mining of the nation's reserves of strategic metals. The U.S. Bureau of Mines conducted metallurgical research and testing of domestic ores to determine their adaptability to commercial processes. As of 1943, the U.S. Bureau of Mines and the U.S. Geological Survey had conducted extensive diamond drilling prospecting for strategic metals around the nation, which resulted in the discovery of large antimony and tungsten deposits in Idaho's Valley and Idaho counties. Labor and supply shortages and transportation difficulties hindered some operations, so the government enacted price subsidies and furloughed soldiers for mine labor. A stockpiling program established in 1946 was aimed at ensuring adequate supplies of strategic and critical minerals for national defense; this provided a good market for these metals for some Idaho mines.[261]

Some common metals mined in Idaho were also important in defense. Copper and zinc, for example, were significant ingredients of cartridge brass. Lead, valued during World War I for shrapnel, by World War II was more in demand for storage batteries, cable, paint, solder, and plumbing goods.[262]

Strategic-Metals Mining Districts in Idaho

The following discussion highlights a few of the most productive and well-known strategic-metal mining districts in Idaho. This is an overview; not all significant districts are mentioned.

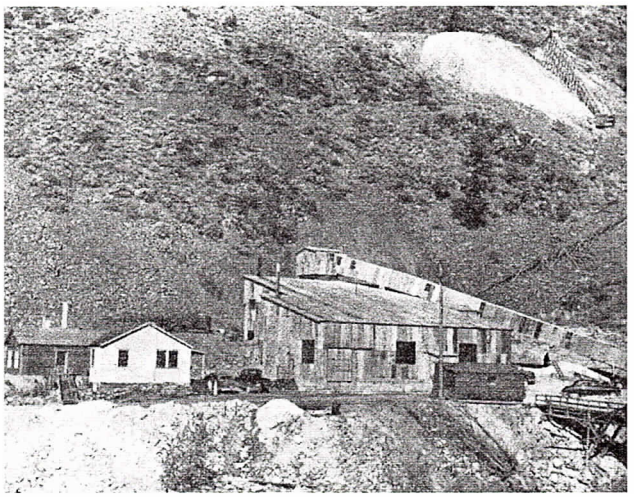


Figure 62–Office and Milling Plant of the Ima Mine, Blue Wing District, Lemhi County, Idaho, in *Annual report of the mining industry of Idaho.* (TN24.I2 A2, 1949, p. 166)

Tungsten and Antimony

Tungsten's strategic value lies in its melting point, which is higher than that of any other metal. Primarily utilized in forming alloys for steels for cutting tools and in tungsten carbide, in World War II tungsten was used in armor-piercing shells and in the filaments of lamps, radios, radar, and x-ray tubes. Tungsten occurs in the minerals called scheelite and hubnerite. The known deposits in Idaho are scattered over a broad area in or near the southern part of the Idaho Batholith. In Warren and Murray and other areas of Idaho, tungsten often hampered gold recovery in sluice boxes and on amalgamation plates. In the 1940s and 1950s, after the development of new technologies and markets, Idaho was one of the leading tungsten-producing states. Between 1942 and 1944, Idaho produced 40 percent of domestic tungsten; the Ima Mine in Lemhi County and the Yellow Pine tungsten ore body in Valley County (discovered as a result of diamond drilling by the U.S. Bureau of Mines in 1941) were the two principal sources.[263]

The Ima Mine produced tungsten concentrates before and during World War I, but shut down when the war ended due to declining prices. At that time, jigs and Wilfley tables in the mill obtained only a 25 percent recovery. In early 1945, the Bradley Mining Company took over the Ima Mine and developed it into one of the nation's largest producers, with byproducts of silver, lead, and copper. The mine recovered tungsten and a pyritic silver concentrate through gravity concentration, flotation, and magnetic-separation units in the 1940s, with an 85 percent recovery.[264]

Used primarily to harden and strengthen lead alloys, antimony's wartime applications include bullets, shrapnel, bearings, storage batteries, and flame-proof fabrics. Most of the domestically produced antimony comes from Idaho's Wood River region and the Coeur d'Alene and Clark Fork districts in Idaho, where it is recovered as a byproduct from complex ores containing lead, silver, zinc, and copper. Stibnite, an antimony sulphide, is found in some districts, including the Yellow Pine area, which contains the largest known stibnite deposit in the nation. Antimony production at Yellow Pine began in 1932, and it remained the main producer in the United States until 1952. In fact, during World War II, Yellow Pine produced 95 percent of the antimony mined in the U.S. Since then, almost all antimony produced in Idaho is a byproduct from ores treated by the Sunshine Mining Company plant near Kellogg. This company developed a process for producing a high-purity antimony metal from the complex antimony-silver ores of the Coeur d'Alene dry belt.[265]

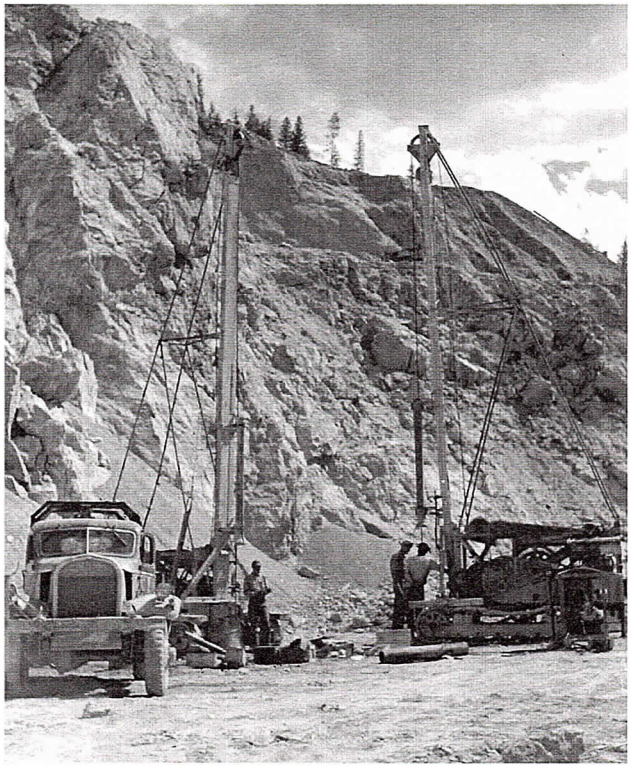


Figure 63–Wagon drill on bench at Bradley Mine open pit, Stibnite, antimony ore in quartz. (ISHS 63-160.169)

The discovery of ore deposits at Stibnite in Valley County–gold, antimony, mercury, tungsten, and silver–occurred during the Thunder Mountain rush in the early 1900s, but the isolated area was slow to develop. The production of gold and antimony there commenced on a large scale in 1932, after the Bradley Mining Company of San Francisco bought the properties (F. W. Bradley was president of the Bunker Hill

& Sullivan Mining Company). In 1938, the company began large-scale open pit mining in conjunction with its underground operations, and in 1943, it converted completely to open pit operations. In 1944, after Bradley Mining started working its important tungsten deposits, the selective flotation mill was expanded to process 750 tons per day of tungsten or antimony concentrates. The company built a smelter in 1948. Twenty-six huge pipes condensed the antimony concentrate from gas back into a fine powder that was packed in drums or bags, then shipped to an out-of-state refinery.[266]

Total yields from Stibnite for the twenty years between 1932 and 1952 totalled $53 million. The tungsten ore body was exhausted in 1945 and the re-treatment of old tailings was completed that year. Later, the company established open-pit operations, using power shovels, tracks, and trucks to mine benches thirty feet in height; dynamite, placed in holes bored by churn and wagon drills, to blast away walls of rock; and a pump to force water diverted from the East Fork of the South Fork of the Salmon River, from the open pit into a timbered diversion tunnel.[267]

As Yellow Pine mine's company town, Stibnite provided some 160 low-cost company houses. The facilities included a recreation hall, a school, and a hospital; the mercantile was owned by employees. At one time, over one thousand people lived in Stibnite.[268] The Yellow Pine property closed down in 1952 when the domestic price of antimony fell below the cost of production. During the 1950s, government-guaranteed prices for tungsten stimulated prospecting and led to the discovery of new deposits. Besides Stibnite, properties in Custer, Shoshone, and other counties also produced tungsten.[269]

The first claims on the Hermada antimony deposit in Elmore County were staked in 1947. Like the Yellow Pine property, the Hermada Mine was originally worked by adits and other underground workings, but these were abandoned in favor of open-pit mining. The ore was stripped and mostly mined with a bulldozer, then broken either by a bulldozer or by blasting, and finally, hand sorted and hand loaded into trucks. Most of the ore was concentrated at the nearby Atlanta plant of Talache Mines, a flotation mill. Fines and low-grade ore were mixed with waste and pushed into a dump.[270]

Mercury

The chief ore containing mercury is cinnabar; the metal's extraction is obtained by roasting the sulphide ore and then condensing it in very pure form from the escaping vapor. The liquid is processed in a hoeing machine and filtered before it is bottled.[271]

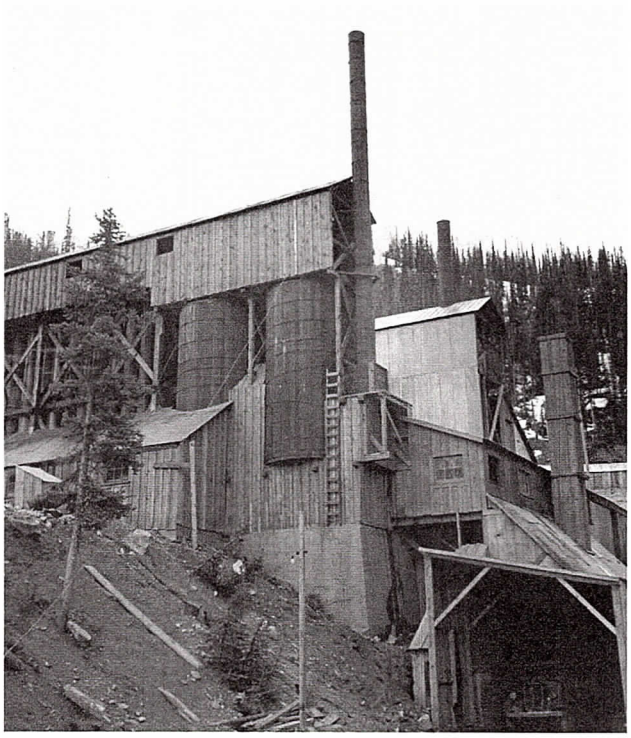


Figure 64–Plant with rotary furnaces at Hermes Mine, 1943. (ISHS 62-191.1 Mines–Stibnite (Hermes Mine) Hermes mercury furnace plan, 1943 Donor: Ernest Oberbillig)

In war time, the price of mercury typically increases because the value of a **flask**–seventy-six pounds of liquid mercury equals one unit of trade–is generally linked to the price established by production from mines in Spain and Italy. Typically used in thermometers, dental fillings, ultraviolet lights, and electrical apparatus, throughout World Wars I and II, mercury was a major constituent in detonators for explosives. The first small recovery of mercury in Idaho was made during World War I, and years of production followed from 1939-1948 and from 1951-1961. Idaho's deposits occur in the eastern part of Valley County's Yellow Pine district (the Hermes Mine), and the Idaho-Almaden Mines in Washington County near Weiser has also produced some mercury.

The Idaho-Almaden deposit was discovered around 1936. L. K. Requa and his associates leased the claims and explored by trenching, sinking shallow shafts, and drifting. Most of the mining was done by open pit, and in the early years the ore was mucked, sorted, and trammed by hand. Some mining was done underground by room-and-pillar stoping based on the ratio of overburden to ore. After a large amount of low-grade ore had been developed, in 1955 the owners installed a 150-ton rotary furnace, the largest of its kind in the United States. The mercury was condensed in steel

pipes, and the gases were cleaned as they passed through redwood-stave tanks to a stack. The mine roasted about twenty-five tons of ore to fill each flask. From then until 1961, when the ore was exhausted, the open pit mine ranked as one of the major domestic producers.[272]

Some flasks of mercury were shipped from the cinnabar deposits in Yellow Pine during World War I, but the district's Hermes Mine came into its own during World War II, when it was the second largest mercury producer in the United States. Owner J. J. Oberbillig spent the 1920s consolidating claims and blocking out ore. In 1927, F. W. Bradley took over. His company brought in heavy machinery on the backs of mules. By 1929, trucks had reached the remote area, and in 1930 a small landing field had been cleared. The United Mercury Company took over in 1939, and built bunkhouses, cookhouse, cottages, blacksmith shop, framing shed, warehouses, a post office, assay office, sawmill, and school to house sixty employees. The company installed two seventy-five-ton rotary furnaces in 1941, and in 1958 built a flotation plant with leaching tanks and electrolytic deposition equipment at the Hermes Mine. The mine shut down in 1948 but reopened during the Korean War.[273]

Cobalt

Idaho is one of the few cobalt-producing areas of the United States. This metal, used in manufacturing chemical catalysts and steel alloys, was recognized in the Blackbird mining district in Lemhi County prior to 1900. Although a small amount was produced in 1918, due to the high expense of separating cobalt from copper, the Blackbird mine's high elevation, and strong foreign competition, not much cobalt mining occurred in Idaho until the 1940, when a war-related search for cobalt deposits recognized the Blackbird district's potential.

In 1943, the Howe Sound Company diamond drilled in Blackbird and began active underground exploration. The company built a six-hundred-ton concentrator that used differential flotation to produce cobalt and copper concentrates and gold. Howe Sound also built a company town called Cobalt about nine miles from the mine. In the 1950s, the Blackbird district produced nearly fourteen million pounds of cobalt and, also, significant amounts of copper and gold. The concentrates were shipped to a smelter and refinery in Utah. The district's Calera Mine closed in 1960 upon the termination of a government contract to purchase cobalt.[274] One other Idaho source–the Coeur d'Alene district's electrolytic zinc plant in Kellogg–produced cobalt as a byproduct of its operation.[275]

Manganese

The production of high-strength steel requires manganese as an alloying metal; it is also used in the production of cell batteries and in the chemical industry. The United States has relied heavily on imported manganese ore. The metal was first found in Idaho in 1919. Although the state does not produce much of this ore, some production occurred in the mid-1920s near Cleveland in southeastern Idaho. Most of Idaho's manganese comes from this area and from Lava Hot Springs. Other deposits are found in Shoshone, Lemhi, Owyhee, and Washington counties. In the 1950s, the U.S. government began a stockpiling program and offered premium prices for manganese ore. A buying depot in Butte, Montana, accepted low-grade ore. These measures to encourage the expansion of domestic manganese mining stimulated production in Idaho to some extent, particularly in Adams, Bannock, and Butte counties.[276]

Minerals Found in Black Sands

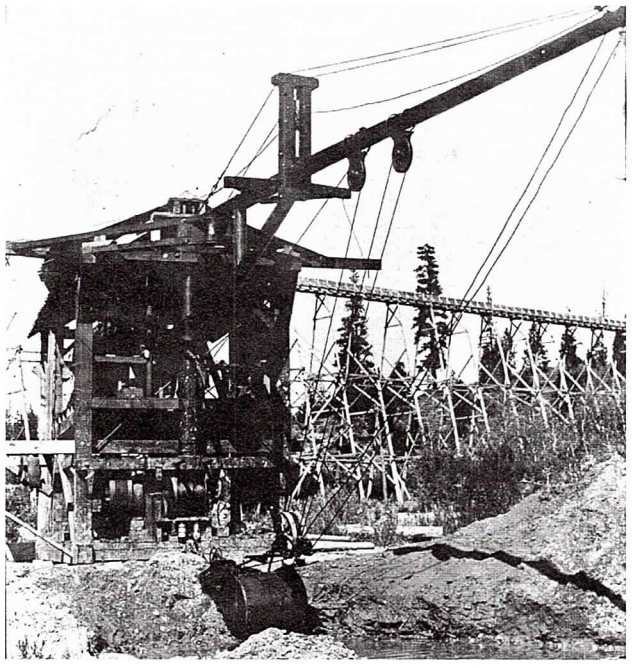


Figure 65–Monazite plant of the Centerville Mining & Milling Company. (ISHS P1994.4.22 Subject: Mines (Boise Basin) Centerville Mining & Milling Company monazite plant in Lewis Gulch Source: Henry M. Atkinson)

Black sands are heavy sand minerals found in placer deposits, many of them previously worked for gold. In Idaho, the only black sand minerals considered economically significant as of the late 1950s were monazite (a rare-earth phosphate containing thorium, a radioactive metallic element), ilmenite (titanium), complex columbium-tantalum-uranium minerals,

and other uranium-thorium minerals. Monazite from placer deposits is one of the main sources of commercial thorium and rare earths produced in the United States. The deposits are without value unless they have been concentrated into commercial-sized black sand placers. The interest in these metals came from their applications in nuclear energy and in high-temperature metallurgical applications such as the space program. Prices for monazite rose after 1951, at which time placer deposits in Idaho and Florida met the demand. Idaho areas that were dredged for monazite included the Boise Basin (where monazite was a byproduct of gold dredging), Bear Valley, Warren, Ruby Meadows north of McCall, and the Long Valley south of Cascade.[277]

Between 1949 and 1955, the U.S. Bureau of Mines conducted a survey of radioactive placer minerals in Idaho, funded by the Atomic Energy Commission. The Commission also stimulated uranium production by offering discovery and development bonuses. This led to a uranium mining boom that continued until 1958. People in Idaho and other western states prospected for radioactive materials with Geiger counters. First found in Idaho in 1920, the first uranium ore was shipped in 1955 from a deposit south of Salmon. Uranium mines in Custer County east of Stanley produced in the late 1950s. At least sixteen radioactive minerals were identified in various Idaho locations in both placer and lode deposits.[278]

Dredging at Bear Valley in Valley County between 1953 and 1959 produced $12.5 million in columbium (niobium), tantalum, uranium, and some monazite. This dredging of Bear Valley initiated the first exploitation in the world of placer deposits primarily for the recovery of radioactive blacks. In some years, these placers supplied almost the entire domestic production of niobium and tantalum. A plant in Lowman treated euxenite concentrates from the Bear Valley by electrostatic and electromagnetic processes. Minerals were separated by being passed over electrically charged rotating drums or belts (based on their conductivity) or by passing through a strong magnetic field (based on their magnetic susceptibility).[279]

From 1950 until 1955, dredging for monazite occurred in the Long Valley area of Valley County after India put an embargo on its exports of the rare-earth mineral. The operation closed down, however, due to an unfavorable market for monazite. The monazite, ilmenite, garnet, and zircon was separated at the Baumhoff-Marshall plant in Boise. In 1956, several thousand tons of **stockpiled** ilmenite were retreated, cleaned, and shipped to market. The production of monazite and byproducts yielded about $3.5 million.[280]

Exploration of thorite rare-earth deposits in the Lemhi Pass region was done mostly by bulldozer in 1956. The black sand placer deposits of thorium and rare earths may exceed that of the lode deposits, however.[281]

The classification of beryl as a strategic metal comes both from the strong, hard, fatigue-resistant alloy it makes when combined with copper and from its use in nuclear reactors. Idaho has only a few known deposits of this metal, and by 1963 the state had produced only one ton at most from a deposit in Latah County.[282]

ENVIRONMENTAL EFFECTS OF METAL MINING IN IDAHO

The environmental effects of mining in Idaho vary widely. Many have been discussed in other sections of this report. The progressive nature of mining–working and reworking a site as new technology and new uses for metals developed–altered the natural landscape. Trails and roads were constructed to access mines and mills. Residents of mining communities hunted and fished intensively. The forests surrounding mines were clear-cut to supply mine timbers, fuelwood, and charcoal-producing operations. Dams and ditch systems changed existing water flow patterns. Hydraulic mining resulted in steep cutbanks at the washing pits and huge volumes of tailings downstream. Dredging churned up the ground and left behind windrows of tailings and artificial ponds. The working of underground lode mines left identifiable openings in the ground and waste rock dumps ranging from small to extensive. Milling operations left behind tailings on-site and often much farther downstream. Water drained from mines polluted streams and rivers. Open pit mines created gaping holes in the earth and large piles of overburden. Smelter sites, marked by slag piles, sent toxic fumes containing sulfur dioxide and heavy metal particulates into the air and polluted the areas located downwind.

The examination of one district, the Coeur d'Alene mills, sheds light on the effects mining methods and technology had on the surrounding landscape over an eighty-year period. By the early 1900s, the environmental effects of tailings disposal from Coeur d'Alene mills had become an important issue. At that time, the mills discharged over four thousand tons of tailings into the South Fork of the Coeur d'Alene River and

its tributaries daily. These tailings were either coarse and had relatively low values in lead and silver, or they were fine with relatively high values in lead and silver. Coarse tailings tended to settle quickly near their deposit site, but fine tailings were readily swept away downstream. Sometimes railroads hauled coarse tailings away and used them for ballast under tracks and ties.[283]



Figure 66–Mining in Murray in 1880s. (ISHS #609 Mining)

The introduction of flotation, however, led to much finer tailings starting in the early 1910s. Nearly all mill feed was ground to a fineness suitable for flotation. These tailings were thus carried much farther downstream, often forming tailings bars on river bottom land and smothering farmland. Flotation plants were established just to re-treat tailings behind dams and on dumps. After running through flotation cells, these fine tailings also were discharged and carried away in the streams. Changes in the kinds of ores exploited also affected the tailings. Because concentrators could not make perfect separation, tailings carried lead, silver, zinc, copper, tungsten, and antimony along with the gangue, ranging in size from small pebbles to extremely fine powder. The mills have dumped an estimated seventy-two tons of tailings containing heavy metals and toxic chemicals into the South Fork of the Coeur d'Alene River.[284]

Downstream farmers began complaining that the tailings were toxic to livestock and vegetation as early as the 1890s. In the early 1900s, they took their case, without success, to the state and U.S. district courts. The Mine Owners Association responded in several ways. They built three dams designed to control the tailings. Unfortunately, flooding in later years washed tailings over the dams into the lower valley and Lake Coeur d'Alene. The mining companies opposed the farmers in court and hired detectives to spy on them, but they also established a joint fund to make financial payments for damages or to purchase land or pollution easements, eventually buying over eleven thousand acres of land. By the late 1920s, it had become a political controversy, and the Idaho legislature became involved along with several federal agencies. Due to renewed pressure, the mining companies built dikes along the Coeur d'Alene River and established a suction dredge below Cataldo Mission. The dredged tailings were deposited on the Mission Flats; by 1951, the tailings covered over two thousand acres at a depth of twenty-five to thirty feet. Some of these tailings were later re-milled by flotation for lead and zinc. Some were also used as roadbed for Interstate 90.[285]

In the 1950s, mining companies adopted a new method of removing tailings: pumping them back underground into the openings created by mining. Only about 58 percent of the tailings in a mill can be disposed of in this way because tailings take up more space than the original ore did. Tailings continued to enter streams and rivers until 1968, when mining companies began to build tailings ponds near the mills in anticipation of tightened environmental laws and regulations.[286]

Smelter fumes containing sulfur dioxide and heavy metal particulates have also been a problem downwind of the Bunker Hill smelter. The company chose Kellogg, with its small population, as its smelter location in 1917 partly to avoid litigation related to the fumes. Such problems are typical with smelters, and by the early 1900s, significant improvements in smelter technology had been developed that limited smoke pollution. Baghouses and taller smokestacks, for example, were introduced in the early 1900s, along with electrostatic precipitators that helped gases



Figure 67–Open-pit mine of Bradley Mining Company, Stibnite, 1949. (ISHS 62-191.5 Mines–Stibnite (Bradley Mine), April 24, 1949. Donor: Ernest Oberbillig)

diffuse. From the beginning, the Bunker Hill smelter, with its baghouse and electrostatic precipitators, was state-of-the-art. As extra insurance, the company bought smoke easements. The 1970 Clean Air Act and establishment of the Environmental Protection Agency marked the beginning of increased federal involvement with Bunker Hill.[287]

In 1973, a fire in the Bunker Hill smelter damaged the baghouse. The smelter continued operating for the next six months without repairs to the baghouse. This released the equivalent of eleven years of emissions. The Bunker Hill lead smelter shut down in 1981, partly due to a tighter EPA ambient air quality standard for lead enacted in 1980, and partly due to a drop in the prices of lead, silver, and zinc. Two years later, the Environmental Protection Agency designated twenty-one square miles surrounding the Bunker Hill Mine as one of the nation's largest Superfund clean-up sites.[288]

One kind of clean up to repair the damage that occurs at mining sites is revegetation. In some areas, prospectors and miners stripped the vegetation–either by hand, fire, ground sluicing, or hydraulicking–so they could locate or work mineral outcrops more easily. When considering revegetation in these areas to restore them, recent studies in the Mojave Desert indicate that soil age is the most important factor in determining the rate of recovery of vegetation at abandoned mining towns. At disturbed sites with young soils, fast-breeding, short-lived plants moved in first, growing a new layer of vegetation in an average of eighty years. These were followed by a mix of species, including longer-lived plants. Even at sites with relatively young soils, however, it can take several millennia for the original mix of plant species to return.[289] An example of revegetation in Idaho occurred when dredge operators in the Bear Valley replaced topsoil and reseeded it to produce pasture land after the state passed a dredge reclamation law in 1953 that required restoration of water courses after dredging and construction of settling ponds to avoid downstream damage.[290]

CONCLUSION

Idaho's mining industry had far-reaching effects on the development of the territory and the state. Without the gold rushes of the 1860s, Idaho's development would probably have remained limited to the transportation corridors established across the territory until the transcontinental railroads arrived in the 1880s.

The early gold and silver rushes pushed the Nez Perce, Shoshone and other Indian peoples who had lived in the area for generations out of their traditional homelands and onto small reservations with boundaries that were carefully drawn to exclude the known rich mining areas. The mining, fishing, hunting, grazing, and logging activities of Euroamerican settlers often destroyed the natural resources that had provided their sustenance, and the loss of homelands and traditional natural resources severely limited their options and threatened their survival.

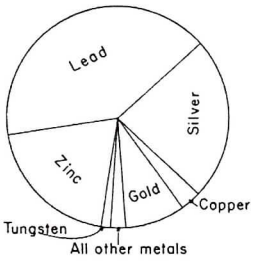


Figure 68–Percentage of production in Idaho, by metal. "Idaho's mineral production by commodities, 1861-1962" (USGS, Mineral and Water Resources, 17)

The millions of dollars in gold taken from Idaho's mining districts in the 1860s not only added to the national circulating medium at a time when the country suffered from an unfavorable international trade balance (due to the loss of cotton, its largest export), but also probably helped pay down the national debt. By the end of 1867, some $156 million in gold, with some silver from Owyhee, had been produced in the Pacific Northwest (Idaho, Montana, Washington, Oregon, and British Columbia).[291]

The major gold and silver rushes of the 1860s–Pierce, Florence, Silver City, and the Boise Basin–put Idaho on the map. Miners, merchants, professionals, packers, and adventurers came to this previously little-known region and participated in its growth. Some decided to stay, even after the placer or lode deposits of an area were no longer profitable to work. While a few people turned to ranching to support themselves, others continued small-scale mining operations, making a living from their properties and occasionally benefiting from later advances in technology and transportation.

The instant cities created by the early rushes created transportation and supply networks. Supplies came in from the West, the East, and the South. Towns along the Pacific Coast, the Columbia River, and later the transcontinental railroad lines benefited from the mining activities of Idaho. Material goods, people, bullion, and information traveled along these routes. The new mining camps of Idaho were almost immediately integrated into national economic life, bringing in standardized material culture and social organization. Financing came from local, national, and international sources. In short, Idaho was transformed from an isolated frontier economy to a capitalist economy that depended increasingly on industrial activities.

Railroads, critical to Idaho's mining industry and to its settlement, allowed cheaper and faster hauling of mine machinery and the shipment of ores to smelters and refineries. Besides connecting the mines, mills, and smelters to the world economic system, railroads also benefited farmers, ranchers, and loggers by providing transportation for agricultural and timber products. Railroad companies often built branch lines to serve productive mining districts, such as to Wood River or the Coeur d'Alenes. These, in turn, encouraged mining and agriculture.

Lode mining resulted in more stable communities than did placer mining. Lode deposits often took many years to deplete, instead of just a few short seasons, and their development required and helped pay for numerous improvements, such as roads and railroads, freighting and stagecoaching, logging, charcoal production, and machine shops. Large-scale industrial development created a far different economy than small-scale operations based on that of individual operators and loose partnerships. The more permanent settlements associated with lode mining tended to replace footloose entrepreneurs with wage workers, which in turn provided a more stable and dependable market for Idaho farmers and ranchers.

Hydraulic mining was one form of placer mining that sometimes lasted for many years. Much of Idaho's hydraulic mining of the 1870s and 1880s was done by Chinese miners. For many Chinese immigrants, the Idaho mines provided opportunities for a better life and a way to support their families back in China. In turn, the Chinese helped slow population loss by settling in mining districts that many Euroamericans had abandoned.

The boundaries of Idaho Territory and the selection of county seats were strongly influenced by mining. Idaho Territory was created March 4, 1863. Its boundaries were drawn to solve problems created by mining settlement of an extensive mountainous region.[292] Without the 1860s rushes creating administrative challenges, northern Idaho probably would

have remained part of Washington Territory, governed from distant Olympia. County seats in the early years were often relocated when one mining camp faded and another rose to prominence. The mining-related settlement of Idaho led to its admission to the Union as a state in 1890.

The base metal mines of Wood River, and particularly of the Coeur d'Alenes, changed the character of Idaho's industrial development. These lead-silver-zinc properties required large-scale investment and corporate, integrated development in order to be profitable. Miners, mine owners, and managers engaged in bitter labor disputes in a number of Idaho's mining districts. The ore remained rich at depth in many of the mines, leading to fantastic production. Profits from the rich mines of Shoshone County benefited investors outside of Idaho, particularly Spokane. The building of smelters in Idaho helped provide more efficient processing of the complex ores. Idaho pioneered a number of methods of extracting refractory ores and recovering their values. In the end, mining after 1900 produced more wealth than did all the efforts of the 1800s. But at the same time, agriculture replaced mining as Idaho's primary economic base.[293]

The national Depression of the 1930s combined with rising gold prices to attract many small-scale gold prospectors and miners to Idaho's old mining camps. This influx of population probably helped stabilize state and county revenues. During this period, too, the Civilian Conservation Corps and other federal programs built roads on state and federal lands, many of them greatly improving access to mining districts.

Historic Value of Metal Production for Idaho, 1860-1980
Cumulative Totals by Mining Area

Atlanta	$ 16,000,000	Miller's Camp-Secesh	500,000
Banner	3,000,000	Mineral City	800,000
Bay Horse-Clayton	42,000,000	Muldoon	200,000
Bear Valley	12,800,000	Neal	2,000,000
Big Creek	400,000	Newsome-Golden	2,940,000
Blackbird (Cobalt)	49,000,000	Orogrande	640,000
Boise Basin	60,000,000	Owyhee	90,000,000
Boise Ridge	428,000	Palouse	340,000
Boise River	450,000	Patterson	10,000,000
Buffalo Hump	540,000	Pearl	400,000
Cariboo Mountain	1,200,000	Pend d'Oreille	2,000,000
Clark's Fork	2,500,000	Pierce	8,000,000
Coeur d'Alene	3,845,732,000*	Porthill	4,500,000
Deadwood	1,200,000	Rocky Bar-Pine	6,090,000
Dixie (South Fork Clearwater)	1,500,000	Salmon River Bars	2,500,000
Elk City	16,000,000	Seafoam-Greyhound	400,000
Era and Martin	400,000	Seven Devils-Heath	2,800,000
Florence	9,600,000	South Mountain	1,900,000
Germania-Livingston	650,000	Stanley	400,000
Gibbonsville	2,000,000	Stibnite	53,000,000
Gilmore	11,600,000	Thunder Mountain	500,000
Hailey Gold Belt	1,000,000	Ulysses	600,000
Leadore	300,000	Vienna-Sawtooth City	800,000
Leesburg	5,420,000	Viola	2,500,000
Lemhi	1,940,000	Warren	16,120,000
Little Lost River	2,000,000	Weiser Mercury	8,000,000
Little Smoky	1,200,000	Wood River	62,000,000
Long Valley	3,500,000	Yankee Fork	12,000,000
Loon Creek	1,200,000	Yellow Jacket	400,000
Mackay-Copper Basin	15,000,000		
Marshall Lake	2,000,000	TOTAL	4,402,890,000

*Value of metal production in the Coeur d'Alene mining district rose to $4.2 billion by the end of 1982.

Many of these totals are based largely upon reliable sources (usually Bureau of Mines or other governmental compilations), but some are of unknown accuracy. Most lode and dredge production figures are reliable, and almost all Idaho metal production is of those kinds. Less than 2% of the total production of $4,402,890,000 are from sources of uncertain accuracy. This table must be used with great caution, since mineral prices – even for gold – varied greatly over the century the figures cover. Inflation has weighted the period since 1940 very heavily. Gold and silver prices after 1976 have fluctuated ten or twenty times as much. Boise Basin's gold values, for example, recently have risen to more than one or two billion dollars. Other major gold districts (Elk City, Florence, Leesburg, Pierce, Rocky Bar, Warren and Yankee Fork) have increased similarly. Silver prices have varied much more. Assignment of smelting values and federal support prices also affects some of these totals (such as Blackbird) to a marked degree.

Figure 69–Table of Historic Value of Metal Production for Idaho, 1860-1980 from Wells, *Gold Camps and Silver Cities*, p. 160

During and after World War II, Idaho became the leading producer of certain strategic metals such as tungsten, antimony, mercury, and cobalt. Large dredging operations worked placer gravels in areas such as the Boise Basin and Yankee Fork. Open pit operations at Florida Mountain, Stibnite, and other areas have yielded significant amounts of precious metals. Modern mining equipment includes portable dredges and metal detectors. By 1970, Idaho's placer and lode mines had produced almost three billion dollars in metals. (See Figure 69 for estimated values up to 1980.) Over 80 percent of this total came from the Coeur d'Alenes. Five other regions produced over $40 million each: Boise Basin, Wood River, Stibnite, Blackbird, and Owyhee. Eight others produced between $10 and $35 million: Atlanta, Bear Valley, Bayhorse, Florence, Gilmore, Mackay, Patterson, and Yankee Fork. The other major producers were Elk City, Leesburg, Pierce, Porthill, Rocky Bar, Warren, and the Idaho-Almaden mercury mine near Weiser.[294]

Mining has had a devastating impact on some of Idaho's landscapes. The effects are many and varied, ranging from logged-out drainages, intensive hunting and fishing, stream pollution from tailings and from water drained from mines, and air pollution from smelter fumes. Certain mining methods have reshaped the lands they have worked, particularly hydraulic mining, dredging, and open pit mining. In some areas, this environmental damage has had direct monetary costs that taxpayers and mining companies have had to finance, such as the cleaning up of a huge Superfund site in the Kellogg area.

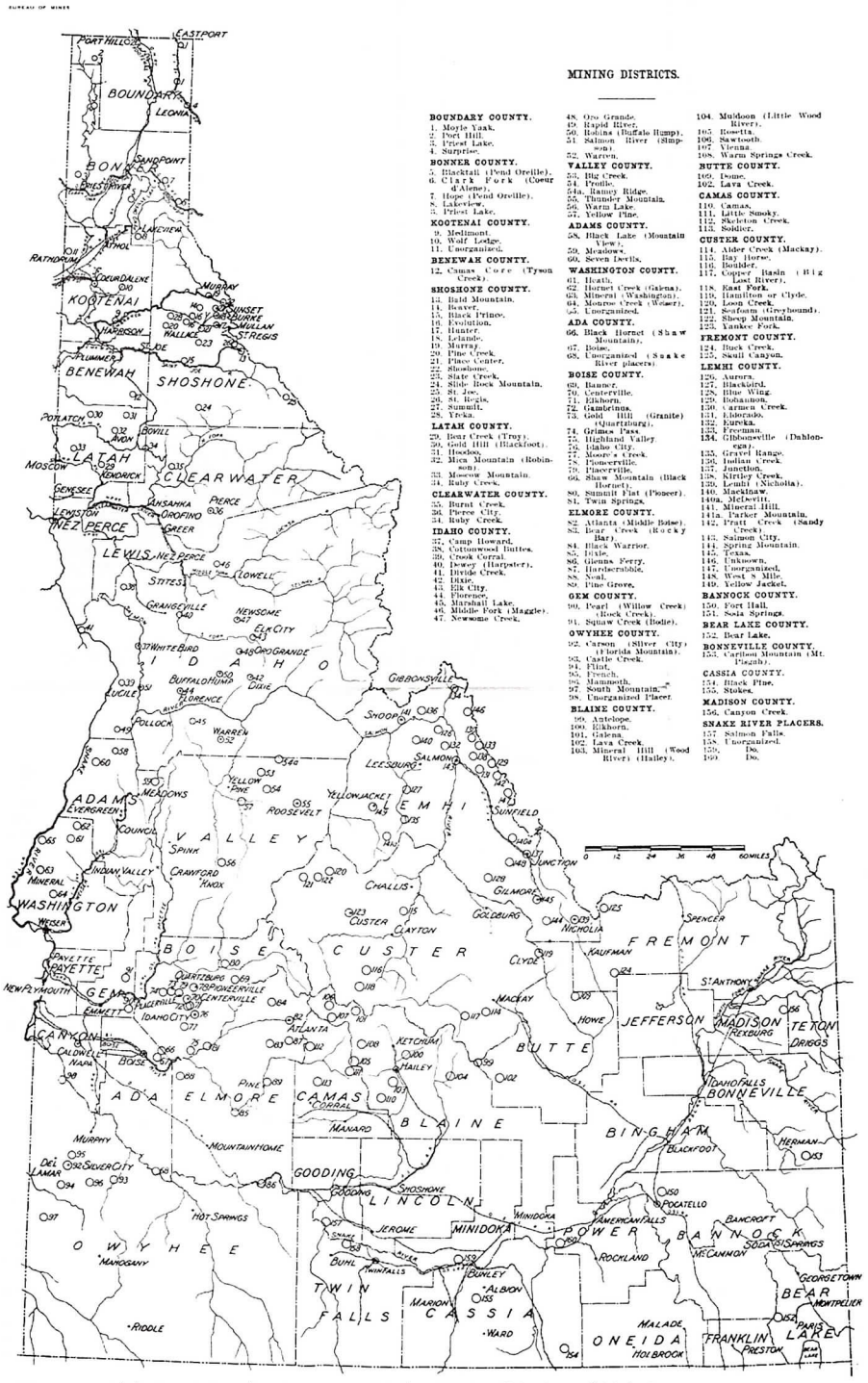


Figure 70–Idaho's mining districts, 1919. (Varley, Mining Districts of Idaho)

PROPERTY TYPES

The preceding section of this report developed a historic context for the theme of metal mining in Idaho, 1860-1960. This section defines property types related to the context and outlines the integrity and significance requirements for the various property types. It also summarizes some of the sites recorded to date in Idaho, provides possible research questions, identifies information gaps, and offers preliminary management recommendations.

The property types in this report have been developed using the standards set forth in National Register Bulletins 15, 16A, 16B, 30, 36, and 42, according to the regulations described in 36 CFR 800. Other regulations and guidance that inform this document include the National Historic Preservation Act, of 1966, as amended, the Secretary of the Interior's Standards for Historic Preservation Planning, and Idaho's 1998 *Comprehensive Historic Preservation Plan*.

This section does not address prehistoric or protohistoric sites. Nor does it discuss properties related to mining that can be evaluated and nominated according to standard practices such as communities that developed to support mining activities (other than company towns), mine union halls, farming and ranching sites that raised products for miners, or residences of significant mine owners/investors located away from the mines.

A historic district, as defined by the National Register, is an area with a significant concentration, linkage, or continuity of sites, buildings, structures, or objects that are linked historically by function, theme, or physical development or aesthetically by plan or physical development. The properties are usually contiguous. Industrial landscapes are geographical regions that have been used historically for industry and have been distinctively modified by industrial activities such as mining. Today, they reflect the cumulative impact of industrial land use and of the cultural traditions of the people working and living in the region. Generally, industrial mining landscapes are defined as historic districts for National Register nominations. The district includes the spaces between contributing and non-contributing elements. The boundaries should encompass but not exceed the full extent of the significant resources and land area making up the property.

A discontiguous district is composed of two or more definable significant areas separated by nonsignificant areas. The space between the elements is not related to the significance of the district, and visual continuity is not a factor in the significance. This applies to many mining properties. For example, several lode mines and a mill that were operated by one company may form a historic district even though they are not physically adjacent to each other.

A contributing site, district, building, structure, or object adds to the historical associations, historic architectural qualities, or archaeological values for which a property or historic district is significant. A noncontributing site, district, building, structure, or object does not. A contributing resource has the following characteristics:

- It was present during the period of time that the property achieved its significance.
- It relates to the documented significance of the property.
- It possesses historical integrity or is capable of yielding important information relevant to the significance of the property.

The administrative unit known as a mining district defined the political, legal, economic, and social activity of the area during the historic period. Miners created mining districts to serve as ad hoc official units of administration. Many had relatively well-defined boundaries, although they tended to be somewhat fluid as conditions changed over the years. These boundaries have legal, political, social, technological, and environmental meaning. The mining district may include a settlement network that defines a regional community, a legal organization that regulates mining claims, and distinctive geological characteristics and ore deposits. It is sometimes appropriate to use historic mining districts to define National Register historic districts, if this is practical (some are quite large), particularly when the historic context ties in well with this boundary. In other cases, selecting boundaries based on topography, such as watersheds, may be more practical.[295]

MINING LANDSCAPES

Mining landscapes is a broad category that can include any of the property types listed in the following sections. Historic mining properties generally can be considered rural historic landscapes. These are geographical areas that have been shaped by historic human activity and that have tangible features resulting from historic human use. They document mining-related environmental change that took place over time periods ranging from a few days to decades. They may range in size from small, well-defined locations (for example, along a creek drainage) to regions that cover square miles. Mining landscapes are vernacular rather than designed, and they contain substantial areas of vegetation, open space, or natural features that embody significant historical values. Buildings, industrial structures, objects, and archaeological sites may also be present. Mining landscapes have been shaped by prospecting and exploration; development; production and processing; and decline. Each of these stages may have been repeated several times as new technology was developed or new ore bodies were discovered. The components of landscapes are often arranged in a pattern that minimizes haulage of ores and other materials.



Figure 71–Gold Hill had placer as well as lode mining. (ISHS 00.0442/A Mines–Morgan Hill Group–Gold Hill Wells, *Gold Camps and Silver Cities*, p. 11)

The National Register defines a number of landscape characteristics. These processes and physical components are helpful in describing and evaluating historic landscapes, as discussed in National Register Bulletin 30. The landscape characteristics, with mining-related examples of each in parentheses, are:

- Land uses and activities (hydraulic mining)
- Patterns of spatial organization (linear residential area)
- Response to the natural environment (mill building constructed on a hillside)
- Cultural traditions (stacked boulders at a hydraulic mining site)
- Circulation networks (wagon road)
- Boundary demarcations (**claim marker**)
- Vegetation related to land use (secondary growth on waste rock dumps)
- Buildings, structures, and objects (cyanide mill)
- Clusters of features (group of buildings near mine shaft)
- Archaeological sites (foundation and other remains of a bunkhouse)
- Small-scale elements (tail race)

Some mining landscapes may qualify individually for listing in the National Register; others will contribute to the significance of a historic district. Most mining landscapes should be classified as historic districts, but landscapes that are small in size and have no standing buildings or structures are classified as sites.

Viewing mining areas as historic landscapes emphasizes the systems and patterns they represent. Since mining landscapes are visually complex and have evolved over time, it is helpful to map them on a large scale. Landscapes for each time period need to be reconstructed in order to document variability and change in landscape process and components. Historical images such as photographs and maps combined with an analysis of the archaeological record can help reconstruct the different episodes of mining or milling activity at a site. They also help analyze relationships between individual objects, working and living areas, transportation systems, mines and mills, and natural features.

DEFINITIONS OF PROPERTY TYPES

Property types link the historic context to the actual physical remains that illustrate that context. The property type of a particular feature needs to be understood before its integrity and National Register eligibility can be evaluated. The property types described below represent the historic context "Mining Idaho's History: Metal Mining in Idaho, 1860-1960." Note that mining-related properties may also be significant under other historic contexts besides mining.

Property types associated with mining in Idaho are categorized in this report by their association with historic activities. The broad categories are: Mineral Exploration Resources, Placer Mining Resources, Resources Associated with Extraction at Lode Mines, Ore Beneficiation Resources, Industrial Support Resources, Residential Resources, and Transportation Resources.

Some researchers differentiate mining property types based on whether a property was a subsistence or an industrial mining operation. This report does not do so. Sites that appear industrial in scale today were often worked most recently at a subsistence level, and almost all large-scale operations began as properties managed by individual entrepreneurs. Features from earlier periods may remain, making the distinction less than clear-cut. It does not work well to take a "moment in time" approach to a site that has evolved over time. Distinctions between scales of operations can be a very helpful component of research questions, however, such as ones that explore at which point industrial operations became nucleated or at which point subsistence mines became industrial.

The examples given in the following sections are intended as general guidelines only. The characteristics of specific properties may result in evaluations that differ from the examples. Unique or rare resources are not described in great detail here because information related to such resources will be developed and provided when that resource is recorded and evaluated.

The property types presented in this report are designed to represent different aspects of mining processes and to lend themselves to groupings in a database of mining-related sites and in National Register nominations. These property types will probably be amended and new ones will be added as more sites are inventoried and evaluated and as new interpretations are made. Additional information on the processes related to these property types, such as the operation of a dredge, may be found in the historic context.

Ideally researchers would evaluate feature systems using an interdisciplinary approach blending history, archaeology, engineering, and anthropology in order to construct the most accurate image of mining in Idaho. Documentary research and the preparation of a local historic context should be completed before the field inventory is undertaken. This allows a good research design to be developed for guiding the fieldwork.

Mining districts are characterized by cycles of occupation and abandonment. These cycles create layers of feature systems, with each layer composed of one or more feature systems from the same time period. Site components are often separated horizontally rather than vertically. Buildings are often moved or torn down when abandoned, and the next occupation occurs elsewhere. Mining camps tend to be separated into geographical clusters of many property types, each representing a different time period or component. Some features such as mills, however, may have overlapping layers of additions and changes in process that are evident in one location or building. Many features may be greatly altered by the cycles of activity.

Once the inventory has been completed, several mining site locations that retain their historic associations with one another may be combined with transportation and residential property types in a given geographical area to form a historic district. Or, a Multiple Property Documentation form may be developed for particular types of mining properties in Idaho, such as company towns associated with mines, mills, or smelters, or dredging-related sites, or placer mining sites in a particular drainage, which may have a thematic relationship. This form documents a group of significant properties linked by a common historic context but spatially separate. Individual properties and historic districts associated with the context are nominated on a National Register Registration Form. Linear resources such as historic roads are often submitted as multiple property nominations because extant segments are listed rather than entire routes. This type of nomination helps when additional properties are anticipated to be nominated at a later date.

The concept of feature systems provides a helpful analytical framework for interpreting a site. Feature systems are the association of several related feature groups that represent a distinct human activity during the same time period (a site, on the other hand, may represent more than one time period and contain several feature systems). Feature systems once worked

together to extract ore and to recover its values, and the system should be kept in mind when evaluating what today appears to be disconnected and geographically isolated buildings, machinery, landforms, and archaeological features.

The property types listed below focus on individual features and groups of features. Since mining-related property types are generally part of larger systems that all originated in the same human activity, it is best to think in broad terms and processes and to combine related properties and property types into larger subsystems and systems. This process adds meaning to the group as a whole. In other words, do not evaluate a single feature such as a ditch in isolation; assess all its associated features. A small lode mine may have many individual features, such as a shaft, collapsed adits, a log cabin, remains of a blacksmith shop, waste rock dump, an ore bin, ore car tracks, and an internal road and trail network. All should be evaluated as components of a system. Prepare a site plan and a flow diagram in order to understand what remains and what is missing. The full system may be defined as a mining landscape.

CAUTION: ***Many of the property types discussed in the following sections may present obvious or hidden dangers when encountered in the field.*** For example, the underground workings at abandoned lode mines generally are flooded, collapsed, and hazardous and, thus, cannot be seen or recorded. Other hazards in the field might include unstable adit or shaft openings, subsidences, unstable highwalls, dilapidated structures, abandoned equipment, and acid mine drainage.

Property Type Associated Mining Function

Adit ..... Extraction at lode mines
aerial tramway ..... Extraction at lode mines
Airstrip ..... Transportation
assay office ..... Industrial support
blacksmith shop ..... Industrial support
Bridge ..... Transportation
company town ..... Residential
concentrating machinery ..... Ore beneficiation and refining
ditch/flume/pipeline /penstock ..... Industrial support
Draglines ..... Placer mining
Dredging ..... Placer mining
drift mining ..... Placer mining
garden/orchard ..... Residential
ground sluicing and booming ..... Placer mining
hoisting machinery ..... Extraction at lode mines
hydraulic mining ..... Placer mining
Incline ..... Extraction at lode mines
leach dump ..... Extraction at lode mines
mill site ..... Ore beneficiation and refining
mill tailings, tailings pond, and dam ..... Ore beneficiation and refining
ore bin ..... Extraction at lode mines
ore car tramway ..... Extraction at lode mines
Outhouse ..... Residential
powder magazine ..... Industrial support
power plant ..... Industrial support
railroad (internal) ..... Transportation
railroad (long haul) ..... Transportation
Refinery ..... Ore beneficiation and refining
reservoir/dam ..... Industrial support
Residence ..... Residential
river bar mining ..... Placer mining
river mining ..... Placer mining
road (internal) ..... Transportation
road (long haul) ..... Transportation
Sawmill ..... Industrial support
Shaft ..... Extraction at lode mines
slag pile ..... Ore beneficiation and refining
sorting and sampling shed ... Extraction at lode mines
sorting, crushing, and classifying machinery ..... Ore beneficiation and refining
stable/barn ..... Transportation
surface mine ..... Extraction at lode mines
telephone and telegraph lines ..... Industrial support
traditional hand methods ..... Placer mining
Trail ..... Transportation
trash dump ..... Residential
ventilating and pumping machinery ..... Extraction at lode mines
waste rock dump ..... Extraction at lode mines
way station/rest area ..... Transportation

Property Types: Mining Resources

The following discussion of the resource categories related to mining in Idaho classifies and gives examples of the various features and suggests what part of the features that may remain today. This is not an exhaustive list, but a guide to the types of resource or features that may be found in the areas mentioned. **Many of Idaho's mines had both placer and lode deposits and, thus, were worked by several different methods of mining. Such sites may be quite internally complex and may reflect several periods of occupation and features related to different methods of mining.**

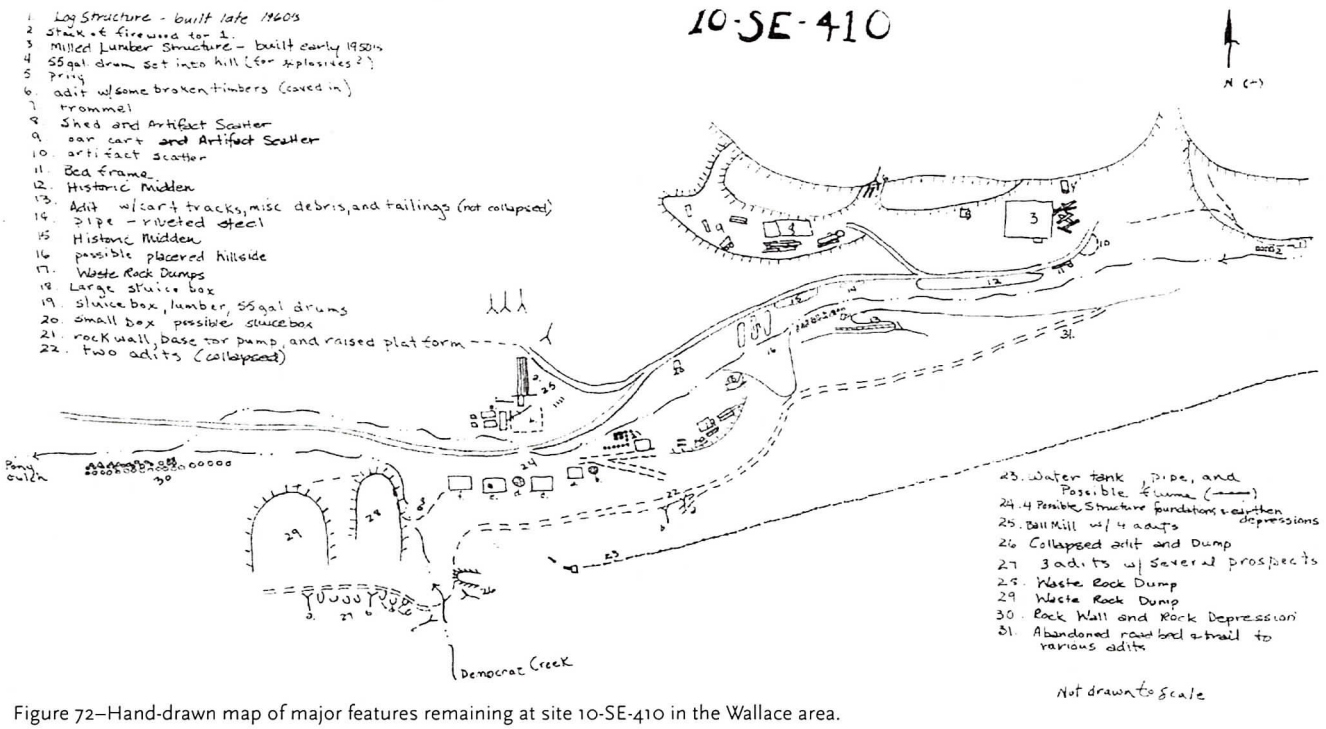


Figure 72–Hand-drawn map of major features remaining at site 10-SE-410 in the Wallace area.

Mineral Exploration Resources

This property type includes both prospecting and exploration resources. Prospecting refers to searching for placer or ore deposits. Exploration involves outlining the deposit to determine its value and extent.

Many of Idaho's lode mines have had much surface work done on veins but no actual production. Unless there is a deep shaft with a large waste rock dump and two or more adits, the mine probably did not produce and the surface remains reflect development work only.

Features related to underground exploration generally are no longer visible due to unsafe conditions. If the underground workings are accessible, however, drifts driven along the vein to explore for other ore bodies can be considered exploratory features, although they are also an integral part of the extraction process.

Hand-dug prospect pit, trench, adit, or drift

Hand-dug prospect pits and trenches are abundant in Idaho's mining districts. They are associated with both prospecting and exploration activities. At placer mines, pits and trenches may be found across streambeds or on benches high above creeks. Prospectors of a placer deposit might appraise the gravel's worth by excavating a series of prospect pits down to bedrock on a grid across the entire alluvial terrace. Small exploratory adits and drifts also fall into this property type.

Hand-dug circular prospect pits can be difficult to differentiate in the field from depressions caused by fallen trees or holes dug by relic collectors. It may also be difficult to differentiate between exploration work and extractive work just from the physical remains.

Prospectors generally dug trenches at right angles to the strike to find the width of the vein. A trench dug along the strike indicates a search for better values along the length of the deposit. A long, deep cut or trench along the vein with little waste rock on the surface indicates that ore was probably removed either from the surface or by mining upward from underground workings.[296]

An example of exploratory features is site 10-SE-1155. The site consists of a shaft with log shoring and three shallow prospect pits dating from approximately 1900. The features were dug as part of the exploration of copper deposits along the Bitterroot Divide, and the claim was patented but apparently did not produce.

Machine-dug prospect pit or trench: The purpose of these pits and trenches is the same as for hand-dug pits and trenches. The only difference is that mechanical excavating equipment such as bulldozers and backhoes were used to make the excavations. These features tend to be larger than their hand-dug counterparts, and they may be as deep as fifteen feet. Septic tank diggers can dig shafts several feet in diameter in relatively soft ground; drilling and blasting is required for hard rock, with removal of broken material by buckets hoisted by windlass, winch, or power take-off on a tractor or truck.

Claim marker

Locators of placer and lode claims marked the corners of their claims with posts, blazed trees, stone cairns, or other means. A location notice posted at a conspicuous place on the claim contained the name or names of the locators, date of location, a statement

of the legal subdivisions embraced in the claim, or a description of the claim boundaries by metes and bounds with reference to a corner of an existing survey or to a natural object or permanent monument that could be identified readily. Claim markers recorded at Idaho mining sites include stone monuments and hewn posts with tobacco tins nailed to the top (e.g., 10-BY-259). (See Fig. 4)

Other

Other features related to prospecting and exploration include hillsides stripped of vegetation in order to aid in prospecting. This was done by hand, fire, ground sluicing, or hydraulicking. Moveable tools associated with prospecting and exploration that may be found include gold pans, picks, long-handled shovels, sluice box sections, rockers, wooden buckets and windlasses, brooms, pry bars, churn drills, or unrecovered drill hole casings. At diamond drilling sites, a smear of light-colored mud may be seen flowing down a hillside. This is the ground-up material known as sludge that is carried to the surface and left in a pit (mud sump), which may overflow.

For prospecting to a depth of fifteen feet or so, hand-dug pits or shafts usually were sufficient (sometimes the shafts would have to be timbered). For deeper testing, portable **churn drills** in gravel and diamond drills in hard rock were generally used.[297] Drill holes made by the various types of drills are an exploration feature. Diamond drills create holes 1-3 inches in diameter; rotary drills 4-15 inches in diameter; and percussion drills 2.5-6 inches in diameter. Associated features include discarded drill cores or piles of drill cuttings left on site. Large ore deposits that were not mined may still show a square, rectangular, triangular, or row pattern of drill holes.

PLACER MINING RESOURCES

Cultural resources associated with placer mining in Idaho cover a wide variety of features, including those associated with traditional hand methods, ground sluicing and booming, hydraulicking, river mining, and dredging. Placer mining surface equipment was often moved along a creek and then abandoned miles from where it was first used. Many of Idaho's placer mining deposits were worked by hand methods, then by hydraulicking, and later by dredges. Each of these methods tends to obscure the remains of earlier activities. Any placer-related artifacts from the pre-1890s period, when supplies were sometimes difficult to obtain, would most likely be constructed on-site of local materials.

Many mines recorded in Idaho had both placer and lode deposits and, thus, were worked by several different methods of mining. Such sites may be quite complex and may reflect several different periods of occupation and features related to different mining methods. For example, site 10-SE-410 in the Wallace area (see Fig. 72), mined from the late 1880s to the present, has thirty-one major features, including sluice boxes, steel pipe, a water tank, a ball mill, adits, possible remains of a stamp mill, dredge tailings, and artifact scatters. Sometimes all or parts of the remains of placer mining are buried under waste rock dumps from lode mining activity, such as at the Jacobs Gulch Mine/Lower Nottingham Mine (sites 10-OE-5312 and 10-OE-3675). Ironically, some of this site now lies under a modern collecting pond.



Figure 73–Remains of washing plant at New Florence. (ISHS 2758 Mining Machinery–New Florence, Idaho. Washing plant.)

It is sometimes possible to determine the relative chronological ordering of different tailings types. The age can be judged by the growth of trees and other vegetation on the tailings and by their association with dateable artifacts. Little information can be recovered by subsurface excavation of tailings. Their value lies in the recognizable configurations that reflect the methods used to work a particular area of ground.

The physical characteristics of alluvial tailings resulting from placer mining are affected by topography, mining method, human experience, nature of the substrate, position of the paystreak, hydraulic factors, and

depth of overburden. Fine-grained deposits are generally washed away. Ground with many boulders and cobbles led to piles of stacked rocks in various arrangements.[298]

Water conveyance systems, almost always an integral component of placer mining sites, are described in the category of **Industrial Support Resources**.

Traditional hand methods

Traditional hand methods of placer mining include the use of rockers, long toms, and sluice boxes. Some sites, particularly those that were worked in the 1930s or later, may still have wooden remains of rockers, sluice boxes, manufactured gold-recovery machines of the 1930s, and components such as grizzlies and trestles. Sluicing resulted in low, parallel lines of gravels and cobbles. The finer debris from sluicing often accumulated in circular or elongated mounds several feet high and long. Associated tools might include horse-drawn scrapers (for tailings disposal), shovels, pitchforks, picks, carpentry tools, and hand tools for cleaning exposed bedrock such as stiff brushes and hand scrapers.

Often, the only evidence of early placering is scattered, low mounds of cobbles and gravel perhaps one to three feet high and an unnatural, hummocky appearance to the ground. This is often obscured by vegetation.

Few recorded sites in Idaho are good examples of traditional hand placering methods. Some, such as site 10-CW-254, have remains of sluice boxes that probably dated from the 1930s or 1940s. Napias Creek in the Leesburg area and Baboon Gulch near Florence show evidence of hand methods.

Drift mining

Placers buried under deep overburden were sometimes worked by adits and shafts in a method known as drift mining. The underground workings were usually timbered. Windlasses or derricks brought the gravel to the surface. Drift mining used traditional methods such as sluice boxes to work the gravels that were removed by drifting. The Boise Basin had the most extensive drifting operations in Idaho in the 1860s.[299]

Sometimes the remains of drift mining can be seen, but often there is little surface evidence. The most prominent surface features are the mine entrance, hoisting mechanisms, and tailing piles, along with associated remains such as a blacksmith shop, carpenter shop, engine house, or sawmill. Documentary or physical evidence that gravels were washed in quantity is necessary to justify identifying a collapsed shaft with drift mining rather than exploratory works. An example of a drift mine is the Myrtle Placer (site 10-SE-677) in the Delta area. The miners drifted under the twenty-foot-deep overburden, timbered the workings with cedar posts, and used a windlass to haul the gravels out of the shaft in hundred-pound metal carbide barrels.

Ground sluicing and booming

Ground sluicing eliminated much of the hand labor excavating gravels and transporting gravels to sluices and was very productive in districts such as Leesburg. The remains of ground sluicing and booming include windrows of boulders and trenches in which the overburden was washed away down to bedrock. Booming operations can be identified by a dam with an automatic gate, along with other components associated with ground sluicing. Relatively few ground sluicing sites have been identified in Idaho to date. The Moore Gulch Chinese Mining Site (site 10-CW-159) near Pierce has ground sluices and other placer mining features dating from 1870-1895, including ditches, dams, tailings, a blacksmithing area, various mining-related artifacts, and a trash dump. The Hoodoo mining district also has remains of ground sluicing at various sites. Features related to booming have been identified at a few sites, such as site 10-SE-910, a hydraulic mining area in Shoshone County.

Hydraulic mining

Hydraulic mining came to most of Idaho's mining districts within a few years of the discovery of gold. Hydraulicking was used as early as 1863 in the Boise Basin, where elaborate ditch systems supplied the water. The terraces in the Boise Basin were situated up to three or four hundred feet above the streams and were as much as two hundred feet deep and half a mile wide. These were extensively worked by hydraulic methods and remained productive through the 1890s. While the water was available, hydraulicking continued day and night. The terraces were later reworked by dredging and large-scale hydraulicking. Extensive use of hydraulicking came relatively late to other areas such as Silver City.[300]

Hydraulic mining deeply scarred and eroded the landscape. Evidence of this activity on the land includes the steep, "finned" cutbanks or vertical cliffs typical of this method of working placer deposits. Hydraulic washing pits vary greatly in size and shape, but they generally have a scalloped, semi-circular concave shape at the headwall. Tailings that washed out the end of the sluice box often form overlapping fans. (see "tailings" in glossary) Use of a hydraulic elevator resulted in characteristic deep holes and low rounded mounds of tailings. Waste cobbles, generally hand-stacked in parallel walls

to the side of the sluice and tailings, were washed out from the end of the sluice box. The tailings from one season's work were often deposited in the pit from the previous season. Two or more floor levels within a washing pit may indicate several seasons of work or safety precautions on a steep hillside.

Associated features include remains of sluice boxes, ditches, flumes, other water conveyance features, derricks, stone boats, pieces of rubber boots, remains of elevators or stackers, bedrock drainage tunnels to nearby streams or ravines for deposition of tailings, and wooden monitor supports. Remains of hydraulic piping may be found, typically metal pipes and nozzles, but occasionally pieces of canvas hose. Revegetation is most rapid in the bottom of hydraulic pits and less so on the steep slopes of the pits, which are often eroded. Twentieth-century hydraulic mining sites sometimes were worked by mechanized earth movers such as scrapers, power shovels, and bulldozers. These operations may have left behind broken and discarded pieces of machinery (rollers, track plates), fuel drums, fan-shaped overburden piles, and excavations and tailings piles with push patterns and blade marks.

Today, neatly stacked rows of rocks at hydraulic sites are sometimes referred to as "Chinese walls." This is misleading, since both Asians and Europeans created such walls to store large amounts of rock without interfering with the sluicing operation or to reinforce an exposed cutbank. The ethnic origins of stacked tailings cannot be determined by the rock configuration alone; diagnostic Chinese artifacts or primary historical documentation provide more definite evidence of Asian mining at a particular site.[301]

Many hydraulic mining sites have been recorded in Idaho. The Buffalo Hill placers (site 10-IH-655) and the Pioneer Placer (site 10-IH-2331) outside of Elk City include dramatic features such as high cutbanks as well as ditches, stacks of rocks, and tailings. Some hydraulic mining sites are located on terraces above the Salmon River. The Boulder Creek drainage in Boundary County has sites 10-BY-198, 10-BY-248, 10-BY-401, and 10-BY-27, which together comprise the Idaho Gold and Ruby ditch, main hydraulic washing pit, remains of a steam shovel, and main camp and lode mine. The hydraulicking there occurred between 1909 and the 1920s. This large-scale operation included a five-mile ditch dug by a steam-powered shovel that measured twenty-one feet wide and six to eight feet deep, twenty miles of road, phone line, lode claims, large bedrock flume, spillway, machine shop, sawmill, planing mill, overhead cable system, and company town with thirty-five residences. An unusual feature at this complex is a poured concrete headrace in Boulder Creek that directed water to the company's flume.

River mining

River mining altered the landscape greatly by diverting rivers away from areas that were being worked. After the operations were completed, the rivers usually returned to their original beds, thus destroying most of the evidence of the river mining. Remains include extensive flumes, tunnels, and canals that were used to turn the streams, and large stacks of boulders (as high as twenty feet), and holes in the bed of the river as deep as twenty-five feet.[302]

Dredging

Dredging peaked in Idaho in 1902, when ten were in operation at one time; declined in the 1910s; and then peaked again after the price of gold increased in 1934. Since 1911, most of Idaho's placer gold has come from dredging operations. More than fifty dredges have operated in Idaho over the years, processing gravels from the Boise Basin to Yankee Fork to Elk City to Delta. The use of churn drilling to test proposed dredging grounds began in the 1890s. Some areas, like the Boise Basin, had deposits that were ideally suited to dredging–abundant water; absence of large boulders, clay, and cement; and soft, easily cleaned bedrock. As a result, dredges worked the Boise Basin off and on from 1898 into the 1950s.[303] After World War II, dredges were again a familiar sight in some districts, some even reworking the same gravels processed by earlier dredges that had shorter bucket lines. By the late 1950s, large-scale dredging operations in Idaho were concentrated in Bear Valley (rare earths) and Elk City (gold). Higher labor and operating costs, the working out of the dredge grounds, and the lack of markets for rare earths such as monazite soon shut down these operations, however.

Large floating dredges left many marks on the landscape that are often still visible today. These include tailings in the form of tall, orderly windrows of coarse gravel and rocks covering fine gravels, clay, and sand. These typically have a serrated pattern composed of a continuous series of arc-shaped ridges, usually arranged in a series of nearly parallel ridges and valleys. (see "tailings" in glossary) Dredge ponds are often still evident, as are flumes and ditches if water had to be conveyed to the site to create the pond. Piles of overburden moved by mechanized equipment may be seen, along with test holes, anchorages for dredge mooring cables, discarded pieces of machinery, and tracks cut to facilitate fueling the dredge. If not needed elsewhere,

dredges were often stripped and abandoned after a deposit had been exhausted, and many sites still have their remains, including hulls, dredge motors, booms, buckets, hoppers, trommels, sluices, and tailings stacker. Buildings associated with dredging operations include machine shops, retort buildings, assay shops, bunkhouses, cookhouses, dwellings, and tent pads.

The best dredging ground was usually in broad, relatively flat river valleys. Dredging destroyed the original stream course, shifting the channel and often dividing it into multiple smaller channels. Some new lakes and ponds formed by dredging are still evident today. Revegetation generally occurs first in the low areas between the rows of gravel, especially around the margins of the dredge ponds. The ponds may fill with sediments. Reclamation of dredging sites, required by law since the 1950s, has obscured or obliterated some of these landforms. Many dredge tailings piles extend along Napias Creek in the Leesburg area. These average forty to fifty feet in diameter and twenty-five to thirty feet high. Probably one of Idaho's best dredging-related complexes is located at Yankee Fork. The remains date from 1940 until 1952 and include the dredge camp, dredge camp sawmill, log cabins, and the dredge itself (site 10-CR-1001), which was donated to the Challis National Forest in 1967.

Dragline

Most dragline operations included a tractor with bulldozer, trucks, a portable pumping unit for bringing water to the pond, a blacksmith shop, and a welding outfit for replacing bucket teeth. Dragline operations had floating washing plants that were almost identical to those on bucket-line dredges. Remains of all of these features may be found today. The overburden removed in a dragline operation is generally stacked in two parallel rows of conical piles on either side of the streambed. The tailings are segregated by rocks and sands and are deposited between the rows. In more random operations, overlapping conical piles are evident. The remains of a dragline operation dating from the late 1930s or the 1950s, visible at site 10-CW-350, include a wooden sluice box and a trash dump. Site 10-CW-380 has a large dragline bucket, conical tailings along Moose Creek, and collapsed structural remains.



Figure 74–Abandoned steam-powered dragline dredging equipment, n.d. (ISHS 2756 (McKay, Florence, p. 145))

River bar mining

Placer gold deposits were found along the Snake and Salmon rivers in Idaho, both in the sands of river bars and in higher bench gravels. Gold recovery techniques ranged from rocking and traditional sluicing to directing water from ditches and flumes in order to wash gravels into sluice boxes or other recovery apparatus. The Snake River plain extends four hundred miles across southern Idaho from Montana to Oregon, cutting a deep canyon across the state. Placers along the Snake River near Shoshone Falls were known as early as 1855, but they were not worked extensively until after 1869, a low-water year that allowed systematic prospecting of the channel. Gold was found in many other stretches of the river the following year, leading to a influx of miners. These placers were advantageously located near the stage road connecting Kelton, Utah, with Boise. Small communities were established along sixty miles of the river, and many Chinese moved in to work the deposits. Some mining of widely scattered alluvial deposits was also done farther downstream in Hells Canyon. As much as 100,000 ounces of fine gold may have been recovered from the Snake River.[304]

Both Chinese and Euroamerican miners worked the bars of the Salmon River during the 1870s and 1880s. By 1890, most of the richest deposits had been worked out by hand and hydraulic methods, and placering on the river declined. It picked up again during the depressions of 1893 and the 1930s; men worked abandoned claims along the river as a way to make money during hard times.[305]

Along the Snake and Salmon rivers, evidence of placer mining and associated dwellings has been found at many of the river bars. Features include stacked cobbles, dugouts, building foundations, household artifacts, trash dumps, cabin foundations, hydraulic cutbanks and pits, mining equipment, rectangular rock structures, adits, shafts, remains of burlap sluice boxes, and water conveyance systems. Features associated only

with this type of mining (as opposed to features such as cutbanks, which are associated with hydraulicking) are uncommon. The remains of houseboats and other types of boats used by miners are an example.

Much of the evidence of river bar mining, such as piles of cobbles, has been washed away by high water (site 10-IH-109, for example, has parallel rock walls that extend to just above the high water line). Some former placer mining areas, such as Horse Island on the Snake River, are now submerged beneath hydro-electric reservoirs. A survey of Chinese mining sites along sixteen miles of the Snake River identified perhaps sixty individual rock wall sites, including the well-preserved Mon Chu site (site 10-JE-95). The Lower Salmon River Archaeological District is about fifty-one miles long and includes many historic archaeological sites, mostly remains of placer mining.

Resources Associated with Extraction at Lode Mines

The locations of mineralized faults determined much of the development of Idaho's mining districts after the initial placer-mining boom. Lode mine workings follow or intersect underground veins by means of shafts, tunnels, adits, and other openings. Unlike placer deposits, which generally follow stream channels, lode deposits may extend away from creek bottoms and even into adjacent drainages.

Physical remains on the surface are often clustered together. Large-scale operations are often carefully designed to minimize ore handling between the working face and the mine opening and from there to the waste rock dump or mill. Features were often constructed on man-made terraces. Many smaller operations are more haphazard in arrangement and consist only of features related to ore extraction. If any ore was produced, it was transported by ore wagon or some other means to a mill or smelter located far from the mine itself. The hillsides around a lode mining area were often stripped of timber during the historic period to provide materials for mine timbers and building construction and fuel for mine machinery and other uses.



Figure 75–Shaft and associated buildings at Ruby Creek Mine near Bovill, ca. 1933. (ISHS 2820)

Building remains at lode mines are typically foundations or depressions, remains of log buildings now only a few logs high, or collapsed remains of buildings. Other remains may include corrugated galvanized iron siding (used on many buildings by about 1900 due to its strength, durability, low cost, and ability to be reused), and board-and-batten siding and double-board siding. Sometimes the ingenious use of available building materials, such as flattened barrels and cans reused for siding, is evident. Forest fires and heavy snow in the winter have taken a toll on buildings at remote, high-elevation locations. Many buildings indicated on claim maps cannot be found on the ground today.

Shaft

Shafts are vertical or steeply inclined openings in the ground. The opening at the surface is known as the shaft collar. The shafts may be lined with timber (more recent shafts may be supported by pre-cast concrete frames or by steel), and a few still have ladders going down. Most shafts were driven to access underground workings, but some were driven only to provide ventilation to the workings. In an attempt to reconstruct the development of underground workings of a mine, one must use historic documentation, bearing in mind the likelihood of destruction or reworking of drifts, stopes, raises, and other features that occurred as the work progressed.

Adit

Adits, unlike shafts, are driven close to horizontal; the opening is known as the portal. Adits usually measure at least four feet wide and tall, and some were driven only to provide ventilation or drainage to the underground workings. Most adits found today are collapsed rather than open and often look like long, narrow trenches. The underground workings at abandoned lode mines generally are

flooded, collapsed, and hazardous, and thus cannot be seen or recorded. Occasionally a mine adit will be safe to enter, like the Sunnyside Mine at Thunder Mountain, which has a long adit in which historic graffiti still exists.

Tunnels

Similar in character to adits, tunnels are differentiated by having two openings to the outside, one at each end. A relatively uncommon feature at Idaho's lode mines, one occurs at the Mountain Chief Mine in the Seven Devils mining district, which has a six-hundred-foot tunnel through a ridge, with portals at either end. Ore cart rail is in place, and the timber supports are in good shape as of this writing.[306]

Hoisting machinery

Features associated with hoisting machinery include remains of whims, hoist engines, hoist houses, metal ore buckets, cages, steel or wooden headframes, and sheave wheels and idler towers that supported the wire rope or cable between the hoist house and headframe.

Ventilating and pumping machinery

This property type includes machinery associated with ventilating and pumping out water from the underground workings of a mine, such as air blowers and Cornish pumps. It also includes buildings that housed the machinery.

Waste rock dump

Broken waste rock from a lode mine was typically dumped just beneath the level of the adit portal or next to the shaft collar. The size of waste rock dumps reflects the amount of ore removed from the opening associated with it. The dumps usually contain shattered rock the size of cobbles or smaller, and some may contain debris such as the remains of buildings. A waste rock dump outside of an adit portal that has no brownish red rock indicates that the workings from this level up to the next were in the sulphide zone.[307] At some mines, such as the Idaho-Almaden near Weiser, either the mining company or the county used waste rock for road building.

Sorting and sampling shed: Ore was hand-sorted underground, at the mine portal, or at the mill. The high-grade ore was sacked immediately or stored in an ore bin until it could be shipped. Sorting sheds may have remains of conveyor belts with walkways beside them or seats across them. The belts are closely associated with chutes that feed the storage bunkers.

Ore car tramway

Ore cars on narrow- or standard-gauge rails often hauled supplies in and ore and waste rock out of a lode

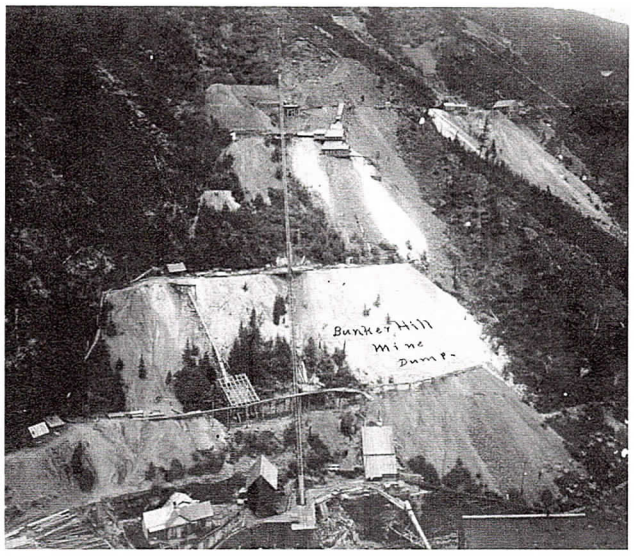


Figure 76–Overview of Bunker Hill Mine showing several levels of operation and many features. (ISHS 70-70.1 Mines- Coeur D'Alene (Bunker Hill) Bunker Hill Mine Dump)

mine. The gangue was deposited on the waste rock dump, usually close to the mine opening, and ore was conveyed to an ore bin or directly to a mill. In small or early mines, humans or animals pushed or pulled the ore cars. Later, electric tramways were used in some places, and a variety of types of engines, including Shay locomotives, hauled the ore cars.

Many of Idaho's mines still have ore cart runways that connect the mine opening with the waste rock dump. Features associated with ore car tramways include ore car rails (wooden and faced with strap iron, or steel, narrow gauge or standard) and trestles supporting ore car rails.

Ore bin

Ore bins are sturdy, long-lasting wooden (mostly log) or steel containers that receive and discharge ore into ore wagons or rail cars. Rectangular in shape, ore bins generally have sloping bottoms with gates that release the ore. They may be freestanding, such as ones perched close to waste rock dumps, or connected to a tram house or a mill. Ore bins located at the top of a mill usually held enough ore to provide the mill with several days' work. An ore sorting shed was sometimes located near the ore bins; the ore car unloaded directly into the shed, where the high-grade ore was sorted and sacked for shipping. The Silver Tide mine (site 10-EL-862) has a twentieth-century ore bin built of logs and lined with sheet metal.

Incline

Some mines used inclines with cables on a 20-40 percent grade to haul specially designed ore cars down to ore bins.



Figure 77–Neil MacAskill tramming ore, Lincoln Mine at Pearl, Idaho, 1907. (ISHS 71-185.28)

Aerial tramway

Aerial tramways, powered by gravity or by machinery, carried ore downhill from the mine opening to the mill and hauled supplies back uphill in buckets suspended from one or two continuous or reversible wire ropes or cables hung between fixed points. First used in the 1890s, tramways usually hauled ore long distances over rough country; ore was dumped from the buckets into an ore bin at the top of the mill. Aerial tramways usually had stations at each end for loading and unloading and for controlling the rope, along with intermediate towers that supported track cable and traction rope. Some spanned rivers. At least one aerial tramway in Idaho spanned a lake (site 10-AM-155).

Remains of an aerial tramway may include loading stations and terminals (sometimes with ore bins), steel or wooden towers, brake station building, ore buckets, wire rope or cable, pulleys, control machinery, and evidence of cleared vegetation along the route. Due to deterioration over time, the cable is usually found on the ground rather than suspended (an aerial tramway



Figure 78–Mining machinery Tram at Monarch mine near Atlanta. It led from the mine to the mill below the town. Donor: Quentin Wakeman. (ISHS 80-56.24)

near Burke, site 10-SE-777, still is suspended in places). The aerial tramway that brought ore to the stamp mill at the Gold Coin Mine (site 10-SE-803) still has its associated machinery and equipment including pulleys, ore cars, and brake and control levers.

Surface mine

The development of large, low-grade ore bodies by open cut, glory-hole, or open pit mining leads to an extensive reworking of the landscape. An example of the historic workings at the Orogrande mining district in Idaho County with its low-grade deposit of ore, the Orogrande-Frisco, shows the progression from working first an extensive glory hole and then an open pit operation. First, the oxidized ores were mined by the glory-hole method in the early 1900s, and good values were recovered from the amalgamation process. The operations and recovery rate at the company's stamp mill were watched closely by mine operators in the region who were hoping to learn how to treat low-grade ores at their mines.[308]

Interest in the gold remaining in Orogrande's gravels and ores revived in the early 1930s, partly as a result of improved roads. In addition, the development of dragline shovels and bulldozers allowed working low-grade gravels on a large scale. Active development work at the Orogrande-Frisco mine resumed in 1933, and the mining company built a five-hundred-ton cyanide mill. In 1937, the mine was described as the largest open-pit mine in Idaho, and in 1938, its mill was the largest cyanide-process mill in the Pacific Northwest.[309]

Such operations required large areas for mining, stripping, disposal of waste rock, stockpiling, heap

leaching, and roads. In the process, earlier settlements may be displaced, surrounded, or swallowed up by the overburden, waste materials, or the pit itself. The main features at an open-cut or open-pit mine include the cutbank or open pit itself (rather than the shaft or adit typical of most of Idaho's lode mines) and the overburden pile. The pit is surrounded by a series of benches with roads or railway lines. The pit may expose earlier underground workings such as drifts, stopes, and rises, but it more often destroys them. In some cases, sites are graded back to their original topography and reclaimed once mining has ceased. Objects that might be found at an open-pit mine include remains of an inclined skip, rail track and cars, telephone lines, ore bin, pipelines or other conveyor systems to transport solids, concrete blending apron, haul roads, crushing plant, and parts of stripping, excavating, drilling, blasting, and hauling machinery. The blasting at an open-pit mine may have caused structural damage in nearby buildings, such as masonry cracks, broken tile, or failure of window panes. The volume of waste rock created at an open-pit mine can be quite large; in some cases, ten tons or more of waste rock are removed for each ton of ore taken from the open pit operation.

Leach dump

At some open-pit mines, such as ones working copper deposits, leaching operations were conducted on leach dumps or leach heaps, consisting of a huge pile of shattered rock of low-grade value, variable in size, with steep sides. Acidic water pumped into shallow cells or ponds on the top surface percolated through the leach dump, becoming rich in copper as it filtered to the bottom. The copper was then precipitated or deposited in metallic form on scrap iron.

Other

Other features related to lode mining sites that are sometimes found today include machine pads, areas of subsidence, and ore chutes (often lined with metal plate and leading to an ore bin). Miscellaneous portable objects associated with extraction found at lode mines include barrel hoops, stacks of slab wood or firewood cut into four-foot lengths, discarded machinery such as machine or hand drills, drill steels, batteries, picks, shovels, barrels of fuel, kerosene cans, blasting devices, wheelbarrows, timbering such as square sets, twenty-five-pound kegs for blasting powder or carbide (often reused), and empty tin cans that have been put to other uses such as candle lanterns or tool holders.

Ore Beneficiation and Refining Resources

Mills often reflect an overlay of several technologies. New technologies improved the recovery of valuable metals and reduced the amount of skilled labor required for each ton of ore processed. The machinery in mills and smelters was powered by animals, water, firewood, charcoal, gasoline or diesel engines, and electricity. They generally relied on gravity to move the ore through the different processes. Water washed the pulverized rock through the millworks in wooden or metal troughs known as **launders**.

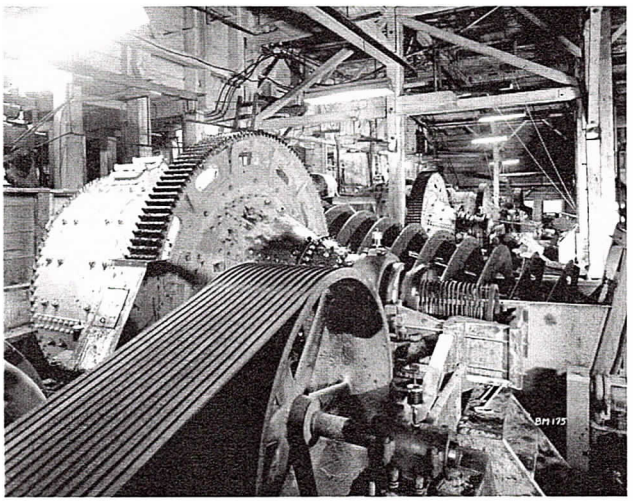


Figure 79–Ball mill at Meadow Creek Mine, Stibnite, ca. 1940. (ISHS 75-15.11)

Form followed function closely in mills. The buildings were designed to make maximum use of the force of gravity and to reduce the distance traveled by the ore as it was concentrated, smelted, or refined. Mechanical elevators sometimes lifted the slurry to higher parts of the mill. When processes were changed or added, shed additions might be added to the original building. The interior machinery was sometimes moved around to allow for new equipment, or machinery no longer in use might remain in place. Siding was generally board-and-batten, double (horizontal and vertical planks), or corrugated metal. More recent mill buildings might have steel frames and be covered with galvanized iron.

Mill buildings today are generally in ruins if not completely obliterated. A typical collapsed mill is a pile of lumber, bolts, nails, machine parts, sheet metal, cable, and other architectural and machinery-related items.

Sorting, crushing, and classifying machinery

Workers broke ore with sledges and sorted the pieces to separate high-grade ore that could be shipped

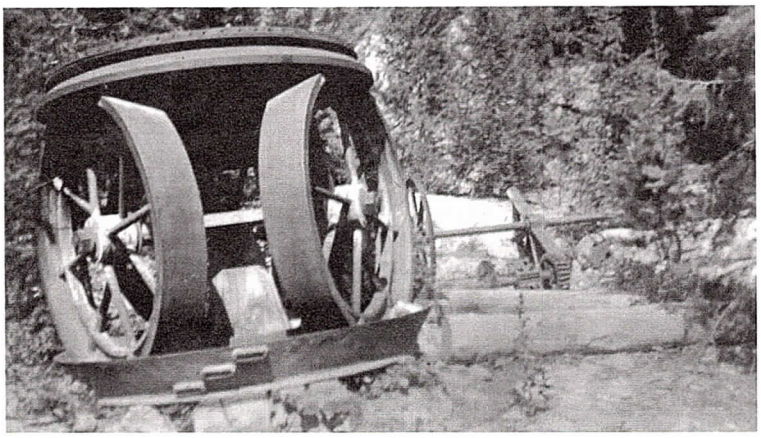


Figure 80–Old Spanish town at forks of Elk Creek about 4 miles from Rocky Bar. Donor: Robert Romig, Boise.

directly to a smelter instead of going through the mill. The sorting could be done underground, with some of the waste rock immediately being used for filling the stope. Most ores, however, required concentrating to reduce shipping charges. Precious minerals were not terribly bulky, but ores bearing base metals such as lead, copper, and zinc were. Today, evidence of above-ground sorting includes a shed with a conveyor belt or sledges.

After sorting, ore requiring treatment at a mill was crushed and ground to a uniform size by one or several pieces of machinery, either in the mine, in a building near the mill, or at the top level of the mill. The fineness of the crushing depended on the particle size needed in the rest of the milling process.

The least costly device for crushing quartz was the arrastra, built almost entirely of local materials and used only seasonally. Ore was crushed in a rock-lined pit by heavy drag stones powered by a water wheel, a horse, or other methods. The typical remains at an arrastra site include a circular, stone-lined depression, and sometimes the drag stones are still present (in Dixie, however, some were recycled as grave markers) Other arrastra parts might also still exist like the center pole, wooden bar, corral, and water wheel or motor. The Martinez Cabin and Arrastra (site 10-IH-396) in the Warren area still has drag stones, central spindle, parts of the tub, and evidence of the ditch that brought water to the arrastra.

The Chilean roller mill, a variant of the arrastra, is sometimes found relatively intact at remote sites. For example, the Golden Anchor Mine in the Marshall Lake mining district brought in a steam-powered Chilean mill in the 1910s or 1920s.[310] A water-powered Chilean mill resting on a cement slab has been recorded at the Deer Creek Mine (site 10-NP-300).

A common type of primary crusher was a rock breaker, which broke ore into pieces about the size of apples. The rock breaker, generally a jaw crusher or a gyratory crusher, was located near the top level of the mill, below the ore bin. The most popular primary crusher was the Blake jaw crusher. An ore feeder regulated the flow of ore to the fine grinders. Rock breakers are sometimes still found intact at milling sites. After the initial breaking or crushing, the ore went to a stamp mill for further crushing by heavy iron dies that dropped repeatedly onto it. Rock breakers and stamp mills, the industry standard for crushing ore throughout the second half of the nineteenth century, were housed in buildings with heavy stone or concrete reinforced foundations under the stamps to absorb the vibrations caused by the constant pounding. Often all that remains of a stamp mill are these foundations, sometimes with large bolts still in place, although scattered machinery pieces may also be found at these sites. Water tanks, often wooden, may be located near the top of the mill. Some intact stamp mills still exist in Idaho, often in remote areas. For example, the Pickles Mining Site (site 10-IH-2121) south of Warren has a two-stamp mill made in Chicago.

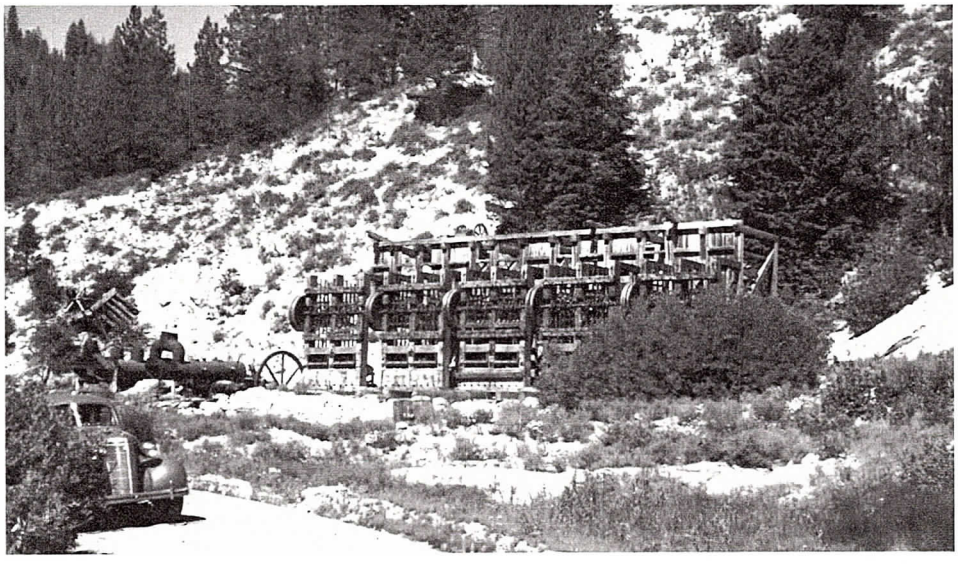


Figure 81–Fifty-stamp mill at Elmore Mine, Atlanta, 1940. (ISHS 72-201.170 F752.A17 Ore Dressing–Atlanta (Elmore Mine) 50 stamp mill at Elmore Mine,owned by "Alturas Gold, Ltd.", June-July, 1940)

Fine crushers–ball, tube, and rod mills–began to replace stamp mills in the early 1900s because they produced the smaller and more uniform particle sizes required to treat sulphide ores by cyanidation and flotation. Often just the metal parts or the machine pads for these types of mills are all that can be found at a site today. The Hematite Mine in the Dixie mining district (site 10-IH-2057) has an intact ball mill that probably dates from the 1930s or 1940s, and a few others have been recorded in the state. Mills whose machinery has not been removed often have several pieces of sorting and classifying machinery. In the Gold Point Mill (National Register reference #00000792) outside of Elk City, for example, a grizzly follows the rock crusher, and a trommel and a rake classifier follows the ball mill.

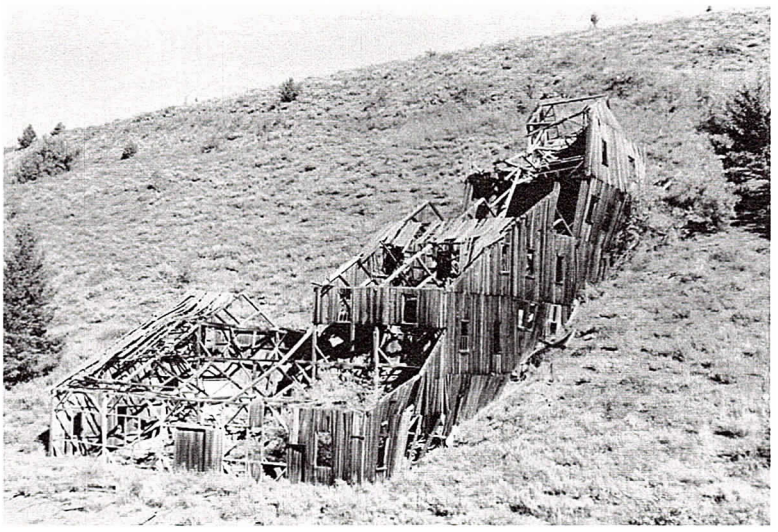


Figure 82–Remains of mill at Rich Gulch, Owyhees, 1975. (ISHS 78-5.300/g Ore dressing–Owyhee (Rich Gulch) /g–looking north-west at full view of mill, October 1975 (Sites survey))

Concentrating machinery

After fine crushing, ore was treated by one or more methods to separate the valuable minerals from the surrounding rock. These processes are combined in one property type because many mills used more than one of these processes at the same time and/or switched from one to another over the years, sometimes leaving the no-longer-used machinery in place.

A variety of gravity concentrators were available to millmen, and they were used on gold, silver, lead, zinc, and copper ores prior to the introduction of flotation. These devices–jigs, buddles, vanners, and by the early 1900s Wilfley and other types of tables–all used a shaking, vibrating motion to separate the heavier metal-bearing ores destined for the smelter from waste rock. They were generally located at the bottom of the mill.

Although not common, it is possible to find any of these types of gravity concentrators intact inside a mill. Jigs may still contain the metal screens and piston rods that stratified the ore into concentrates, middlings, and tailings. Tables are usually parallelograms rather than rectangles, and their top surfaces are often still covered with linoleum and wooden lathes nailed in place. Sometimes only parts can be identified, or concrete pads on which the machinery once rested.

The Washoe pan amalgamation process was used to process silver ores that were not too refractory. Ground silver ore was put in heated pans or tubs along with mercury, salt, and copper sulfate. The pulp then went to settlers (large tubs with rotating stirring arms that separated the amalgam from the pulp). The mercury was separated from the amalgam in a retort. Variants of this process used in some Idaho mills included the Reese River process and the Freiberg barrel process. Typically, the pans, settlers, or agitators at pan amalgamation mills are no longer present.

A mill site in Idaho typically consists of a collapsed or dilapidated building from which most if not all of the machinery has been removed. Typically, the remains found today include mill tailings, trash scatters, construction-related artifacts (nails, bolts, lumber, window glass, roofing), building foundations, and machinery pads.

Evidence of the flotation process, introduced in the 1910s to treat complex ores, includes long wooden troughs divided into square rectangular cells that are open at the top. Launders took the discharge into dewatering tanks. Agitators were often present within the flotation cells, and paddle-style skimmers may still be located above the cells.

As more efficient recovery processes such as flotation and cyanidation were developed in the twentieth century, many old tailings piles were ground to a finer consistency and reworked by cyanide leaching. By the 1920s, power machinery was being used for this process. The tailings were hauled in trucks or rail cars to processing plants or mills built on-site. This work obliterated older landscape features and created new ones. Artifacts found at such sites might include hand or power buckets (usually clamshell), hoops that once held wooden leaching vats together, freight wagons, trucks, rail cars, roads, and rail beds. Tank supports or even large wooden tanks (filtration and dewatering units)

may still be in place inside the mill. A ditch and other water conveyance system features may have brought water to the leaching pond. For example, a cyanide leaching pond covering about two acres was built in the 1930s at the Sunbeam Mine in the Yankee Fork mining district to process old tailings.[311]

Large vats used as filtration and dewatering units are sometimes all that remains to reveal use of a chemical process at a mill. Often made of vertical boards, these vats are held together by cables. Circular concrete floor pads for cyanide tanks also help reveal the process. Cyanide can dumps may also indicate ore treated chemically by cyanidation; a supply of zinc dust or shavings is another indication.

Smelter

Smelting heated the ore in the presence of fluxes in order to chemically separate the metals and the waste rock. The matte resulting from the smelting process was then shipped to other plants to be refined into bullion suitable for commercial exchange or industrial use. To be successful, smelters required a source of cheap fuel, lead ore (necessary for processing ores containing silver), flux to enhance fusion, and relatively close sources of appropriate ore or cheap railroad transportation of ore.

The physical plant of a smelter might include the following: the process mill, storage and charge bins for concentrates, fluxes, and coke, roaster, sintering plant, furnaces (reverberatory, blast, and converters), power house, pump house, fume recovery and emission system, assay office and laboratory, warehouses, machine and carpenter shops, offices, pumping plant, haulage tracks, water and power systems, matte storage and shipping facilities, employee housing, railroad spur, loading platforms, and dock and loading area (if adjacent to navigable waters). Many smelters had clerestoried or monitored roofs to let in light and to dissipate heat.

Most, if not all, smelters were completely dismantled and possibly relocated after the mine shut down, as with the smelter at Stibnite which was shipped to Kellogg in 1958.[312] Often the dominant surviving feature at a smelter are the Tall stacks that dispersed the noxious fumes and smoke. Other features that may be found today include stone foundations, chimneys, and remains of the plant's rail line. The smelter complex at Bunker Hill was removed as part of the clean-up of the Superfund site there. All that remains of the 1905 smelter at Ponderay (site 10-BR-539) today are foundations, indications of the railroad spur, and a slag pile extending to Lake Pend Oreille. The remains of a small-scale post-World War II smelter used to recovery mercury from ore still stand near Warren (site 10-IH-1391). The smelter today consists of firebrick walls and two fire chambers resting on a concrete foundation slab.

Mill tailings, tailings pond and dam

Mill tailings are the waste product of mills. They consist of pulverized, pale-colored ore, the consistency of sand, from which most of the valuable minerals have been extracted. Tailings resulting from chemical processes such as cyanidation and chlorination, often of intense pastel hues, are likely to be very fine and silt-like. Tailings were often deposited by water directly into streams or creeks below mills. The fines washed downstream almost immediately; the coarse materials only during high-water episodes. Larger or heavier sediments are closest to the outlet, and the finer materials are progressively farther away. Tailings may have altered streamflow and affected downstream waters. Tailings piles are usually steep-sided, sometimes terraced, and often eroded. Sometimes retaining walls were built to contain the piles. Over time, the fine material often blew away.

Tailings piles can cover large areas: the tailings from the mill at Meadow Creek in the Stibnite area, for example, cover about one hundred acres. By the 1950s, some of Idaho's lode mines were pumping some of their "sands" (tailings of a sandy consistency) back into underground workings. Sometimes the tailings had to be thickened before they could be returned to the stopes. Other uses for tailings over the years were as roadbed and even as an ingredient in building blocks.[313]

Some mills, such as Yellow Pine, hauled tailings to a storage area separate from the mine. Others, such as the Orogrande-Frisco in Orogrande, processed large tonnages of ore but today show little or no evidence of tailings. In such cases, the tailings may have been washed away, hauled to a custom mill, or pumped back underground as fill to support stoped areas.

In the twentieth century, some mills dewatered and then pumped or hauled their tailings to a tailings pond, a dammed-up shallow lake where the solid material settled out and water evaporated or was pumped to storage tanks. At some mills, the tailings flowed by gravity downhill from the mill in launders or flumes or pipelines. The tailings were a mixture of pulverized wastes that ranged from coarse to slurry. Tailings dams might be built of wood pilings and planks. If the tailings

ponds are terraced, each successive terrace marks the front of an earlier dam. Many of the tailings ponds in the Coeur d'Alenes today were built in or after 1968, due to mining companies' anticipation of tightened environmental laws and regulations.

Tailings ponds were often impounded behind embankments built from the tailing material itself. A catchment pond downstream from the embankment was sometimes created to collect seepage water. Metal pipelines, usually located on a gentle gradient, that hauled waste from a mill to a tailings dump or tailings pond may still be found. Sometimes the remaining features are open wooden troughs rather than pipes.

At the Harmony Mines' facilities near Baker, tailings were conveyed to a tailing pond that was dammed by a relatively thick product from the mill's classifier. Clear water was carried under the dam in a trough and discharged at the foot of the dam.[314]

The tailings from the flotation mill at the Jack Waite Mine near Burke (site 10-SE-909) were contained by a series of retaining walls, diversion structures, and an earthen dam that diverted the flow of nearby East Eagle Creek. Tailings, vertical logs and planks, and cobbles created a bulkhead and retaining wall and diverted the water between two tailings piles. An open box culvert built of planks attached to vertical wooden posts formed a second water diversion system. Log retaining walls also stabilized the downstream ends of the tailings piles. Wooden flumes on top of the tailings piles deposited the slurry on the piles. The tailings pond was built in response to concerns about polluting downstream creeks. A flume carried the slurry over a two-mile distance from the mill to the impoundment site. This was used until the early 1940s, but the system failed in the early 1950s, releasing high concentrations of heavy metals.

Slag pile

Slag piles are huge mounds of waste material from a smelter, ranging in size from pebbles to cobbles. The material is restructured ore and fluxes that have been vitrified by the high temperatures used in smelting. Often prominent landscape features, slag piles are usually dark or multicolored steep-sided hills or tablelands, often prominent landscape features. A few still exist in Idaho, located near smelter sites.

Slag was sometimes hauled far from its point of origin on roadbeds, or as traction sand on winter roads. The slag pile at the Bunker Hill smelter was reworked to recover zinc after construction of the Slag Fuming Plant in 1942.[315]

Refinery

The process of removing impurities from metals to make them useable is known as refining. Various methods of refining include 1) fire refining, or removal of impurities by selective oxidation, 2) electrolytic refining, or the deposition of a pure metal by electrolysis leaving the impurities undissolved or undeposited, 3) chemical refining, or the solution of impurities by chemical reagents, and 4) distillation. At times, the first three may be used successively on one metal.

Idaho has had only a few refineries. In the 1800s, refineries were located on the east coast in places such as New Jersey and Baltimore. Ore mined in Idaho had to be shipped around the nation, and sometimes overseas, to be refined.[316] The electrolytic zinc plant near Kellogg, built in 1928, was one of the few refineries built in Idaho. Today's examples are the Bradley Mining Company purification plant at Boise and the above-mentioned electrolytic zinc plant near Kellogg. The latter has been recorded in great detail for the Historic American Engineering Record.

Other

Custom mills often had large ore houses in which they stored back orders of custom ore from mines.

Industrial Support Resources

Industrial support facilities for placer and lode mining operations include a variety of property types. Some are located close to the mine workings and others may be miles away. They are connected by association.

Water conveyance systems

Water had many uses at mining-related sites: it provided a source of power, conveyed materials, and provided drinking water and water for firefighting. The remains of water conveyance systems can be found at most of Idaho's placer mining sites, at many mills and lode mines, and at some residential sites. Some water conveyance systems may extend for many miles, forming a complicated network of main ditches and feeder lines. Water conveyance systems were essential engineering elements in the operation of many mines.

Reservoir/dam

Dams built for water conveyance systems during the historic period were earthen, stone, log, or a combination of these materials. Storage reservoirs formed behind the dams and were gradually lowered as the water was released for use downstream. Dams are often located at constricted points or on breakslopes, and they



Figure 83–Siphon tube carrying water across Boise River near Twin Springs, ca. 1900. (ISHS 2501-A)

sometimes have evidence of gate control. Containment and wing dams diverted water away from areas that were being placer mined. These often no longer exist because they have been washed away.

Ditch/flume/pipeline/penstock

Ditches for conveying water were dug by hand or by machine; some were chiseled out of rock. They vary in width and depth from just one foot to many feet.



Figure 84–Flume bringing water to hydraulic operation. (ISHS 63-194.18a Hydraulic Mining–Placer Mining operations)

Ditches were often breached in order to wash overburden off a hillslope or as a result of spring run-off and erosion. Breaches have sometimes been repaired with dry-laid rock and earth shoring. Flumes, typically made of sawed lumber, might also be constructed of ax-hewn logs. The remains found today often consist of rotted lumber trestles (usually collapsed) and flume boards, sometimes scattered downhill from the flume location.

Associated features include pressure boxes, wooden wire-wrapped pipes, waste gates, holding ponds, buried pipes, trestles supporting flumes or pipes, siphons, spillways, stumps notched to allow passage of pipes, water tanks, trash weirs (fences across streams), drill holes and iron brackets along a cliff, tunnels that diverted water from one drainage system to another, ditch maintenance trails, ditch-tenders' work camps, and telephone lines. Ditch intakes have usually been washed away and are no longer identifiable on the ground.

Features associated with water power might include **Pelton wheels**, penstocks, ditches and flumes, ditches that held penstocks in place, dams and reservoirs, and other water conveyance system features. For example, the Pelton wheel at the Morning Mine in the Coeur d'Alenes was built in 1900 to run the mine's air compressors. It measured thirty-two feet in diameter, the largest in the world at the time. Flumes and other components of the water system feeding one of the

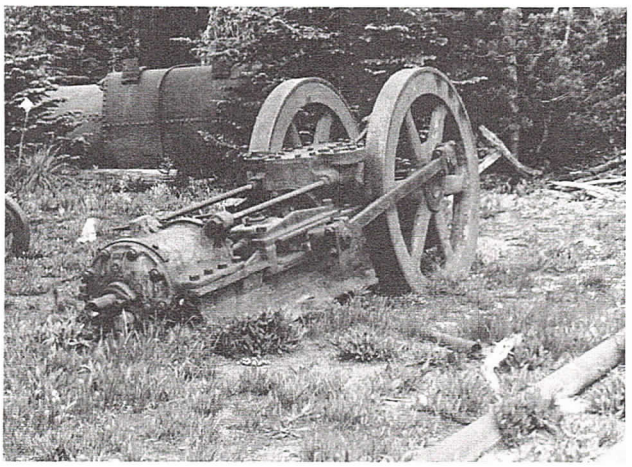


Figure 85–Remains of a Twin-cylinder steam engine by Ingersoll, Concord Mine, Buffalo Hump, 1974. (ISHS 74-144.8)

pipelines that powered this large wheel still exist (site 10-SE-275).

Power plant

The source or sources of power at a mine, mill, or other industrial mining site should be determined whenever possible. Possible sources of power include human, animal, water (provided by a water conveyance system), steam (boilers), charcoal, electricity, coal, oil, diesel fuel, and gasoline. Mills sometimes ran on water seasonally and on steam or some other power source when water was not available. The power house might be attached to a mill or other building or it might stand on its own. Some operations, such as the Sunbeam Dam and hydroelectric plant built in 1910, only operated for a few years. Many hydroelectric facilities, such as the 1907 Atlanta Dam and Power Plant on the Middle Fork of the Boise River, provided power to the company mill and mines and also sold surplus power to other mining companies and to nearby communities.[317] Often only a concrete pad and anchoring bolts remain today.

Features associated with steam boilers might include the boilers themselves, boiler houses, fire bricks, sheds holding slab wood, fuelwood, charcoal, or sawdust. Large piles of firewood cut into four-foot lengths or charcoal scatters are sometimes found near a mill or boiler house. Clinkers (incombustible byproducts of coal burned in a boiler) may be scattered near the boiler. The remains of the steam boiler at site 10-BV-112 near Caribou Mountain has a story to tell; it evidently blew up.

Features associated with electric power might include poles, power line, generator, diesel power plant, transformer station, glass insulators, switchboard, substation, hydroelectric plant and dam, and housing for the crew.

At larger mines, compressed air–obtained by water power, electricity, or other means–often powered equipment such as drills, hoists, and trams. If this was so, a compressor shed might be located near the mine portal. At the Gold Coin Mine (site 10-SE-803) in the Coeur d'Alenes, the compressor shed still contains the remains of the compressor inside as of this writing.

Charcoal was used by blacksmiths at mines, in smelters to fuel reverberatory and blast furnaces, and in boilers to make steam for running machinery. For example, Idaho smelters at Ketchum, Muldoon, Bayhorse, and Nicholia relied on charcoal from parabolic beehive kilns.[318] Charcoal is produced by burning wood within an enclosed environment under controlled conditions to drive moisture and volatile chemicals from the wood. Standardized brick charcoal kilns were introduced in the late 1860s, and both they and the more traditional earthen pit method of charring wood often supplied the same smelters. Coal, oil, and then electricity began to replace charcoal as a fuel for blast furnaces in the early twentieth century.

Features associated with charcoal production include hillsides harvested of timber, remains of open-pit charring such as leveled areas and circular charcoal/ash concentrations, and beehive charcoal kilns. Beehive kilns have associated features such as flumes that carried wood to the ovens, stacks of cordwood, earthen banks next to the kilns for loading, and residences for workers who hauled wood, made charcoal, and delivered the charcoal to smelters.

The remains of twelve charcoal pits used until 1922 are located near Leesburg. These doughnut-shaped mounds measured approximately twenty-eight feet by thirty-eight feet, typically with a depression around the



Figure 86–Remains of charcoal kilns at Nicholia. (ISHS 73-142.3)

charcoal area, evidence of dirt piled on top of the charcoal, and sometimes a central depression resulting from the removal of the charcoal. The Birch Creek Charcoal Kilns in Lemhi County (National Register Reference #72001577) built in the 1880s conform to a standardized style used throughout the West, with some local variations. Constructed of clay, lime, and plaster, they measured about twenty feet in diameter and height, and rested on stone and brick foundations. Each had a lower and upper door and small openings around the kiln to sample the burn. Each held about forty-five cords of wood, and the entire process took about seven days. Other charcoal kilns associated with smelters stand near Bayhorse and Muldoon.[319]

Blacksmith shop

Even after machines replaced draft animals, placer and lode mines and mills still needed blacksmiths to repair equipment and machinery, sharpen tools, and maintain rails and ore cars. At smaller mines, the blacksmithing area might have been simply a flattened area near a mine portal or on top of a waste rock dump (sometimes stumps that held the anvil can still be found).

Blacksmith shops, generally log buildings (sometimes with a nearby or attached charcoal shed), are often found close to adit or shaft portals. The forge rested on an earth, stone, or concrete base while a stump inside the building supported the anvil. Other items typically found in blacksmith shops include barrel hoops (from a barrel of water), evidence of coal storage, scrap pile, dirt floor, pieces of metal or of tools, pieces of the bellows, and worktables or benches around the perimeter of the room. The blacksmith shop at the H-Y Mine in the Thunder Mountain mining district has many of these typical features and also a connected coal storage shed.[320]

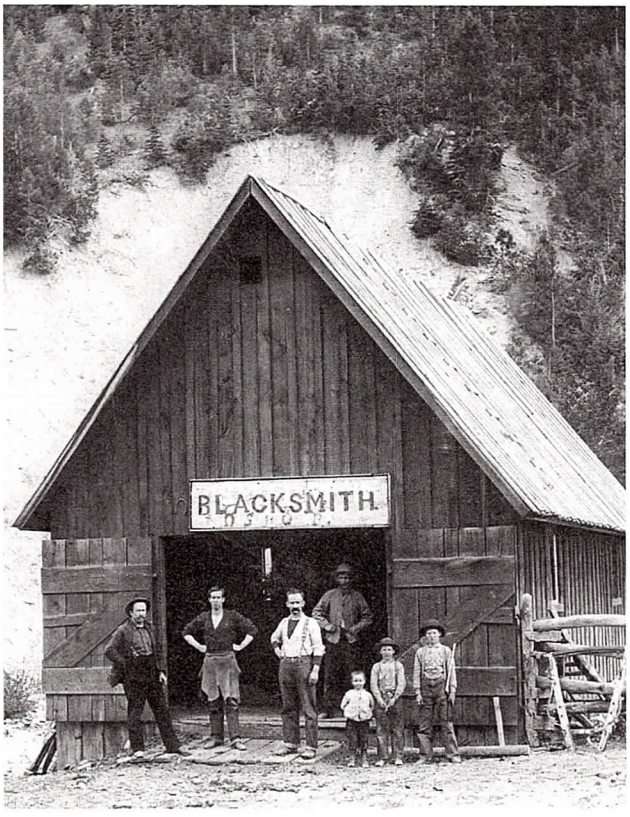


Figure 87–Blacksmith shop, Atlanta. (ISHS 73-129.0027 Atlanta Blacksmithing in Wells, *Gold Camp and Silver Cities*, p. PARL: QE 103. B8 no. 22 1983)

Assay office

Assaying work occurred either at the mine (if it was a larger operation), in a nearby community, or outside the mining district. Assay offices were often built close to the mill or mine site but far enough away so that vibrations from underground blasting would not interfere with assaying. (see Fig. 36)

Evidence of assay offices consists primarily of a scatter of fragments of crucibles and cupels, a small assay furnace with a D-shaped doorway (or broken pieces of firebrick), and slag and charcoal. A concrete pad might indicate the place where the assaying scales were positioned. Other features might include wooden work tables and shelves, bucking board for grinding samples, and pieces of glass bottles that held the fluxes.

Powder magazine

For safety reasons, explosives were generally stored in a thick-walled building located at some distance from other buildings at the mine. The powder magazine typically was built of logs, rocks, and earth, often with the hillside forming one or more walls.

Sawmill

Many larger mines maintained their own sawmill, particularly during the camp or flume construction phase. Sawmills were powered by a variety of power sources including steam boilers and electricity. Associated landscape features would include tree stumps, skid roads, sawdust piles, flumes for logs or cordwood, log decks, stacks of cordwood, woodcutters' cabins, and a saw pit for whipsawing.

Telephone and telegraph lines

Some lode and placer mines had telephone lines connecting different parts of their workings, such as the headgate at a dam with the hydraulic pit or with the compressor shed at a lode mine. Porcelain insulators nailed to trees and galvanized wire phone lines indicate the presence of a phone line.

Other support buildings

This category includes a wide range of the types of buildings–including but not limited to office and other administrative facilities, storehouse, warehouse, pump house, **shaft house**, timber framing shed, dry or change house (where underground workers changed clothes), lime kiln and quarry, carpentry shop, machine shop, and pumping station–that might be found at or associated with mine, mill, and smelter sites in Idaho. Such buildings were constructed of logs, sawed lumber, concrete blocks, structural steel, or other materials. Some of these buildings, such as machine shops, may have been located underground in order to be as close as possible to the workings.

Residential Resources



Figure 88–Building a cabin at Thunder Mountain. (ISHS 60-72.43 Buildings, Log, Wells, *Gold Camps and Silver Cities*, p. 145)

The residences at placer and lode mines in Idaho ranged from a wall tent or log cabin to company housing complete with bunkhouses, cookhouses, and other buildings. They might be adjacent to the mine or mill or might be some distance away. They were occupied by single people, occupational households (such as a group of partners operating a mine or employees living in a company bunkhouse), cooperative households (loose aggregates living together temporarily), and families. Many of these residential sites were hastily built and were occupied only seasonally or intermittently. The buildings were almost always utilitarian in design and were made of local materials. Walls of permanent buildings were either log or frame; after World War II, Quonset huts and mobile homes were moved into some active mining districts. Many residences were relocated or destroyed by mining activity as the original workings expanded.

Very few, if any, standing structures dating from the 1860s are known; it is possible that none of these have survived 140 years of harsh weather and subsequent mining activities. Most of the excavation and detailed examination of mining residences done in Idaho to date has focused on dwellings occupied by Chinese miners. Most researchers have concluded that the Chinese used a wide variety of building materials, adopted local building techniques, and used existing structures. It is, therefore, difficult to identify Chinese sites based on architectural form alone. Along the Lower Salmon River, however, characteristics of excavated dwellings that may reflect architectural features attributable only to the Chinese are chimneys adjacent to the entrance, rockshelter with rock walls, and various forms of outside fireplaces.[321]

This report covers only the camps, buildings, and structures directly connected with mining, milling, or smelting operations as treated in this Residential Resources section. Communities that served a mining district are not included in this discussion.

Residence

The domestic households of miners often changed over time as people joined new households or moved away. The archaeological remains of a household at a single point in time provide only a sample as it evolved over time. Many of Idaho's placer mining sites have dwelling remains associated with them, generally on low-value land close to the deposit that was being worked. Foundations or building pads and collapsed remains of log and frame buildings are most common. Tent pads–simple leveled areas–are found in some areas. The semi-subterranean lean-tos constructed quickly by many placer miners are difficult to identify in the field. A dugout refers to the leveling of an area for a dwelling, generally requiring the excavation of a slope, and a rock hearth or chimney often remains on the site.

The dwellings and other buildings at lode mining camps are often built of log, even though lumber was usually available from nearby sawmills. This may have been because well-chinked log buildings provided more protection from the cold than did uninsulated frame buildings, or because logs cost the builder less. A number of options were available for corner notching, chinking or daubing, foundations, log shape, gable treatment, roof structure, and roofing materials. Log buildings in northern Idaho typically have saddle or lap notching, ridgepole-purlin roof structures, steep shake roofs, and gable-front house plans with front roof extensions. The gable extension is generally found only in the higher elevations of southern Idaho.[322] The cabins were typically chinked with pole quarter-rounds nailed onto the interior or exterior walls and daubed with mud. Early log buildings destroyed by

fire were often replaced by frame buildings. Buildings constructed during the Depression often had board-and-batten siding. The wood shingle roofs of the 1800s often gave way to metal roofs in the twentieth century.

Buildings constructed in remote areas and used for a short time were often relocated. The mover would number the logs in a log dwelling, for example, disassemble it, and then reconstruct it elsewhere. Sometimes the only evidence of this activity is the numbering on the logs. Pre-cut buildings that were sent packaged to a site ready for assembly also had numbered timbers.

Dugouts recorded on the slope above the drainage bottom of Baboon Gulch in Florence (site 10-IH-1918) are excavated and leveled areas representing miners' dwellings such as tents, huts, or cabins, all thought to date after approximately 1870. Similar dugouts have been found in other early placer mining areas, such as Pierce. An example of an unusually substantial mining residence is the two-story rock and cement Mansion Building at the Melcher Mine (site 10-CA-348).

The Mon Tung site (site 10-JE-89) on the Snake River, believed to have been occupied by a Chinese miner and merchant who drowned in 1880, was later destroyed by fire. The structure is similar to many other single-room rock wall shelters, occupied by both Chinese and Euroamericans, found in this area. It probably had a canvas tarp attached to a lumber or driftwood framework. A variety of diagnostic artifacts were found at the site, including common Chinese domestic wares for storing or consuming food. Two sites along the South Fork of the Salmon River that are believed to have been occupied by Chinese have been excavated, reconstructed, and interpreted (the Ah Toy and Tong Yan sites); both had earthen dwellings.[323]



Figure 89–Ah Toy earthen dwelling, South Fork Salmon River, 1989. (MPD Chinese Sites in the Warren Mining District, 1989)

Trash dump

A trash dump may contain household, industrial, or architectural artifacts. Surface scatters downhill from living areas are more common than substantial dumps used for long periods of time.

Outhouse

Outhouses are generally four-foot-square frame buildings. Many have collapsed, and sometimes only the pit is evident today.

Garden/orchard

Gardens (sometimes outlined by rocks) and other plantings established during the historic period, such as apple trees, rhubarb, or lilacs, are features of residential sites. Terraced gardens established and worked by Chinese have been identified in the Warren and Pierce mining districts. Such commercial gardens do not qualify as a mining-related property type unless their proprietor also worked at a nearby mine.

Company town

Company towns at mining, milling, and smelting sites ranged from only a few buildings to large communities. The topography, function, and ideology determined the layout of the various buildings. The landscaping, layout, and architecture expressed company culture. In some towns, rows of standardized single-family or attached housing dominated the community. The dwellings were generally frame in the twentieth century and log in earlier or more remote settlements. At the Blackbird Mine, tents were replaced with war-surplus frame buildings and Quonset huts in the late 1940s. In some company towns, housing size and quality varied depending on the occupational status of the worker; managers had larger dwellings with more high-style architectural detail and often more desirable locations than did wage workers. Single-family houses originally measured twelve by twenty-four feet and had rounded roofs. Individuals often modified their standardized residences, especially after the company turned ownership over to private individuals. Some workers brought their families to live with them, and this is sometimes evidenced by the artifacts (like non-utilitarian ceramics and toys) found on site, such as at the Jesse James Mine in the Yankee Fork area. A good example of a company town is Cinnabar in the Yellow Pine area, which has many board-and-batten buildings.[324]

Company towns that were once prominent communities in Idaho are not always easy to identify on the ground today, since most buildings did not have



Figure 90–Bunkhouse at Yellow Jacket Mine, ca. 1925. (ISHS 79-39.1)

permanent foundations. For example, the removal of buildings at Stibnite, which once had 160 houses, followed by a crew "cleaning up" the townsite, made it difficult to tell where the houses once were located. Another community in the area known as Midnight Camp today has two streets with frame structures in ruins and tent-house structural remains.[325]

Employees often lived in a bunkhouse and took their meals in a central cookhouse, and these buildings can often be found today, particularly at lode mining and milling sites. Bunkhouses are often more than one story and are built of logs or sawn lumber. Cookhouses, such as the one at the Pacific Mine (site 10-CR-724) near Bayhorse, can sometimes be identified by adjacent trash dumps that include large tin cans, cow bones, and fragments of white porcelain plates and cups.

Other buildings within company towns might include the company store (often in a prominent location), commercial laundry, garage, hotel, barn, school, hospital, recreational hall, post office, water system, sewage system, guest houses, apartment buildings, heating plant, and service station. The standing boarding house/dormitory at the Meadow Creek smelter community near Stibnite still retains its commercial laundry equipment as of this writing.[326]

Residential areas at some large-scale placer mines, such as dredging operations, were sometimes relatively permanent. For example, the 1940s and early 1950s camp for Yankee Fork dredge workers had hewn log buildings with steep tin roofs, with rear board-and-batten woodsheds.[327]

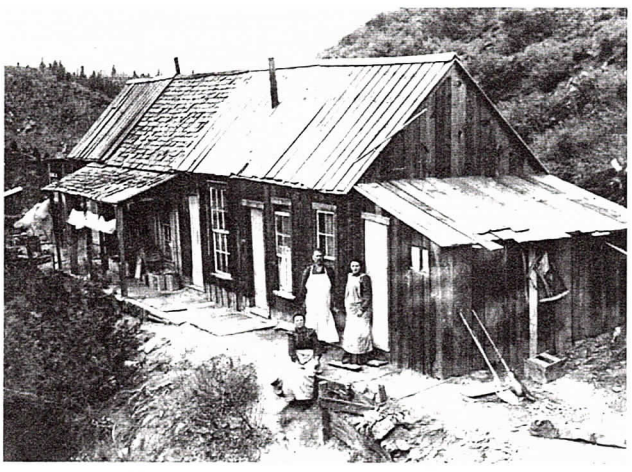


Figure 91–Cookhouse at Monarch Mine, Quartz Gulch, Atlanta. (ISHS 73-129.12)

Other

Improved springs, storage yards, outbuildings, root cellars, wells, woodsheds, meat houses, cold storage buildings, pathways, graves, and artifact scatters are often associated with dwellings. Artifacts commonly found include bedsprings, iron cookstove parts, and pieces of leather shoes.

Transportation Resources

Transportation affected every aspect of life on the mining frontier. Every mining-related site had an internal network of roads and trails connecting all features, and it was usually designed to minimize haulage. Mine sites also had to have some form

of transportation connection with the outside world, whether by trail, wagon road, automobile road, steamboat, ferry, railroad, airplane, or combination. Road networks often help delineate the boundaries of a mining landscape, including outlying sites such as mines, mills, supply operations such as sawmills, and settlements.



Figure 92–Bunker Hill & Sullivan mine, showing tracks leading from main tunnel to mill. Aerial tramway on right led to upper workings. (ISHS 1114-B, Kellogg, Idaho)

Resources that moved ore within a mine or mill site, such as aerial or ore car tramways, are listed under the Placer Mining Resources, Resources Associated with Extraction at Ore Mines, and Ore Beneficiation Resources property types.

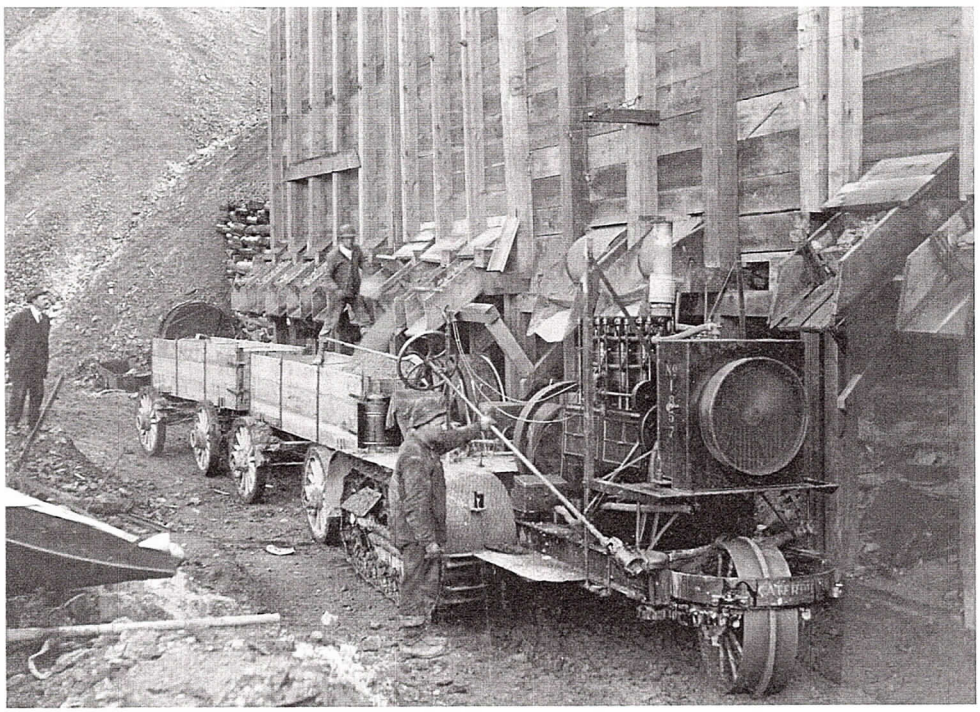
Trail

This property type includes internal trails, paths, and boardwalks connecting features within one site. It also includes early long-distance trails, constructed with hand tools or with horse-drawn equipment, that were built before or supplementary to wagon roads. Roads often obliterated earlier trails, but segments of trails may still be evident where the later road took a different route. A specialized type of trail was the stone boat trail (for horses pulling stone boats loaded with ore).

For example, a trail (10-BY-244) in Boundary County runs from the main camp of the Idaho Gold and Ruby Mine to a placer area in a different drainage. The trail, which is shown on a 1923 map, measures two to three feet wide and includes a log and pole bridge.

Road (Internal)

This category includes wagon and automobile roads built to haul materials within a mine, mill, or smelter site. These were generally built by the mining company. Associated features sometimes found today include the remains of freight wagons, trucks, cars, and sleds.


Figure 93–Ore bins and caterpillar traction engine hauling ore from Tyler lease to Bunker Hill mill. (ISHS 1158-40)

Road (Long Haul)

This category encompasses wagon and automobile roads that connected a mining-related site with outside communities. In the early years, these were often built by subscription by members of the community. Most roads found today, however, were built by county, state, or federal agency road crews. Automobile roads often obliterated earlier wagon roads, but segments of wagon roads may still be evident where the later road took a different route.

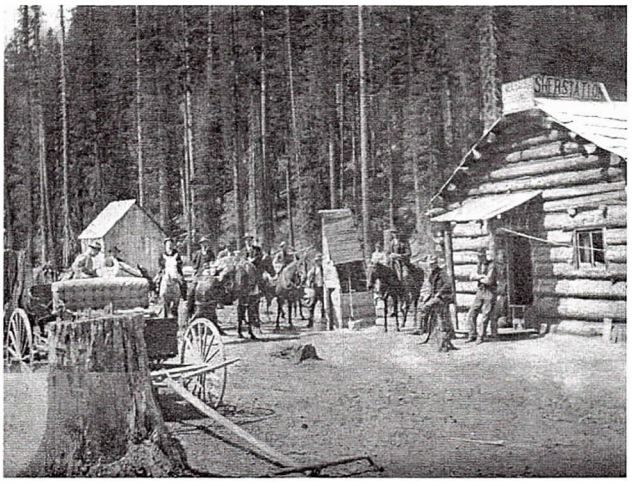


Figure 94–Way station, Big Creek Road (caption in book: "Half-way house, Big Creek Road") in *Annual report of the mining industry of Idaho.* (TN24.I2 A2, 1911, p. 65)

Dry-stacked stone cribbing, wooden culverts, wagon ruts, cutbanks, cliffs that have been blasted, corduroy segments (poles laid crosswise to the road), bridge remains, and snubbing posts or trees with marks where ropes lowered wagons down a steep slope are all evidence of the methods of construction and use of the road. Associated features include water sources, viewpoints, rest areas, tollgates, road markers (including tree blazes), graves, mule packing equipment, freight wagons, trucks, cars, sleds, and borrow pits. Recorded wagon roads often measure between ten to twelve feet in width, although this varies with the terrain.

A good example of an early 1900s wagon road is the Elk City Wagon Road. Between 1895 and 1932, this fifty-three-mile-long road served travelers in the South Fork of the Clearwater area, connecting Harpster (near Grangeville) in the west to Elk City in the east. The first automobile traveled the road in 1911. Features along the road include surface cultural debris, tree blazes and other markers, corduroy road segments, and a widened viewpoint.[328]

Way station/rest area

Way stations were typically log or frame buildings that provided overnight lodging and food to travelers and their animals. Rest areas or campgrounds may have been simply a cleared, leveled area with a source of water and perhaps feed for animals. Sometimes only depressions, a debris scatter, and a developed spring are found at such sites.

Stable/barn

Stables in mining districts are often log buildings. Identifying features include small or no windows; low, wide doors; location away from dwellings; overhead storage area for hay; and mangers along the walls. Evidence of a corral is often present. Smaller related features might include hitching rails, animal tack, and watering troughs.

Railroad (Internal)

Many larger mining properties had their own railroad for hauling crude ore from the mine to the mill. For example, the Morning Mining & Milling Company had a railroad that was several miles long; Shay locomotives pulled the ore cars.[329] The rails, ties, railbeds, trestles, railroad bed, and other components of these lines are sometimes extant.

Railroad (Long Haul)

The track-related features of a railroad line are the rails, ties, ballast, and earthen and rock subgrade. The relative weight of the rail is often roughly proportional to the freight tonnage carried, and the patterns of wear on the rail heads can indicate whether the rail had been used elsewhere previously.[330] Abandoned railroad lines have often had the rails removed or have been paved over at road crossings. Erosion from high water, replacement of bridges, encroachment of vegetation, and removal of subgrade have often reduced the integrity of railroad lines.

Most railroad rights-of-way contained a variety of buildings and structures for loading and unloading freight at stations and at trackside industries such as mines, mills, and smelters. Associated features could include yards, spur lines, sidings, wyes, interchanges, bridges, telegraph-telephone pole lines, right-of-way fences, cuts, berms, highway crossings, trackside signals, signs, stations, water tanks, tool houses, freight platforms, fueling stations, section houses, roundhouses, turntables, freight stations, crew housing, storage buildings, construction camps, fabrication sites for major bridges, maintenance and repair shops, and cooling towers.

Many of the features associated with the transcontinental lines became superfluous as diesel-electric locomotives replaced steam engines in the mid-1900s. Most local servicing facilities were removed. Sometimes, all that remains is the railroad bed, and it may have been converted to a recreational trail or reused as a right-of-way for electric transmission lines. The transcontinental lines often removed redundant facilities thoroughly, so today many features are no longer evident. Rolling stock is rarely found abandoned intact, but rail cars have sometimes been converted into buildings.

Bridge types include timber pile trestle, timber truss, steel plate girder, and steel through-truss bridges. Concrete abutments and piers and trestle approach



Figure 95–Through plate girder bridge on Wallace branch, Union Pacific Railroad, ca. 1998. (Hufstetler & Martin, Union Pacific, 34)

spans (sometimes later buried under earthen fill) may date from the historic period.

Bridge

These range from logs laid directly in streambeds to wooden bridges supported by log or stone abutments to engineer-designed bridges. Sometimes, only the bridge abutments remain.

Airstrip

Twentieth-century sites in remote areas sometimes had airstrips so that supplies and workers could be easily transported to and from the mining district. This category includes well-developed airfields as well as rough landing strips. Airstrips were sometimes used only seasonally, such as during the winter when snow made roads impassable. The St. Joseph Lead Company at Atlanta, for example, was served in winter in the 1930s by a mail plane and a passenger and express plane. One of the early airstrips in Idaho was at Meadow Creek near Stibnite. Built in 1928, it was enlarged in the 1950s.[331] Besides the cleared and graded airstrips, associated features might include a gas house, horse-drawn grader and roller, hangar, and fences.

Other

This category includes miscellaneous transportation-related resources that are occasionally found associated with mining districts. Some of these are moveable objects. Examples include steamboats and steamboat landings, ferries and ferry landings, and ferry cables.

Distribution and Locational Information

Historic exploration features could conceivably be found in Idaho dating any time from 1860 to the present, but the physical evidence of early exploration has generally been destroyed by later exploration and mining activity, for example, by being covered with dredge tailing piles or by waste rock dumps.

Properties associated with placer mining are located close to gold-bearing gravels, whether in existing streambeds or on hillsides where the gold was concentrated; the claims tend to follow current or old streambeds. The water-conveyance systems associated with placer mines may extend quite a distance from the site of the actual mining, but they always originate at a creek located higher in elevation than the mining site. The best examples of placer mining by traditional methods are often found at the upper ends of smaller streams and along side ravines and gulches where later large-scale mining was not done. Placer mining areas worked by Chinese often bear names like "Chinese Gulch" or "China Hill."

Properties associated with lode mining are located near veins bearing precious or base metals. Idaho's lode mines tend to be in the areas of the Idaho batholith, particularly along its edges. Southeastern Idaho had very few placer mining camps, and significant placer mining sites are not found north of Murray.

Mills were often sited next to a railroad siding and on a hillside to allow for gravity feed. Smelters were always located on railroad lines. It should not be assumed that milling machinery found at a mine was always located there; machinery was moved around as needs changed. It is believed that most of the mills dating from the 1860s through early 1900s in Idaho are no longer standing, victims of intentional dismantling, forest fires, natural deterioration, or vandalism. Many mills are almost completely gone from the landscape. Perhaps only stone or concrete machine bases remain, along with charred logs and lumber and a few scattered metal artifacts.

Mills were generally located near a dependable water source because water was used to wash the pulverized ore through the mill and sometimes to power the machinery. Chlorination plants and smelters were often sited where prevailing winds would blow away the noxious sulphur and chlorine fumes.

Sometimes the best examples of engineering works are at mines and mills that had little if any production. The early workings were never obliterated by later large-scale operations. Mills in very isolated locations might have intact machinery because it was too costly to move it out. The Gold Point Mill (National Register Reference #00000792) outside of Elk City still has almost all of its original 1930s machinery intact. The flow of ore from the ore bin at the top to concentrating tables at the bottom can be traced through all the pieces of machinery, including the launders. This mill never actually produced any ore, but its owners did not allow the machinery to be salvaged or sold.

Tailings dams were often built near mills to hold the tailings from the mills. Some tailings ponds, however, were established far from the mills they served, such as along the South Fork of the Coeur d'Alene drainage.

Industrial support facilities and residences were generally built as close to the placer or lode deposit as possible, but not on ground considered likely to be disturbed by the mining operations. Isolated gravesites are sometimes found close to a mine or mill. Cemeteries are generally located within a mile of the settlement they were associated with during the historic period. Transportation-related resources are generally linear corridors connecting clusters of activity.

Evaluation of Significance

The National Register of Historic Places is an important tool for evaluating and protecting mining-related and other historic properties. Properties eligible for listing in the National Register generally must be at least fifty years old and must possess two important qualities: historic significance and physical integrity. Evaluating significance involves assessing how well a specific property illustrates its property type(s) and how it relates to the historic context.

When evaluating historic resources, it is important to think in broad terms, not only to assess properties individually but also to assess their place in larger systems. Sites or features should be compared to similar sites or features in neighboring mining districts or the region whenever possible. Evaluating the property in question against other properties is not necessary, however, if the property is the sole example of a property type that is important in illustrating an aspect of the historic context or if it clearly possesses the defined characteristics required to be strongly representative of the context. Mining properties can gain significance if they operated a long time, were new or experimental, or were associated with important owners, engineers, or inventors. For example, a mill that represents a major change in technology or was the first or last of an era might be significant.

In some cases, it is necessary to evaluate an individual property such as one mine, particularly for undertakings that fall under the Section 106 compliance process. In such cases, it is still important to identify and conduct some research on the mining district in which the property is found, in order to provide a broader context for evaluating the significance of the property. In particular cases, such as when the property type is one not often found in Idaho (such as an intact arrastra or an aerial tramway), comparisons should be made whenever possible to similar properties in a broader region, such as the county or the state as a whole.

A number of documents should always be checked when researching a particular historic mining site or district. Consult the introduction to the bibliography included with this report for suggestions on documentary research.

Mining property boundaries should be selected to encompass, but not exceed, the full extent of the resources making up the property. In some cases, the boundaries of actual mining claims may be appropriate, such as a group of claims that had interlocking boards of directors, shared machinery, and so forth. In a placer mining area, a drainage that was worked by several methods over many years might define the historic district. The boundaries of a historic landscape should encompass the significant concentration of buildings, sites, structures, or objects that comprise the mining property, along with landscape features such as tailing piles and waste rock dumps. The edges may be legal or political boundaries, cultural features, historic boundaries, or natural or cultural features such as ridgelines, streams, or roads. For large, discontiguous sites, each discontiguous element of the site should be enclosed by a separate boundary. As inventories are completed, the eligible historic district will take shape.

Do not use arbitrary political boundaries such as today's national forests in defining the "best" example of a particular property type. More relevant boundaries are those based on topography or historic use, such as particular drainages or historic mining districts.

Some types of properties are usually excluded from the National Register. These are: cemeteries; birthplaces or graves of historical persons; properties owned by religious institutions or used for religious purposes; structures that have been moved from their original locations; reconstructed historic buildings; properties primarily commemorative in nature; or properties that achieved significance within the past fifty years. If the property being evaluated is one of these, determine if it meets any of the Criteria Considerations as described in National Register Bulletin 15. For example, cemeteries are generally excluded from the National Register. A cemetery, however, may be eligible as part of a historic district as a result of its association with historic mining activities. It may also be eligible because it is the grave of a highly significant person or due to its distinctive

design features, age, association with historic events, or information potential. Similarly, certain relocated components such as an ore cart, Wilfley table, or steam engine may be contributing features if the most recent relocation occurred over fifty years ago. Components of eligible districts do not have to meet the special requirements unless they compose the majority of the district or are its focal point. Examples of properties that generally will not be eligible include collections of mining artifacts removed from their original locations and placed in outdoor "artifact gardens"; reconstructed mining towns; and buildings, structures, and objects placed in museums.

A historic mining property that achieved significance within the past fifty years can be listed if research has demonstrated that it is exceptionally important. For example, if a particular strategic metal mine played an exceptionally important role in the nation's defense capabilities in the late 1950s or early 1960s, it may be eligible even though its period of significance is less than fifty years ago. Such a determination would require comparison with other mines with similar associations and qualities in order to identify the strongest candidates for National Register listing.

To be considered historically significant, a property must be eligible under at least one of four National Register Criteria. The four Criteria used for evaluating the significance of historic properties are as follows:

Criterion A is used for properties associated with events or patterns of events that have made a significant contribution to the broad patterns of mining on a local, state, or national level. Many properties in Idaho fall within this Criterion if they have sufficient integrity to reflect their association with an event or pattern of events. Themes for mining sites eligible under A could be engineering, exploration/settlement, business, commerce, community planning and development, conservation, economics, ethnic heritage, invention, labor, law, literature, military, science, social history, or industry.

Properties eligible under Criterion A might include placer mining claims along the Snake River, properties related to the development of flotation milling, or a silver-lead mine where important labor/management disputes were played out.

Criterion B is used for historic properties associated with the productive lives of individuals who played a significant role in the development of mining on a local, state, or national level. The property must be associated with the individual during the time when he or she achieved significance. In addition, the property must be associated with that aspect of the individual's life for which the person is considered significant. Finally, the property must be compared to others associated with the individual to determine which one best represents the person's significance. Applicable themes for nomination include exploration/settlement, invention, law, literature, politics/government, and labor.

Only a very few mining-related properties will be eligible under this Criterion. This is due to the difficulty of satisfying the requirements for Criterion B and to the prevailing lack of structural remains. Individuals considered significant on a state level include significant mine operators such as Henry Day and William H. Dewey.

An example might be the Hercules mine and mill (property of Henry Day), if it possesses integrity and if there are no better sites associated with Day. *Criterion C* is used for historic properties that embody distinctive characteristics of a type, period, or method of construction (technology), that represent the work of a master, that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction.

Engineering technology at a mine, mill, or smelter is the style created by mining engineers. The form of the buildings follows function very closely, so these properties are best described in terms of the processes at work at the site. Mills, smelters, hoist houses, and other buildings and structures have an industrial architecture that reflects their functions. The work of mining engineers may have significance based on their design and engineering innovations. This may include water conveyance systems, mills, smelters, and industrial support systems. The whole may be greater than the sum of its parts.

Properties eligible under Criterion C might include an open-pit mining operation, a mine and mill complex designed by an engineer, or a stamp mill with intact machinery and all aspects of the process visible.

Criterion D is most often used for archaeological sites that have yielded, or have potential to yield, information important to the history or prehistory of an area, generally based on artifact remains. Historic metal mining sites are often eligible for National Register listing under Criterion D but not under A, B, or C. To be eligible under D, they must contain important information about metal exploration, extraction, or beneficiation; industrial support activities; transportation networks; or mining-related settlements. Such sites might include the remains of a particular lode mine or

group of placer claims with no intact buildings or structures but with rich artifact remains or the location of a mill, if foundations and remains of machinery allow an understanding of the process at the site.

Archaeological evidence can supplement written primary and secondary sources, oral histories, and ethnographic observations. When the documentary record does not exist or is of little help, the physical remains of particular activities, such as building foundations and artifacts, may provide the only clues available today for understanding activities of the past. Methods for assessing the information potential of sites include conducting pedestrian surveys, recording surface features and artifacts, using subsurface detection instruments, and doing test excavations.

Under Criterion D, the property must have the potential to answer in whole or in part research questions that can only be answered by the actual physical material of cultural resources. Generally, the documentary record provides a context for interpreting the archaeological record. In some cases, the interplay between documents and archaeology may result in leaps in understanding not possible using either method alone. The physical evidence is usually in the form of artifacts, features, and ecological evidence (e.g., nonnative plant species). The remains containing important information may be buried or visible on the surface. The lack of other sources of information, such as written records or similar intact properties, generally increases the importance of an archaeological site.

For example, most mining districts had idiosyncrasies that reflected their environment and their history. Millers tried to reduce costs by using locally available materials and energy sources. Day-to-day operation of a mill or other ore beneficiation resource may have been greatly different from the descriptions in written records. Operational changes and replacement of machinery may have had to be made if the ore quality, contaminants, and hardness of rock changed. Little is known about the application of theory to practice prior to 1900. Intact mills might answer research questions related to adaptations of standardized technology and procedures to suit local needs.

Many historic mining properties do not have the potential of yielding important information and, thus, will not be eligible under Criterion D. At simple mining sites, the documentary record may be more informative than the physical remains.

In evaluating a property for significance under Criterion D, the following steps must be taken:

1. Identify research questions related to the historic context and characteristics of the site. The research questions may be framed in the form of a hypothesis.
2. Determine the specific archaeological and historical data needed to answer these research questions.
3. Determine whether the site contains sufficient archaeological data to address the research questions.
4. Identify other known properties that could better address the research questions.

Research topics and data requirements should be identified by conducting a literature review. A research design identifies problem domains and indicates why these research interests are significant, linking property types with viable research questions. For example, much work in western North America and in other countries has already been done on Chinese mining sites. Rather than justifying eligibility based only on the potential of sites to establish a baseline database, an attempt should be made to explain how the data available at the site will answer significant research questions.

Research questions should be designed to increase the understanding of the broader context in which particular events in Idaho occurred. Do not ask questions of archaeological data that could be better answered through documentary research and oral interviews. Research questions that simply verify historical documentation, or that reconstruct food practices or industrial technology that are already understood, should be considered trivial.

Research questions for evaluating the significance of an archaeological site can be asked at three different geographical scales: the world system, the mining district, and the locality. Broad questions that synthesize data and link the historic context to the physical resources are best. It is important to avoid posing questions from the perspective of an individual site. Narrowly defined questions must be relevant to broader questions about human behavior. Consult the section in this report entitled "Possible Future Research Questions."

The investigator should choose a broad theoretical perspective for determining which questions to ask when evaluating site significance under Criterion D. Such research strategies currently in favor include evolutionary ecology, Marxism, cultural materialism, structuralism, symbolism, power theory, and contextualism.[332] Each provides a set of principles and a questioning framework that can be used to explain mining communities. All look at patterns in the archaeological record.

Because archaeological research is evolving and

dynamic, appropriate research interests are continually answered, debated, and modified. This means that the research questions of the future–and the kinds of data needed to answer these questions–cannot be determined with certainty.

To summarize, the following principles should guide evaluations of the significance of historic mining-related properties:

- Complete documentary research and prepare a local historic context that is integrated with the statewide context in this report before undertaking the field inventory.
- Evaluate feature systems using an interdisciplinary approach blending history, archaeology, engineering, and anthropology. Evaluate entire systems rather than individual features or property types.
- Compare sites or features to similar sites or features in neighboring mining districts or the region whenever possible.
- Understand that historic mining and milling sites are not and do not need to reflect "moments in time." Mining districts are characterized by cycles of occupation and abandonment, which create layers of feature systems.
- Design research questions to increase the understanding of the broader context in which particular events in Idaho occurred. Do not ask questions of archaeological data that could be better answered through documentary research and oral interviews.
- Generally, define complex industrial mining landscapes that have evolved over time as historic districts.

Integrity Thresholds

Integrity is the ability of a property to convey its significance. A property with integrity should have the physical characteristics necessary to convey a sense of why, when, and where the site is important. To be independently eligible for listing in the National Register, a property must possess integrity and must be significant under at least one of the four Criteria discussed in the preceding section. Physical integrity refers to the actual physical condition of a property at the time it is being evaluated. It takes into consideration such basic factors as the extent of natural decay and intentional alterations. If the property retains surface integrity, it may be eligible under Criterion A, B, C, or D. If it retains only subsurface integrity, it may be eligible only under Criterion D.

The period(s) of significance for a mining property is the time range during which it was occupied or used and for which the property is likely to yield important information. The general character and feeling of the historic period must be retained for eligibility. The period of significance of a particular property is the benchmark for measuring whether subsequent changes contribute to its historic evolution or alter its historic integrity.

To retain historic integrity, a property will always possess several, and usually most, of the aspects. In evaluating a property, first determine which of the aspects of integrity are most important in conveying the significance of the resource (this requires knowing why, where, and for what period the property is significant). These receive more weight during the evaluation process than the others. Thus, integrity depends to a substantial degree on the property's historic context(s).

When evaluating integrity, determine which aspects are critical for the property and whether they are present. The seven aspects of integrity are:

- *location*–**The place where the significant activities that shaped a property took place.** Some types of mining equipment, such as stamp mills and steam boilers, were designed to be relatively portable. Even buildings may have been moved within and between mining sites. Pieces of equipment moved onto a site later than the historic era of significance are not contributing elements, but they may not detract substantially from an otherwise intact site. "Artifact gardens" lack integrity and are not eligible. Integrity of location for portable buildings and machinery may not be required if they retain integrity of setting.
- *design*–**The composition of natural and cultural elements comprising the form, plan, and spatial organization of a property.** The patterning of structures, buildings, and discrete activity areas relative to one another is important under this aspect. For an archaeological site, integrity of design applies to intra- or inter-site patterning. Design may be illustrated by the plan or layout of an engineered mine complex, railroad, or company town. The cumulative effect of missing components in a designed system must be considered.
- *setting*–**The physical environment within and surrounding a property, including small-scale elements.** Integrity of setting includes topographic features, views, landscapes, man-made features, and relationships between buildings and other features. Modern intrusions such as the leveling of dredge piles, the building of modern dwellings, or recent mining activity compromises setting. Settings for many mining properties are transitory by nature as a result of activities such as logging and other landscape changes. Natural vegetation changes do not affect the integrity of the setting. Recent open-pit mining may destroy the integrity of a mining site significant for earlier mining activities.
- *materials*–**Construction materials, including vegetation.** Materials should be original unless remodelings reflect a series of significant historic occupations. Any repair and restoration work should have been done with comparable materials. Recreations of buildings or structures are not eligible.

- *workmanship*–**How people have fashioned their environment for function and decorative purposes.** The site should retain evidence of original workmanship (technology, crafts, or aesthetic principles). Mining machinery and equipment should reflect the workmanship of the person who designed it and, if appropriate, the modifications made by the user.
- *feeling*–**Presence of physical characteristics that reflect the historic scene; the cumulative effect of setting, design, materials, and workmanship creates the sense of past time and place.** Integrity of feeling is present if a site's features in combination with its setting convey a sense of the property during its period of significance. Weathering is generally more significant in forested areas than in dry landscapes. Erosion and re-vegetation of tailings, waste rock dumps, and other topographical features diminish the integrity of feeling of a landscape. Many large-scale features, however, such as open pits or waste rock dumps, are very long lasting and are important components of historic mining districts. The feelings evoked by abandoned mining complexes can reflect the character of the boom and bust cycles that typify mining. The loss of this feeling of isolation and abandonment due to modern development can diminish the integrity of a mining property.
- *association*–**The direct line between a property and the important events or persons that shaped it.** The physical aspects of the mining property such as structures, machinery, and landscape features are sufficiently intact that the property conveys a sense of the historic mining activities that occurred at the location. Geographical information, such as the property's relationship to natural resources and topographical features, are also important. Integrity of association must be demonstrated by historic research.

Two other aspects of integrity are useful for evaluating the integrity of historical archaeology properties: visibility and focus. Visibility refers to the relative abundance of material remains and how observable they are today. Focus is the extent to which the physical remains can be interpreted clearly and can be linked to the historic property. Sites with good visibility have building remains, machinery, large artifact scatters, and other similar features. If the visible remains have been highly altered, they may lack focus because their historic appearance has been lost so that historical and archaeological methods cannot interpret the sites.

The integrity of mining properties frequently depends less on the condition of the extant buildings than on the degree to which the overall mining system remains intact and visible. A comprehensive assessment of integrity considers all the component parts of a mining system. Deterioration of individual aspects of the system may not eliminate the overall integrity of the resource, if there is clear physical evidence of a complete system. A property without standing buildings can be eligible if other features have integrity and if key aspects of the mining system remain visible. Thus, a mining site with shafts, adits, mill foundations, tailing piles, waste rock dumps, tramways, and ore bins might retain integrity. A property may be considered contributing to a historic district even if its components lack individual distinction. The combined impact of the separate components may enable the property to convey the collective image of a historically significant mining operation.

For a district to retain integrity as a whole, the majority of the components that make up the district's historic character must possess integrity even if they are individually undistinguished. Also, the relationships among the district's components must be substantially unchanged since the period of significance. A district is not eligible if it contains so many alterations or new intrusions that it no longer conveys the sense of a historic environment. Generally, human-caused changes that are not in keeping with the surrounding environment are considered adverse factors to integrity, while natural changes to the setting, such as the maturing of a forest, are not necessarily adverse.

It is appropriate to accept a greater degree of alteration or fewer features for rare or highly important sites. For example, an early 1860s placer mining site that has not been greatly altered by later mining activity would have relatively high significance because such sites are rare. Sites from periods that are less important to the history of Idaho may require more integrity. But small mines that produced little or even no ore may still be significant.

Most of Idaho's mining districts experienced several cycles of near abandonment and then reoccupation. Many of the miners were highly mobile; sites were reoccupied or rebuilt in adjacent locations, and cabins were sometimes salvaged and rebuilt elsewhere. Mining equipment and machinery, too, was often moved from one place to another rather than abandoned. The mining activity of more recent years is often responsible for most of the existing mining landscape. For

example, large-scale hydraulic mining activities have destroyed the physical evidence of earlier rocker and sluice box operations in many areas. Such activities as the removal of old mill tailings for reworking, construction of new roads, covering earlier camps with waste rock, dredging operations, and cutting across old shafts, adits, and underground workings damage the archaeological record. For some placer grounds and lode mines, temporal markers in domestic refuse and debris may be the only way to distinguish these different periods of use or to date a particular feature.

Large-scale mines are generally still connected by roads built along the same corridors as the earlier wagon and truck roads. The extant landscape conveys a feeling of continuity, even though most of the vegetation in the area has regrown after being cut for fuelwood and mine timbers during the past. Despite alterations, the landscape features and patterns of spatial organization should still be discernible when viewed as a system. The arrangement of natural features, tailings piles, structures, transportation networks, waste rock dumps, mill tailings, and clusters of development retain integrity of design, setting, and association.

The integrity of a mining landscape is lost by the cumulative effect of relocated and lost historic buildings and structures, interruptions in the natural succession of vegetation, realignment or widening of roads, modern mining uncharacteristic of historic methods, disturbance of archaeological sites, filling in of ditches, and the loss of small-scale features. For example, some mining districts may today exhibit many historic mining landscape features such as adit openings and waste rock dumps but no standing buildings. These may be scattered over a large area. Such a landscape may not retain its integrity due to cumulative losses of buildings and other features and the overlay of modern mining and perhaps resort activities. Such an area also has lost its information potential and should not be considered eligible to the National Register as a historic district.

The following sections discuss particular considerations when evaluating integrity under the four Criteria.

Criteria A and B

Under Criteria A and B, the associative aspects of integrity are generally emphasized. These are the property's relationship to important persons, activities, and events. Properties significant for their historic association are eligible if they retain the essential physical features that made up their character or appearance during the period of its association with the important event, historical pattern, or person(s). Would a person from the historic period recognize the property as it exists today? Evaluating integrity of feeling and association relies to some degree on subjective perceptions. These attributes by themselves are not sufficient to make a case of integrity.

When nominating historic archaeological sites under Criterion A, integrity of location, design, materials, and association are of primary importance. Integrity of setting within the site is important. The site must also have both visibility and focus.

Criterion C

Under Criterion C, physical characteristics are generally emphasized.

A property significant under Criterion C must retain most of the physical features that constitute the style or technique it represents. It must clearly illustrate the design and construction of the building, structure, or engineering feature. Integrity of materials and workmanship are very important, and integrity of setting is usually important, particularly for historic districts. It must possess both visibility and focus. It also must provide a good illustration of particular technological or architectural types. Elements to be considered include buildings and machinery and landscape features. Buildings may have collapsed, machines may have been salvaged, and rail tracks removed. Yet, the combination of paths, roads, shaft openings, trash dumps, remains of headframes, large waste rock dumps, and tailings piles may collectively create a landscape that conveys a sense of the processes used at the mine and mill. The flow chart from the mine opening to the mill and perhaps beyond should be able to be reconstructed. Evaluate the site's ability to illustrate the property's evolution through time. Underground workings do not need to be inspected for integrity if the mine is unsafe.

Archaeological sites eligible under Criterion C must be in overall good condition with excellent preservation of features, artifacts, and spatial relationships. These remains should be able to illustrate a site type, time period, method of construction, or work of a master. Integrity of feeling also adds to the integrity of archaeological sites or districts.

Criterion D

For properties eligible under Criterion D, integrity is based upon the property's potential to yield specific data that address important research questions. The archaeological deposits must be relatively intact and complete in order to retain integrity. The integrity requirements relate directly to the types of research questions defined by the research design. In general, archaeological integrity may be demonstrated by the presence of spatial patterning of surface artifacts or

features that represent differential uses or activities; spatial patterning of subsurface artifacts or features; or lack of serious disturbance to the property's archaeological deposits. Cultural and environmental formation processes must be considered in evaluating an archaeological site's integrity (for example, children playing with discarded items affects the archaeological record).

Under Criterion D, the aspects of location, design, materials, and association are generally most relevant. Integrity of materials is generally described as the completeness or quality of the artifact assemblage and feature preservation. Integrity of association is based on the strength of the relationship between the site's content and the important research questions.

Evaluating integrity of properties under Criterion D may emphasize associations with events, trends, or individuals; representatives of a group; or physical characteristics. Integrity of association is measured by the strength of the relationship between the site's data or information and the important research questions.

Subsurface integrity means that the relationships among the various cultural constituents contained by sediments or buried by duff are relatively undisturbed on a scale that satisfies the data requirements of research questions. Integrity of materials is usually described in terms of the completeness of the artifact/feature assemblage, the lack of intrusive artifacts and features, and the quality of artifact or feature preservation. The integrity of setting is not necessary if the site has important information potential. Good focus (but not visibility) is necessary. Sites with more than one occupation may lack focus if their archaeological remains are mixed and if the episodes of use cannot be distinguished.

Test units may show the presence or absence of artifacts and features below the present ground surface. Probing or remote sensing may aid in determining the presence of subsurface components of a site. Testing is done to determine the information potential of a site and to define the boundaries of the archaeological deposits. If the patterning of artifacts and features on the ground surface is sufficient to warrant eligibility, however, then formal subsurface testing may not be required.

Some artifacts provide specific indicators of gender and age of user, of activity (such as assaying), and of manufacturer. The contents of artifact scatters, trash dumps, and privies can provide insights on aspects of subsistence, consumption patterns, demography, ethnic affiliation, material diffusion, technological change, and temporal parameters. Cabins and other dwellings can yield information on architecture, economic status, chronology, demography, material consumption and production, ethnic affiliation, subsistence processes, and social structure.

The archaeological data needed to answer specific research questions must be defined in order to evaluate the integrity of archaeological sites. For example, questions about mining technology and the workplace require data about variability and change in architectural arrangements, the spatial arrangement of work-related activities, the function and arrangement of machinery, and landforms. This information can be used to understand the processes, to link archaeological features from other locations, and to evaluate the potential of the mining site to meet the data requirements of the key research questions.

For example, if the research questions relate to ethnicity and ethnic relations, the site must be datable and must include a significant number or pattern of ethnicity markers. This is not always clear-cut; for example, the presence of Chinese opium tins at a site does not necessarily imply that the site was occupied by Chinese. For questions related to frontier consumer behavior, the site must be datable and contain a diverse and/or significant amount of the following categories of information: date and place of manufacture or origin; whether the artifact is hand-made or mass-produced; and sufficient evidence of subsistence patterns or consumer behavior. Questions about consumer behavior generally require comparisons to other sites.

Many research questions that are broad and not site-specific require comparisons to be made with other similar sites of the same or different time periods. For example, questions about spatial relationships among subsistence versus industrial mining sites would require examining many sites. An adequate database, therefore, would include many similar sites with appropriate archaeological data within a well-defined cultural landscape (drainage basin, mining district, or state, for example).

Some sites may be significant for their potential to yield information important to the science of historic archaeology. For example, archaeological records can act as a check on documentary research. This type of work needs to be well designed to avoid being trivial or redundant, however. Sites that were occupied for a very short period may be used for cross-dating and for studying the rate of technological diffusion into households and industrial sites on the mining frontier. Artifact collections, particularly from a site with a brief period of use and no significant contamination by multiple users, might serve as good comparative collections, but this requires knowledge of which periods of mining history are under-represented in existing collections.

Applying the Concepts of Evaluation and Integrity to Mining-Related Property Types

Evaluating the remains of historic mining activities can be quite challenging. Surviving buildings and technology are not common at mining sites. Most mining operations consisted of buildings and machinery that could be relocated as necessary when the ore or financing was exhausted. Much abandoned machinery has been salvaged or sold. Many mining-related sites today are characterized primarily by landscape features and archaeological features such as foundations and trash dumps.

The primary requirement for a property to be eligible for listing in the National Register is that historic values are tied to tangible properties. The significance of a historic mining property–whether a building, structure, object, site, or district–should be determined based on an understanding of the history of the area. The historic context, therefore, allows for a comprehensive evaluation of a historic mining property's significance. Individual properties associated with the historic context of metal mining in Idaho generally should be compared with other properties related to that context in order to evaluate their relative significance.

Historic mining landscapes often consist of the remains of many property types. Assessment of the landscape's significance and integrity should include discussion of the significance and integrity of the individual property types and of the overall landscape characteristics and qualities.

The following sections outline considerations about evaluating significance and integrity for each of the groupings of property types defined in this report beyond the general considerations discussed above.

Exploration Resources

Significance: Exploration-related resources found at mining sites today have probably survived only because they were located in low-value areas that did not end up being developed. They are unlikely to be eligible under Criterion A or B except as contributing elements of a historic district. They are often associated with rampant speculation or boom and bust cycles, often financed by out-of-state investors. A combination of research and fieldwork may reveal a pattern of prospecting features that offers physical evidence of this speculative phase of mining. To be independently eligible under Criterion C, in the area of engineering, the exploration feature must be a representative or unique example of prospecting methods. If considered representative, then comparison with other exploration features in the mining district or state must be drawn. In order to be independently eligible under Criterion D, the exploration resource must be able to yield important information on the historic functions or engineering of the mine.

A grouping of hand-dug prospect pits and trenches along a ridge, with no other associated features, is generally not eligible.

Integrity: Prospecting and exploration features are contributing features of placer or lode mine sites or of a historic district if they retain their basic physical characteristics of location, design, workmanship, and association. Modifications caused by the growth of vegetation or by subsequent mining activity during the historic period will not negatively affect integrity, but modifications caused by human activity after the historic period (the partial filling in of a pit with a bulldozer, for example) may make the feature or the property ineligible or non-contributing. The boundaries of a mining site that includes prospecting and exploration features should encompass these features. If exploration features cannot be associated with other mining-related cultural resources, they are not independently eligible.

Placer Mining Resources

Significance: The remains of placer mining activity in Idaho may be eligible for listing under Criterion A if they are associated with an important source of placer gold such as particular drainages in the Boise Basin. Under Criterion B, they should be clearly associated with a significant

miner or investor. To be eligible under Criterion C, the resource must be a representative or unusual example of an important placer mining technology or of building design and construction. To be eligible under Criterion D, the resource must be likely to yield significant information on placer mining in Idaho.

A claim worked by hydraulics that has evidence of the water conveyance system in the form of a dam, ditch segments and pieces of metal piping, cutbanks and a concave washing pit, pieces of a sluice box, a tail race, and stacked cobbles would probably be eligible. In this case, the components lack individual distinction but the site retains enough integrity to illustrate the process. A dredging site that today has only tailings would not be eligible unless the tailings can answer a research question better either on its own or in comparison with other sites.

Integrity: Resources related to placer mining should retain integrity of design, setting, materials, and association. Placer mining sites should be documented, mapped, and evaluated as processes, not as clusters of isolated features. Each historic mine was once a well-integrated complex of water delivery systems, residential areas, mining areas, waste deposit areas, and transportation and possibly communications networks. The property as a whole should illustrate its relationship to the historic context.

If the property's design has been altered, the modifications should have been made within the period of significance or should be sympathetic to the original design. When evaluating a structure such as a dredge, all parts of the structure must be considered. If a structure has lost its configuration or pattern of organization through deterioration or demolition, it is usually categorized as an archaeological site and evaluated under Criterion D.

Integrity of setting means that the surrounding area should look the way it did during the period of significance for the property. Most if not all of the ground that was placered in the early years of a district was reworked several times; often all evidence of the earliest work has been obliterated. Flooding may have obliterated other features, such as ditch intakes or wing dams.

Standing buildings (primarily dwellings) associated with placer mining activities will not be individually eligible under Criterion A unless other associated mining-related features present help to provide a more complete picture of the activities at the location. Buildings may be individually eligible under Criterion C if they possess unique or representative architectural characteristics, however. A mine complex that consists of only minor ruins and small-scale elements, such as pieces of piping or stacks of rock, will not be independently eligible under Criterion D because these features cannot reflect the process and do not contain significant information for answering research questions.

Placer mining equipment was frequently moved from one claim or even mining district to another during the historic period. Integrity of location is, therefore, not critical for some resources. Although movable, an object such as a sluice box or a dredge is associated with a specific setting or environment and should be in a setting appropriate to its significant historic use, role, or character. In addition, tools or pieces of equipment were often reused in ways different from their original purpose. Possible reuse of items should be considered, because such reuse often removes artifacts from one chronological and functional context to another within the same mining district. Mining machinery that was moved to the location within the property's period of significance is considered contributing to the significance of the property even though it is not in its original location.

A hydraulic mining site that has been extensively salvaged or vandalized, has no standing structures, few if any foundations, no mining equipment, no undisturbed deposits of artifacts containing diagnostic items, and a water conveyance system that has been greatly modified by road construction has lost its integrity and is not eligible.

Resources Related to Extraction at Lode Mines

Significance: To be eligible for listing under Criterion A, a lode mine must be a good illustration of the type of development work and/or production done at area mines during the period of significance. The mine does not need to have been a big producer, as long-term development work and speculation played a significant role in many mining areas. Under Criterion B, the property should be clearly associated with a significant miner or investor.

For eligibility under Criterion C, the mine must provide a very good, relatively intact example of the surface workings at a lode mine, whether small-scale or large-scale. The technology of tunneling, shoring, ventilating, and transporting miners, supplies, and ore involve distinctive characteristics of a type that may be eligible under Criterion C if they retain integrity and if historic associations can be documented. Some mines may exhibit different technologies for the same function. For example, one mining site could have the

remains of a whim, steam-driven hoist engine, and a system driven by an electric engine. Such a site is a good example of how the archaeological record is the cumulative end product of all past human activities at a particular site.

Some lode mines may be eligible under Criterion D because they have the potential to yield information needed to answer significant research questions. Waste rock dumps and underground workings at a lode mine may provide information about the local geology and the ore deposit that was being worked. Ore samples can reveal whether the ore was high-grade or low-grade and whether it was being taken from the oxidized or the sulphide zone. This information potential alone, however, does not make the site eligible under Criterion D.

A relatively undisturbed lode mining site that has several collapsed adits, structural remains near portals, a shaft with remains of a headframe, waste rock dumps, a network of roads and trails connecting the mine openings, an ore chute, ore cart rail, and the foundations of a mill may be eligible as an archaeological site if it has the potential to answer significant research questions.

Integrity: Resources related to extraction at lode mines generally must possess integrity of design, setting, materials, association, and feeling in order to be eligible. The property as a whole must retain sufficient integrity to illustrate the various steps in the process of lode mining.

Mines typically evolve through time and do not reflect their original construction plan, but they should be able to illustrate the property's evolution. When describing a lode mining complex, it is helpful to explain the discrete steps necessary for the process and to identify the observable features and artifact assemblages that are still present to illustrate each step. For example, there might be features or artifacts associated with the following processes at a lode mine: hoisting ore, dumping waste rock, pumping water from the adit, transporting ore to the mill, hauling waste rock to the dump, and repairing tools.

It is ideal to reconstruct the underground structure of mining sites, but this is rarely possible due to the lack of diagrams of the underground workings and the hazardous nature of most abandoned mines. So, design integrity will generally be evaluated by the property's ability to reconstruct the flow chart from the mine opening and on to the mill and beyond.

The removal of small machinery does not affect integrity except under Criterion C. Mines that consist only of an adit and associated waste rock dumps, with typical construction design and materials but no mine support features or handling, transportation, or milling facilities, are probably not independently eligible. Such mine openings and dumps would, however, contribute to a historic district. A mine complex that consists of only minor ruins and small-scale elements such as vents, ore bins, and wood piles will not be independently eligible under Criterion D because these features cannot reflect the process.

Lode mining sites that have been worked in recent decades have often lost several aspects of integrity because modern machinery and exploration and mining methods tend to change the landscape significantly. Historic building remains may have been bulldozed aside, trenches may have been dug with bulldozers, and a maze of modern roads may have been constructed. An open-pit mine that has operated since the historic period retains its integrity if recent extraction methods have been similar to those practiced during the historic period and if the character of the pit has remained basically the same, even though it is larger than it was during the period of significance.

Ore Beneficiation Resources

Significance: Ore beneficiation resources may be eligible under Criterion A due to their association with the development of the milling industry in Idaho. Under Criterion B, they may be eligible if they are associated with a significant individual. And under Criterion C, they may be eligible under engineering if they retain sufficient machinery and remains of the power system(s) to illustrate the various steps of processing at the mill. For eligibility under Criterion D, they must be likely to provide information needed to answer significant research questions.

In order to be significant under Criterion D in terms of research questions related to industrial technology, the property must be dateable and must contain features or artifacts with enough integrity to provide information not available in written records about the equipment or processes used. If a mill is partially destroyed, it is not eligible if comparison indicates that similar properties with more integrity have been identified. Tailings and slag heaps can provide information about the local geology, scale of mining operations, and concentrating and re-treatment techniques. This information potential alone, however, does not make the site eligible under Criterion D; it must be tied to research questions that cannot be answered by other means such as documentation.

A flotation mill that is still standing and has some

of the machinery inside, such as a steam boiler, primary crusher, ball mill, and flotation cells, may be eligible under Criteria A and C. If the mine openings, water conveyance system, and transportation network also have good integrity, the site could be eligible as a representative example of a complex mining system.

A smelter site that contains only foundations, minimal evidence of the transportation network, and a slag dump is not eligible unless these features can answer significant research questions.

Integrity: In order to be eligible for listing under A, B, or C, a property related to ore beneficiation generally must possess integrity of location, design, setting, materials, and association. Ideally, the remains of the mill convey its significance as a key component of the overall industrial system. The integrity of a mill is enhanced by the identification of the mines that provided the ore and the place where ore was delivered to the mill; by evidence of the power system; by identification of the places where crushing, grinding, concentrating, flotation, and amalgamation were conducted; by the presence of mill tailings; and by the transportation network. Many of the mills in Idaho possess poor integrity and, thus, will only be eligible under Criterion D, if at all. They are less likely than residential features to contain artifacts specific to particular ethnic or other groups (corporate or mass-produced design and materials mask individual choice). The remains of mills, their power systems, associated equipment such as vanner tables, and mill tailings generally contribute to a historic district, however. Small-scale features such as stacks of firewood or an ore chute would not be independently eligible.

A mill, smelter, or refinery needs greater integrity to be eligible under Criterion C than under Criterion A. Integrity of design is generally limited to the ability to reconstruct the flow chart from the mine opening to the mill tailings piles. A process flow chart is essential for understanding the metallurgy at a particular mill, along with drawings of existing machinery and other features. For example, an arrastra or stamp mill will not be eligible under A, B, or C unless it possesses enough features to reveal its functioning (thus, an arrastra site that today consists of only the coping and drag stones would not be individually eligible unless it contained information potential).

If milling equipment such as a flotation tank or vanner table was moved to the site from its original location during the historic period, this does not detract from the site's integrity so long as it contributes to the significance of the property to which it was moved.

If the mill was associated with a particular mine, as most were, the property boundaries should include both the mine and the mill. If it was a custom mill or smelter, then the boundaries will most likely be the boundaries of the millsite itself.

Industrial Support Resources

Significance: A great variety of support facilities were necessary at Idaho's placer and lode mines. They played a significant role in mining operations and in the development of the area as a whole. Support facilities can be eligible under Criterion A due to their association with mining-related activity in the district. They may also be eligible under Criterion B as a result of their association with significant individuals in local or state history. Under Criterion C, they are eligible if they are unique or representative examples of particular styles of construction or engineering design. And under Criterion D, they are eligible if they have the potential to contribute information necessary to answer significant research questions about the mining property.

The artifact assemblages present at some industrial support sites might be significant as good comparative collections of tools. A literature review must be done in order to determine which periods or aspects of mining history are under-represented by this type of collection. The site itself must have been used for a relatively short period of time, with no contamination by multiple users with various purposes. At a blacksmith shop, for example, tools used by the blacksmith and repaired tools are of more interest than the repair scrap. One archaeologist recommends that at least three tools or tool fragments per square meter of excavation should be present for the collection to be useful for comparative purposes. She cautions that the range of shop tools and types of repairs probably could be more reliably identified through contemporary textbooks about shop practice than through excavation.[333]

Water conveyance systems were used for many purposes, and their purposes must be determined before they can be evaluated. They may have brought water to placer or lode mining operations, to machinery in a mill, to residences and other buildings at a mine, to gardens or orchards, to fire-fighting systems, or to sawmills and other support plants. The network should be traced from the source to the destinations.

Landscape features such as ditches, flumes, and trestles are contributing features of sites or districts if they are still recognizable. After an adequate representative sample of linear features such as ditches have been recorded, such features will not be independently

eligible for listing as representative examples without association with other features of the entire mining system. Examples of rare or innovative techniques may be eligible under Criterion C.

Mining operations that were unsuccessful, even ones that failed to produce any gold, may still be eligible. An example would be the remains of a claim developed by a well-financed company that put in extensive preliminary work such as water conveyance systems. Such a site can illustrate the speculative nature of mining.

Mine support facilities must be evaluated as part of the overall mine and mill system. Thus, an office building that would not be eligible on its own might well be a contributing element of an eligible mining site due to its association with other features such as a shaft and the remains of a mill. The boundaries of mine support facilities, like those of all mining-related sites, should encompass all of the related features at the site, including the mine, mill, residential, and transportation features.

One researcher has defined the data requirements for answering research questions related to acculturation of Chinese blacksmiths. These include definitive proof that the feature in question was used by Chinese workers: broken or repaired tools and workshop scrap; catastrophic destruction of the shop so temporally distinct occupations can be isolated; and association of the workshop with contemporary residential features in order to compare acculturation in the work and home spheres. The required non-archaeological information would include reports on existing archaeological work at Euroamerican blacksmith shops; contemporary textbooks about shop practice; and information on artifact assemblages from blacksmith shops at homeland Chinese sites or at very early mining sites (probably in California) to establish a pre-acculturation baseline.[334]

Integrity: Mine support facilities must possess integrity of design, setting, materials, and association to be eligible for listing under Criteria A, B, or C. Eligible buildings must include all of their basic structural elements. The whole building or system must be considered, and its significant features must be identified. If a building has lost its basic structural elements, as is true for many of the log cabins and frame buildings in Idaho's mining districts, it is generally categorized as a site and evaluated under Criterion D. Under Criterion D, the resources must retain sufficient integrity to provide meaningful information on particular research questions. If the support facilities have been relocated, they generally must have been moved during the historic period to be eligible for listing.

An extensive water conveyance system that has good integrity of all aspects of the system could be eligible under Criterion C even if other parts of the mining system are no longer evident. Features that are necessary, whether collapsed or intact, would include the dam, headgate, ditches and flumes, pressure box, penstock, and feeder ditches. This would require very high integrity, however, and comparison with other water conveyance systems that still have associated features intact (such as the hydraulic mining site or Pelton wheel).

Industrial support resources generally are not eligible unless other aspects of the mining system also have good integrity. Thus, a ditch and flume system missing evidence of a dam and leading to a mining area that has been greatly disturbed would not be eligible. The remains of an assay office at a site that has lost integrity as a system would not be eligible unless it could answer research questions specifically tied to that type of resource.

Properties that are associated with power production and supply must have integrity of configuration and organization as a system to be eligible. For example, a dam/ditch/flume/penstock system feeding water to an intact Pelton wheel that powered a compressor, with the appropriate drive belts still intact, would possess integrity.

Residential Resources

Significance: Residential resources associated with historic mining properties may be eligible under Criterion A if they reflect their association with important aspects of mining history. Under Criterion B, they must be associated with a significant individual to be eligible. For listing under Criterion C, they should be a unique or representative example of a particular style of construction. And under Criterion D, they must have the potential to answer significant research questions.

Company towns might be eligible under both Criteria A and C due to their association with the pattern of large corporations building communities for employees and due to distinctive architectural characteristics that the buildings may embody. A company town in which all the buildings have been removed and the townsite bulldozed would not retain sufficient integrity to be eligible, no matter how historically significant the town once was. A group of datable dugouts along a placer gulch would be eligible if they had sufficient artifacts associated with them to answer important research questions.

Integrity: Residential features associated with mining sites should possess integrity of design, setting, materials, and association to be eligible for listing under Criteria A, B, or C. Eligible buildings must include all of their basic structural elements. The whole building must be considered, and its significant features must be identified. If a building has lost its basic structural elements, as is true for many of the log cabins, frame buildings, and dugouts in Idaho's mining districts, it is generally categorized as a site and evaluated under Criterion D. If the building has been relocated, it generally must have been moved during the historic period to retain integrity. Under Criterion D, the property must retain sufficient integrity to provide meaningful information on significant research questions.

The remains of dwellings and residential areas at placer mines may be able to answer research questions about variability and change among households, demography, social geography, ideology, consumer behavior, ethnicity, class, and gender roles. For example, a Chinese dwelling rich in Chinese ceramics and other diagnostic artifacts might be eligible under Criterion D as a result of its ability to answer significant research questions. Privies and dumps associated with mining sites occasionally provide large enough collections of artifacts and other materials to allow statistically valid data analysis. A cemetery might contain information on ethnic groups and on the health of common people that is not otherwise available.

For research questions related to class and status issues, the sites to be analyzed must be datable and must contain a significant quantity and diversity of items that can be identified as luxury or higher-status goods; recycled goods; and manufactured or locally obtained items. The various features must reflect differences in total numbers and variety of artifacts and other indicators of class such as living space.

Transportation Resources

Significance: For a trail or road to be eligible under Criterion A, it generally must possess sufficient integrity to illustrate overall patterns of history associated with the transportation of individuals and freight within a mining district. For example, a trail corridor would be eligible if the tread is present, the vegetation has not been significantly changed by human activity, and blazes are still evident. A transportation resource is unlikely to be eligible under Criterion B. Under Criterion C, the property must be a representative or unique example of a certain type of engineering design. To be eligible under Criterion D, the property must be sufficiently intact to answer significant research questions.

Trails and roads associated with lode or placer mines require verification that today's corridor is the actual location of the historic travel corridor. Natural ecosystem changes over time will not detract from overall integrity, but man-caused changes after the historic period will. Transportation resources that can be identified only by historic records need to be distinguished from those that can still be located on the ground.

A historic wagon road with associated features such as hand-dug cuts, way stations, and trees with snubbing marks would probably be eligible. A historic trail to a mine, with no distinguishing features, would not be independently eligible.

Integrity: Transportation-related resources should retain integrity of location, design, materials, workmanship, and association. When evaluating linear resources such as trails, roads, or railroads, examine and evaluate the historic corridor that connected all associated areas of activity that worked together as part of the larger system.

Routine maintenance work on a road such as grading, applying layers of gravel, or replacing culverts does not significantly alter integrity. Increasing road width or rerouting segments does affect integrity. Replacement of ties, rails, and other components of a railroad reduces integrity of materials but does not disqualify the line from listing. Changes related to adaptations made during the historic period (such as removal of certain railroad sidings) do not substantially diminish integrity. Abandoned railroad grades, even ones that have been converted to recreational trails, can still convey the essential nature of a linear transportation resource linking communities and industrial sites. Retention of historic bridges, culverts, and signage strengthens integrity.

Transportation resources that have lost engineering features are generally not independently eligible under Criterion C. Only sites with significant and unusual subsurface data are eligible under Criterion D, if they have the potential to answer significant research questions. Locations of associated buildings have more potential for containing data allowing the answering of research questions.

Impacts/Needs Assessment

Threats to Historic Mining Properties

Many of Idaho's historic mining sites have been destroyed, damaged, or altered; isolated from their setting; or neglected so that the property deteriorates and ultimately is destroyed. Many, if not most, mining sites in Idaho have been reduced to archaeological sites. Various aspects of the natural and cultural environment threaten the remaining historic mining-related resources. Natural factors include heavy snow loads on buildings, wildland fire, floods, erosion, collapse of adits and shafts, and weathering. Erosion particularly affects wooden features, landscape features such as tailings piles, and sites along rivers and lakes.

Cultural threats to mining-related sites include renewed mining activities, logging, salvaging of machinery and building materials for reuse or for firewood, grazing, farming, intentional demolition of buildings by owners, widening and resurfacing of historic roads, modern alterations of buildings and structures, off-road vehicular use, recreational activities, road construction, building of summer homes and resorts, misguided clean-up efforts, over-visitation, construction of dams and reservoirs, neglect, and government-mandated reclamation and hazard-reduction work. Vandalism has also taken a toll at many historic mining sites, particularly those that have road access. Since at least the 1890s, people have been collecting and taking home artifacts from earlier mining periods.

Renewed mining activity in an area, particularly with larger-scale machinery and methods such as dredges or bulldozers, often destroys older mining features. Sometimes waste rock is dumped on top of historic sites. In 1968, the U.S. government abandoned the gold standard, and gold prices soared in the 1980s. This encouraged extensive exploration and some new mining operations. Modern methods such as open-pit mines, tailings ponds, and heap leaching can be very destructive of large areas of ground.

In recent decades, federal legislation has emphasized abandoned mine reclamation and hazardous mine waste cleanup. This work aims to eliminate or abate physical hazards and to restore lands and waters degraded by mineral extraction. It includes stabilizing waste rock dumps, removing buildings and structures, excavating and removing tailings, closing hazardous adits and shafts, and completely cleaning up hazardous sites such as the Bunker Hill smelter. This work has had a tremendous impact on many sites.

The Idaho SHPO already works with various federal agencies in establishing regularly scheduled field inspections of mining-related sites determined eligible for or already listed in the National Register. Such periodic monitoring of sites alerts cultural resource managers to problems such as vandalism, erosion, blowdown, or wildland fire.

Information Gaps

Many of Idaho's mining-related cultural resources on public and private land have not yet been recorded and evaluated. Although many unrecorded site locations are tentatively or definitely known, others are unknown at this point. Some important mining sites in Idaho have not yet been recorded. This may be because they are on private land, a project that would affect them has not been undertaken, or few physical remains are left to record. Dateable sites from the 1860s through the 1880s are underrepresented in the state's recorded sites. The communities associated with mining have often received more attention from historic preservationists and the general public than have the actual mining sites.

Most of Idaho's mining-related cultural resource inventory work has resulted from Section 106 compliance activity involving federal projects. As a result, the surveys have been project specific and performed in order to comply with federal laws. Surveys driven by proposed projects have

boundaries that do not relate to the historical development of the area and seldom allow complete mining systems to be considered. Individual components are often inventoried and evaluated in isolation. This has tended to bias the known information somewhat. Some of the early site forms dating from the 1970s have only minimal information, and some of the surveys were focused on a particular topic.

Many of the existing site forms record features that only represent a portion of a mining system. An example would be a site form that records a mine shaft and several cabins but does not record associated industrial support buildings, the water-delivery system, or the mill. This recording of individual features rather than complete systems leads to a fragmentary assessment of significance and should be avoided in the future.

Most of the historic mining sites that have been inventoried have not been evaluated, and only a relatively small number are listed in the National Register. No state-wide surveys of particular mining-related property types have been done to date.

As of July 2008, approximately twenty-five mines and/or mining districts have been thoroughly investigated and reported. The Idaho SHPO has site forms for hundreds of historic mining sites in its files. It is currently quite difficult to identify and compare site forms of similar property types, however. The state should emphasize building a comparative database to aid in evaluating the significance of historic mining properties.

FUTURE RESEARCH QUESTIONS

The following list provides some possible broad research questions, arranged by historic theme, that might be answered by a combination of archaeological fieldwork and documentary research. Some have already been studied at particular sites. Appropriate research questions will likely vary from one period of significance to another. In fact, it is likely that new research questions and techniques will have been developed by the time some listed sites are excavated.

Placer and Lode Mining and Ore Beneficiation

- Under what conditions was cheap, labor-intensive technology as effective as capital-intensive technology?
- Did technological advances associated with hydraulic mining contribute to improvements in large irrigation projects or hydroelectric power generation?
- How did the mining and milling technologies used in Idaho change over time? How were the various aspects of the mining system adapted to reduce costs by using local materials and energy sources or to reflect local conditions such as particular ores, the severe winters, shortages of water, or under-capitalization?
- How has the mining landscape changed over time due to human and natural factors? Can vegetation be used to help date landscape features in the absence of other indices?
- What kinds of economic, technological, and social differences existed among the mining operations and employees of subsistence, speculative, and large-scale mines?
- How did the placer mining of the 1930s differ from that of other periods?
- What local technological, economic, and social changes reflected similar changes on a national or international level?
- Were subsistence lode mining operations in Idaho's mining districts relatively widely dispersed, and were industrial mining operations characterized by nucleated settlements arranged around a mine and a mill? How did these patterns of settlement change over time?
- How did prospecting and exploration change in response to new information about the geology of Idaho's mineral resources?
- Do subsistence mining sites show evidence of more economic self-sufficiency than industrial mining sites?
- Did Idaho's Chinese miners generally work for large companies, or were they composed of smaller groups of entrepreneurial partners?
- Under what conditions were innovations in mining technology accepted or rejected? Was technological change gradual and cumulative or episodic and associated with social and cultural revolutions?
- What were the impacts of changes in mining technology upon the workplace?
- Was the development of aboveground mining

facilities such as roads, buildings, and water-conveyance systems directly linked to the value of the claim? How did individually owned properties and those supported by investors differ in this respect?
- Do features associated with historical boundary markers such as claim markers extend beyond the boundaries? Are the boundaries "ideal" rather than actual?
- How does the industrial mining frontier differ from the agricultural frontier? Is there more standardization?

Settlements and Company Towns Close to Mines

- How did all groups in Idaho's mining communities participate in the regional and world economy? What are the differences in consumer behavior among the various household types?
- How did communities of charcoal workers differ from others of their time period?
- Are differences between the lifeways of those working for large corporations and those of entrepreneurs visible in the archaeological record?
- Were Chinese miners or other ethnic groups physically separated from their Euroamerican counterparts? What patterns of building arrangement on the landscape characterized their dwellings?
- Was the rate of acculturation among the Chinese in the work sphere more rapid than that in the home sphere? Did Chinese of different economic classes assimilate at different rates? How does Chinese miners' assimilation compare with that of urban Chinese in the American West?
- Did trade and communication networks decline or increase during a period of declining mining activity?
- How did living and working conditions at mines compare with those of working-class people elsewhere? With those at farms, towns, and ferry sites?
- What are the similarities and differences in consumer behavior among the various household types?
- Can company-controlled dwellings be distinguished today from those occupied by individuals or families? How do they reflect power relationships and class and status differences between managers and workers?
- What was the spatial organization of company towns, and how was this determined by the topography, the weather, and other factors? How do company towns differ from non-company mining settlements?
- What were the roles of women at settlements close to mines?
- What services and social opportunities were available in mining camps and towns for women? Did social clubs exist for women? Did they have healthcare? Were they able to obtain supplies needed for their health and comfort?
- Can economic conditions for women in mining camps be discerned in the archeological record?

Transportation

- How do continuity and change in transportation systems reflect overall mining landscape evolution?
- What were the engineering limitations imposed on road and trail builders and users by local terrain and available technology?
- How did the availability of specific transportation technologies affect the perception of the appropriate uses of an area?

Goals

The following suggested goals list specific objectives that the Idaho State Historic Preservation Office and its partners may take to improve the evaluation, preservation, and interpretation of historic mining sites in Idaho. As conditions change and knowledge about these sites evolves, these goals and objectives should be revisited and amended as necessary.

Conduct mining property inventories and prepare National Register nominations based on these inventories.

- ☐ Select specific property types to inventory. Suggested property types: smelters; dredging sites; flotation mills; hydraulic mining sites; and mining-related company towns (perhaps including other types of company towns).
- ☐ Conduct inventories of particular mining districts or other historically relevant geographical areas, using an interdisciplinary approach.
- ☐ Select research questions; identify properties that are likely to contain information relevant to these questions; and do the necessary historical research, inventories, and archaeological data recovery.

Increase the recording of mining systems, including landscape features.

- ☐ Train cultural resource managers and consultants to record entire systems, not just particular features such as mills, and to conduct necessary historical research when inventorying mining sites.
- ☐ Encourage the taking of repeat photos (current shots taken from the vantage point of historic photographs) as part of site recordation.
- ☐ Before extensive ground-disturbing activities are allowed to proceed, require documentation of the landscape through large-format, black-and-white photographs and color slides, including aerial views.
- ☐ Develop Memoranda of Agreement or Programmatic Agreements with agencies related to Section 106 compliance at mining-related sites (freeing up time for accomplishing other objectives).

Establish a database to improve evaluations of the significance of mining-related sites.

- ☐ Design a database, based on property types in this report, that enables statistical analysis of recorded sites and their property types and allows identification of sites containing particular property types (include "unknown" and "other" property types for each broad category).
- ☐ Categorize and enter information from existing site forms into the new database.
- ☐ Require future inventories to identify the property types of any mining-related sites that are recorded.
- ☐ Revise metal mining historic context and mining-related property types list, descriptions, and integrity and evaluation discussions as necessary.
- ☐ Provide researchers access to the database, with precautions taken to protect confidential information such as certain site locations.

Improve availability of information on mining-related sites in Idaho.

- ☐ Encourage the recording of oral histories and the copying of historic photographs related to thematic nominations.
- ☐ Encourage preparation of a study exploring the impacts of metal mining since 1860 on the physical environment of Idaho and on the health of the state's residents.

- ☐ Compile a comprehensive bibliography of sources concerning metal mining in Idaho, including archival material, historic photographs, maps, and oral histories.
- ☐ Incorporate the recording of formal oral histories and the search for historic photographs and archival material into mitigation plans.

Encourage interpretation of mining sites for the public.

- ☐ Develop slide programs or videos on important aspects of Idaho's mining history and distribute them to schools, civic groups, museums, and other organizations.
- ☐ Inventory mining-related sites and museums in Idaho that offer some form of interpretation.
- ☐ Identify sites and districts that have great interpretive potential (consider the significance of the property, its ability to show process, presence of features with good integrity, safety of visitors, protection of features and artifacts, and accessibility).
- ☐ Prepare on-site and off-site exhibits (e.g., a wayside exhibit or an exhibit in a local museum) about mitigation work at mining sites such as archaeological excavations or building preservation work.
- ☐ Prepare a thematic brochure linking mining-related sites to a brief outline of Idaho's mining history.
- ☐ For appropriate sites, incorporate the preparation of interpretive plans into mitigation plans.
- ☐ Develop an interpretive plan for selected mining sites (or statewide). The plan should specify products such as wayside exhibits, driving tour brochures, and guidebooks for specific regions or properties. It should also specify mechanisms for involving all interested parties.

Involve mine owners, miners, and the general public in the effort to preserve significant mining-related sites in Idaho.

- ☐ Consider establishing an organization dedicated to preserving and interpreting significant mining sites and landscapes in Idaho.
- ☐ Encourage mining associations, owners of significant mines, the Mining History Association, the Idaho Geological Survey, the U.S. Geological Survey, and university faculty to consider supporting preservation programs related to mining.
- ☐ Work with agency cultural resource managers and private property owners to identify and target specific properties to be inventoried and perhaps monitored.
- ☐ Work with the Forest Service to conduct *Passport In Time* programs at selected mining sites.
- ☐ Prepare a Historic Preservation Plan for Idaho's mining properties, in consultation with all interested parties.

Timeline

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Metal Mining in Idaho, 1849-1960

1849 Gold rush to California.

1855 Nez Perce Treaty signed that established a large reservation along the Clearwater and Snake Rivers in north-central Idaho, eastern Washington and eastern Oregon.

1858 Gold discovered on the Fraser River in British Columbia.

1859 Gold discovered near Colville in northeastern Washington.

1860 E.D. Pierce and others discovered gold on Oro Fino Creek north of the Clearwater River within the Nez Perce Reservation. The rush to the Clearwater began.

1861 Gold discovered in Baker City area of eastern Oregon.

1861 Oregon Steam Navigation Company formed to provide service on the Columbia River, bringing miners and freight to Idaho mines.

1861 Civil War begins. Union efforts were later supported by revenue from Idaho minerals.

1861 Lewiston established as a trade and service center for miners.

1861 Gold discovered in Dixie (South Fork Clearwater River), Elk City, Florence, and Salmon River bars.

1862 Party from Florence discovered gold in Boise Basin. Gold located in Warren, the Owyhees, and Newsome (South Fork Clearwater River). Fine gold found along Snake River. Copper first discovered in the Seven Devils.

1862 Mullan Road connecting Walla Walla to Fort Benton (Montana) completed.

1863 Gold discovered in Alder Gulch-Virginia City area of Montana.

1863 Idaho Territory created. Lewiston, located in the heart of the Nez Perce Reservation, established as territorial capital.

1863 Pressure from mining and settlement led to second treaty with Nez Perce that greatly reduced the size of their reservation.

1863 Boise established as supply and services center for surrounding mining districts.

1863 First quartz claims of high-grade ore located in Boise Basin. Gold discovered at Rocky Bar, Long Valley, and Miller's Camp (near Warren). Rush to Owyhees.

1864 Prospectors from Warren located gold in Atlanta and South Boise area. First stamp mill for an Idaho mine brought to Rocky Bar.

1864 Gold discovered at Little Smoky near Ketchum.

1864 Idaho passed a law that allowed Chinese to work in Idaho mines but stipulated a monthly tax.

1864 Late in the year, territorial capital clandestinely moved to Boise.

1865 End of Civil War.

1865 First Chinese miners reached Idaho County.

1866 Gold placers struck on Palouse. Leesburg gold discovery led rush to Lemhi County. Leesburg prospectors discovered gold at Loon Creek. Loon Creek party found gold at Yellow Jacket.

1867 Gold discovered at Pearl.

1868 Hydraulic giant in operation near Stanley after gold discovery there.

1869 Transcontinental railway completed, greatly improving transportation to Idaho. Kelton Road established to carry mail and freight from railhead at Kelton, Utah, to Boise.

1869 Many Chinese railroad workers came to the Idaho mines.

1869 Monitors came into general use in hydraulicking.

1870 Gold rush to Cariboo Mountain. Gold discovered at Yankee Fork.

1870 Chinese placer miners began to dominate the placer grounds of Idaho County.

1871 Lead-silver discovered at South Mountain, south of Silver City.

1872 Mining Act of 1872 passed by Congress.

1877 Mining began at Bay Horse and Clayton. The first smelter in Idaho installed at Bay Horse. Gold discovered in Gibbonsville.

1878 Silver discovered at Vienna and Sawtooth City.

1879 Rush to Yankee Fork brought outside interests.

1879 Lead-silver mining started at Wood River mines and gold at neighboring Camas and the Hailey gold belt.

1879 Lead-silver discoveries made in the Germania Basin (East Fork Salmon River), Mackay and Alder Creek area, Sheep Creek, Seafoam, and Greyhound Ridge.

1880 Lead-silver mining began at Gilmore.

1881 Silver discovered at Mineral City west of present-day Cambridge. Lead-silver found in Muldoon and two smelters brought in the next year. Lead-silver and copper mined at Birch Creek in Lemhi County.

1882 Prospecting led to first discoveries on the Coeur d'Alene.

1882 Chinese Exclusion Act passed. Chinese immigration to the U.S. began to decline.

1883 Northern Pacific Railway completed across the Idaho panhandle.

1884 Gold rush to the Coeur d'Alene. Rush to Mackay after discovery of copper.

1885 Smelter installed at Nicholia supported by charcoal kilns constructed on Birch Creek.

1885 Gold discovered at Big Creek on the Salmon River.

1886 Anti-Chinese societies formed in Idaho.

1888 Lead-silver discovered at various locations around Lake Pend Oreille.

1889 Gold discovered at Neal located at the head of Blacks Creek west of Boise.

1890 Idaho admitted to the Union as a state.

1891 Cyanidation introduced in the U.S.

1892 Gold discovered at Blackbird in the Lemhi Valley.

1893 Nationwide financial panic.

1894 Bucket-elevator dredge introduced to the U.S.

1894 Gold discovered at Thunder Mountain.

1896 Gold located at Orogrande.

1897 Chinese excluded from mining in Idaho.

1898 Gold discovered at Buffalo Hump led to rush there.

1900 Rush to Thunder Mountain.

1901 Cobalt found at Blackbird.

1902 Major gold rush to Thunder Mountain.

1903 Tungsten mining started on Patterson Creek in the Pahsimeroi Valley.

1904 Lead-silver mine located in Leadore.

1910 Flotation began to be widely used in recovering gold.

1910 Ball, tube and rod mills began replacing stamp mills in Idaho.

1913 Lead-silver production began at Clarks Fork.

1914 Stibnite gold and antimony claims recorded.

1914 Significant gold production began at Marshall Lake near Thunder Mountain.

1915 Lead-silver located in the Selkirk range near Porthill.

1917 U.S. entered World War I and mining in Florence area practically ceased.

1918 World War I ended.

1918 Mercury first identified at Stibnite.

1927 Mercury discovered near Weiser.

1929 Stock market crashed. Great Depression ensued and depression-era mining began.

1930 Increased use of dredge and dragline in Idaho mining areas. Cyanidation plants with ball mills commonly used in Idaho.

1932 U.S. went off the gold standard.

1933 CCC established. CCC built roads and trails that improved transportation in Idaho.

1934 Gold Reserve Act removed gold from coinage. Price set at $35.00 per ounce.

1938 Mill at the Orogrande-Frisco mine in Orogrande had the largest cyanide-process mill in the Pacific Northwest.

1940 Gold dredge installed at Yankee Fork.

1941 U.S. enters World War II.

1942 War Production Board shut down all mining operations in the U.S.

1945 World War II ended and gold mines in U.S. allowed to resume operations.

1953 Idaho law required water courses to be restored after dredging.

1953 Columbium, tantalum, and uranium placer dredging began at Bear Valley.

1955 Multiple Use Mining Act passed.

1960 Multiple Use-Sustained Yield Act passed.

1960 Nez Perce Tribe awarded compensation for land and gold royalty rights on gold production in Florence and other mining districts that the Tribe had lost because of treaty violations.

Endnotes

1 Editor's note, See Sally Zanjani, *A Mine of Her Own, Women Prospectors in the American West, 1850-1950* (University of Nebraska Press, 2000) for her definitive volume on America's women prospectors. Mention of M.A. Rice appears on page 166.

2 Richard White, *Its Your Misfortune and None of My Own, A New History of the American West* (University of Oklahoma Press, 1991), 260.

3 Randall Rohe, "The Geography and Material Culture of the Western Mining Town," *Material Culture* 16 (fall 1984), 99-120.

4 For a listing of Idaho's mining districts not mentioned in the text, consult "Mining Districts in Idaho," Idaho State Historical Society Reference Series #472, April 1969. This document and other mining-related documents available on-line at http://history.idaho.gov/reference_series.html

5 A.H. Koschmann and M.H. Bergendahl, *Principal Gold-Producing Districts of the United States* (U.S. Geological Survey Professional Paper #610, 1968), 12.

6 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, (Idaho Bureau of Mines and Geology, Special Report 1, 1964), 15; Richard V. Francaviglia, *Hard Places, Reading the Landscapes of America's Historic Mining Districts* (Iowa City, University of Iowa Press, 1992), 158.

7 Rohe, "The Geography and Material Culture of the Western Mining Town," 100.

8 Thor H. Kiilsgaard, *The Mineral Resources and Mineral Industry of Nine Idaho Counties* (Boise, Idaho, Idaho Bureau of Mines and Geology, 1947), 2-3; Terry S. Maley, *Exploring Idaho Geology* (Boise, Idaho, Mineral Land Publications, 1987), 64, 67, 189-190; John Wellington Finch, *Prospecting for Gold Ores* (Moscow, Id., Idaho Bureau of Mines and Geology, Pamphlet 36, 1932), 8, 25; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 192; Donald L. Hardesty, *The Archeology of Mining and Miners, A View from the Silver State* (Special Publication Series 6, Ann Arbor, Mich., Society for Historical Archeology, 1988), 18; S. R. Capps and Ralph J. Roberts, *The Dixie Placer District, Idaho* (Idaho Bureau of Mines and Geology, Pamphlet 48, 1939), 7; Koschmann & Bergendahl, *Principal Gold-Producing Districts*, 120.

9 W.W. Staley, *Gold in Idaho* (Idaho Bureau of Mines and Geology Pamphlet 68, 1946), 10; Capps & Roberts, *Dixie Placer District*, 26.

10 Maley, *Exploring Idaho Geology*, 189; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 96, 101.

11 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 191-192.

12 Henry L. Day, "Mining Highlights of the Coeur d'Alene District," *Idaho Yesterdays* 7 (winter 1964), 2; Charles R. Hubbard, *A Survey of the Mineral Resources of Idaho* (Idaho Bureau of Mines and Geology, Pamphlet 105, 1955), 52; Maley, *Exploring Idaho Geology*, 195; Koschmann & Bergendahl, *Principal Gold-Producing Districts*, 139; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 188.

13 Mark Wyman, "Mining Law in Idaho" *Idaho Yesterdays* Spring 1981:16.

14 Finch, *Prospecting for Gold Ores*, 30; John C. Reed, *Gold-Bearing Gravel of the Nezperce National Forest, Idaho County, Idaho* (Idaho Bureau of Mines and Geology Pamphlet 40, 1934), 27-28; Young, *Western Mining*, 31; Mark Wyman, "Mining Law in Idaho," *Idaho Yesterdays* 25 (spring 1981), 15.

15 Merle W. Wells, *Rush to Idaho* (Idaho Bureau of Mines and Geology Bulletin 19, 1961), 19; Philip John Shenon and Roy Full, *An Evaluation Study of the Mineral Resources in the Lands Ceded to the United States by the Nez Perce Tribe of Indians on April 17, 1867* (Nez Perce Tribe vs. United States of America, Indian Claims Commission Docket 175-180), 1:192; Wells, *Gold Camps & Silver Cities*, 4.

16 Paul, *Mining Frontiers*, 170, 173; Reed, *Gold-bearing Gravel*, 28; Wyman, "Mining Law," 17.

17 York, "Placer Mining Era," 135.

18 For further information, see Idaho Statutes, Title 47, Mines and Mining, http://www.legislature.idaho.gov/idstat/Title47/T47.htm.

19 Young, *Western Mining*, 7, 18-20; Browne, *Mineral Resources*, 530, 532; *Mining & Scientific Press*, 23 Nov. 1895, 343.

20 J. Ross Browne, *Report of J. Ross Browne on the Mineral Resources of the States and Territories West of the Rocky Mountains* (Washington, D.C., Government Printing Office, 1867), 530; W.W. Staley, *Elementary Methods of Placer Mining* (Idaho Bureau of Mines and Geology Pamphlet 35, 1931), 6; Jeffrey M. LaLande, "Sojourners in Search of Gold, Hydraulic Mining Techniques of the Chinese on the Oregon Frontier," *Industrial Archaeology* 11 (1985 1), 33.

21 Harold Albert York, "The History of the Placer Mining Era in the State of Idaho" (M.A. thesis, University of Oregon, 1939), 138-139; Young, *Western Mining*, 26; Staley, *Elementary Methods of Placer Mining*, 13a, 15.

22 John Wellington Finch, *Prospecting for Gold Ores*, 30, 31; Otis E. Young, Jr., *Western Mining*, 27-28, 30; Wallace W. Elliott, *History of Idaho Territory, Showing Its Resources and Advantages...* (Wallace W. Elliott Co., 1884), 67.

23 David D. Alt and Donald W. Hyndman, *Roadside Geology of Idaho* (Missoula, Mountain Press Publishing Co., 1989), 231, 323; Rodman W. Paul, *Mining Frontiers of the Far West*, 1848-1880 (N.Y., Holt, Rinehart and Winston, 1963), 100; Clyde Ross, *Mining History of South-Central Idaho* (Idaho Bureau of Mines and Geology, Pamphlet 131, 1963), 6; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 187.

24 A. J. Teske, *Idaho's Mineral Industry, the First Hundred Years* (Idaho Bureau of Mines and Geology Bulletin 18, 1961), 20-21; Wells, *Gold Camps & Silver Cities*, 85-86; Eugene Pfleider, ed., *Surface Mining* (New York, American Institute of Mining, Metallurgical and Petroleum Engineers, Inc., 1968), 71-72, 74-75; Charles F. Jackson, et al., *Lead and Zinc Mining and Milling in the United States, Current Practices and Costs* (U.S. Bureau of Mines, Bulletin 381, 1935), 63-64; U.S. Forest Service, *Anatomy of a Mine from Prospect to Production* (Ogden, Utah, Intermountain Forest and Range Experimental Station, 1977), 39-40.

25 Otis E. Young, Jr., *Black Powder and Hand Steel, Miners and Machines on the Old Western Frontier* (Norman, Okla., University of Oklahoma Press, 1976), 68.

26 Young, *Western Mining*, 34, 39, 41, 45, 47, 50-51.

27 Hardesty, *Archaeology of Mining and Miners*, 39.

28 Maley, *Exploring Idaho Geology*, 201-202; Otis E. Young, Jr., *Western Mining* (Norman, Okla., University of Oklahoma Press, 1970), 52.

29 Randall Eugene Rohe, "The Geographical Impact of Placer Mining in the American West, 1848-1974," (Ph.D. dissertation, University of Colorado, 1978), 1.

30 Author's note, Beginning in the early 1860s, as prospectors moved out from the Pierce and Florence mining districts, placer miners worked every low bar and stream confluence along the lower Salmon River. Most of the production, however, came from the area between Riggins and Whitebird and an area downstream of Shoup. The two types of gold found along the Salmon River consist of very fine or "skim gold" (although not as fine as the flour gold of the Snake River), and a coarse gold found in the higher bars and bench gravel.

31 Idaho State Historical Society, "Placer Mining Methods," Reference Series #99, 1964, 2.

32 Richard Christian Waldbauer, *An Historical and Archaeological Survey of the Hoodoo Mining District, Idaho* (USFS Cultural Resources Report 7, 1981), 60, 64; Eugene B. Wilson, *Hydraulic and Placer Mining* (New York, John Wiley and Sons, 1905), 27.

33 York, "Placer Mining Era," 141-142; Barton, Stoddard, & Milhollin, *A Report of Gold Production on the Nez Perce Indian Reservation, 1860-1867* (Boise, prepared for U.S. Department of Justice, Indian Claims Section, 1958), 18.

34 York, "Placer Mining Era," 141-142; Barton, Stoddard, & Milhollin, *Report*, 18.

35 William A. Goulder, *Reminiscences, Incidents*

in the Life of a Pioneer in Oregon and Idaho (Boise, Timothy Regan, 1909), 211-214; Waldbauer, *Hoodoo Mining District*, 66.

36 Randall E. Rohe, "Origins & Diffusion of Traditional Placer Mining in the West," *Material Culture* 18 (fall 1986), 139.

37 York, "Placer Mining Era," 142-143; Waldbauer, *Hoodoo Mining District*, 64, 66; Staley, *Elementary Methods of Placer Mining*, 10-12; Young, *Western Mining*, 118; Idaho Inspector of Mines, *Annual Report of the Mining Industry of Idaho*, 1949, 31-32.

38 Young, *Western Mining*, 117; Waldbauer, *Hoodoo Mining District*, 74; Barton, Stoddard, & Milhollin, *Report*, 17-18; Goulder, *Reminiscences*, 251; Randall E. Rohe, "Hydraulicking in the American West, The Development and Diffusion of a Mining Technique," *Montana The Magazine of Western History* 35 (spring 1985), 19; Amy C. Earls, et al., *Leesburg Historic Mining District, Lemhi County, Idaho, A Cultural Resource Investigation* (Reno, Nev., Mariah Assoc., Inc., 1993), 300.

39 Rohe, "Geographical Impact of Placer Mining," 184.

40 Idaho State Historical Society, "Placer Mining Methods," Reference Series #99, 1964, 2.

41 Rohe, "Hydraulicking," 19, 28-29, 34; Jeffrey M. LaLande, "Sojourners in the Oregon Siskiyous, Adaptation and Acculturation of the Chinese Miners in the Applegate Valley, ca. 1855-1900" (M.A. thesis, Oregon State University, 1981), 332-333.

42 Paul, *Mining Frontiers*, 256; LaLande, "Hydraulic Mining Techniques of the Chinese," 33.

43 Henry DeGroot, "Hydraulic Mining," *Mining and Scientific Press* 68 (Dec. 1893-Feb. 894), 53; LaLande, "Sojourners in the Oregon Siskiyous," 317; Donna L. Turnipseed, "Lessons from a Ditch, A Study of Three Water Conveyance Systems Located in Idaho County, Idaho, 1860-1880" (M.S. Thesis, University of Idaho, 1997), 55; Leonard J. Arrington, *History of Idaho* (Moscow, Idaho, University of Idaho Press, 1994), 234; Waldbauer, *Hoodoo Mining District*, 75, 80; Young, *Western Mining*, 127; LaLande, "Sojourners in the Oregon Siskiyous," 316-317; Wilson, *Hydraulic and Placer Mining*, 100; Rohe, "Hydraulicking," 21, 23-24; LaLande, "Hydraulic Mining Techniques," 34, 44; DeGroot, "Hydraulic Mining," 69.

44 Wilson, *Hydraulic and Placer Mining*, 81, 86-87.

45 LaLande, "Hydraulic Mining Techniques," 35, 45; Rohe, "Hydraulicking," 22; Wilson, *Hydraulic and Placer Mining*, 38; Fredric L. Quivik, *Expert Report of Fredric L. Quivik, United States v. ASARCO, et al Civil Action 96-0122-N-EJL* (1999), ix; Daniel Liestman, "Nineteenth-Century Chinese and the Environment of the Pacific Northwest," *Pacific Northwest Quarterly* 90 (winter 1998/99), 20-21.

46 Rohe, "Hydraulicking," 25, 27; DeGroot, "Hydraulic Mining," 102; Paul, *Mining Frontiers*, 48.

47 Waldbauer, *Hoodoo Mining District*, 67-69; Wilson, *Hydraulic and Placer Mining*, 64; Turnipseed, "Lessons from a Ditch," 23; DeGroot, "Hydraulic Mining," 5.

48 Wilson, *Hydraulic and Placer Mining*, 48; Turnipseed, "Lessons from a Ditch," 27-28, 31, 39, 47; Elizabeth M. Smith, *History of the Boise National Forest, 1905-1976* (Boise, Idaho, Idaho State Historical Society, 1983), 14.

49 Waldbauer, *Hoodoo Mining District*, 72; Darby Campbell Stapp, "The Historic Ethnography of a Chinese Mining Community in Idaho" (Ph.D. dissertation, University of Pennsylvania, 1990), 174; DeGroot, "Hydraulic Mining," 37; Rohe, "Geographical Impact of Placer Mining," 253-254.

50 Carlos A. Schwantes, *In Mountain Shadows, A History of Idaho* (Lincoln, University of Nebraska Press, 1991), 94; Randall E. Rohe, "Gold Dredging in the American West, Origin and Diffusion," *Pacific Historian* 28 (summer 1984), 6, 8, 14; Rohe, "Geographical Impact of Placer Mining," 230.

51 Young, *Western Mining*, 132; Rohe, "Gold Dredging," 5-6; Spence, "Golden Age of Dredging," 401, 403-405.

52 Harry S. Lord, "Developments in Dragline Methods, Equipment and Maintenance," in Idaho Inspector of Mines, *Annual Report of the Mining Industry of Idaho*, 1941, 44-49; Rohe, "Gold Dredging," 10; Pfleider, *Surface Mining*, 520-521.

53 Howard A. Packard, *Gold Dredge on the Yankee Fork* (Great Falls, Mont., Yankee Fork Publishing Co., 1983), 15, 19-20; Murray, "Boise Basin's Dredging Heritage," 2.

54 Dale Herbort, "Handbook for the Identification of Historic Metal Mining Properties" (prepared for the Abandoned Mine Reclamation Bureau, Montana Department of State Lands, draft, 1995), 48-49; Lord, "Dragline Methods," 47.

55 Rohe, "Traditional Placer Mining," 140-141, 144-145; LaLande, "Sojourners in the Oregon Sisikiyous," 323-324.

56 Barton, Stoddard, & Milhollin, *Report*, 39, 41; Lorain & Metzger, *Reconnaissance*, 79, 82.

57 Wells, *Rush to Idaho*, 14; S.H. Lorain and O.H. Metzger, *Reconnaissance of Placer Mining Districts in Semhi County, Idaho* (U.S. Bureau of Mines Information Circular 7082, 1939), 84.

58 Staley, *Fine Gold of Snake River*, 3; Wells, *Rush to Idaho*, 13-14.

59 James M. Hill, *Notes on the Fine Gold of Snake River, Idaho* (U.S. Geological Survey Bulletin 620 (1916)), 284-285; Staley, *Fine Gold of Snake River*, 7.

60 Wells, *Gold Camps & Silver Cities*, 92; W. W. Staley, *Fine Gold of Snake River and Lower Salmon River, Idaho* (Idaho Bureau of Mines and Geology, Pamphlet 72, 1945), 10; J. Simon Bruder, et al., eds., *American Falls, Cultural and Paleontological Resources Inventory on the Snake River Plain* (submitted to Bureau of Reclamation by Dames & Moore, 1999), 4-31, 4-33, 4-37, 4-38.

61 *Idaho Water Facts*. Boise: Idaho Department of Water Resources.

62 Jean M. Grove, *The Little Ice Age*, Methuen, 1988, p. 239.

63 Rohe, "Geographical Impact of Placer Mining," 141, 145, 147.

64 Kathryn L. McKay, *Gold for the Taking, Historical Overview of the Florence Mining District, Idaho County, Idaho* (prepared for the Nez Perce National Forest by Tracks of the Past, 1998), 50.

65 Young, *Western Mining*, 150.

66 A. C. Todd, "Cousin Jack in Idaho," *Idaho Yesterdays* 8 (Winter 1964-1965):5-6.

67 Merrill D. Beal and Merle W. Wells, *History of Idaho* (N.Y., Lewis Historical Publishing Co., 1959), 1:364; Teske, *Idaho's Mineral Industry*, 21, 29; Robert Peele, *Mining Engineers' Handbook* (New York, John Wiley & Sons, 1918, 1927, 1941), 1, 10-123.

68 Hardesty, *Archaeology of Mining and Miners*, 22; Paul, *Mining Frontiers*, 57, 68.

69 Bruce J. Noble, Jr., and Robert Spude, National Register Bulletin 42, Guidelines for Identifying, Evaluating, and Registering Historic Mining Properties (National Park Service, 1992), 13; Donald L. Hardesty, "Evolution on the Industrial Frontier," 213-29 in Stanton W. Green and Stephen M. Perlman, *Archaeology of Frontiers and Boundaries* (New York, Academic Press, 1985), 215, 219; Francaviglia, *Hard Places*, 116.

70 Young, *Western Mining*, 154; Hardesty, *Archaeology of Mining and Miners*, 27; Walker De Marquis Wyman, "The Underground Miner, 1860-1910, Labor and Industrial Change in the Northern Rockies" (Ph.D. dissertation, University of Washington, 1971), 198.

71 Hardesty, *Archaeology of Mining and Miners*, 27; W.A. Staley, *Timbering and Support of Underground Workings for Small Mines* (Idaho Bureau of Mines and Geology Bulletin 21, 1962), 1-2.

72 Hardesty, *Archaeology of Mining and Miners*, 21-22; Young, *Western Mining*, 182, 187, 189-191; Beal & Wells, *History of Idaho*, 364-365; Arrington, *History of Idaho*, 1, 248; Patricia Hart and Ivar Nelson, *Mining Town, The Photographic Record of T. N. Barnard and Nellie Stockbridge from the Coeur d'Alenes* (Seattle, University of Washington Press, 1984), 34.

73 Hardesty, *Archaeology of Mining and Miners*, 29; Young, *Western Mining*, 175.

74 Hardesty, *Archaeology of Mining and Miners*, 29; Young, *Western Mining*, 169; Beal & Wells, *History of Idaho*, 420.

75 Young, *Western Mining*, 162, 191; Young, *Black Powder*, 111.

76 Ronald C. Brown, *Hard-Rock Miners, The Intermountain West*, 1860-1920 (Texas A&M University Press, College Station and London, 1979), 65; Young, *Western Mining*, 208-209; Mark Wyman, *Hard Rock Epic, Western Miners and the Industrial Revolution, 1860-1910* (Berkeley, University of California Press, 1979), 40, 43, 45.

77 Peele, *Mining Engineers' Handbook*, 1, 10-430.

78 Peele, *Mining Engineers' Handbook*, 1, 10-459, 10-460; Pfleider, *Surface Mining*, 141.

79 Pfleider, *Surface Mining*, 142, 148, 167, 178-179; Koehler S. Stout, *Mining Methods and Equipment Illustrated* (Butte, Montana Bureau of Mines and Geology Bulletin 63, 1967), 54, 58, 64; Robert Romig, "Florida Mountain Mines," Idaho State Historical Society Reference Series #909, 1989, 4.

80 Pfleider, *Surface Mining*, 12, 427-428.

81 Pfleider, *Surface Mining*, 4, 11; 169.

82 Idaho State Historical Society, "Recovery Processes for Idaho Ores," Reference Series #380, 1966, 1.

83 Robert L. Romig, "The South Boise Quartz Mines, 1863-1892, A Study in Western Mining Industry and Finance" (M.A. thesis, University of California, 1959), 4.

84 Thomas Varley, et al., *A Preliminary Report on the Mining Districts of Idaho* (U.S. Bureau of Mines Bulletin 166, 1919), 4.

85 Author's note, Gold-silver ores that were difficult to treat were found in the Boise Basin, Atlanta, the Owyhees, Seafoam and Greyhound (Custer County), and many districts in central Idaho. Idaho's silver-lead-zinc ores come primarily from the Coeur d'Alenes in Shoshone County and the Wood River district in Blaine County. Additional sources were the Lakeview and Blacktail districts in Bonner County and the Clark Fork district in Bannock County. The rich ore from these mines was treated at small local smelters or at the large Bunker Hill smelter in Kellogg (built 1917), or it was sorted and hauled out by wagon and then shipped by railroad to distant smelters. Varley et al., *Mining Districts of Idaho*, 4; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 181-182

86 Valerie Rodman, "Modeling as a Preservation Planning Tool in Western Gold and Silver Mining Districts" (M. A. thesis, University of Nevada, 1985), 54.

87 Peele, *Mining Engineers' Handbook*, 2:28-15.

88 Roger E. Kelly and Marsha C.S. Kelly, "Arrastras, Unique Western Historic Milling Sites," *Historical Archaeology* 17 (1983 1), 85-86; A. W. Fahrenwald, *The Recovery of Gold from Its Ores* (Idaho Bureau of Mines and Geology, Pamphlet 37, 1932), 9.

89 Young, *Western Mining*, 71-72.

90 Young, *Western Mining*, 69-71; Kelly & Kelly, "Arrastras," 86-87; Robert Gresham Bailey, *River of No Return (the Great Salmon River of Idaho)* (Lewiston, Idaho, Bailey-Blake Printing Co., 1983), 204.

91 T. A. Rickard, *The Stamp Milling of Gold Ores* (New York, Engineering and Mining Journal, 1903), 1-2; Hardesty, *Archaeology of Mining and Miners*, 41; Arrington, *History of Idaho*, 252; Young, *Western Mining*, 198.

92 Hardesty, *Archaeology of Mining and Miners*, 41; Fahrenwald, *Recovery of Gold*, 9; Young, *Western Mining*, 286.

93 Young, *Western Mining*, 198-199; Hardesty, *Archaeology of Mining and Miners*, 41-43.

94 Fahrenwald, *Recovery of Gold*, 8-9.

95 Hardesty, *Archaeology of Mining and Miners*, 43.

96 Herbort, "Identification of Historic Metal Mining Properties," 56-57; Hardesty, *Archaeology of Mining and Miners*, 45, 49-50.

97 U.S. Forest Service, *Anatomy of a Mine*, 62-63.

98 Hardesty, *Archaeology of Mining and Miners*, 51; Teske, *Idaho's Mineral Industry*, 24; Fahrenwald, *Recovery of Gold*, 10; Young, *Western Mining*, 284.

99 Author's note, The relatively cheap and simple process began to be widely used in Idaho in the 1910s; flotation replaced gravity concentration in the Coeur d'Alenes, for example, ca. 1916. By 1930, flotation was considered the best method to recover gold from sulphide ores, and it was also used successfully in Wood River, Stibnite, Atlanta, and other Idaho districts.

100 Bunyak, "To Float or Sink," 35, 38; Stewart Campbell, *27th Annual Report of the Idaho Mining Industry*, 1925, 16-17; Fahrenwald, *Recovery of Gold*, 11; Young, *Western Mining*, 133, 139, 201; Hardesty, *Archaeology of Mining and Miners*, 43; Idaho State Historical Society, "Recovery Processes for Idaho Ores," Reference Series #380, 1966, 2.

101 Arrington, *History of Idaho*, 1, 240-241; Hardesty, *Archaeology of Mining and Miners*, 44-45, 47.

102 Idaho State Historical Society, "Recovery Processes for Idaho Ores," Reference Series #380, 1966, 2.

103 Paul, *Mining Frontiers*, 99-101.

104 James E. Fell, Jr., *Ores to Metals, The Rocky Mountain Smelting Industry* (Lincoln, University of Nebraska Press, 1979), 63, 65; Dan Craig Gard, "Smoke and Ash, A Study of 19th-Century Charcoal Production in Montana and Idaho Using Parabolic Beehive Kilns" (M.A. thesis, University of Montana, 1998), 2, 32-33; Peele, *Mining Engineers' Handbook*, 2, 32-02.

105 Herbort, "Identification of Historic Metal Mining Properties," 93.

106 Frank B. Fulkerson, *Economic Aspects of Silver Production in the Coeur d'Alene Mining Region, Shoshone County, Idaho* (U.S. Bureau of Mines Information Circular 8207, 1964), 18; Wells, *Gold Camps & Silver Cities*, 104.

107 Hayward, *Metallurgical Practice*, 14.

108 Francaviglia, *Hard Places*, 72.

109 Livingston-Little, *North Idaho*, 68, 74; Fee, "Chinese in an Idaho Wilderness," 17.

110 Bancroft, *History of Washington, Idaho and Montana*, 406, 422; Livingston-Little, *North Idaho*, 36-37; Trimble, *Mining Advance*, 10, 267; York, "Placer Mining Era," 82-84; Bolino, "Economic History," 118; Stacy Peterson, "Silas Skinner's Owyhee Toll Road," *Idaho Yesterdays* 10 (spring 1966), 12-13; Paul, *Mining Frontiers*, 52-53, 139; Wells and Hart, *Idaho, Gem of the Mountains*, 38; Idaho State Historical Society, "The Effect of Mining in the Economy of the Boise Region," Reference Series #172, 2-3. Between 1857 and 1863, Captain John Mullan oversaw the surveying and construction of the Mullan Road, which stretched for 624 miles between Fort Benton (Montana) and Walla Walla, Washington. It ran through the Coeur d'Alene mining district and was closely associated with its early development (Schwantes, *In Mountain Shadows*, 45-46).

111 McKay, *Florence Mining District*, 320-321.

112 Arrington, *History of Idaho*, 1, 313-314; Paul, *Mining Frontiers*, 148; Beal & Wells, *History of Idaho*, 1, 402-403.

113 Mark Hufstetler, and Dale Martin, *The Union Pacific Railroad to the Silver Valley, A Cultural Resource Reconnaissance Study* (submitted to Union Pacific Railroad by Renewable Technologies, Inc., 1999), 3, 9-10; Livingston-Little, *North Idaho*, 89; Hart & Nelson, *Mining Town*, 82, 84.

114 Hufstetler & Martin, *Union Pacific Railroad*, 3-4; Arrington, *History of Idaho*, 1, 333.

115 Dale M. Gray, Historic Resources of the Elk City Wagon Road National Register of Historic Places Multiple Property Documentation Form, 1999.

116 Earls et al., *Leesburg Historic Mining District*, 263, 265; Wells, *Gold Camps & Silver Cities*, 69; Umpleby, *Lemhi County*, 20-21.

117 Idaho State Historical Society, "Four Stages In Idaho's Mining Development," Reference Series #4.

118 Rohe, "Geographical Impact of Placer Mining," 3, 16; Paul, *Mining Frontiers*, 21.

119 Hardesty, *Archaeology of Mining and Miners*, 1.

120 Trimble, *Mining Advance*, 25-26; Rohe, "Geographical Impact of Placer Mining," 19.

121 Paul, *Mining Frontiers*, 40-42, 254; Trimble, *Mining Advance*, 10.

122 D.E. Livingston-Little, *Economic History of North Idaho, 1800-1900* (Los Angeles, Journal of the West, 1965), 47-49; Wells, *Rush to Idaho*, 2; York, "Placer Mining Era," 41; Trimble, *Mining Advance*, 203; Alvin M. Josephy, Jr., *The Nez Perce Indians and the Opening of the Northwest* (New Haven, Conn., Yale University Press, 1965), 390-391; Shenon and Full, *Evaluation*, 9.

123 Schwantes, *In Mountain Shadows*, 55.

124 Josephy, *Nez Perce Indians*, 397, 404-405; Wells, *Rush to Idaho*, 9.

125 Josephy, *Nez Perce Indians*, 398-399, 420, 423, 429-430; Schiach et al., *Illustrated History of North Idaho*, 388; Elliott, *History of Idaho Territory*, 156; Trimble, *Mining Advance*, 205.

126 Schwantes, *In Mountain Shadows*, 73-74; Beal and Wells, *History of Idaho*, 458-459. In 1957, the Nez Perce tribe filed a claim against the United States to recover compensation for the land and gold royalty rights in Washington, Idaho, and Oregon lost as a result of violations of treaties signed through 1867, and in 1960 the Indian Claims Commission awarded the tribe $7.65 million (Idaho Daily Statesman, 6 Aug. 1961).

127 McKay, *Florence Mining District*, 104.

128 Susan Pengilly Neitzel, "Unsettled Issues, Original Indian Title to the Boise and Bruneau Valleys, Southwestern Idaho" (M.A. thesis, Boise State University, 1998), 14, 34, 36, 84-85, 119, 126, 129, 133; Wells & Hart, *Idaho, Gem of the Mountains*, 38. Indian land rights in southwestern Idaho remained unextinguished, however, because two treaties dealing with these lands were never ratified. Moreover, their claim for

restitution was never presented to the Indian Claims Commission.

129 Arrington, *History of Idaho*, 183-184, 186; James Lawrence Onderdonk, *Idaho, Fact and Statistics Concerning Its Mining, Farming...* (San Francisco, A.L. Bancroft & Co., 1885), 34; Elliott, *History of Idaho Territory*, 64-65; Schwantes, *In Mountain Shadows*, 49-51; Wells, *Rush to Idaho*, 2-3; William S. Schiach, John M. Hendersen, and Harry B. Averill, *An Illustrated History of North Idaho Embracing Nez Perces, Idaho, Latah, and Shoshone Counties, State of Idaho* (Chicago, Western Historical Publishing, 1903), 19-20. The encroachment of thousands of miners on the Nez Perce lands took a great toll on the native people's way of life.

130 York, "Placer Mining Era," 182.

131 Barton, Stoddard, & Milhollin, *An Evaluation of the Gold Mined Before April 17, 1867 from the Nez Perce Indian Reservation as Established by the Treaty of June 11, 1855, and of the Occupancy Use of the Reservation as it was Related to the Mining Activity* (Salt Lake City, Indian Claims Commission, Docket 180-A, 1957), 1:17; Josephy, *Nez Perce Indians*, 396-403.

132 *Washington Statesman*, 6 Dec. 1861; Trimble, *Mining Advance*, 206; Shenon & Full, *Evaluation*, 145.

133 Jeffrey Michael Fee, "A Dragon in the Eagle's Land, Chinese in an Idaho Wilderness, Warren Mining District, ca. 1870-1900" (M.S. thesis, University of Idaho, 1991), 17.

134 Ross, *South-Central Idaho*, 5; Wells & Hart, *Idaho, Gem of the Mountains*, 38.

135 Merle Wells, *Boise, an Illustrated History* (Woodland Hills, Calif., Windsor Publications, 1982), 17-18.

136 A. Bernard Knapp, "Social Approaches to the Archaeology and Anthropology of Mining," in Knapp et al., *Social Approaches to an Industrial Past*, 5; James, *Ruins of a World, Chinese Gold Mining at the Mon-Tung Site in the Snake River Canyon*, 10-11; McKay, *Florence Mining District*, 260-261.

137 Barton, Stoddard, & Milhollin, *Royalties and Gold Production Costs on the Nez Perce Indian Reservation, 1860-1867* (prepared for U.S. Department of Justice, Indian Claims Section. Boise, Idaho, 1958), 47; Wells, *Rush to Idaho*, 18.

138 Idaho State Historical Society, "Idaho's Gold Production," Reference Series #5, 1; Arrington, *History of Idaho*, 1, 231.

139 Beal & Wells, *History of Idaho*, 1:298.

140 Wells, *Gold Camps & Silver Cities*, 67, 72; J. B. Umpleby, *Geology and Ore Deposits of Lemhi County, Idaho* (U.S. Geological Survey Bulletin 528, 1913), 20; Earls et al, *Leesburg Historic Mining District*, 15-16, 18, 257, 351-352.

141 Wells, *Gold Camps & Silver Cities*, 99, 102.

142 Frederick Leslie Ransome, *The Geology and Ore Deposits of the Coeur d'Alene District, Idaho* (U.S. Geological Survey Professional Paper 62, 1908), 78-79.

143 Smith, *Boise National Forest*, 11; Arrington, *History of Idaho*, 1:291.

144 Stapp, "Chinese Mining Community," 58.

145 Couch, "Topophilia," 209-210; Wegars, "Chinese in Northern Idaho," 29; Rohe, "After the Gold Rush," 12; Fee, "Chinese in an Idaho Wilderness," 19; Bolino, "Economic History," 57; Paul, *Mining Frontiers*, 144; McKay, *Florence Mining District*, 92; Stapp, "Chinese Mining Community," 61; Ronald L. James, "Why No Chinamen are Found in Twin Falls," *Idaho Yesterdays* 36 (1993 no. 4), 21-22.

146 "Gold Mines of Cariboo Mountain," *Idaho Yesterdays* 19 (winter 1976), 13; Wegars, "Chinese in Northern Idaho," 138.

147 Hubert Howe Bancroft, *History of Washington, Idaho and Montana, 1845-1889* (San Francisco, The History Co., 1890), 427; Wyman, "Mining Law," 16; Zhu, *Chinaman's Chance*, 48.

148 Wunder, "Courts and the Chinese," 24, 27; Melvin D. Wikoff, "Chinese in the Idaho County Gold Fields, 1864-1933" (M.S. thesis, Texas A & I University, 1972), 165, 170, 175-176, 179; Arrington, *History of Idaho*, 267-268; Wegars, "Chinese in Northern Idaho," 33-36; Zhu, *Chinaman's Chance*, 4, 101; Wyman, "Mining Law," 16.

149 M. Alfreda Elsensohn, *Idaho Chinese Lore* (Caldwell, Idaho, Caxton Printers, Ltd., 1970), 37; Wunder, "Courts and the Chinese," 30-32; Stapp, "Chinese Mining Community," 365; Zhu, *Chinaman's Chance*, 101; Wyman, "Mining Law," 16.

150 Wegars, "Chinese in North Idaho," 133-134, 136.

151 Stapp, "Chinese Mining Community," 101, 121; LaLande, "Sojourners in the Oregon Siskiyous," 250, 259, 267, 278, 295, 298-300, 304.

152 ; Robert F. G. Spier, "Food Habits of Nineteenth Century California Chinese," *California Historical Society Quarterly* 37 (1958), 79-80; Fee, "Chinese in an Idaho Wilderness," 65, 69; Zhu, *Chinaman's Chance*, 103.

153 Zhu, *Chinaman's Chance*, 59, 106, 122; Wegars, "Chinese in Northern Idaho," 135.

154 LaLande, "Hydraulic Mining Techniques," 31, 39-40; Trull, "Chinese in Idaho," 67; LaLande, "Sojourners in the Oregon Siskiyous," 323-324; Elsensohn, *Chinese*, 1:87; Rohe, "Hydraulicking in the American West," 27; Zhu, *Chinaman's Chance*, 106.

155 Mitzi Rossillon and Dale Martin, "In Dubious Gravel, Placer Gold for the Unemployed?" (Paper presented at the Montana History Conference, Helena, Oct. 27, 1995), 2; Miller, *Automobile Gold Rushes*, 15-16.

156 Rossillon & Martin, "Placer Gold for the Unemployed?", 1-3, 5; Miller, *Automobile Gold Rushes*, 19, 22, 31-32, 42-44.

157 Bailey, *River of No Return*, 470-471; Lorain & Metzger, *Reconnaissance*, 80.

158 Charles W. Miller, Jr., *The Automobile Gold Rushes & Depression Era Mining* (University of Idaho Press, 1998), 141; Finch, *Ore Deposits of the Western States*, 438; L. W. Hovis, "Historic Mining Sites, A Typology for the Alaskan National Parks" (ms. on file, Alaska Regional Office, Anchorage, National Park Service, 1992), 26.

159 Staley, *Gold in Idaho*, 9; Teske, *Idaho's Mineral Industry*, 58.

160 Hiram T. French, *History of Idaho, A Narrative Account of Its Progress, Its People and Its Principal Interests* (3 vols., Chicago, Lewis Publishing Co., 1914), 37; Idaho State Historical Society, *Idaho, An Illustrated History* (Boise, Idaho, Idaho State Historical Society, 1976), 46; Ross, *South-Central Idaho*, 7.

161 Teske, *Idaho's Mineral Industry*, 14.

162 Wells, *Gold Camps & Silver Cities*, 11, 85; Beal & Wells, *History of Idaho*, 1:420.

163 Romig, "South Boise Quartz Mines," 75.

164 Hubbard, *Mineral Resources of Idaho*, 50.

165 Beal & Wells, *History of Idaho*, 1:367, 570, 575; Ross, *South-Central Idaho*, 7-8.

166 Wells, *Gold Camps & Silver Cities*, 132.

167 Arrington, *History of Idaho*, 1, 449-450.

168 John C. Reed, *Early and Recent Mining Activity in North-Central Idaho* (Idaho Bureau of Mines and Geology Press Bulletin 18, 1936), 3-4; Ross, *South-Central Idaho*, 25; Idaho State Historical Society, *Idaho, An Illustrated History*, 39.

169 Miller, *Automobile Gold Rushes*, 80, 111-112.

170 Teske, *Idaho's Mineral Industry*, 58; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 94.

171 Donald L. Hardesty, "Power and the Industrial Mining Community in the American West," 81-96 in Knapp et al., *Social Approaches to an Industrial Past*, 81-82.

172 Wells and Hart, *Idaho, Gem of the Mountains*, 41; Idaho State Historical Society, *Idaho, An Illustrated History*, 67-68.

173 Bolino, "Role of Mining," 129, 132; Richard H. Peterson, "Simeon Gannett Reed and the Bunker Hill and Sullivan, the Frustrations of a Mining Investor," *Idaho Yesterdays* 23 (fall 1979), 3.

174 Clark C. Spence, *British Investments and the American Mining Frontier, 1860-1901* (Moscow, Idaho, University of Idaho Press, 1995), 2, 9; Romig, "South Boise Quartz Mines," 53; Wells, *Gold Camps & Silver Cities*, 97; William Turrentine Jackson, "British Capital in Northwest Mines," *Pacific Northwest Quarterly* 47 (July 1956), 75, 78, 82, 84-85. Bolino ("Role of Mining," 131) reports that the best British investment in Idaho was the purchase of the Minnie Moore mine on Wood River in 1884.

175 Idaho State Historical Society, *Idaho, An Illustrated History*, 113; Arrington, *History of Idaho*, 1:458.

176 Rohe, "The Geography and Material Culture of the Western Mining Town," 100.

177 Defenbach, Idaho, 309; York, "Placer Mining Era," 196-197; Dryden, Clearwater, 97-98; Hawley, *History of Idaho*, 119.

178 Rohe, "The Geography and Material Culture of the Western Mining Town," 100, 104.

179 Koschmann & Bergendahl, *Principal Gold-Producing Districts*, 133-34.

180 Brown, *Hard-Rock Miners*, 70, 72-73; Young, *Western Mining*, 165.

181 Young, *Western Mining*, 224; Wyman,

"Underground Miner," 111, 386; Paul, *Mining Frontiers*, 143.

182 A.C. Todd, "Cousin Jack in Idaho," *Idaho Yesterdays* 8 (winter 1964-65), 2, 6.

183 Brown, *Hard-Rock Miners*, 101-102, 110; Wyman, "Underground Miner," 118; Shenon & Full, *Evaluation*, 1:197.

184 Brown, *Hard-Rock Miners*, 77-78, 82, 86, 93; Wyman, "Underground Miner," 257, 268, 289; Wyman, "Mining Law," 19-20, 22; Hawley, *History of Idaho*, 493.

185 Hart & Nelson, *Mining Town*, 46-47; Donald L. Hardesty, "Power and the Industrial Mining Community in the American West," 81-96 in A. Bernard Knapp, Vincent C. Pigott and Eugenia W. Herbert, *Social Approaches to the Industrial Past, The Archaeology and Anthropology of Mining* (London, H.B. Routledge, 1998), 88; James B. Allen, *The Company Town in the American West* (Norman, Oklahoma, University of Oklahoma Press, 1966), 80, 92.

186 Wells, *Rush to Idaho*, 20, 28; James H. Hawley, *History of Idaho, the Gem of the Mountains*, 4 vols. (Chicago, S. J. Clarke Pub. Co., 1920), 116, 120, 122; William J. Trimble, *The Mining Advance into the Inland Empire* (Madison, Wisc., Bulletin of the University of Wisconsin 638, 1914), 379.

187 Merle William Wells, "The Western Federation of Miners," *Journal of the West* 12 (Jan. 1973), 19; Brown, *Hard-Rock Miners*,145; Wells, *Gold Camps & Silver Cities*, 41.

188 Wells, "Western Federation of Miners," 19; Teske, *Idaho's Mineral Industry*, 14; Richard E. Lingenfelter, *The Hard-Rock Miners, A History of the Mining Labor Movement in the American West, 1863-1893* (Berkeley, University of California Press, 1974), 79-81, 118-119; Janene Caywood, Theodore Catton, and David Putnam, *Comprehensive Historical Overview and Results of Archaeological Test Excavation at Selected Historical Mining Sites on Florida Mountain, Owyhee County, Idaho* (prepared for CH2M Hill, Corvallis, Oregon, 1993), 35.

189 Lingenfelter, *Hard-Rock Miners*, 171, 176.

190 Katherine G. Aiken, "Mining in the Coeur d'Alenes" (16-18, in Idaho Humanities Council, *Idaho and the American West*, Boise, Idaho, Idaho Humanities Council, 1994), 16.

191 Lingenfelter, *Hard-Rock Miners*, 198-201, 204-205; Hart & Nelson, *Mining Town*, 50, 54-56; Paul, *Mining Frontiers*, 282.

192 Ransome, *Coeur d'Alene District*, 81; Aiken, "Mining in the Coeur d'Alenes," 17; John Fahey, *The Inland Empire, Unfolding Years, 1879-1929* (Seattle, University of Washington Press, 1986), 181.

193 Lingenfelter, *Hard-Rock Miners*, 227; Arrington, *History of Idaho*,1, 460; Wells, "Western Federation of Miners," 22, 28, 34.

194 John Fahey, *The Days of the Hercules* (Moscow, Idaho, University Press of Idaho, 1978), 177, 201; Stanley S. Phipps, "The Coeur d'Alene Miners' Unions in the Post Bullpen Era, 1900 to 1916, the Socialist Party and I.W.W. Connections" (M.A. thesis, University of Idaho, 1980), ii-iii..

195 Corinne M. Davis, "One Union Against a Town, Local 18 of the International Union of Mine, Mill and Smelter Workers at the Bunker Hill Company, Kellogg, Idaho, 1941-1960" (M.S. thesis, University of Idaho, 1991), iii.; Aiken, "Mining in the Coeur d'Alenes," 17.

196 Wells, *Gold Camps & Silver Cities*, 26, 45-46.

197 Idaho State Historical Society, *Idaho, An Illustrated History*, 50.

198 Science Applications International Corporation, *Plan to Mitigate Adverse Effects to Historic Properties at the Stone Cabin Mine Project, Owyhee County, Idaho* (submitted to Kinross DeLamar Mine Company, March 14, 1995), 3-9; Wells, *Gold Camps & Silver Cities*, 26, 45-46.

199 Caywood et al., *Comprehensive Historical Overview*, 28; Wells, *Gold Camps & Silver Cities*, 25; Thornton Waite, *Union Pacific Rails to the Mines, The Boise, Nampa & Owyhee Railway* (Idaho Falls, Thornton Waite, 1999), 10, 17.

200 Koschmann & Bergendahl, *Principal Gold-Producing Districts*, 138; Wells, *Gold Camps & Silver Cities*, 49; Science Applications, *Plan to Mitigate*, 3-3, 3-8; Caywood et al., *Comprehensive Historical Overview*, 31, 65, 71; Robert L. Romig, "Florida Mountain Mines," Idaho State Historical Society Reference Series #909, 1989, 3-6.

201 Science Applications International Corporation, The Arrowrock Group, and Western Resources Consulting, *Historic Mining on Florida Mountain, Data Recovery at the Stone Cabin Mine Study Area, Owyhee County, Idaho* (prepared for Kinross DeLamar Mining Company and Bureau of Land Management, draft, 1996), 3-3; Romig, "Florida Mountain Mines," Idaho State Historical Society Reference Series #909, 5.

202 Romig, "South Boise Quartz Mines," 4-5, 8, 11, 17, 20-21, 23, 32, 44, 51; Wells, *Gold Camps & Silver Cities*, 16-17.

203 Romig, "South Boise Quartz Mines," 54, 56, 66-67, 74; Wells, *Gold Camps & Silver Cities*, 23.

204 Romig, "South Boise Quartz Mines," 79-80, 87, 89; Wells, *Gold Camps & Silver Cities*, 25.

205 Romig, "South Boise Quartz Mines," 58; Varley et al., *Mining Districts of Idaho*, 57; Wells, *Gold Camps & Silver Cities*, 60, 63; Atlanta Historic District National Register Nomination.

206 Wells, *Gold Camps & Silver Cities*, 61-63; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 192; Eugene Delos Gardner, *Milling Methods and Costs at the Mine of the St. Joseph Lead Co., Atlanta, Idaho* (U.S. Bureau of Mines Information Circular 6836, 1935), 1-2.

207 Wells, *Gold Camps & Silver Cities*, 93-98; Koschmann & Bergendahl, *Principal Gold-Producing Districts*, 128; Nancy Carol Luebbert, "A History of the Yankee Fork Mining District, Custer County, Idaho" (M.A. thesis, Dartmouth College, 1978), 6; Wells & Hart, *Idaho, Gem of the Mountains*, 40.

208 Idaho State Historical Society, "Gibbonsville," Reference Series #387, n.d., 2.

209 Mary Rossillon, *An Overview of History in the Drainage Basin of the Middle Fork of the Salmon River* (University of Idaho Anthropological Research Manuscript Series 60, 1980), 24; Wells, *Gold Camps & Silver Cities*, 83-84.

210 "Gold Mines of Cariboo Mountain," *Idaho Yesterdays*, 15.

211 Schiach et al., *Illustrated History of North Idaho*, 27; M. Alfreda Elsensohn, *Pioneer Days in Idaho County* (2 vols., Caldwell, Idaho, Caxton Printers, 1947-1951), 1:196.

212 McKay, *Florence Mining District*, 93-94.

213 Idaho State Historical Society, "Mining in Idaho," Reference Series #65, 1970, 6; McKay, *Florence Mining District*, 94-96.

214 McKay, *Florence Mining District*, 96; Kenneth J. Swanson, *Thunder Mountain Mining Project Cultural Resource Investigation* (prepared for James M. Montgomery, Consulting Engineers, 1984), A-49; Wells, *Gold Camps & Silver Cities*, 155-156.

215 Swanson, *Thunder Mountain Mining Project*, A-20-25, A-29; Wells, *Gold Camps & Silver Cities*, 154.

216 Nicholas A. Casner, "Toxic River, Politics and Coeur d'Alene Mining Pollution in the 1930's," *Idaho Yesterdays* 1991 35(3), 3; Ross, *Metal Mining in Idaho*, 5; Wells & Hart, *Idaho, Gem of the Mountains*, 45; Koschmann & Bergendahl, *Principal Gold-Producing Districts*, 139.

217 Fahey, *The Days of the Hercules*, 251; Arrington, *History of Idaho*, 1:356, 358; Fulkerson, *Silver Production*, 16; Katherine G. Aiken, "Bunker Hill Versus the Lead Trust, The Struggle for Control of the Metals Market in the Coeur d'Alene Mining District, 1885-1918," *Pacific Northwest Quarterly* 84 (1993 no. 2), 42-43.

218 Wells & Hart, *Idaho, Gem of the Mountains*, 45-46; Ransome, *Coeur d'Alene District*, 80.

219 Wegars, "Chinese in Northern Idaho," 131, 134-135, 164.

220 Arrington, *History of Idaho*, 1, 352-354; Livingston-Little, *North Idaho*, 88; Bolino, "Role of Mining," 129; David Sisson, *Pine Creek Rehabilitation Project*, ID6-96-43 (prepared for Bureau of Land Management, Coeur d'Alene District, 1996), 26.

221 Livingston-Little, *North Idaho*, 103; Hart & Nelson, *Mining Town*, 27, 34; James Ralph Finlay, *The Mining Industry of the Coeur d'Alenes, Idaho* (New York, American Institute of Mining and Metallurgical Engineers, 1902), 33; Ransome, *Coeur d'Alene District*, 81.

222 Ransome, *Coeur d'Alene District*, 86; Fahey, *Days of the Hercules*, 99-100.

223 Hart & Nelson, *Mining Town*, 40, 42; Fahey, *Days of the Hercules*, 5-6, 50, 240, 251; Arrington, *History of Idaho*, 1, 355; Fahey, *Inland Empire*, 183-184.

224 Quivik, *Expert Report*, vi; Varley et al., *Mining Districts of Idaho*, 24-25, 27, 29-30, 32; Day, "Mining Highlights of the Coeur d'Alene District," 43-45; M. Dalton, *Milling Methods and Costs at the Morning Concentrator of the Federal Mining and Smelting Co., Mullan, Idaho*

(U.S. Bureau of Mines Information Circular 6587, 1932), 1-2.

225 Fahey, *Inland Empire*, 181-183; Fell, *Ores to Metals*, 152-153; Fahey, *Days of the Hercules*, 68; Idaho State Historical Society, *Idaho, An Illustrated History*,196, 198-199.

226 Fahey, *Days of the Hercules*, 38, 168; Aiken, "Bunker Hill versus the Lead Trust," 44, 46.

227 Varley et al., *Mining Districts of Idaho*, 9; George Domijan, "Historic American Engineering Record, Bunker Hill Lead Smelter" (1993), 3; Fahey, *Inland Empire*, 173-174, 185.

228 Author's note, The smelter of the Panhandle Smelting and Refining Company in Ponderay was the only smelter in northern Idaho not part of the smelter trust until the Bunker Hill smelter was built in 1917. It operated only sporadically for a few years in the early 1900s, despite a good location on the Northern Pacific Railroad and Spokane International lines and a ferry dock on Lake Pend Oreille. Paul, *Mining Frontiers*, 264; Fell, *Ores to Metals*, x, 200, 218, 223; Nancy F. Renk, Flume Creek Historical Services, e-mail to Kathryn L. McKay, 26 Jan. 2001.

229 Fahey, *Inland Empire*, 185; Lieb, Keyston & Co., *An Analysis of the Position, History, and Outlook for Bunker Hill and Sullivan Mining and Concentrating Company* (San Francisco, Recorder Printing and Publishing Co., 1936), 6-7.

230 Domijan, "Bunker Hill Lead Smelter," 9, 11, 13, 15, 19; Bunker Hill Company, *Bunker Hill Company, A Story of Progress from Mines to Metals*. Kellogg, Idaho, Bunker Hill Company, (1958), 8-10; Day, "Mining Highlights of the Coeur d'Alene District," 53-56; Teske, *Idaho's Mineral Industry*, 40.

231 Day, "Mining Highlights of the Coeur d'Alene District," 47, 51-52; Arrington, *History of Idaho*, 2, 128; Domijan, "Bunker Hill Lead Smelter," 25.

232 Fahey, *Inland Empire*, 185-187; Fahey, *Days of the Hercules*, 172-173, 176; Sisson, *Pine Creek Rehabilitation Project*, 12-13.

233 Henry Lawrence Day, "96 Years of Mining in Idaho" (typescript, 1956), 5-6; Ransome, *Coeur d'Alene District*, 83.

234 Varley et al., *Mining Districts of Idaho*, 12; Fahey, *Days of the Hercules*, 155; George Domijan, "Historic American Engineering Record, Sullivan Electrolytic Zinc Plant" (1993), 3.

235 Domijan, "Sullivan Electrolytic Zinc Plant," 3.

236 Domijan, "Sullivan Electrolytic Zinc Plant," 4-5, 27, 45, 47, 52; Day, "Mining Highlights of the Coeur d'Alene District," 37.

237 Day, "Mining Highlights of the Coeur d'Alene District," 65-67; Scamahorn Air Photo Company, *The Coeur d'Alene Mining District as Seen Through the Aerial Camera of Scamahorn Air Photo Company* (Spokane, Wash., Scamahorn Air Photo. Co., 1948), 5; Alt & Hyndman, *Roadside Geology*, 72; Fulkerson, *Silver Production*, 2; Domijan, "Bunker Hill Lead Smelter," 22-23.

238 Day, "Mining Highlights of the Coeur d'Alene District," 6; Domijan, "Bunker Hill Lead Smelter," 25; Fulkerson, *Silver Production*, 2; Sisson, *Pine Creek Rehabilitation Project*, 14.

239 Day, "Mining Highlights of the Coeur d'Alene District," 41; Teske, *Idaho's Mineral Industry*, 31; Bunker Hill Company, *A Story of Progress*, 2-3.

240 Hubbard, *Mineral Resources of Idaho*, 18-19.

241 Thomas R. Navin, *Copper Mining and Management* (Tucson, University of Arizona Press, 1978), 132.

242 Navin, *Copper*, 4, 9, 30-31; Francaviglia, *Hard Places*, 131; Pfleider, *Surface Mining*, 875.

243 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 69, 74; Clyde Ross, *The Copper Deposits Near Salmon, Idaho* (U.S. Geological Survey Bulletin 774, 1925), 2, 30; R. Duncan Gardner, *Milling Methods and Costs at the Harmony Mines, Baker, Idaho* (U.S. Bureau of Mines Information Circular 6285, 1930), 1; Ransome, *Coeur d'Alene District*, 81-82; Waldbauer, *Hoodoo Mining District*, 48-49; Wells, *Gold Camps & Silver Cities*, 64.

244 Idaho State Historical Society, "Recovery Processes for Idaho Ores," Reference Series #380, 1-2.

245 Navin, *Copper*, 43-48.

246 Wells, *Gold Camps & Silver Cities*, 107-108; David H. Stratton and Glen W. Lindeman, "A Study of Historical Resources of the Hells Canyon National Recreation Area" (prepared for the Hells Canyon National Recreation Area, 1978), 42-44; Federal Writers' Project, *Idaho, A Guide in Word and Picture* (Works Progress Administration. Caldwell, Idaho, Caxton Printers, 1937), 173.

247 Koschmann & Bergendahl, *Principal Gold-Producing Districts*, 127; *Empire Mine, Mackay, Custer County, Idaho, Copper* (U.S. Bureau of Mines War Minerals Report 267, 1944), 2-3; Varley et al., *Mining Districts of Idaho*, 69-70; Wells, *Gold Camps & Silver Cities*, 123-126.

248 Romig, "South Boise Quartz Mines," 94.

249 Hubbard, *Mineral Resources of Idaho*, 33; Ross, *Metal Mining in Idaho*, 4; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 182.

250 Clark C. Spence, *For Wood River or Bust, Idaho's Silver Boom of the 1880s* (Moscow, Idaho, University of Idaho Press, 1999), 199; Ross, *Metal Mining in Idaho*, 6.

251 Bolino, "Role of Mining," 129; 144; Wells, *Gold Camps & Silver Cities*, 13, 31; French, *History of Idaho*, 473.

252 Carleton Norman Savage, *Geology and Mineral Resources of Bonner County* (Idaho Bureau of Mines and Geology County Report 6, 1967), 3-4, 80-81; Lorelea Hudson et al., *A Historic Overview for the Colville and Idaho Panhandle National Forests and the Bureau of Land Management Spokane and Coeur d'Alene Districts* (prepared by Cultural Resource Consultants for the USDA Forest Service, Northern Region Report 6, 1980), 201; Peter Kun, *Geology and Mineral Resources of the Lakeview Mining District, Idaho*, (Idaho Bureau of Mines and Geology, Pamphlet 156, 1974), 4-5.

253 Virgil Raymonde Kirkwell and Drexel Wells, *Geology and Ore Deposits of Boundary County, Idaho* (Idaho Bureau of Mines and Geology Bulletin 10, 1926), 56; Hudson et al., *Colville and Idaho Panhandle*, 202.

254 Author's note, Before 1880, when Idaho began mining these types of ores, lead-silver smelting in blast furnaces had been successfully accomplished in Eureka, Nevada, and put into large-scale operation at Leadville, Colorado. When Idaho's lead-silver properties such as those in Wood River, Sawtooth, Vienna, Bayhorse, Little Smokey, and Coeur d'Alene were developed, they adopted the Eureka process.

255 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 190; Wells & Hart, *Idaho, Gem of the Mountains*, 47; Steven R. Simms, *Archeological Survey in the Bayhorse Mining District, Custer County, Idaho* (Salt Lake City, Utah, Archeological Center, Dept. of Anthropology, University of Utah, 1980), 20, 23-27; Gard, "Smoke and Ash," 111.

256 Spence, *Wood River*, 7, 60-61; Beal & Wells, *History of Idaho*, 1, 571-572; Bolino, "Role of Mining," 125; Idaho State Historical Society, *Idaho, An Illustrated History*, 111, 113.

257 Arrington, *History of Idaho*, #1, 348; Spence, *Wood River*, 197-199, 217-218, 221.

258 Spence, *Wood River*, 229-230; Victoria E. Mitchell, "History of the Triumph, Independence, and North Star Mines, Blaine County, Idaho" (Idaho Geological Survey, Staff Report 97-1, 1997), 5, 18, 20, 22, 31; Varley et al., *Mining Districts of Idaho*, 67-68.

259 Pearl M. Oberg, *Between These Mountains, History of Birch Creek Valley, Idaho* (New York, Exposition Press, 1970), 62, 65-65.

260 Lyle Longhurst, *The Gilmore & Pittsburgh, Lemhi County's Only Railroad (1989)*, iii-iv, 126; Wells, *Gold Camps & Silver Cities*, 128-129.

261 Ross, *South-Central Idaho*, 19; Teske, *Idaho's Mineral Industry*, 56-57; "Idaho is Greatest Prospecting Field for War Minerals," 14-18 in Idaho Inspector of Mines, *Forty-fifth Annual Report of the Idaho Mining Industry* (1943), 15.

262 F.E. Wormser, "Lead," 17-21 in Arthur Campbell, *Forty-third Annual Report of the Mining Industry of Idaho* (1941), 17.

263 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 223-225, 233; Alt & Hyndman, *Roadside Geology*, 221; Stibnite Historic District National Register nomination, section 8, 1; Arthur Campbell, "Idaho's Strategic Minerals," 10-14 in *Forty-fifth Annual Report of the Mining Industry of Idaho*, 1943, 13.

264 C. M. Dice, *Methods and Costs of Concentrating Hubnerite Ores at the Ima Tungsten Mine, Lemhi County, Idaho* (U.S. Bureau of Mines Information Circular 7230, 1943), 1, 4; Day, "96 Years of Mining in Idaho," 10-11; *Blue Wing Mining District, Lemhi County, Idaho, Tungsten* (Washington, D.C., U.S. Bureau of Mines, 1943), 1-3, 13.

265 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 41-42, 44; James M. Montgomery, Consulting Engineers, Inc., *Cultural Resources Inventory/Assessment Package*

Environmental Impact Statement, Stibnite Mining Project Gold Mine and Mill (1981), 2-9; Arthur Campbell, "Idaho's Strategic Minerals," 10-14 in *Forty-fifth Annual Report on the Mining Industry of Idaho*, 1943, 12.

266 Montgomery, *Stibnite Mining Project*, 2-11, 2-13.

267 Wells, *Gold Camps & Silver Cities*, 157; John W. Cole and H.D. Bailey, *Exploration, Development, Mining, and Milling of a Unique Tungsten Ore Body at the Yellow Pine Mine, Stibnite, Idaho* (U.S. Bureau of Mines Information Circular 7443, 1948), 3-4, 12-13, 17; Day, "96 Years of Mining in Idaho," 7; Stibnite Historic District National Register nomination.

268 Montgomery, *Stibnite Mining Project*, 2-7, 2-8, 2-12

269 Hubbard, *Mineral Resources of Idaho*, 57-58.

270 Constantine C. Popoff, *Hermada Antimony Deposit, Elmore County, Idaho* (U.S. Bureau of Mines, Report of Investigations 4950, 1953), 3-4, 6.

271 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 120; Hubbard, *Mineral Resources of Idaho*, 38; Margaret R. Lickes, *Mining, Processing, and Costs, Idaho Almaden Mercury Mine, Washington County, Idaho* (U.S. Bureau of Mines Information Circular 7800, 1957), 6, 15-16; Ross, *South-Central Idaho*, 21.

272 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 121; Lickes, *Idaho Almaden Mercury Mine*, 4-5; Wells, *Gold Camps & Silver Cities*, 157; Alt & Hyndman, *Roadside Geology*, 171.

273 Smith, *Boise National Forest*, 14-15; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 121; Montgomery, *Stibnite Mining Project*, 2-16; U.S. Bureau of Mines, *Bonanza (Hermes) Mercury Mines, Valley County, Idaho* (U.S. Bureau of Mines, War Minerals Report 106, 1943), 1-3.

274 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 66; Hubbard, *Mineral Resources of Idaho*, 14-15.

275 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 66, 68.

276 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 17, 19; Hubbard, *Mineral Resources of Idaho*, 36-37; Arthur Campbell, "Idaho's Strategic Minerals" 10-14 in Idaho Inspector of Mines, Forty-fifth Annual *Report of the Mining Industry of Idaho*, 1943, 12.

277 R. H. Storch, *Ilmenite and Other Black-Sand Minerals in the Gold Fork Placer Deposit, Valley County, Idaho* (U.S. Bureau of Mines, Report of Investigations 5395, 1958), 1; Richard H. Storch and D. C. Holt, *Titanium Placer Deposits of Idaho* (Washington, D.C., U.S. Bureau of Mines, Report of Investigations 6319, 1963), 1; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 212-213, 219; Hubbard, *Mineral Resources of Idaho*, 55; Teske, *Idaho's Mineral Industry*, 17.

278 Noble & Spude, Historic Mining Properties, 18; E. F. Cook, *Radioactive Minerals in Idaho* (Idaho Bureau of Mines and Geology, Mineral Resources Report 8, 1957), 1; Ross, *South-Central Idaho*, 24.

279 Wells, *Gold Camps & Silver Cities*, 157; Storch & Holt, *Titanium Placer Deposits*, 2; Teske, *Idaho's Mineral Industry*, 24; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 15, 235.

280 Storch & Holt, *Titanium Placer Deposits*, 3; Smith, *Boise National Forest*, 15-16; Day, "96 Years of Mining in Idaho," 10; Wells, *Gold Camps & Silver Cities*, 52.

281 Alfred L. Anderson, *Uranium, Thorium, Columbium, and Rare Earth Deposits in the Salmon Region, Lemhi County, Idaho* (Idaho Bureau of Mines and Geology, Pamphlet 115, 1958), 1, 49; U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 214, 216.

282 U.S. Geological Survey, *Mineral and Water Resources of Idaho*, 49; Hubbard, *Mineral Resources of Idaho*, 8.

283 Quivik, *Expert Report*, vii-viii.

284 Quivik, *Expert Report*, vi-vii, x-xi; Casner, "Toxic River," 3-4.

285 Katherine Gertrude Aiken, "Not Long Ago a Smoking Chimney Was a Sign of Prosperity", Corporate and Community Response to Pollution at the Bunker Hill Smelter in Kellogg, Idaho," *Environmental History Review* 18 (summer 1994), 68; Casner, "Toxic River," 3, 5, 11, 13, 18; George Domijan, "Land Status and Mining Development in the Coeur d'Alene Mining District of Northern Idaho" (M.S. thesis, University of Idaho, 1986), 91-92.

286 Domijan, "Land Status," 93-94.

287 Casner, "Toxic River," 6; Katherine Aiken, "Western Smelters and the Problem of Smelter Smoke," 502ff, in Dale D. Goble and Paul W. Hirt, eds., *Northwest Lands, Northwest Peoples, Readings in Environmental History* (Seattle, Wash., University of Washington Press, 1999), 502-503, 507-508, 510.

288 Aiken, "Mining in the Coeur d'Alenes," 18; Chris Johnson, "Bunker Hill, The Company That Made a Town," *Idaho Yesterdays* 41 (1997 no. 1), 3-4.

289 Kathryn Brown, "Ghost Towns Tell Tales of Ecological Boom and Bust," *Science* 290 (6 Oct. 2000), 35, 37.

290 Wyman, "Mining Law," 22; Rohe, "Gold Dredging," 14; Teske, *Idaho's Mineral Industry*, 23.

291 Livingston-Little, *North Idaho*, 51; Trimble, *Mining Advance*, 117-118.

292 Wells & Hart, *Idaho, Gem of the Mountains*, 33.

293 Wells & Hart, *Idaho, Gem of the Mountains*, 51.

294 Idaho State Historical Society, "Mining in Idaho," Reference Series #65, 1970, 1.

295 Donald L. Hardesty and Barbara J. Little, *Assessing Site Significance, A Guide for Archaeologists and Historians* (Walnut Creek, Calif., Alta Mira Press, 2000), 106, 137.

296 Idaho State Historical Society, "Lode Mining Cultural Resources," Reference Series #1062, 1994, 1-2.

297 Pfleider, *Surface Mining*, 934-935.

298 Neville Ritchie, "Archaeological Interpretation of Alluvial Gold Tailing Sites, Central Otago, New Zealand," *New Zealand Journal of Archaeology* 3 (1981), 66.

299 Rohe, "Traditional Placer Mining," 149.

300 Rohe, "Hydraulicking," 30; John Wellington Finch, ed., *Ore Deposits of the Western States* (New York, American Institute of Mining and Metallurgical Engineers, 1933), 440; Koschmann & Bergendahl, *Principal Gold-Producing Districts*, 123-124.

301 LaLande, "Sojourners in Search of Gold," 45-46.

302 Rohe, "Geographical Impact of Placer Mining," 224, 266.

303 Clyde Ross, *A Graphic History of Metal Mining in Idaho* (U.S.G.S. Contributions to Economic Geology 821-A, 1930), 5; Wells & Arthur A. Hart, *Idaho, Gem of the Mountains* (Northridge, Calif., Windsor Publications, 1985), 49; Teske, *Idaho's Mineral Industry*, 22; Miller, *Automobile Gold Rushes*, 102; Sharon Murray, "A Bucket Full, Boise Basin's Dredging Heritage, 1898-1951," *Idaho Yesterdays* 34 (fall 1990), 2; Rohe, "Geographical Impact of Placer Mining," 163, 165, 167-68; Clark C. Spence, "The Golden Age of Dredging, The Development of an Industry and Its Environmental Impact," *Western Historical Quarterly* 11 (Oct. 1980), 408.

304 Wells, *Gold Camps & Silver Cities*, 88-89, 91-92; Ronald L. James, *Ruins of a World, Chinese Gold Mining at the Mon-Tung Site in the Snake River Canyon* (U.S. Bureau of Land Management, Idaho Cultural Resource Series 4, 1995), 3-4, 6-8, 11; Staley, *Gold in Idaho*, 30; T. Egleston, *The Treatment of Fine Gold in the Sands of Snake River, Idaho* (New York, American Institute of Mining Engineers, 1890), 5-7, 11.

305 Shenon and Full, *Evaluation*, 3:408; James Lawrence Onderdonk, *Idaho, Fact and Statistics Concerning Its Mining, Farming...* (San Francisco, A.L. Bancroft & Co., 1885), 97; Lorain & Metzger, *Reconnaissance*, 80.

306 Swanson, *Thunder Mountain Mining Project*, 28; Stratton & Lindeman, *Hells Canyon*, 40.

307 Idaho State Historical Society, "Lode Mining Cultural Resources," Reference Series #1062, 1994, 3.

308 Kathryn L. McKay, *Gold for the Taking, Historical Overview of the Florence Mining District, Idaho County, Idaho* (prepared for the Nez Perce National Forest by Tracks of the Past, 1998), 99.

309 McKay, *Florence Mining District*, 99.

310 Sharon Ann Murray, "The Marshall Lake Mines, Their History and Development" (M.A. thesis, University of Idaho, 1979), ii.

311 Mark Druss and Claudia Druss, *Archeological Investigations at the Sunbeam Mine, Central Idaho* (submitted to USDA Forest Service, 1983), 29.

312 Montgomery, *Stibnite Mining Project*, 2-13.

313 Montgomery, *Stibnite Mining Project*, 3-21; Domijan, "Land Status," 87.

314 Gardner, *Harmony Mines*, 14.

315 Domijan, "Bunker Hill Lead Smelter," 23.

316 Paul, *Mining Frontiers*, 268.

317 Claudia Druss, *A History of Mining on Bismarck Mountain, 1870-1940* (Basin & Range Research, 1988), 9; Idaho State

Historical Society, "Atlanta Dam and Power Plant," Reference Series #494, 1979.

318 Gard, "Smoke and Ash," 7, 10, 25-26, 85

319 Earls et al., *Leesburg Historic Mining District*, 223, 226, 252; Gard, "Smoke and Ash," 25, 85-86; Oberg, *Between These Mountains*, 73-77.

320 Swanson, *Thunder Mountain Mining Project*, 18-19.

321 David A. Sisson, "Archaeological Evidence of Chinese Use along the Lower Salmon River, Idaho," 33-63 in Wegards, *Hidden Heritage*, 50, 58; LaLande, "Sojourners in the Oregon Siskiyou," 296-301.

322 Jennifer Eastman Atteberry, *Building with Logs, Western Log Construction in Context* (University of Idaho Press, 1999), 40, 99, 114.

323 James, *Ruins of a World*, 21-22, 43, 45, 66-67; Fee, "Chinese in an Idaho Wilderness," 111.

324 Edwin B. Douglas, "Current Program Aims at Cobalt Production in 1951" (59-63 in George A. McDowell, *52nd Annual Report of the Mining Industry of Idaho* (1950), 62; Druss, *Bismarck Mountain*, 10; Montgomery, *Stibnite Mining Project*, 2-17.

325 Montgomery, *Stibnite Mining Project*, 2-12, 2-13, 3-9, 3-14.

326 Montgomery, *Stibnite Mining Project*, 3-20.

327 Packard, *Yankee Fork*, 28.

328 Dale Gray, Elk City Wagon Road National Register nomination (draft), 1999.

329 Finlay, *Mining Industry*, 36.

330 Hufstetler & Martin, *Union Pacific Railroad*, 21-22.

331 Gardner, *St. Joseph Lead*, 1; Montgomery, *Stibnite Mining Project*, 2-14.

332 Hardesty, *Archaeology of Mining and Miners*, 111.

333 Mitzi Rossillon, "Impact Mitigation for Select Historic Features at the Park Mines (24BW210), Broadwater County, Montana" (Prepared by Renewable Technologies, Inc., for Montana Department of Environmental Quality, 1998), 41, 47.

334 Rossillon, Park Mines, 46-47.

Glossary

ADIT A mostly horizontal passage driven from the surface for the working, ventilation, or dewatering of a mine. An adit has only one opening, as distinguished from a tunnel.

AERIAL TRAMWAY A system for the transportation of ore or rock in buckets that are suspended from a continuous cable system.

ALLUVIAL DEPOSIT Clay, silt, sand, and gravel transported by flowing water and deposited in comparatively recent geological time as sediments in river beds, estuaries, flood plains, on lakes, shores, and in fans at the base of mountain slopes.

AMALGAM An alloy of mercury with gold or another metal in the form of a soft putty. In the case of placer gold, a "dry" amalgam is one from which all excess mercury has been removed by squeezing through chamois leather and containing nearly equal proportions of gold and mercury.

AMALGAMATION The process of using mercury to extract gold or silver from pulverized ore. The mercury combines with the gold and silver to form an amalgam; the amalgam is then heated to vaporize the mercury and leave the gold or silver as a residue. The mercury can be condensed from the vapor and re-used.

APEX The legal name for the top of a vein in place (in most cases this is underground).

ARRASTRA A circular mill for grinding ores, employed in the processing of gold and silver ores; a crushing mill. Heavy drag stones were dragged over the mixture of ore and mercury using a horse, water wheel, steam, or gasoline engine for power. As the ore was crushed, the free gold was amalgamated. The gold-containing amalgam was then dug from between the cobblestones forming the circular path.

ASSAY To determine the amount and value of metal contained in an ore using a quantitative chemical analysis. The content, type, or quality of metal in an ore was tested, or "assayed," by an experienced assayer using various methods, including fire assay or acid tests.

ASSESSMENT WORK Annual work done on an unpatented mining claim, required by federal mining laws for the maintenance of title to a claim.

BAGHOUSE Pollution-control device that prevented particulates from being emitted from a smelter stack.

BALL MILL A rotating horizontal cylinder in which nonmetallic materials were ground using various types of grinding media such as quartz pebbles, porcelain balls, or steel balls. Ball mills were fine crushers; they followed primary crushers.

BASE METAL Copper, lead, zinc, and other common industrial metals.

BATHOLITH A large body of intrusive, igneous, granitic rock crystallized at a considerable depth below the earth's surface.

BED A seam, or horizontal vein of ore.

BEDROCK The solid rock that underlies soil or gravel.

BENCH PLACER Gravel deposits in ancient stream channels and flood plains that stand from fifty to several hundred feet above the present streams.

BENCHES Concentric level terraces in an open-pit mine. The mineral or waste is removed in successive layers, each of which is a bench.

BENEFICIATION See "Ore beneficiation."

BLACK SANDS Sands that contain minerals of tin, tungsten, titanium, nickel, cobalt, and iron that are commonly found on stream and river banks and seashores.

BLAST FURNACE A columnar furnace in which mixed charges of oxide ores, fluxes, and fuels are blown with a continuous blast of hot oxygen-enriched air in order to chemically reduce metals to their metallic state. The air blast melts the ore and fluxes, and metal and slag are separated.

BLASTING In underground mining, forcing off portions of rock by means of blasting powder. A hole is made with a borer, gunpowder is inserted and tamped in, and a fuse is attached and lit.

BOOMING A technique used at placer claims where the water supply was not plentiful. It involved accumulating water with dams and reservoirs and the sudden release of a large supply of water to excavate placer gravels from a hillside.

BUCKET In mining, an enlarged metal or wooden bucket used to haul matter out of a mine shaft. Sometimes used to carry miners.

BUDDLE A pan with a rapidly spinning agitator into which tailings or water from ore dressing passes before it runs off.

BULLION Uncoined gold and silver, often sent to the U.S. Mint for final refining.

CAGE A frame with one or more platforms used to hoist men, supplies, and ore up and down a vertical mine shaft.

CHARCOAL KILN A furnace in which wood was reduced to charcoal. The charcoal was used in smelting gold and silver ore. Also known as charcoal oven.

CHILEAN MILL A milling system similar to an arrastra but using a large stone or iron-shod wheel in place of drag stones to nip and crush ore.

CHINA PUMP A water-powered sump using a chain or belt of paddles or buckets used to divert streams from a mining site; an irrigation device native to southeast China.

CHLORIDES Silver ore lying above the water table where exposure to the atmosphere converts silver sulpherets to chlorides; a compound of chlorine and silver.

CHLORINATION A chemical method of removing gold from its gangue by the injection of chlorine gas into milled and roasted ore.

CHURN DRILLING Drilling method used primarily for exploratory work. Churn drills were a cable tool rig often used for placer evaluations, drilling blast holes at open pit operations, water well drilling.

CHUTE See "Ore chute."

CLAIM See "mining claim."

CLAIM MARKER A post, tree, rock cairn, or other marker placed at each corner and at the center of a claim.

CLASSIFIER A device for dividing and grading crushed ore in a mill.

CLEAN-UP The periodic recovery of amalgam from a sluice box or other gold-recovery device used to separate gold from sand, gravel, and other materials.

COKE The product obtained from fixed carbon and incombustible material after strongly heating bituminous coal out of contact with air and driving off the volatile constituents.

COLLAR Timbering or concrete around the mouth or top of a shaft.

COMPLEX ORE An ore containing a number of minerals of economic value. It usually implies an ore whose valuable metals are difficult to recover.

CONCENTRATE Ore that has been crushed and has had waste rock partially removed.

CONCENTRATOR/CONCENTRATION A device or process for reducing the values in an ore into a smaller bulk in order to reduce the expense of further treatment and shipment to a smelter. Sluicing of placer ground was the earliest form. Hand-sorting of ore to obtain a higher grade was probably the most commonly used. In concentrating mills the ore was crushed, screened to the proper size, and then passed over vibrating tables to separate the heavier metals from the gangue. Concentrators included jigs, vanners, and Wilfley tables.

CONTACT METAMORPHISM This occurs when country rock is intruded by a body of magma. Changes to the surrounding rocks occur because of penetration by the magmatic fluids and heat from the intrusion.

CORNISH PUMP A very early steam-powered mine pump for removing water from underground workings, invented for the Cornish tin mines of England. Consisted of a steam engine that operated a walking beam. If the shaft was greater than 300 feet deep, an additional pump had to be installed.

COUNTRY ROCK The rock surrounding a vein or lode, also known as waste rock or gangue.

CRIBBING Close timbering, as the lining of a shaft. In placer work, cribbing may be needed to support the walls of a shaft or a test pit put down in loose or wet ground.

CROSS-CUT A horizontal opening driven at right angles to the direction of the lode to connect major workings, used for access, exploration, communication, and ventilation.

CRUCIBLE A small refractory vessel for melting or calcinating ores and metals.

CRUSHING Grinding ore or quartz by stamps, crushers, or rolls. Various types include Chilean mills, stamp mills, jaw crushers, ball mills, rod mills, and tube mills.

CUSTOM MILL A refinery, smelter, or concentrator. In a custom plant, the processing is done on a fee basis with ownership of the metal technically remaining with the customer.

CYANIDE PROCESS/CYANIDATION A method of extracting precious metals from low-grade ore or tailings by dissolving gold and silver in a solution of alkaline cyanide. The process was first used in the United States in 1892. The practice consisted of fine grinding of the entire tonnage in a roller, tube, rod, or ball mill. The crushed ore passed to leaching tanks. A solution of sodium or potassium cyanide was placed in the tank with the ore. The ore then gave up the silver or gold mineral into the solution. The gold was retrieved in zinc boxes (or by other methods of precipitation) where the precious metals were precipitated. The precipitate was smelted and refined into gold and silver bullion.

DAM A barrier to confine or raise water for storage or diversion or to create a hydraulic head. A dam may also be a barrier to keep water from mine workings.

DEVELOPMENT Driving openings into a proved ore body to prepare it for full-scale mining.

DIAMOND DRILLING Method of drilling vertical or angled holes in overburden and ore deposits. Generally powered by gas or diesel engine with water as the drilling medium. Produces a core one to three inches in diameter.

DIKE A tabular, nearly vertical wall-like rock body, generally igneous in origin, that cuts across surrounding rock strata; a well-defined and mineralized shear zone.

DIP The inclination of the vein downward into the earth, compared to a horizontal plane (a 90 degree dip is vertical). Dip is a term used to describe the extent and direction of tilting of fractures and layering of rock.

DISSEMINATED ORE Ore in which the metal-bearing particles are sparsely scattered through a rock mass.

DITCH An artificial water course to convey water for mining. The ditch is dug into the earth.

DOUBLE JACKING In underground mining, a method of hand drilling the holes to place dynamite. Two miners work together, one holding the drilling bit (or steel) in place with two hands while the second miner swings a sledgehammer.

DRAGLINE DREDGE Power-shovel excavator with floating washing plants or special amalgamators. (see Fig. 8 F)

DREDGE A floating placer mine operation on a large raft or barge. Buckets or suction pumps scooped up sands and gravels that were then screened, sorted, and sluiced. Gold stayed in the sluice-boxes while waste gravels and sand were washed back into the creek or sent by conveyor to stacks in the creekbed behind. A dredge was first successfully worked in the United States at the Bannack Mining District, Montana, in 1895.

DRIFT A small tunnel run from the main tunnel or shaft to prospect for the pay load or block out the ground to facilitate its working. Drifts follow a vein or ore body.

DRIFT MINING A variety of underground methods used to work alluvial deposits. Because it is so much more expensive than sluicing or hydraulicking, it tends to be used only on richer deposits.

DROSSING Refers to the scum that forms on molten metals as a result of either oxidation or the rise of impurities to the surface.

DUMP The place where the waste rock or tailings are put after being taken from the mine.

ELECTROLYTIC REFINING The process of refining metals by casting them into anodes that are placed in an electrolyte consisting, usually, of a salt of the same metal dissolved in water. An electric current causes the pure metal to deposit on the cathode. Similarly, an electrically inert anode will result in deposition of the metal on the cathode from a purified solution of a salt of the metal.

ELEVATOR In hydraulic mining, a pipe used to move placer deposits or tailings to a higher elevation by means of pressurized water.

ENRICHED ORE Ore in which the original metal content has been increased by the addition of more metal brought down by descending surface waters. The water leaches metals from oxidized upper portions of the ore bodies and deposits it in the lower, unoxidized portions.

EXPLORATION The work involved in gaining an understanding of the size, shape, position, and value of an ore body.

FACE The extreme end of a tunnel, drift, or excavation; the place where the mining work is prosecuted.

FAULT A displacement or break in the earth's surface along which movement has taken place so that the veins are not continuous. Faults are caused by tensional, compressional, or shear forces.

FINES Fine gold particles found in placer gravels.

FISSURE VEIN Deposit of mineral matter in or along a fissure or fissure system (fissures are fractures and faults).

FLASK (MERCURY) An iron bottle in which quicksilver is sent to market. One flask contains seventy-six pounds of mercury.

FLOTATION The separation of minerals from each other and from waste matter by inducing (through the use of reagents) relative differences in their abilities to float in a liquid medium. The process will separate all metallic sulfides or elemental metals. If necessary, differential flotation can be used on complex ores. In such an ore, each sulfide mineral, such as copper, lead, and zinc, can be separated from the others.

FLUME An elevated, inclined trough, usually made of wood, for conveying water.

FLUX A chemical substance used in metallurgy to react with gangue minerals to form slags that are liquid at the furnace temperatures concerned and low enough in density to float on the molten bath of metal or matte.

FREE-MILLING ORE Ores that contain free gold or silver that can be separated from its surrounding country rock by the relatively simple methods of crushing and amalgamation (without roasting or other chemical treatment).

FREIBERG PROCESS Ore beneficiation method that combined roasting and amalgamation to extract values from ore. The process economized on both fuel and mercury, although it required more elaborate machinery than the patio process.

GANGUE The general name for all the minerals that contain no metals, or are the non-commercial and waste materials in a vein. As much of this gangue as possible is removed by the processes of concentrating and smelting.

GAUGE (RAIL) The distance between rails on a railroad line. Spur lines serving mines were either standard- or narrow-gauge. Standard gauge is usually 4 feet 8.5 inches.

GIANT Nozzle employed in hydraulicking to direct water pressure against a gravel bank.

GLORY HOLE A conical pit of large size whose sides, being unsupported in any way, tend to slump into their natural angle of repose. They can be created by the collapse of a stope or by a controlled caving process. The bottom of a glory hole can be connected to a raise driven from an underground haulage level.

GRIZZLY An iron or wooden grate or screen that prevents large rocks or boulders from entering a sluice or other gold recovery equipment.

GROUND SLUICE/GROUND SLUICING A linear excavation within a placer mine, usually dug down to bedrock, that is used for gold recovery in lieu of or in addition to a wooden sluice system. A stream of water was directed across the floodplain by using stone walls and barriers.

GRUBSTAKE Supplies provided by a business owner to a prospector in return for a negotiated share in his earnings. An agreement between the miner and a business owner whereby food, clothing, ammunition, and mining supplies would be furnished in exchange for a negotiated percentage of return on the miner's earnings.

HAUL ROAD In open-pit mining, a road rising from the bottom of an open pit at an incline of 8-12 percent up and down which ore trucks move. The haul road may spiral out of the mine or it may switch back and forth with hairpin curves.

HEAD DAM Collects water from a drainage and directs it into the ditch system of a placer mining operation.

HEADBOX A wooden structure next to a ditch and directly upslope from a hydraulic mine. The box, also called a pressure box or bulkhead, served as a small reservoir that fed ditch water into the steel pipe leading down to the mine.

HEADFRAME A timber or steel structure erected at the top of a shaft to carry the pulleys over which the cable runs for hoisting the cage. It is braced to withstand the pull of the hoisting engine.

HEAP LEACHING A recovery process in which prepared ore is stacked in heaps on impervious pads and a solvent percolated through the heap to dissolve selected metal values.

HEAVY METALS Principally the metals zinc, copper, cobalt, and lead.

HIGH-GRADING Stealing rich ore by carrying it out of the mine or by removing rich amalgam from a mill. Also, production of high-grade ore by sorting the ore.

HILLSIDE PLACER A group of gravel deposits intermediate between creek and bench placers.

HOIST An engine for raising ore, rock, or other materials from a mine and for lowering and raising men and materials. Any engine with a drum on which hoisting rope is wound.

HYDRAULIC MINING The excavation of a bank of gold-bearing gravel by a jet of water that is discharged through a nozzle under great pressure. The nozzle was known as a "monitor" or a "giant." The gravel was carried away by the water and transported through sluices with riffles to catch the gold. Delivering the water required a complex system of dams, ditches, headbox, and hydraulic nozzle.

HYDRAULICKING See "Hydraulic mining."

IGNEOUS ROCK Rock that has solidified from an original molten state.

INCLINE An adit run into a mine at an incline from vertical.

INTRUSIVE Molten material that crystallizes and solidifies at depth, never reaching the earth's surface before consolidation. The rock may be exposed later by erosion.

JAW CRUSHER A primary crusher designed to reduce large rocks or ores to sizes capable of being handled by any of the secondary crushers. It consists of a moving jaw, hinged at one end, that swings toward and away from a stationary jaw in a regular oscillatory cycle.

JIG A machine in which the feed is stratified in water by means of a pulsating motion and from which the stratified products are separately removed.

LAUNDER A chute or trough for conveying pulp, water, or powdered ore in the milling process.

LEACHING The removal of the more soluble minerals by percolating water, or extracting a soluble metallic compound from an ore by selectively dissolving it in a suitable solvent, such as water, sulfuric acid, hydrochloric acid, cyanide, etc.

LEDGE A visible portion of rock that contains rich ore.

LEVEL Passageways that connect on the same general horizontal plane; horizontal passage or drift into a mine from a shaft. It is customary to work mines by numbered levels.

LIXIVIATION A process of removing silver from refractory ores that involves the roasting and chlorination of the ore, followed by leaching with water, and then leaching with certain chemicals to precipitate the final product.

LOCATION A validly registered mining claim that has been shown to contain a valuable mineral deposit.

LODE A fissure in rock filled with valuable mineral, usually a quartz vein.

LODE DEPOSIT A tabular-shaped deposit of valuable mineral between definite boundaries. It may consist of several veins spaced closely together.

LODE MINING The mining of an in-place vein or deposit of metalliferous minerals (can be surface or underground).

LONG TOM A small, compact sluice box that was twelve feet long and made of two boxes. The lower end was closed, but had a screen in the bottom of the last two feet. Water entered at the upper end and washed the gravel through the screen. The remaining slurry dropped into the lower box and the gold was collected in the riffles of the second box.

MATTE The metallic mixture that results from smelting sulphide ores.

METAMORPHIC Metamorphic rocks have been transformed from preexisting rocks into texturally or mineralogically distinct new rocks by high temperature, high pressure, or chemically active fluids.

MILL A mineral treatment plant in which crushing, grinding, and further processing of ore is conducted to produce a concentrate.

MILLSITE Nonmineral public lands to be used as a mill site under the Mining Law of 1872, as amended, for the processing of ore for the development of a claim.

MILLING See "Ore beneficiation."

MINERS' INCH The volume of water flowing through a 1-inch-square hole in a board 6 inches below the stream's surface; 2.5 cubic feet of water per second equals 100 miners' inches.

MINING CLAIM A tract of land with defined surface boundaries that includes mineral rights to placer deposits or to all veins of ore extending downward from the surface. In the U.S., the maximum size for a lode claim is 600 by 1,500 feet; the maximum size for a placer claim is 600 by 1,320 feet. On an unpatented mining claim, full title has not been acquired from the U.S. government.

MINING DISTRICT An indefinitely defined mining area with a code of mining laws and a recorder, established by a mining community for self-government.

MONITOR See "Hydraulic mining."

MUCKING OUT Shoveling into ore cars the ore and waste rock left by the blasting of an ore face.

OPEN CUT/OPEN PIT Methods of mining ore in which the workings are open to the surface.

ORE The portion of a mineral deposit containing valuable metals that can be mined at a profit.

ORE BENEFICIATION The process of extracting metal from worthless rock (the gangue); may include crushing, grinding, chemical treatment, and smelting. The resulting concentrate contains most of the metals' values.

ORE BIN A metal or wooden structure used to store ore prior to shipment.

ORE BODY A solid and fairly continuous mass of ore that may include low-grade ore and waste as well as high-grade materials.

ORE CAR A mine car for carrying ore or waste rock.

ORE CHUTE An inclined passage for moving ore from a higher level in a structure, usually a mill, to a lower level, or to an ore car or conveyor.

ORE DEPOSIT A general term applied to rocks containing minerals of economic value in such amount that they can be profitably exploited. Also applied to deposits that may become profitable to work by change in the economic circumstances that control their value.

ORE WAGON A wagon of heavy construction with high sides for hauling ore from a mine to a mill.

OUTCROP The exposure at the ground's surface of a vein of ore.

OVERBURDEN Waste earth and rock covering a mineral deposit.

OXIDATION Firing in a kiln or furnace at temperatures sufficient to complete combustion and give the product oxide colors.

PANNING A simple placer mining technique that removes gold from placer deposits with only a shovel and a hand-held pan. As water, sand, and gravel are swirled in the pan, the lighter sand and gravel is washed over the rim and the heavier gold sinks to the bottom of the pan.

PATENT A written title to land granted by the government after the claimant fulfills certain obligations.

PELTON WHEEL A metal, water-powered wheel (with buckets divided and shaped to increase the revolving velocity) used to generate hydro-electricity from small streams. Pelton wheels were used to provide illumination and other electrical power to late-nineteenth-century hydraulic mines.

PENSTOCK In hydraulic mining, the main pipe that conducted water between a ditch and the "giant" nozzle, usually made of riveted sheet-metal segments; or, a gate for regulating water flow.

PERCUSSION DRILLING Drilling into rock with either a hammer drill or a piston drill. The earliest type–hammering on a hand-held drill steel–was replaced by drills powered by steam, using compressed air and water to clean the hole.

PIT, EXPLORATION OR PROSPECT A small excavation to explore for minerals, usually less than ten feet deep.

PLACER Alluvial deposit of sand or gravel eroded from original bedrock. The mineral concentration results from weathering processes.

PLACER MINING The extraction of metals from alluvial gravel by removing the material without value. Simple hand techniques include panning, sluicing, rocking, and dry concentrating. More complex mechanized techniques such as dredging and hydraulic mining require more capital investment and allow lower-grade deposits to be worked profitably.

POCKET Rich spot in a vein or deposit.

PORTAL The surface entrance to a drift, tunnel, or adit.

POWER SHOVEL An excavating and loading machine consisting of a digging bucket at the end of an arm suspended from a boom, which extends from the part of the machine housing the power plant. The bucket moves forward and upward when digging, so it does not usually excavate below the level at which it stands.

PRECIOUS METAL Usually designated as gold, silver, and platinum.

PROSPECT Any mine workings of unproven value; an excavation showing a deposit of ore. Includes shallow shafts, adits, trenches, and drill holes.

PROSPECT PIT A pit dug to prospect mineral-bearing ground.

PULP A mixture of ground ore and water capable of flowing through suitably graded channels as a fluid.

RAISE In underground mining, a vertical or inclined opening or passageway driven upward to connect one mine working area with another at a higher level.

REAGENT A chemical or solution used to produce a desired chemical reaction; a substance used in assay or flotation.

REESE RIVER PROCESS Pan amalgamation after previous roasting.

REFRACTORY ORES Ores that resist the action of chemical reagents in the normal treatment processes and that may require roasting or other means to effect the full recovery of the valuable minerals.

RETORT A vessel with a long neck used for distilling mercury from amalgam.

RETORTING Heating an amalgam of mercury and gold or silver to vaporize the mercury and leave the gold and silver as a residue.

REVERBERATORY FURNACE A long flat furnace used in smelting copper concentrates. Its principal function is the slagging of gangue minerals and the production of matte.

RIFFLES The lining of the bottom of a sluice, made of blocks or slats of wood or stones, arranged so that chinks are left between them. The riffles slow water flow over them and trap the gold contained in sands or gravels.

ROASTING The treatment of ore by heat and air, or oxygen-enriched air, in order to oxidize the minerals, removing sulphur and arsenic compounds in the process.

ROCKER A short, sluice-like trough with a shallow hopper at its upper end. The rocker separates larger gravels from fine heavy elements and captures precious metals by rocking the gravels back and forth over a series of screens and riffles.

ROD MILL A mill for fine grinding using long steel rods to grind the material.

ROTARY DRILLING Method of drilling vertical holes in overburden and ore bodies for exploration or for blasthole drilling. Generally ran on self-contained truck-mounted units.

RUSSELL PROCESS A metallurgical process that extracts silver via a leaching process (lixiviation).

SEDIMENTARY ROCK Sedimentary rock is derived from preexisting igneous, sedimentary, and metamorphic rocks. It is formed by lithification of sediments, precipitation from solution, and consolidation of the remains of plants or animals.

SHAFT A vertical opening from the surface of a lode

mine, either on a vein or through the country rock. Made to prospect or mine underground ore or to hoist miners and materials in and out of a mine. May be used only in connection with pumping or ventilating operations.

SHAFT COLLAR The timbers by which the upper parts of a shaft are kept from falling in.

SHAFT HOUSE A building at the mouth of a shaft where ore or rock is received from the mine.

SHAY LOCOMOTIVE A type of railroad engine that was used throughout the West to haul carloads of ore or timber.

SHEAR The tendency of forces to deform or fracture a rock in a direction parallel to the force, as by sliding one section against another.

SINGLE JACKING In mining, a method of hand drilling the holes to place the dynamite. One miner, working alone, held the drilling bit in place with one hand, swinging a sledgehammer with his other hand.

SINKING The driving or excavation of a shaft or winze.

SINTERING The heat treatment of fine ore particles to produce larger pieces for blast furnace feed.

SKIM GOLD A residual placer deposit that yields high values in gold.

SLAG Molten, glassy waste from which metals have been removed by the smelting process.

SLIMES Very small, solid particles that pass through a 400-mesh screen. The powdered ore is held in suspension in water so as to form a kind of thin mud.

SLUICE/SLUICE BOX A series of inclined wooden or metal troughs, each of which were about twelve feet long and twelve inches square. These were coupled together to form a continuous trough twenty-four to seventy-two feet long. Devices known as riffles were placed in the bottom of the sluice. As the gravel was washed through the trough, the heavier metals such as gold were retained by the riffles and the gravel was deposited at the bottom end.

SMELTER A furnace in which metal is separated by fusion from those impurities with which it is chemically combined or physically mixed, as in ores.

SMELTING The chemical reduction of a metal from its ore and certain fluxes by melting at high temperatures. The non-metallic material floated on top of the heavier metallic constituents in the molten state and remained in that position when it cooled and hardened.

STAMP MILL Machinery for crushing ore using heavy iron blocks. A stamp consisted of a vertical steel stem with an iron foot or shoe that was lifted by a cam and dropped onto coarsely crushed ore. Usually five stamps in a row were included in one battery (steel box). The discharge flowed over amalgamating plates, which caught particles of gold. Silver ore passed from stamps to pans for amalgamation.

STEAM ENGINE A reciprocating engine, working by the force of steam on the piston; the steam expands from the initial pressure to the exhaust pressure in a single stage. Used for pumping, hoisting, milling, operating steam locomotives, etc.

STOCKPILED Set aside for future processing.

STOPE An opening made in extracting ore from a lode. In its length along a vein, a completed stope could range from several feet to as much as two thousand feet or so. Its width across a vein had to be at least four feet for work space but might reach as much as forty feet, depending on the width of the ore shoot. In height or depth, large stopes were developed by driving a series of horizontal access tunnels, usually about 100 feet apart in elevation; such tunnels and their vertical connecting raises or shafts provided for ventilation and other needs in addition to offering access to ore. Stopes extended up through the mountain, and were driven upwards to remove the ore by gravity. Since veins could dip in any direction, stopes follow the veins. (See Underground workings at a mine using the timbered cut-and-fill, inside front cover.)

STRIKE The extent and direction of tilting of fractures and layering of rock; the direction the vein takes horizontally or on a level. Also, discovery of an ore deposit.

STRING A series of sluice boxes telescoped together.

STRIPPING Removal of barren or sub-ore-grade materials to expose and permit the mining of mineable grade ore.

SULPHIDE A compound of sulphur with another element.

TABLE, VIBRATING OR CONCENTRATING A rectangular table equipped with riffles that concentrates gold or heavy metals through vibration of material in a stream of water.

TAILINGS The gangue and other refuse material resulting from washing, concentrating, or treating ground ore that is discharged from a mill after the recoverable valuable minerals have been extracted. Although the milling process removes much of the precious metal from the tailings, they may be reworked at a later date to retrieve more of the precious metals with more efficient processes.

TAILINGS POND A pond with a constraining wall or dam into which mill effluents are deposited.

THICKENER A large round tank in a mill used to separate solids from a solution; also the clear liquid overflowing the tank.

TIMBERING The operation of setting timber supports in a mine.

TRAMWAY An established system of roads, rails, or cables over which ore is moved from the mine to the mill.

TRENCH A long, narrow excavation dug through overburden, or blasted out of rock, to expose a vein or ore structure.

TROMMEL A revolving cylindrical screen that sorts ore by size. (see Fig. 8 F)

TROY OUNCE The one-twelfth part of a pound of 5760 grains, i.e., 480 grains. It equals 1,09714 avoirdupois ounces, or 31.1035 grams. This is the ounce used in all assay returns for gold or other precious metals.

TUNNEL Horizontal passageway (common usage); more accurately, a horizontal opening driven at right angle to the vein, or along a vein in search of ore, open to the atmosphere at both ends.

UNDERCURRENT The portion of a sluice system that receives the water and "fines" that drop through the grizzly. It was often set perpendicular to the main sluice and tailings sluice. The lower-velocity water washed the small-sized material over a series of quicksilver-coated riffles that captured the gold.

VANNER Device used as both fine sand and slime concentrators. The vanner was rarely used after the advent of flotation, which is a much more efficient process.

VEIN Aggregation of mineral matter in fissures of rocks, lying within boundaries clearly separate from neighboring rock. A vein is a fissure or crack in a rock filled by minerals that have traveled upwards from a deep source.

WASHING PIT The main excavation of a hydraulic mine, often very large and deep.

WASHOE PROCESS Treating silver ores by grinding in tubs or pans and adding mercury, sometimes with other chemicals such as salt or blue vitriol.

WASTE ROCK Valueless material such as barren gravel or overburden. Waste rock is rock broken in the process of opening the mine and excavating tunnels. It contains no or very little ore.

WASTE ROCK DUMP The uneconomical rock that was mined and disposed of in the vicinity of a mining operation, often at or near the entrance of an adit.

WATER WHEEL A wheel with buckets or floats that is turned by flowing water and thus drives machinery used in mining and milling.

WHIM A large drum worked by horse, steam, or water, used to raise ores and other materials to the surface from a shaft.

WILFLEY TABLE An early form of jerking table used to concentrate ore by gravity.

WING DAM An L-shaped rock and/or wooden coffer dam, built within the bed of a "live" stream so as to divert the flow from a section of the streambed and enable mining to take place.

WINZE A shaft or incline driven downward in a lode mine to connect one level with another, to explore the ore deposit, or to ventilate underground workings.

APPENDIX A

Idaho Mining-related Properties Listed in the National Register as of December 2010

Name	*NR Ref. #*	*Location*
Ada County		
Assay Office	66000305	Boise
Boise City-Silver City Road:		
Fick Property Segment	99000852	Kuna
Swan Falls Dam and Power Plant	76000667	Murphy
Adams County		
Hells Canyon Archaeological District	84000984	Cuprum
Blaine County		
Sawtooth City	750000625	Sun Valley
Boise County		
Placerville Historic District	84001029	Placerville
Idaho City	75000626	Idaho City
Clearwater County		
Orofino Historic District	82000384	Orofino
Moore Gulch Chinese Mining Site	83000285	Pierce
Custer County		
Bayhorse	76000671	Challis
Custer Historic District	81000207	Custer
Idaho Mining & Smelter Co. Store	05001601	Clayton
Elmore County		
Atlanta Dam and Power Plant	77000459	Atlanta
Atlanta Historic District	78001059	Atlanta
South Boise Historic Mining District	75000629	Rocky Bar
Idaho County		
Lower Salmon River Archaeological District	86002170	Cottonwood
Ah Toy Garden	90000893	Warren
Celadon Slope Garden	90000891	Warren
Chi-Sandra Garden	90000892	Warren
Chinese Cemetery	94000270	Warren
Gold Point Mill	00000792	Elk City
Old China Trail	90000894	Warren
Chinese Mining Camp Archeological District	94001018	Warren
Elk City Wagon Road - Vicory Gulch Smith Grade Segment	01000536	Elk City
Kootenai/Bonner Counties		
Lake Pend Oreille Lime and Cement Industry Historic District	94001450	Lakeview, Bayview
Lemhi County		
Birch Creek Charcoal Kilns	72001577	Leadore
Leesburg	75000634	Salmon
Owyhee County		
Delamar Historic District	76000679	Silver City
Silver City Historic District	72000446	Silver City
Valley County		
Braddock Gold Co. Log Building & Forge Ruins	85002157	Thunder City
Stibnite Historic District	87001186	Yellow Pine

Annotated Bibliography
(by subject and county)

Certain documents should always be checked when researching a particular historic mining site or district. Sources that provide summaries by mining district, along with lists of references, are Clyde P. Ross' *The Metal and Coal Mining Districts of Idaho* (1941) and Thomas Varley's *A Preliminary Report on the Mining Districts of Idaho* (1919). *Mineral and Water Resources of Idaho* by the U.S. Geological Survey (1964) provides good descriptions of Idaho's mining industry arranged by metal rather than by location.

The *Annual Reports of the Mining Industry of Idaho* (1899 to present) has a cumulative index through 1937; after that date, each report is indexed separately. Some volumes of these annual reports of the state mine inspector are arranged by county and district, others by resource. U.S. Geological Survey, U.S. Bureau of Mines, and Idaho State Bureau of Mines and Geology publications are particularly helpful, and many are listed in this bibliography. *Mineral Resources of the United States* (1903-1923) and the *Minerals Yearbook* (1924 to present) discuss precious and base metal production in Idaho.

The Idaho Geological Survey in Moscow (formerly the Idaho Bureau of Mines and Geology) maintains an extensive collection of information on Idaho's mines, including most of the forms that were filed annually with the Idaho Mine Inspector. The files also contain historical information collected from a number of other sources. Another good source for overviews of the history of mining districts and other topics is the Idaho State Historical Society's Reference Series. These consist of handouts that range from one to several pages.

When researching a mine that has not been patented, records in the county clerk and recorder's office may be helpful. Use the name of the locator (miner) or of the claim itself to look up the claim in the Placer or Quartz Lode Index books. These books direct the researcher to specific book and page numbers. From these records, one can obtain the name of the locator, date of filing, a generalized description of the project, and a detailed narrative description of the boundaries. Annual assessment work, recorded in separate books, tells what years a mining claim was in operation (if it is not in the book, it was either patented or abandoned). Other records in the county courthouse that might be relevant include by-laws of mining districts and records of litigation.

More detailed records are available for patented claims. The county assessor's office maintains tax histories of the property, and property appraisals may include photos, maps, and drawings. Ownership can be traced backwards through the Deed books. The Bureau of Land Management has Mineral Surveys for all patented claims that can be accessed by their legal location. These show property boundaries and locate and describe any improvements on the property at the time of patent, including exploration trenches, adits, shafts, buildings, ditches, corrals, and mills. Historic Township Survey Maps, also available from the Bureau of Land Management, show roads, trails, patented claims, and some buildings, and the surveyor's field notes may provide additional useful information. General Land Office maps, arranged by township, may also be helpful. Most of this material is available on microfiche.

Other government records that might provide information include Forest Service Land Status maps, aerial photographs, and special-use files; Secretary of War records (if minerals were produced for military purposes); and Idaho Department of Lands records of mining claims on state lands. The Idaho State Historic Preservation Office maintains IMACS site forms for all recorded sites in the state, as well as National Register nomination forms for those properties listed in the National Register. The office also has an extensive library of cultural resource reports, many of which concern historic mining properties.

Other sources to look for when researching Idaho's mining properties include oral histories, historic photographs, local informants, old maps (including mine geologic maps), Sanborn Fire Insurance Maps, annual reports and other company records of mining companies, newspapers,

and a wide variety of archival materials. The Idaho State Historical Society library in Boise and the University of Idaho library in Moscow have excellent collections of archival and other materials related to the history of mining in Idaho.

This bibliography is not meant to be comprehensive. In addition, the subheadings are intended to help researchers find documents relatively easily, but the system is not perfect. For example, some of the documents are probably placed under historic rather than current county designations (use the county maps to identify earlier names for today's counties). Also note that documents that cover several counties are placed under the catch-all subheading of "Idaho Mining History."

The subheadings are as follows:

- General Mining History
- Geology
- Placer Mining
- Lode Mining
- Ore Beneficiation
- Mining Law
- Environmental Impacts of Mining
- Chinese
- Transportation
- Evaluating Historic Mining Sites
- Idaho Mining History
- Idaho Mining by County
- Snake and Salmon Rivers

In addition to books and printed material listed in the Bibliography, the following list is meant to provide the researcher with additional reference sources to consult when researching the archeology and history of mining:

- Maps
- Photographs
- Aerial photographs
- Architectural Plans and Drawings
- Business and City Directories
- Newspapers
- Tax and Building Records
- Property Title Records
- State Land Leases
- Irrigation/Farming Records
- Local Histories
- Census Records
- Vital Records (Birth, Marriage, and Death Records)
- Genealogical Records
- Historic Cemetery Records
- Oral Histories/Interviews
- Mining Records
- Business Records
- Court Records
- Idaho/National Register of Historic Places and State Inventory Files
- Treaties
- Mining Newspapers
- Mining Museum Collections
- Local Museum Collections
- Railroad Survey Reports
- General Land Office Reports, available on-line through Bureau of Land Management, Idaho
- Idaho State Historical Society Reference Series, topics on mining, available on-line at http://history.idaho.gov/reference_series.html

General Mining History

Allen, James B. *The Company Town in the American West.* Norman, Okla.: University of Oklahoma Press, 1966.

Aschmann, Homer. "The Natural History of a Mine." *Economic Geography* 46 (1970:2): 172-89. [economics of developing and operating a mine]

Atteberry, Jennifer Eastman. *Building with Logs: Western Log Construction in Context.* Moscow, Idaho: University of Idaho Press, 1999. [author surveyed hundreds of log buildings in Idaho; identifies patterns and also discusses the "illusion" of uniform building techniques]

Conlin, Joseph R. *Bacon, Beans, and Galantines: Food and Foodways on the Western Mining Frontier.* Reno: University of Nevada Press, 1986. [detailed examination of the eating habits of western miners]

_____. "Beans, Bacon and Galantine Truffles - The Food of the Western Miners." *Arizona and the West* 23 (spring 1981): 29-52. [overview of the eating habits of Western miners]

Crane, Walter R. *Gold and Silver Comprising an Economic History of Mining in the United States...* New York: John Wiley & Sons, 1908.

Fetherling, Douglas. *The Gold Crusades: A Social History of Gold Rushes, 1849-1929.* Toronto: University of Toronto Press, 1997. [gives an international perspective on the common characteristics of gold rushes]

Greever, William S. *The Bonanza West: The Story of the Western Mining Rushes, 1848-1900.* Norman: University of Oklahoma Press, 1963. [includes chapters on the mining rushes to Idaho and on the Coeur d'Alene labor troubles]

Gregory, Cedric Errol. *A Concise History of Mining.* N. Y.: Pergamon Press, 1980. [good overviews of the "uranium age" and particular topics such as hoisting and ventilation]

Hogan, Richard. *Class and Community in Frontier Colorado.* Lawrence, Kansas: University Press of Kansas, 1990. [examines several towns in Colorado from a Marxist perspective; includes an examination of the types of communities that the mining industry produced]

Ingalls, Walter Renton. *Lead and Zinc in the United States...* New York: Hill Publishing Company, 1908. [chapter on Idaho and Montana]

Jackson, William Turrentine. "British Capital in Northwest Mines." *Pacific Northwest Quarterly* 47 (July 1956): 75-85. [includes a good discussion of British investments in several mining operations in Idaho, especially the profitable DeLamar Mining Company]

Navin, Thomas R. *Copper Mining and Management.* Tucson: University of Arizona Press, 1978. [good explanation of copper mining and processing, histories of the large companies]

Paul, Rodman W. *The Far West and the Great Plains in Transition,* 1859-1900. N.Y.: Harper & Row, 1988. [similar to Paul's 1963 book, with a chapter on mining in the 1880s and 1890s]

_____. *Mining Frontiers of the Far West,* 1848-1880. N.Y.: Holt, Rinehart and Winston, 1963. [discusses the moving frontiers of the West, and how Idaho fit into the bigger picture]

Rickard, T. A. *A History of American Mining.* New York: McGraw-Hill Book Company, 1932. [contains chapters on the development of the Northwest and on flotation]

Rohe, Randall E. "Feeding the Mines: The Development of Supply Centers for the Goldfields." *Annals of Wyoming* 57 (spring 1985): 40-59. [focuses on supply routes serving areas other than Idaho, but discusses some generalities that were also true in Idaho]

Sears, Marion V. *Mining Stock Exchanges, 1860-1930: An Historical Survey.* Missoula: University of Montana Press, 1973.

Spence, Clark C. *British Investments and the American Mining Frontier, 1860-1901.* Moscow, Idaho: University of Idaho Press, 1995.

_____. "'I Was a Stranger and Ye Took Me In'." *Montana The Magazine of Western History* 44 (winter 1994): 42-53. [investment in mining and milling, including speculation and dishonesty]

Stout, Koehler S. *Mining Methods and Equipment Illustrated.* Butte: Montana Bureau of Mines and Geology, Bulletin 63, 1967. [describes above- and below-ground mining methods of the 1960s, with good illustrations]

Trimble, William J. *The Mining Advance into the Inland Empire.* Madison, Wisc.: Bulletin of the University of Wisconsin 638, 1914. [standard work on the eastward movement of the mining frontier]

White, Richard. *"It's Your Misfortune and None of My Own": A History of the American West.* Norman, Okla.: University of Oklahoma Press, 1991. [applies the approach of "New Western" historians to a study of Western attitudes about land and natural resources, placing mining in the context of responding to a developing world economy]

Wyman, Walker De Marquis. "The Underground Miner, 1860-1910: Labor and Industrial Change in the Northern Rockies." Ph.D. dissertation, University of Washington, 1971.

Young, George J. *Elements of Mining.* New York: McGraw-Hill, 1946. [textbook, illustrated]

Young, Otis E., Jr. *Black Powder and Hand Steel: Miners and Machines on the Old Western Frontier.* Norman, Okla.: University of Oklahoma Press, 1976. [developments in mining technology and how they affected western mining]

_____. "The Craft of the Prospector." *Montana The Magazine of Western History* 20 (winter 1970): 28-39.

_____. *Western Mining.* Norman: University of Oklahoma Press, 1970. [standard work on gold and silver mining in the western United States]

Geology

(see also documents on specific areas)

Alt, David D., and Donald W. Hyndman. *Roadside Geology of Idaho.* Missoula: Mountain Press Publishing Co.,

1989. [survey of the geology of the state, with some information on geology in mining districts]

Capps, Stephen Reid. *Faulting in Western Idaho and Its Relation to the High Placer Deposits*. Idaho Bureau of Mines and Geology, Pamphlet 56, 1941. [focuses on geology, with some information on production]

Fahrenwald, A. W. *A Metallurgical Study of Idaho Placer Sand*. Idaho Bureau of Mines and Geology, Pamphlet 51, 1939. [study of metallurgical characteristics of placer sands containing flour gold]

Finch, John Wellington, ed. *Ore Deposits of the Western States*. New York: American Institute of Mining and Metallurgical Engineers, 1933. [essays on geology, with some state-specific information, and on the production of various types of placers in the West]

Finch, John Wellington. *Prospecting for Gold Ores*. Idaho Bureau of Mines and Geology, Pamphlet 36, 1932. [detailed manual for prospectors looking for lode veins]

Hill, James M. *The Mining Districts of the Western United States*. U.S. Geological Survey, Bulletin 507, 1912. [includes a summary of the geology of Idaho and a bibliography of U.S. Geological Survey publications arranged by county and then by mining district]

Livingston, D. C. *Tungsten, Cinnabar, Manganese, Molybdenum and Tin Deposits of Idaho*. University of Idaho School of Mines, Bulletin 2, 1919. [mostly geological information, with some information on mine development and production; also includes notes on antimony deposits]

Maley, Terry S. *Exploring Idaho Geology*. Boise, Idaho: Mineral Land Publications, 1987. [summarizes Idaho's geology, including ore and placer deposits]

Thomson, Francis A., and Fritz McGonigle. "Zonal Distribution of Gold, Silver, Lead, and Copper Ores in Idaho." *Engineering and Mining Journal-Press* 120 (Aug. 8, 1925). [includes a map of Idaho's metal mining districts in relation to granite outcrops]

Placer Mining

Aubury, Lewis E. "Gold Dredging in California." *California State Mining Bureau*, Bulletin 57, 1910. [comprehensive work on dredging technology, well illustrated, includes a page on dredges in Idaho]

Columbia Basin Inter-Agency Committee. *Alluvial Mining in the Pacific Northwest; a Report by the Alluvial Mining Subcommittee of the Columbia Basin Inter-Agency Committee*. Idaho Bureau of Mines and Geology, Information Circular 9, 1961. [brief summary of placer mining in Idaho in late 1950s, and of relevant laws regarding dredging operations]

DeGroot, Henry. "Hydraulic Mining." *Mining and Scientific Press* 68 (Dec. 1893-Feb. 1894). [technical series on hydraulicking]

Jackson, Charles F. "Small-Scale Placer-Mining Methods." pp. 27-49 in U.S. Bureau of Mines, Technical Paper 591, 1938. [very good description of 1930s methods of placer mining, written for miners]

Janin, Charles. *Gold Dredging in the United States*. U.S. Bureau of Mines, Bulletin 127, 1918. [comprehensive discussion of dredging for gold, illustrated with photographs and sketches, with a list of active dredging companies]

Kirshenbaum, Noel W. "The Giant Gold Diggers: California's Land-Going Fleet of Dredges." *Mining History Journal* 7 (2000): 11-23. [well illustrated, with general information on dredging]

LaLande, Jeffrey M. "Sojourners in Search of Gold: Hydraulic Mining Techniques of the Chinese on the Oregon Frontier." *Industrial Archaeology* 11 (1985 1): 29-52. [very clear explanation of hydraulic mining; examines the mining methods of Chinese vs. Euroamericans in the Applegate Valley of Oregon]

Lewis, Robert S. and George B. Clark. *Elements of Mining*. New York: John Wiley and Sons, 1964 [first edition 1932]. [good manual for placer and lode miners, contains a section on open-cut mining].

Longridge, Cecil C. *Hydraulic Mining*. London: The Mining Journal, 1902. [well illustrated and clear manual on all aspects of hydraulic mining]

Lord, Harry S. "Developments in Dragline Methods, Equipment and Maintenance." In *Annual Report of the Mining Industry of Idaho, 1941*, pp. 44-49. [brief article on the development and typical operation of dragline dredges]

Miller, Charles W., Jr. *The Automobile Gold Rushes & Depression Era Mining*. University of Idaho Press, 1998. [detailed history of 1930s placer gold mining in the West, including significant information on Idaho]

Peele, Robert. *Mining Engineers' Handbook*. New York: John Wiley & Sons, 1918, 1927, 1941. [excellent source of information on placer and lode mining technology]

Rohe, Randall E. "After the Gold Rush: Chinese Mining in the Far West, 1850-1890." *Montana The Magazine of Western History* 32 (fall 1982): 2-19. [good overview of the shifting frontier of Chinese miners in the West]

_____. "Chinese River Mining in the West." *Montana The Magazine of Western History* 46 (autumn 1996): 14-29. [good description of this method of placer gold mining]

_____. "The Geographical Impact of Placer Mining in the American West, 1848-1974." Ph.D. dissertation, University of Colorado, 1978. [detailed look at placer mining in the West and how the various methods affected the landscape]

_____. "Gold Dredging in the American West: Origin and Diffusion." *Pacific Historian* 28 (summer 1984): 4-17. [overview of the spread of dredging and modifications in methods and machinery]

_____. "Hydraulicking in the American West: The Development and Diffusion of a Mining Technique." *Montana The Magazine of Western History* 35 (spring 1985): 18-35. [summary of the development of hydraulic mining in California and its diffusion to specific states, including Idaho]

_____. "Man As a Geomorphic Agent: Hydraulic Mining in the American West." *Pacific Historian* 27 (spring 1983): 4-16. [mostly discusses the effects of hydraulicking on the California landscape]

MINING IDAHO'S HISTORY: METAL MINING IN IDAHO 1860–1960 135

_____. "Origins & Diffusion of Traditional Placer Mining in the West." *Material Culture* 18 (fall 1986): 127-66. [overview of various methods of placer mining; argues that the characterization of methods in an area as progressing from simple to complex is inaccurate]

Rossillon, Mitzi, and Dale Martin. "In Dubious Gravel: Placer Gold for the Unemployed?" Paper presented at the Montana History Conference, Helena, Oct. 27, 1995. [discusses government efforts to encourage unemployed Americans to placer mine in the 1930s]

Spence, Clark C. "The Golden Age of Dredging: The Development of an Industry and Its Environmental Impact." *Western Historical Quarterly* 11 (Oct. 1980): 401-14. [brief article on the technological developments in dredges and on the lack of concern about their environmental impacts]

Staley, W. W. *Gold in Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 68, 1946. [excellent summary of methods of placer mining used in the 1930s]

Thorne, W. E., and A. W. Hooke. *Mining of Alluvial Deposits by Dredging and Hydraulicking*. London: Mining Publications, Ltd., 1929.

Turnipseed, Donna L. "Lessons from a Ditch: A Study of Three Water Conveyance Systems Located in Idaho County, Idaho, 1860-1880." M.S. thesis, University of Idaho, 1997. [detailed examination of water conveyance technology in general, and of three sites in particular]

Wilson, Eugene B. *Hydraulic and Placer Mining*. New York: John Wiley and Sons, 1905. [detailed descriptions of water delivery systems, hydraulic mining equipment, and dredging, with some illustrations]

Lode Mining

Brown, Ronald C. *Hard-Rock Miners: The Intermountain West*, 1860-1920. Texas A&M University Press, College Station and London, 1979. [focuses on the Intermountain West but contains good general descriptions of lode mining conditions]

Finch, John Wellington. *Prospecting for Gold Ores*. Idaho Bureau of Mines and Geology, Pamphlet 36, 1932. [detailed manual for prospectors looking for lode veins]

Jackson, Charles F., et al. *Lead and Zinc Mining and Milling in the United States: Current Practices and Costs*. U.S. Bureau of Mines, Bulletin 381, 1935. [comprehensive discussion of lead and zinc mining and milling procedures, and of several mines in the Coeur d'Alenes]

Lewis, Leroy. "The Art and Science of Fire Assaying for Gold." *Idaho Yesterdays* 32 (summer 1988): 15-21. [good explanation of the mechanics and chemistry of fire assaying]

Lewis, Robert S., and George B. Clark. *Elements of Mining*. New York: John Wiley and Sons, 1964 [first edition 1932]. [good manual for placer and lode miners].

Peele, Robert. *Mining Engineers' Handbook*. New York: John Wiley & Sons, 1918, 1927, 1941. [excellent source of information on placer and lode mining technology]

Pfleider, Eugene P., ed. *Surface Mining*. New York: American Institute of Mining, Metallurgical and Petroleum Engineers, Inc., 1968. [detailed reference work on surface mining for metals, coal, and other materials, with some historical information]

Sinlapajan, Pajon. "Open Pit Mining." M.S. thesis, University of Idaho, 1963. [describes methods of open-pit mining ca. 1963]

Staley, W. W. *Prospecting and Developing a Small Mine*. Idaho Bureau of Mines and Geology, Bulletin 20, 1961. [information on prospecting, locating, sampling, developing, and treating small mining claims, written for miners, with emphasis on lode mining]

_____. *Timbering and Support of Underground Workings for Small Mines*. Idaho Bureau of Mines and Geology, Bulletin 21, 1962. [detailed examination]

Storms, W. H. *Timbering and Mining: A Treatise on Practical American Methods*. New York: 1909. [illustrated manual on timbering methods for underground mines]

U.S. Forest Service. *Anatomy of a Mine from Prospect to Production*. Ogden, Utah: Intermountain Forest and Range Experimental Station, 1977. [clear, well-illustrated explanation of underground and open-pit mining techniques]

Wyman, Mark. *Hard Rock Epic: Western Miners and the Industrial Revolution, 1860-1910*. Berkeley: University of California Press, 1979. [impact of the industrial revolution on lode miners, with many examples from Idaho mines]

_____. "Industrial Revolution in the West: Hard-Rock Miners and the New Technology." *Western Historical Quarterly* 5 (January 1974): 39-57. [discusses how western miners responded to industrial changes through the early 1900s]

Ore Beneficiation

Aiken, Katherine G. "Bunker Hill Versus the Lead Trust: The Struggle for Control of the Metals Market in the Coeur d'Alene Mining District, 1885-1918." *Pacific Northwest Quarterly* 84 (1993 no. 2): 42-49.

Bunyak, Dawn. "To Float or Sink: A Brief History of Flotation Milling." *Mining History Journal* 7 (2000): 35-44. [development of flotation and its effect on the mining industry]

Dorr, John V. N. *Cyanidation and Concentration of Gold and Silver Ores*. New York: McGraw-Hill Book Company, 1936. [detailed manual]

Engineering and Mining Journal Editorial Staff. *Handbook of Milling Details*. New York: McGraw-Hill Book Company, 1914. [detailed, illustrated with sketches]

Fahrenwald, A.W. *The Recovery of Gold from Its Ores*. Idaho Bureau of Mines and Geology, Pamphlet 37, 1932. [good description of amalgamation, flotation, and cyanidation processes]

Fell, James E., Jr. *Ores to Metals: The Rocky Mountain Smelting Industry*. Lincoln: University of Nebraska Press, 1979. [mostly discusses the Colorado smelting industry, but includes information on its ties to the mines in the Coeur d'Alenes]

Gerry, C. N. *Reduction Mills in Idaho in 1925*. U.S. Bureau of Mines, Information Circular 6026, 1927. [very good source for the year 1925–lists the equipment and process at each mill, arranged by district]

Hayward, Carle R. *An Outline of Metallurgical Practice*. New York: D. Van Nostrand Company, 1929. [detailed technical manual on ore beneficiation, with chapters on many different metals]

Jackson, Charles F., et al. *Lead and Zinc Mining and Milling in the United States: Current Practices and Costs*. U.S. Bureau of Mines, Bulletin 381, 1935. [comprehensive discussion of lead and zinc mining and milling procedures, and of several mines in the Coeur d'Alenes]

Kelly, Roger E., and Marsha C.S. Kelly. "Arrastras: Unique Western Historic Milling Sites." *Historical Archaeology* 17 (1983 1): 85-95. [describes two arrastra sites and potential research questions]

MacFarren, H. W. *Textbook of Cyanide Practice*. New York: McGraw-Hill, 1912.

Perkins, E. C., et al. *Chlorination of an Idaho Ilmenite*. U.S. Bureau of Mines, Report of Investigations 5763, 1961.

Richards, Robert H. *Ore Dressing*. New York: Hill Publishing Company, 1903. [detailed, illustrated with many charts and tables and sketches]

Rickard, T.A. *The Stamp Milling of Gold Ores*. New York: Engineering and Mining Journal, 1903. [classic work on the topic]

Romig, Robert L. "The South Boise Quartz Mines, 1863-1892: A Study in Western Mining Industry and Finance." M.A. thesis, University of California, 1959. [explanation of shift in 1860s and 1870s from small-scale to large-scale lode mining, and the accompanying problems]

_____. "Stamp Mills in Trouble." *Pacific Northwest Quarterly* 44 (Oct. 1953): 166-76. [describes the failure of South Boise lode mines in 1866]

Simons, Theodore. *Ore Dressing: Principles and Practice*. New York: McGraw-Hill Book Company, 1924. [quite technical, illustrated with photographs and sketches]

Mining Law

August, Raymond S. "Law in the American West: A History of Its Origins and Its Dissemination." Ph.D. dissertation, University of Idaho, 1987. [includes a chapter on the origins of western mining law]

DeLong, Richard F. "United States Mining Policy: Hardrock Minerals and Federal Lands." M.S. thesis, University of Idaho, 1984. [history of mining-related laws and discussion of current mining policy issues]

Johnson, Fred W. "Federal Placer-Mining Laws and Regulations." pp. 19-25 in U.S. Bureau of Mines, Technical Paper 591, 1938.

Matthews, Olen Paul. "Legal Elements in Mineral Development with Special Reference to Idaho." Ph.D. dissertation, University of Washington, 1980. [includes case studies of mining claims in Stibnite and DeLamar]

Mayer, Carl J., and George A. Riley. *Public Domain, Private Dominion: A History of Public Mineral Policy in America*. San Francisco: Sierra Club Books, 1985. [good overview]

Wunder, John. "The Courts and the Chinese in Frontier Idaho." *Idaho Yesterdays* 25 (spring 1981): 23-32. [summarizes court cases relevant to Chinese in Idaho in the 1800s, highlights a case in the Elk City mining district]

Wyman, Mark. "Mining Law in Idaho." *Idaho Yesterdays* 25 (spring 1981): 14-22. [history of mining law in Idaho, including mine safety regulations]

Environmental Impacts of Mining

Casner, Nicholas A. "Leaded Waters: A History of Mining Pollution on the Coeur d'Alene River in Idaho, 1900-1950." M.A. thesis, Boise State University, 1989. [detailed discussion of pollution in the Silver Valley due to mill tailings]

_____. "Toxic River: Politics and Coeur d'Alene Mining Pollution in the 1930's." *Idaho Yesterdays* 1991 35(3): 2-19. [very good summary of the early court cases and steps taken over the decades to reduce mining pollution in this area]

Domijan, George. "Historic American Engineering Record: Bunker Hill Lead Smelter." 1993. [detailed description and photographs of the processes and significance of the Bunker Hill lead smelter, 1917-81]

Ellis, Max Mapes. "Pollution of the Coeur d'Alene River and Adjacent Waters by Mine Wastes." U.S. Bureau of Fisheries, typescript, 1932. [investigation of the effects of mine wastes on the South Fork and main Coeur d'Alene River, finding devastating impacts on the fishery]

Francaviglia, Richard V. "Copper Mining and Landscape Evolution." *Journal of Arizona History* (autumn 1982): 267-98.

_____. *Hard Places: Reading the Landscapes of America's Historic Mining Districts*. Iowa City: University of Iowa Press, 1992. [discussion of recording and evaluating historic mining landscapes]

Goble, Dale D., and Paul W. Hirt, eds. *Northwest Lands, Northwest Peoples: Readings in Environmental History*. Seattle, Wash.: University of Washington Press, 1999. [two essays on the northern Idaho mines–one on the damage suit filed by ranchers downstream of the mines in the early 1900s, and the other on smelter smoke disputes]

Liestman, Daniel. "Nineteenth-Century Chinese and the Environment of the Pacific Northwest." *Pacific Northwest Quarterly* 90 (winter 1998/99): 17-29. [focuses on the interaction between the Chinese and their environment in the Pacific Northwest, including mining, farming, housing, etc.]

McCarl, Robert. *Contested Space: the Above and Below Ground Landscape of Idaho's Coeur d'Alene Mining District*. Salt Lake City, Utah: University of Utah, 1997. [analysis of the cultural landscape of mining in the Coeur d'Alene region]

McClelland, Linda Flint, et al. *National Register Bulletin 30: Guidelines for Evaluating and Documenting Rural Historic Landscapes*. National Park Service, n.d.

Quivik, Fredric L. *Expert Report of Fredric L. Quivik: United States v. ASARCO, et al Civil Action 96-0122-N-EJL*. 1999. [provides a detailed history of the movement of tailings and other potential contaminants through the Coeur d'Alene River basin and a history of physical and/or chemical changes the tailings and other potential contaminants may have undergone, based on the historical record]

Ritchie, Neville. "Archaeological Interpretation of Alluvial Gold Tailing Sites, Central Otago, New Zealand." *New Zealand Journal of Archaeology* 3 (1981): 51-69. [develops a typology for tailings left behind at placer mining sites]

Rohe, Randall E.. "The Geographical Impact of Placer Mining in the American West, 1848-1974." Ph.D. dissertation, University of Colorado, 1978. [detailed look at placer mining in the West and how the various methods affected the landscape]

_____. "Man As a Geomorphic Agent: Hydraulic Mining in the American West." *Pacific Historian* 27 (spring 1983): 4-16. [mostly discusses the effects of hydraulicking on the California landscape]

Scamahorn Air Photo Company. *The Coeur d'Alene Mining District as Seen Through the Aerial Camera of Scamahorn Air Photo Company*. Spokane, Wash.: Scamahorn Air Photo. Co., 1948. [excellent aerial photographs of many of the mines, mills, and smelters in the Coeur d'Alene mining district, with brief text accompanying each photograph]

Spence, Clark C. "The Golden Age of Dredging: The Development of an Industry and Its Environmental Impact." *Western Historical Quarterly* 11 (Oct. 1980): 401-14. [brief article on the technological developments in dredges and on the lack of concern about their environmental impacts]

Wai, C. M., et al. *A Bibliography of Environmental Studies of the Coeur d'Alene Mining Area, Idaho*. Moscow: University of Idaho, 1985.

White, Richard. *"It's Your Misfortune and None of My Own": A History of the American West*. Norman, Okla.: University of Oklahoma Press, 1991. [applies the approach of "New Western" historians to a study of Western attitudes about land and natural resources, placing mining in the context of responding to a developing world economy]

Williams, Roy E., and Leroy L. Mink. *Settling Ponds as a Mining Wastewater Treatment Facility*. Idaho Bureau of Mines and Geology, Pamphlet 164, 1975. [reports on a study of settling basins established in the Coeur d'Alenes in 1968 to treat mine effluent]

Chinese

Couch, Samuel L. "Topophilia and Chinese Miners: Place Attachment in North Central Idaho." Ph.D. dissertation, University of Idaho, 1996. [discusses Chinese miners in Idaho and their love of their homeland as being one of the reasons so many returned to China.]

Derig, Betty. "Celestials in the Diggings." *Idaho Yesterdays* 16 (1972):2-23. [overview of Chinese in Idaho's mining camps, focusing on court cases and anti-Chinese sentiment]

Elsensohn, M. Alfreda. *Idaho Chinese Lore*. Caldwell, Idaho: Caxton Printers, Ltd., 1970. [some information on Chinese miners in Idaho County and elsewhere]

Fee, Jeffrey Michael. "A Dragon in the Eagle's Land: Chinese in an Idaho Wilderness, Warren Mining District, ca. 1870-1900." M.S. thesis, University of Idaho, 1991. [good history of the Chinese in Warren, Idaho, including information on Chinese gardens]

Feichter, Nancy Koehler. "The Chinese in the Inland Empire During the Nineteenth Century." M.A. thesis, State College of Washington, 1959. [includes some information on Chinese miners in Idaho]

James, Ronald L. *Ruins of a World: Chinese Gold Mining at the Mon-Tung Site in the Snake River Canyon*. U.S. Bureau of Land Management, Idaho Cultural Resource Series 4, 1995. [detailed description of excavation of a dwelling occupied by a Chinese miner in late 1870s-early 1880s along Snake River]

_____. "Why No Chinamen are Found in Twin Falls." *Idaho Yesterdays* 36 (1993 no. 4): 14-24. [overview of Chinese miners in the Snake River Canyon, with discussion of why they began to leave the area in the 1880s]

LaLande, Jeffrey M. "Sojourners in the Oregon Siskiyous: Adaptation and Acculturation of the Chinese Miners in the Applegate Valley, ca. 1855-1900." M.A. thesis, Oregon State University, 1981. [detailed information on Chinese immigration to the United States, subsistence patterns, architecture, and hydraulic mining, with evidence drawn from archaeological work in the Siskiyou Mountains of Oregon]

_____. "Sojourners in Search of Gold: Hydraulic Mining Techniques of the Chinese on the Oregon Frontier." *Industrial Archaeology* 11 (1985 1): 29-52. [excellent summary of hydraulic mining by Chinese in Oregon]

MacDonald, Eileen Hubbell. "A Study of Chinese Migrants in Certain Idaho Settlements and of Selected Families in Transition." M.S. thesis, University of Idaho, 1966.

Mayo, Roy F. *Gold and Strichnine*. MW Publications, 1975. [stories about Chinese miners in Latah County]

Rohe, Randall E. "After the Gold Rush: Chinese Mining in the Far West, 1850-1890." *Montana The Magazine of Western History* 32 (fall 1982): 2-19. [overview, with some information on Chinese mining in Idaho]

_____. "Chinese River Mining in the West." *Montana The Magazine of Western History* 46 (autumn 1996): 14-29. [good description of this method of placer gold mining]

Spier, Robert F.G. "Food Habits of Nineteenth Century California Chinese." *California Historical Society Quarterly* 37 (1958): 79-84. [describes the food preferred by Chinese sojourners in America, plus utensils and farming and fishing methods]

Stapp, Darby Campbell. "The Historic Ethnography of a Chinese Mining Community in Idaho." Ph.D. dissertation, University of Pennsylvania, 1990. [reports on seven sites in the Pierce area, analyzes the information the sites yielded, and poses future research questions]

Stapp, Darby, and Julia Longenecker. "1983 Test Excavations at 10-CW-159, the Pierce Chinese Mining Site." University of Idaho Anthropological Research Manuscript Series 80, 1984. [gives results of trench excavations and some historical context]

Trull, Fern Coble. "The History of the Chinese in Idaho from 1864-1910." M.A. thesis, University of Oregon, 1946. [includes a short section on Chinese miners, mostly drawn from newspaper articles and interviews]

Wegars, Priscilla, ed. *Hidden Heritage: Historical Archaeology of the Overseas Chinese*. Amityville, New York: Baywood Publishing Co., Inc., 1993. [several essays on investigations of sites in Idaho associated with Chinese miners]

_____. "The History and Archaeology of the Chinese in Northern Idaho." Ph.D. dissertation, University of Idaho, 1991. [comprehensive examination of Chinese in northern Idaho, including sections on the experiences of Chinese miners and on identifying Chinese mining sites]

Wikoff, Melvin D. "Chinese in the Idaho County Gold Fields: 1864-1933." M.S. thesis, Texas A & I University, 1972. [includes detailed information on the Chinese in Elk City]

Wunder, John. "The Courts and the Chinese in Frontier Idaho." *Idaho Yesterdays* 25 (spring 1981): 23-32. [summarizes court cases relevant to Chinese in Idaho in the 1800s, highlights a case in the Elk City mining district]

Xu, Yixian. "Chinese Women in Idaho During the Anti-Chinese Movement Before 1900." M.A. thesis, University of Idaho, 1994.

Yu, Li-Hua. "Chinese Immigrants in Idaho." Ph.D. dissertation, Bowling Green State University, 1991. [Chinese mining in north-central mining camps, Boise Basin, Wood River valley, and Coeur d'Alene]

Zhu, Liping. "'A Chinaman's Chance' on the Rocky Mountain Mining Frontier." *Montana The Magazine of Western History* 45 (autumn/winter 1995): 36-51.

_____. *A Chinaman's Chance: The Chinese on the Rocky Mountain Mining Frontier*. Niwot, Colo.: University Press of Colorado, 1997. [argues that contrary to the description of Chinese immigrants in Idaho as victims, Chinese miners experienced good economic opportunities]

_____. "How the Other Half Lives: Chinese Daily Life in Boise Basin Mining Camps." *Idaho Yesterdays* 38 (1995 no. 4): 20-28.

Transportation

Beal, Merrill D. *Intermountain Railroads, Standard and Narrow Gauge*. Caldwell, Idaho: Caxton Printers, 1962.

Gamboa, Erasmo. "The Mexican Mule Pack System of Transportation in the Pacific Northwest and British Columbia." *Journal of the West* 29 (Jan. 1990): 16-27. [describes the important role of skilled Mexican packers on the trails of the Pacific Northwest]

Hult, Ruby El. *Steamboats in the Timber*. Caldwell, Idaho: Caxton Printers, 1952. [steamboats on Lake Coeur d'Alene and the St. Joe and Coeur d'Alene rivers]

Jackson, William Turrentine. *Wells Fargo & Co. in Idaho Territory*. Boise: Idaho State Historical Society, 1984.

Jones, Larry R. "Staging to the South Boise Mines." *Idaho Yesterdays* 29 (summer 1985): 19-25. [discussion of the interrelationship between the stage and freight lines to the mining district and the communities they were designed to serve]

McIntosh, Clarence Fredric. "The Chico and Red Bluff Route: Stage Lines from Southern Idaho to the Sacramento Valley, 1865-1867." *Idaho Yesterdays* 6 (fall 1962): 12-15, 18-19. [overview of the Chico-Owyhee stage service]

Peterson, Stacy. "Silas Skinner's Owyhee Toll Road." *Idaho Yesterdays* 10 (spring 1966): 12-21.

Robertson, Donald B. *Encyclopedia of Western Railroad History: Volume II, the Mountain States, Colorado, Idaho, Montana, Wyoming*. Dallas, Texas: Taylor Publishing Company, 1991. [includes a few good maps of railroad lines and roads]

Winther, Oscar Osburn. *The Transportation Frontier: Trans-Mississippi West, 1865-1890*. Holt, Rinehart & Winston, 1964. [general overview of freighting and staging throughout the West]

Wood, John A. *Railroads through the Coeur d'Alenes*. Caldwell, Idaho: Caxton Printers, 1983. [discusses railroads serving the mines and mills]

Evaluating Historic Mining Sites

Baker, S. G. "Historical Archaeology for Colorado and the Victorian Mining Frontier: Review, Discussion, and Suggestions." *Southwestern Lore* 44 (Dec. 1978): 11-31. [review of archaeological literature concerning the Victorian era in America, particularly the mining frontier, with broad guidelines for evaluating such sites under Criterion D]

Barker, Leo R., et al. *Death Valley to Deadwood; Kennecott to Cripple Creek: Proceedings of the Historic Mining Conference, January 23-27, 1989, Death Valley National Monument*. San Francisco: National Park Service, 1990.

Brown, Kathryn. "Ghost Towns Tell Tales of Ecological Boom and Bust." *Science* 290 (6 Oct. 2000): 35-37. [discusses soil age as key factor in recovery of scarred desert ecosystems at the sites of abandoned mining towns in the Mojave Desert]

Buechler, Jeff. *Black Hills Mining Resources Historic Context*. Prepared by Dakota Research Services for South Dakota State Historical Preservation Center, 1989. [discussion of property types and significance evaluation for historic mining-related sites in the Black Hills of South Dakota]

Buechler, Jeff, ed. *Proceedings of the Workshop on Historic Mining*

Resources: Defining the Research Questions for Evaluation and Preservation. Vermillion, South Dakota: State Historical Preservation Center, South Dakota State Historical Society, 1987.

Fenenga, Franklin. "Post-1800 Mining Camps." *Historical Archaeology* 1 (1967): 80-82. [problems in historical archaeology]

Francaviglia, Richard V. "Copper Mining and Landscape Evolution." *Journal of Arizona History* (autumn 1982): 267-98.

_____. *Hard Places: Reading the Landscapes of America's Historic Mining Districts*. Iowa City: University of Iowa Press, 1992. [discussion of recording and evaluating historic mining landscapes]

_____. "The Ultimate Artifact: Interpreting and Evaluating the Man-Made Topography of Historic Mining Districts." Paper presented at the 21st annual meeting of the Society of Historical Archaeology, Reno, Nevada, 1988.

GCM Services, Inc. *Historic Properties Management Plan: The Butte Mining District*. Prepared for Montana Department of State Lands, 1990. [establishes six broad property types for the Butte historic mining district]

Goddard, Richard A. "On the Edge: The Historical Ethnography of a Satellite Settlement." Ph.D. dissertation, University of Nevada–Reno, 1999. [uses various approaches, including a structural one, to explain why some individuals in McGill, Nevada, chose to live in a settlement of shacks when they could have lived in a modern western town]

Hardesty, Donald L. *The Archeology of Mining and Miners: A View from the Silver State*. Special Publication Series 6. Ann Arbor, Mich.: Society for Historical Archeology, 1988. [important work on understanding mining sites as systems and on inventorying and evaluating significance; uses sites in Nevada as examples]

_____. "Evaluating Site Significance in Historical Mining Districts." *Historical Archaeology 24* (1990): 42-51. [important article discussing ways to evaluate mining features and sites under Criteria C and D, in particular]

_____. "Evolution on the Industrial Frontier," pp. 213-29 in Green, Stanton W., and Stephen M. Perlman. *Archaeology of Frontiers and Boundaries*. New York: Academic Press, 1985. [Hardesty discusses models for cultural change on the industrial frontier]

_____. "Industrial Archaeology on the American Mining Frontier: Suggestions for a Research Agenda." *Journal of New World Archaeology* 6 (1986): 47-56. [provides guidelines for research questions concerning historic mining sites]

Hardesty, Donald L., and Barbara J. Little. *Assessing Site Significance: A Guide for Archaeologists and Historians*. Walnut Creek, Calif.: Alta Mira Press, 2000. [practical guidance in evaluating archaeological sites for their historical significance, including examples of mining-related sites]

Herbort, Dale P. "Handbook for the Identification of Historic Metal Mining Properties." Prepared for the Abandoned Mine Reclamation Bureau, Montana Department of State Lands, draft, 1995. [provides detailed explanation of property types at mining and milling sites]

_____. "Standard Procedures for the Documentation, Evaluation and Management of Historic Mining Properties." Prepared for the Abandoned Mine Reclamation Bureau, Montana Department of State Lands, draft, 1996. [provides detailed guidelines for agency personnel managing historic mining properties, including procedures for inventories and evaluations of significance]

Hovis, L. W. "Historic Mining Sites: A Typology for the Alaskan National Parks." Ms. on file, Alaska Regional Office, Anchorage, National Park Service, 1992. [typology of mining sites in Alaska, based on some three hundred recorded sites]

Knapp, A. Bernard, Vincent C. Pigott and Eugenia W. Herbert. *Social Approaches to the Industrial Past: The Archaeology and Anthropology of Mining*. London: H.B. Routledge, 1998. [essays designed to encourage blending of archaeology, anthropology, and history in studying the history of mining]

McCarl, Robert. *Contested Space: the Above and Below Ground Landscape of Idaho's Coeur d'Alene Mining District*. Salt Lake City, Utah: University of Utah, 1997. [analysis of the cultural landscape of mining in the Coeur d'Alene region]

McClelland, Linda Flint, et al. *National Register Bulletin 30: Guidelines for Evaluating and Documenting Rural Historic Landscapes*. National Park Service, n.d.

National Park Service. *National Register Bulletin 16B: How to Complete the National Register Multiple Property Documentation Form*. National Register Branch, Interagency Resources Division, National Park Service, U.S. Department of the Interior, 1991.

Noble, Bruce J., Jr., and Robert Spude. *National Register Bulletin 42: Guidelines for Identifying, Evaluating, and Registering Historic Mining Properties*. National Park Service, 1992.

Ostrogorsky, Michael. "Rewriting Frontier History: An Archaeological Perspective on Frontier Settlement in the Mining West." *Rendezvous* 1983 18(1-2): 67-72. [posits that as the regional economy of mining areas declined, so did the complexity of their cultural system, based on excavations in Idaho City]

Periman, Richard D. *Historic Preservation and Management Plan for Historic Mining and Associated Properties, Deerlodge National Forest*. U.S. Forest Service, Northern Region, Studies in Heritage Management 14, 1995. [detailed guidance for inventorying and evaluating historic mining sites under Criteria A-D]

Ritchie, Neville. "Archaeological Interpretation of Alluvial Gold Tailing Sites, Central Otago, New Zealand." *New Zealand Journal of Archaeology* 3 (1981): 51-69. [develops a typology for tailings left behind at placer mining sites]

Rodman, Valerie. "Modeling as a Preservation Planning Tool

in Western Gold and Silver Mining Districts" M.A. thesis, University of Nevada, 1985. [constructs an industrial land use model to predict the types of sites associated with activities of miners and millers in the Virginia City, Nevada, National Historic Landmark]

Rohe, Randall Eugene. "The Geographical Impact of Placer Mining in the American West, 1848-1974." Ph.D. dissertation, University of Colorado, 1978. [detailed look at placer mining in the West and how the various methods affected the landscape]

_____. "The Geography and Material Culture of the Western Mining Town." *Material Culture* 16 (fall 1984): 99-120. [article focuses on the historical geography of mining towns, with discussion of their development over time and their similarity across time and space]

Rossillon, Mitzi. "Impact Mitigation for Select Historic Features at the Park Mines (24BW210), Broadwater County, Montana." Prepared by Renewable Technologies, Inc., for Montana Department of Environmental Quality, 1998. [identifies appropriate archaeological research topics and data requirements for industrial features and industrial-support features at mining sites in Montana]

Schmitt, Dave N., and Charles D. Zeier. "Not by Bones Alone: Exploring Household Composition and Socioeconomic Status in an Isolated Historic Mining Community." *Historical Archaeology* 27 (1993 no. 4): 20-38. [based on excavations in a Nevada townsite, concluded that ceramics provide a more reliable indicator of feature-specific socioeconomic status than do food bones]

Smith, Mary Hilderman. "Chinese Placer Mining and Site Formation Processes." Paper presented at the annual meeting of the Society for California Archaeology, San Diego, California, March 23-26, 1983, in Boise National Forest, et al., "Chinese Windows on the Past: A Workshop on the Archaeology of Chinese on the Western Frontier," May 22-26, 1989, Boise. [poses research questions related to Chinese mining in the American West]

Townsend, Jan, et al. *National Register Bulletin 36: Guidelines for Evaluating and Registering Historical Archeological Sites and Districts*. National Park Service, 1993. [instructions for evaluating many sites, including mining sites, that may be eligible under Criterion D]

Watts, Donald W. *A View to the Future: A Comprehensive Historic Preservation Plan for Idaho*. Boise: Idaho State Historic Preservation Office, 1998. [defines historic contexts and discusses Idaho's known cultural resources]

Idaho Mining History

(includes works that cover several counties)

Arrington, Leonard J. "From Panning Gold to Nuclear Fission: Idaho's Economic Development, 1860-1960." *Idaho Yesterdays* 6 (summer 1962): 2-10. [economic history of Idaho, using census statistics]

_____. *History of Idaho*. 2 vols. Moscow, Idaho: University of Idaho Press, 1994. [several chapters cover various aspects of Idaho's mining history]

Ashworth, William. *Hell's Canyon: The Deepest Gorge on Earth*. New York: Hawthorn Books, 1977.

Bailey, Robert G. *Hell's Canyon, a Story of the Deepest Canyon in the North American Continent*. Lewiston: R. G. Bailey Printing Co., 1943. [some mention of mines in Hell's Canyon, and a section on the Buffalo Hump mines]

Bancroft, Hubert Howe. *History of Washington, Idaho and Montana, 1845-1889*. San Francisco: The History Co., 1890. [standard early history of Idaho, with detailed information on some of the mining districts]

Barton, Stoddard, & Milhollin. *An Evaluation of the Gold Mined Before April 17, 1867 from the Nez Perce Indian Reservation as Established by the Treaty of June 11, 1855, and of the Occupancy Use of the Reservation as it was Related to the Mining Activity*. Indian Claims Commission, Docket 180-A. 5 vols. Salt Lake City: 1957. [Vol. I–well researched, detailed account of mining on Nez Perce Indian Reservation from 1860 to April 17, 1867, including an attempt to estimate the production of the evaluated districts; Vol. II–excerpts from newspapers and other writings; Vol. III–excerpts from technical writings by geologists and mining experts, legislative acts, excerpts from official reports on mineral production; Vol. IV–miscellaneous reports and letters, index to and excerpts from county records, mint statistics; censuses of 1863 and 1864; Vol. V–maps]

_____. *A Report of Gold Production on the Nez Perce Indian Reservation, 1860-1867*. Prepared for U.S. Department of Justice, Indian Claims Section. Boise: 1958. [includes a short but very good early history of the Nez Perce Reservation area, plus rather detailed descriptions of the 1860-1867 mining operations in many Idaho County districts and in Boise Basin, South Boise, Silver City, and Leesburg]

Battien, Pauline. *The Gold Seekers–a 200 Year History of Mining in Washington, Idaho, Montana & Lower British Columbia*. Colville, Wash.: P. Battien, 1989. [survey of mining history in the region, with photographs and some detailed information on particular mines]

Beal, Merrill D. *A History of Southeastern Idaho*. Caldwell, Idaho: Caxton Printers, 1942. [includes a short chapter on mining in southeastern Idaho]

Beal, Merrill D., and Merle W. Wells. *History of Idaho*. 3 vols. N.Y.: Lewis Historical Publishing Co., 1959. [good overview; volume 3 is family histories]

Beckwith, Radcliffe H. "The Geology and Ore Deposits of the Buffalo Hump District." *Annals of the New York Academy of Science* 30 (Oct. 17, 1928): 263-96. [includes information on particular ore deposits such as the War Eagle and Blue Jay]

Bolino, August C. "The Role of Mining in the Economic Development of Idaho Territory." *Oregon Historical Quarterly* 59 (June 1958): 116-51. [overview of the effects of mining on the economy of Idaho up to 1890]

Boreson, Keo E. *Final Report Archaeological Reconnaissance of Timber Sales and Land Exchanges in Idaho Panhandle National Forests* 1975-1976. University of Idaho Anthropological Research Manuscript Series

36, 1977. [includes some information on mining districts in northern Idaho]

Boswell, Sharon, et al. "A Cultural Resource Overview for the Colville and Idaho Panhandle National Forests and the Bureau of Land Management–Spokane and Coeur d'Alene Districts, Northeastern Washington/ Northern Idaho." Vol. II, Oral Traditions Overview, 1981. [includes summaries of interviews with area residents about mining]

Broadhead, Ray. *History of Idaho Since World War II*, 1945-1950. University of Idaho, 1950. [includes brief section on research program in mining established by 1945 Idaho legislature]

Browne, J. Ross. *Report of J. Ross Browne on the Mineral Resources of the States and Territories West of the Rocky Mountains*. Washington, D.C.: Government Printing Office, 1867. [one page on Idaho]

Bruder, J. Simon, et al., eds. *American Falls: Cultural and Paleontological Resources Inventory on the Snake River Plain*. Submitted to Bureau of Reclamation by Dames & Moore, 1999. [describes historic recovery processes for Snake River fine gold in some detail]

Bureau of Land Management. *Our Cultural Heritage: A Fragile Record of the Last 10,000 Years Along the Lower Salmon River*. 1987. [brochure for the public that includes an overview of mining along the Lower Salmon]

Carrey, John, and Cort Conley. *River of No Return*. Cambridge, Idaho: Backeddy Books, 1978. [history of Salmon River, with some information on mining activities along the river, by a lifelong resident and a river guide]

Choquette, Wayne, and Craig Holstine. *A Cultural Resource Overview of the Bonneville Power Administration's Proposed Transmission Line from Libby Dam, Montana to Rathdrum, Idaho*. Pullman: Washington Archaeological Research Center, 1980. [some information on mining and mining-related trails in northern Idaho]

Cook, Earl Ferguson. *Idaho's Mineral Frontiers*. Idaho Bureau of Mines and Geology, Information Circular 11, 1961. [summarizes the promising minerals and areas for future development, focuses largely on 1960]

_____. *Prospecting for Uranium, Thorium and Tungsten in Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 102, 1955. [information on how and where to prospect for these minerals]

_____. *Radioactive Minerals in Idaho*. Idaho Bureau of Mines and Geology, Mineral Resources Report 8, 1957. [good summary of radioactive prospecting and production]

_____. *A Silver Lining in Idaho Mining: A Review of the Idaho Mineral Industry in 1961*. Idaho Bureau of Mines and Geology, Information Circular 12, 1962.

Dakis, Mike N. "Bogus Gold." *Idaho Yesterdays* 5 (summer 1961): 2-7. [problems with gold dust as currency]

Day, Henry Lawrence. "96 Years of Mining in Idaho." Typescript, 1956. [overview of the history of mining in Idaho by mineral by the owner of a major mine in the Coeur d'Alene region]

Driggs, Benjamin Woodbury. *History of Teton Valley, Idaho*. Caldwell, Idaho: Caxton Press, 1926.

Egleston, T. "The Treatment of Fine Gold in the Sands of Snake River, Idaho." New York: American Institute of Mining Engineers, 1890.

Elliott, Wallace W. *History of Idaho Territory, Showing Its Resources and Advantages...* Wallace W. Elliott Co., 1884. [general history of Idaho up to early 1880s; also includes more detailed information on particular mines in the county-by-county sections]

Federal Writers' Project. *Idaho: A Guide in Word and Picture*. Works Progress Administration. Caldwell, Idaho: Caxton Printers, 1937. [includes a few pages on Idaho's mineral production compared to other states]

Finch, John Wellington, ed. *Ore Deposits of the Western States*. New York: American Institute of Mining and Metallurgical Engineers, 1933. [essays on geology, with some state-specific information, and on the production of various types of placers in the West]

Florin, Lambert. *Western Ghost Towns*. Seattle: Superior Publishing Co., 1961. [brief descriptions with photographs of the following: Silver City, Idaho City, Placerville, Pioneerville, Gem, Burke, Murray, and Potosi Gulch]

French, Hiram T. *History of Idaho: A Narrative Account of Its Progress, Its People and Its Principal Interests*. 3 vols. Chicago: Lewis Publishing Co., 1914. [volume 1 contains a chapter on mining that is arranged by counties; volumes 2 and 3 are biographies]

Gaboury, William Joseph. "The Stubborn Defense: Idaho's Losing Fight for Free Silver." *Idaho Yesterdays* 5 (winter 1961-62): 2-10. [discusses Populism and the free silver issue in Idaho in the 1890s]

Gard, Dan Craig. "Smoke and Ash: A Study of 19th-Century Charcoal Production in Montana and Idaho Using Parabolic Beehive Kilns." M.A. thesis, University of Montana, 1998. [very good discussion of charcoal kilns, including those at Birch Creek, Idaho]

Goulder, William A. *Reminiscences: Incidents in the Life of a Pioneer in Oregon and Idaho*. Boise: Timothy Regan, 1909. [includes discussion of the rush to the Clearwater mines, by a participant]

Hailey, John. *History of Idaho*. Boise, Idaho: Press of Syms-York Co., 1910. [brief year-by-year accounts of mining in the state, 1860s-1887, written by a packer and stage driver who arrived in Idaho in 1862]

Hawley, James H. *History of Idaho, the Gem of the Mountains*. 4 vols. Chicago: S. J. Clarke Pub. Co., 1920. [volume 1 contains some detailed information on mining, transportation, and other topics; volumes 2-4 are biographies]

Hill, James M. *The Mining Districts of the Western United States*. U.S. Geological Survey, Bulletin 507, 1912. [includes a summary of the geology of Idaho and a bibliography of U.S. Geological Survey publications arranged by county and then by mining district]

_____. *Notes on the Fine Gold of Snake River, Idaho*. U.S. Geological Survey, Bulletin 620 (1916): 271-94. [discussion of placer mining along the river]

Hubbard, Charles R. *A Survey of the Mineral Resources of Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 105, 1955. [good discussion of the history of the production of many metals in Idaho]

Hudson, Lorelea, et al. *A Historic Overview for the Colville and*

Idaho Panhandle National Forests and the Bureau of Land Management Spokane and Coeur d'Alene Districts. Prepared by Cultural Resource Consultants for the USDA Forest Service, Northern Region Report 6, 1980. [includes a chapter on mining in Bonner, Boundary, Kootenai, Shoshone, Benewah, Latah, and Clearwater counties]

Hustedde, Gail S., et al. "Mines and Prospects of the Sandpoint Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Spokane Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Wallace Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

Idaho Bureau of Mines and Geology. *Mineral Resources Report*. Moscow, Idaho: Idaho Bureau of Mines and Geology, 1945.

_____. *Mines and Prospects Map Series*. [inventories of mining activity and production data, with references–prospects and mines are located on topographical maps]

Idaho Inspector of Mines. *Annual Report of the Mining Industry of Idaho*. 1899-1973. Continued by *Annual Report of the Idaho Department of Labor and Industrial Services*. [detailed reports by county and by mine, includes photographs, reports on fatal accidents, and essays on particular topics such as transportation and trends in mining; beginning in 1921, lists mining companies by county]

Idaho Mining Association. *Mining Salutes Idaho's 50 Years of Statehood, 1890-1940*. Idaho Mining Association, 1940. [booklet on the history of mining in Idaho, with most detail for the 1860s-1880s]

Idaho State Historical Society. *Idaho: An Illustrated History*. Boise, Idaho: Idaho State Historical Society, 1976. [chapters on mining arranged chronologically, with good summary of trends]

_____. Reference Series. [many of Idaho's mining districts and a wide variety of mining-related topics are covered in these excellent handouts that range from one to several pages]

Illustrated History of the State of Idaho... Chicago: Lewis Pub. Co., 1899. [includes sections on the mining history of the state, histories of particular counties, and biographies of prominent individuals]

Johnson, Claudius O. "The Story of Silver Politics in Idaho, 1892-1902." *Pacific Northwest Quarterly* 33 (July 1942): 283-296. [analysis of the political situation related to the free silver issue]

Johnson, Richard Z. *An Illustrated History of the State of Idaho*. Chicago: Lewis Publishing Company, 1899. [contains some information on mining]

Josephy, Alvin M., Jr. *The Nez Perce Indians and the Opening of the Northwest*. New Haven, Conn.: Yale University Press, 1965.

Kiilsgaard, Thor H. *The Mineral Resources and Mineral Industry of Nine Idaho Counties*. Boise, Idaho: Idaho Bureau of Mines and Geology, 1947.

Koschmann, A.H., and M.H. Bergendahl. *Principal Gold-producing Districts of the United States*. U.S. Geological Survey, Professional Paper #610, 1968. [excellent summary of Idaho's gold districts, arranged by county]

Lewis, William S. "Experiences of a Packer in Washington Territory Mining Camps During the Sixties." *Washington Historical Quarterly* 19 (1928): 206-13; 19 (1928): 286-93; and 20 (1929): 36-53. [James Watt reminiscences about packing in northern Idaho in the 1860s; detailed and entertaining]

Liestman, Daniel. "Nineteenth-Century Chinese and the Environment of the Pacific Northwest." *Pacific Northwest Quarterly* 90 (winter 1998/99): 17-29. [focuses on the interaction between the Chinese and their environment in the Pacific Northwest, including mining, farming, housing, etc.]

Lindgren, Waldemar. *A Geological Reconnaissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho*. U.S. Geological Survey, Bulletin 213, 1903. [discusses the geology and ore deposits of many districts in central Idaho between the Salmon River and the Oro Fino River, detailed]

_____. *The Gold and Silver Veins of Silver City, De Lamar and Other Mining Districts in Idaho*. Washington, D.C.: Government Printing Office, 1898. [detailed, well-illustrated investigation of the geology and ore deposits of west-central Idaho, including the following mining districts and areas: Silver City, DeLamar, Florida Mountain, War Eagle Mountain, Wood River, Florence, Warren, and Seven Devils]

_____. "Mineral Deposits of the Bitterroot Range and Clearwater Mountains, Montana." In Emmons, S. F., and C. W. Hayes, *Contributions to Economic Geology*, U.S. Geological Survey, Bulletin 213, 1903. [includes a relatively brief discussion of the geology and mining of the Clearwater and Salmon areas]

Livingston, D. C. *Tungsten, Cinnabar, Manganese, Molybdenum and Tin Deposits of Idaho*. University of Idaho School of Mines, Bulletin 2, 1919. [although mostly geological information, some information on mine development and production is included; also includes notes on antimony deposits]

McDivitt, James F. *Economic Evaluation of Phosphate and Other Minerals in Southern Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 111, 1956.

Mercier, Laurie, and Carole Simon-Smolinski, eds. *Idaho's Ethnic Heritage: Historical Overviews*. Idaho: Idaho Ethnic Heritage Project, 1990. [good introduction to a variety of ethnic groups in Idaho, including some that settled in mining districts]

Mitchell, Victoria E., et al. "Mines and Prospects of the Ashton Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Challis Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Driggs Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Dubois Quadrangle,

Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Elk City Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Hailey Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Hamilton Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Preston Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

Mitchell, Victoria E., and Susan A. Smith. "Mining Properties in the Mines and Prospects Map Series for Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, Idaho Department of Lands, 1982.

Murphey, Kelly A., M. J. Freeman, and Peter Bowler. *Valley of the Mighty Snake: An Overview of the Cultural and Natural History of Hagerman Valley, Southwestern Idaho.* Hagerman, Idaho: Hagerman Valley Historical Society, n.d. [contains a few pages on placer mining along the Snake River]

Neitzel, Susan Pengilly. "Unsettled Issues: Original Indian Title to the Boise and Bruneau Valleys, Southwestern Idaho." M.A. thesis, Boise State University, 1998. [discusses the impact of the coming of Euroamerican miners on the Boise and Bruneau Shoshone of southwestern Idaho]

Onderdonk, James Lawrence. *Idaho: Fact and Statistics Concerning Its Mining, Farming...* San Francisco: A.L. Bancroft & Co., 1885. [contains about fifteen pages on Idaho mining activity]

Painter, Rex. *Idaho's Bonanza Years; Ghost Towns, Their History and How to Find Them.* 1966. [brief histories of twenty-two ghost towns, with sketches and photographs]

Pattee, Eldon C. *Beryllium Resources of Idaho, Washington, Montana, and Oregon.* U.S. Bureau of Mines, Report of Investigations 7148, 1968. [report on reconnaissance samples of reported beryllium occurrences found to be too low for economic development at the time, with detailed reports on particular mines]

Povey, Dorothy. *Ghost Mining Camps of Idaho: Their History and How to Find Them.* Boise, Idaho: D. Povey, 1984. [short histories and photographs of twenty-two mining camps in Idaho]

Powell, F. "Gold Dredging on Snake River, Idaho." *Engineering and Mining Journal* 70 (Oct. 6, 1900): 395-96. [describes the burlap method of saving the fine gold of the Snake River, and the evolution of dredges used on the river]

Prater, Lewis Seward. *Black Sands.* Idaho Bureau of Mines and Geology, Information Circular 1, 1957. [information on the various metals found in black sands, and on their markets]

Prater, Lewis S., and C. R. Kurtak. *A Report on Mineral Resources of the Middle Snake River Basin in Idaho.* Idaho Bureau of Mines and Geology, 1953. [summaries of activity at many mining districts]

Raymond, Rossiter W. *Statistics of Mines and Mining in the States and Territories West of the Rocky Mountains.* Washington: Government Printing Office, 1870-77. [annual reports on production and activity at many mines, arranged by mining district; the 1869 volume is titled Mineral Resources of the States and Territories West of the Rocky Mountains]

Reid, Rolland R., and Raoul Choate. *Prospecting for Beryllium In Idaho.* Idaho Bureau of Mines and Geology, Information Circular 7, 1960. [overview of the potential for beryllium in Idaho]

Rice, J. M. *Idaho: How to Make Money in Idaho Territory: Farming, Stock-Raising, Mining, Lumbering, Merchandising, Banking...* Omaha: Republican, 1886. [includes information on some mining districts]

Ross, Clyde P. *A Graphic History of Metal Mining in Idaho.* U.S. Geological Survey, Contributions to Economic Geology 821-A, 1930. [summary of metal mining in the state, with graphs showing production trends over time]

_____. *The Metal and Coal Mining Districts of Idaho, with Notes on the Nonmetallic Mineral Resources of the State.* Idaho Bureau of Mines and Geology, Pamphlet 57, 1951. [includes citations of state and U.S. Geological Survey and U.S. Bureau of Mines publications, plus many technical journal articles published through 1941, all arranged by county and by district, with brief histories and comments on the geology and mineral resources of each district]

Savage, C. N. *Economic Geology of Central Idaho Blacksand Placers.* Idaho Bureau of Mines and Geology, Bulletin 17, 1961. [discussion of the origins of the metals in blacksand placers in various areas, with estimates of mineral content per cubic yard]

_____. *Metals from Blacksands: Selected Technologic and Economic Data.* Idaho Bureau of Mines and Geology, Information Circular 10, 1961. [summary of studies done to date]

Schiach, William S., John M. Hendersen, and Harry B. Averill. *An Illustrated History of North Idaho Embracing Nez Perces, Idaho, Latah, and Shoshone Counties, State of Idaho.* Chicago: Western Historical Publishing, 1903. [detailed recounting of certain mining-related events; includes many biographies of prominent residents of northern Idaho]

Schwantes, Carlos A. *In Mountain Shadows: A History of Idaho.* Lincoln: University of Nebraska Press, 1991. [good overview history, with sections on mining]

Shannon, E.V. *The Minerals of Idaho.* U.S. National Museum Bulletin 131, 1926.

Shenon, Philip John, and Roy P. Full. *An Evaluation Study of the Mineral Resources in the Lands Ceded to the United States by the Nez Perce Tribe of Indians on April 17, 1867.* 4 vols. Nez Perce Tribe vs. United States of America, Indian Claims Commission Docket 175-180. [Vol. I - well researched, detailed account of mining on Nez Perce lands ceded to the United States in 1867, leading to a reasoned estimate of the

production of the evaluated districts between 1867 and 1950; Vol. II–excerpts from newspapers and other writings; Vol. III - includes excerpts from technical writings by geologists and mining experts and legislative acts and mining laws and excerpts from official reports on mineral production; Vol. IV–miscellaneous reports and letters, index to and excerpts from county records]

Sisson, David A. *Lower Salmon River Cultural Resource Management Plan*. Prepared for Bureau of Land Management, Coeur d'Alene District, 1983. [overview of the history of the area, including mining, plus recommendations for management of the cultural resources]

Sparling, Wayne C. *Southern Idaho Ghost Towns*. Caldwell, Idaho: Caxton Printers, 1974. [photographs and information on what was still standing in the early 1970s in many former mining areas in southern Idaho]

Staley, W. W. *Fine Gold of Snake River and Lower Salmon River, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 72, 1945. [includes information on the history of mining along the rivers]

_____. *Gold in Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 68, 1946. [production figures for gold, by county and by year, and some discussion of promising areas for future prospecting]

Storch, Richard H., and D. C. Holt. *Titanium Placer Deposits of Idaho*. Washington, D.C.: U.S. Bureau of Mines, Report of Investigations 6319, 1963. [investigation of potential ilmenite deposits in black sands in various areas of Idaho, with discussion of the geology related to black sands]

Strowd, William B., et al. "Mines and Prospects of the Baker Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Boise Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Dillon Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Grangeville Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Idaho Falls Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Jordan Valley Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Pocatello Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

_____. "Mines and Prospects of the Twin Falls Quadrangle, Idaho." Moscow, Idaho: Idaho Bureau of Mines and Geology, 1981.

Subject Index of Early Idaho Newspapers. Strahorn Memorial Library of College of Idaho, 1944-1949. [30,000 annotated entries, articles and items in a number of leading Idaho territorial newspapers, a few into statehood]

Teske, A. J. *Idaho's Mineral Industry, the First Hundred Years*. Idaho Bureau of Mines and Geology, Bulletin 18, 1961. [includes Merle Wells' essay on the history of Idaho mining]

Todd, A. C. "Cousin Jack in Idaho." *Idaho Yesterdays* 8 (winter 1964-65): 2-11. [overview of Cornish miners in Idaho]

U.S. Bureau of Mines. *Minerals Yearbook*. Washington, D.C.: Government Printing Office, 1932-present. [excellent source of information on Idaho mining, year by year]

U.S. Department of the Interior. *Annual Reports of the Territorial Governors*. Washington, D.C.: Government Printing Office, 1878-90. [each report contains a few pages on mining activity and production in Idaho, and some years have more detailed information on particular districts and mines]

U.S. Geological Survey. *Mineral and Water Resources of Idaho*. Idaho Bureau of Mines and Geology, Special Report 1, 1964. [detailed summaries by mineral of Idaho's production and reserves]

_____. *Mineral Resources of the United States*, Calendar Years 1883-1923. Washington, D.C.: Government Printing Office. [annual reports: 1907 on is arranged by state and has more detailed information than the earlier years]

U.S. Treasury Department. *Report of the Director of the Mint Upon the Statistics of the Production of Precious Metals in the United States*. Washington, D. C.: Government Printing Office, various years. [generally contains a few pages summarizing Idaho's precious metals mining activity and production for each year]

Umpleby, Joseph B. *Geology and Ore Deposits of the Mackay Region, Idaho*. U.S. Geological Survey, Professional Paper 97, 1917. [districts discussed in some detail include Alder Creek, Copper Basin, and Dome]

Union Pacific Railroad Company. *The Resources and Attractions of Idaho; A Complete and Comprehensive Description of the Agricultural, Stock Raising and Mineral Resources of Idaho*. Chicago: Rand, McNally & Co., 1889. [gives some information on various mining districts as of 1889]

Varley, Thomas, et al. *A Preliminary Report on the Mining Districts of Idaho*. U.S. Bureau of Mines, Bulletin 166, 1919. [overview of mining in Idaho, plus descriptions of many districts, arranged by county, with bibliography for each county discussed]

Vergobbi, David J. "Oh, That Proper Mix: Selective Boosterism on the North Idaho Mining Frontier." *American Journalism* 14 (1997): 475-94.

Wahl, Andrew J. *Report on the Ramshorn Mine, Bayhorse, Idaho*. B.S. thesis, University of Idaho, 1925. [includes photographs]

Weed, Walter Harvey. *The Mines Handbook*. New York: W. H. Weed, 1918. [lists mines; may be same information as Inspector's Reports]

Weis, Norman D. *Ghost Towns of the Northwest*. Caldwell, Id.: Caxton Press, 1971. [photographs and text on twelve Idaho communities]

Wells, Merle W. *Gold Camps and Silver Cities*. Idaho Bureau of

Mines and Geology, Bulletin 22, 1963. [excellent, detailed overview of the development of the mines in southern and central Idaho, focusing on the nineteenth century]

_____. *Rush to Idaho.* Idaho Bureau of Mines and Geology, Bulletin 19, 1961. [discusses the early northern Idaho mines and examines the production and living costs in early Pierce and Florence compared to gold production]

Wells, Merle W., and Arthur A. Hart. *Idaho, Gem of the Mountains.* Northridge, Calif.: Windsor Publications, 1985. [contains a very good, although brief, overview of mining in Idaho]

"We're Off to the Mines." *Idaho Yesterdays* 5 (summer 1961): 8-15. [Elk City, Pierce, and Clearwater gold rushes]

Wiley, Will E. "Gold Districts of the Northwest: with a Special Study of the Hoodoo District in Northern Idaho." Typescript, 1915. [history of the Hoodoo mining district, based on documents and interviews]

Wolle, Muriel Vincent Sibell. *The Bonanza Trail: Ghost Towns and Mining Camps of the West.* Bloomington, Ind.: Indiana University Press, 1953. [contains historical information and sketches of some nineteen Idaho mining camps]

York, Harold Albert. "The History of the Placer Mining Era in the State of Idaho." M.A. thesis, University of Oregon, 1939. [covers the early 1860s discoveries in some detail, along with the growth of mining communities during that period]

Yu, Li-Hua. "Chinese Immigrants in Idaho." Ph.D. dissertation, Bowling Green State University, 1991. [Chinese mining in north-central mining camps, Boise Basin, Wood River valley, and Coeur d'Alene]

Idaho Mining by County

Note: Check under both current county designation and historic county designations; some listings may not reflect current county boundaries. Also, check above under Idaho Mining History for works that cover several counties.

Ada

Savage, Carleton Norman. *Geology and Mineral Resources of Ada and Canyon Counties.* Idaho Bureau of Mines and Geology, County Report 3, 1958. [includes some historical information]

Waite, Thornton. *Union Pacific Rails to the Mines: The Boise, Nampa & Owyhee Railway.* Idaho Falls: Thornton Waite, 1999. [history of thirty-mile railroad line serving the Owyhee mines]

Wells, Merle. *Boise, an Illustrated History.* Woodland Hills, Calif.: Windsor Publications, 1982. [history of the city of Boise, with a short section on the mining camps of the area]

Adams

Ayers, Harold S. "Geology and Metallurgy of the Ore Deposits of the Azurite Mine." B.S. thesis, University of Idaho, 1921.

Cook, Earl Ferguson. *Mining Geology of the Seven Devils Region.* Idaho Bureau of Mines and Geology, Pamphlet 97, 1954. [primarily geology]

Ferguson, Daryl E. *Lode Mining in Hells Canyon National Recreation Area: Historical and Archaeological Perspectives, Volume 1.* Rain Shadow Research Inc. Project Report 59, 2003. {Reviews lode mining in counties along the Idaho and Oregon sides of the Snake River in Hells Canyon.]

Lindsay, Winifred B. "Seven Devils." *Idaho Yesterdays* 14 (summer 1970): 12-15. [overview of the history of Seven Devils]

Livingston, D. C. *A Geologic Reconnaissance of the Mineral and Cuddy Mountain Mining District, Washington and Adams Counties, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 13, 1925. [includes some information on ore deposits and development]

Livingston, Douglas Clermont, and F.B. Laney. *The Copper Deposits of Seven Devils and Adjacent Districts (Including Heath, Hornet Creek, Hoodoo, and Deer Creek).* Moscow, Idaho: University of Idaho, 1920. [discusses the deposits of Seven Devils mining district in some detail]

Marganti, J. M. "Geology and Ore Deposits of the Seven Devils Volcanics, Seven Devils Mining District, Hells Canyon, Idaho." M.S. thesis, Washington State University, 1972.

Marsh, Frank A. "Geology of the Ore Deposits of the Azurite Mine." B.S. thesis, University of Idaho, 1929. [includes a short history of the Seven Devils mining district]

Mitchell, Victoria E. "History of the Copper Cliff Mine, Adams County, Idaho." Idaho Geological Survey, Staff Report 97-4, 1997.

_____. "History of the Idaho Gold Coin Mine (Maid of Erin and Summit Mines), Adams County, Idaho." Idaho Geological Survey, Staff Report 97-9, 1997.

_____. "History of the Peacock Mine, Adams County, Idaho." Idaho Geological Survey, Staff Report 97-14, 1997.

Reddy, Sheila D. *Reluctant Fortune–the Story of the Seven Devils. Payette National Forest, 1996.* [history of the Westside mining district and of attempts to develop copper mines in the Seven Devils]

South Peacock Mine, Adams County, Idaho: Copper. Washington, D.C.: U.S. Bureau of Mines, 1943. [short report that concludes that no large bodies of mineable ore exist on the claim, but small lenses might be found]

Stratton, David H., and Glen W. Lindeman. "A Study of Historical Resources of the Hells Canyon National Recreation Area." Prepared for the Hells Canyon National Recreation Area, 1978. [overview includes a history of the Seven Devils mining district and some discussion of gold mining in Hells Canyon]

Alturas

McLeod, George A. *History of Alturas and Blaine Counties, Idaho.* Hailey, Idaho: Hailey Times, 1938. [includes chapters on mining in the area]

Bannock

Mansfield, George Rogers. *Geography, Geology, and Mineral Resources of the Fort Hall Indian Reservation, Idaho.* U.S. Geological Survey, Bulletin 713, 1920. [includes two pages on the metalliferous deposits of the reservation]

Muller, Sean Conroy. "The Geology and Distribution of Base Metal Deposits in the Fort Hall Mining District, Bannock County, Idaho." M.S. thesis, Idaho State University, 1978. [analysis of the potential for metals mining in the district, contains some discussion of historic workings]

Benewah

Anderson, Alfred L. *A Geological Reconnaissance in the St. Maries Region, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 30, 1928. [limited historical information]

Blaine

Anderson, Alfred Leonard. *Geologic Reconnaissance of the Hailey Gold Belt (Camas District), Blaine County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 76, 1946. [includes history and production of ore deposits]

_____. *Geology and Ore Deposits of the Lava Creek District, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 32, 1929. [includes a section on history and production]

Anderson, Alfred L., and Warren R. Wagner. *A Geological Reconnaissance in the Little Wood River (Muldoon) District, Blaine County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 75, 1946. [includes information on ore deposits and mines]

Anderson, A. L., et al. *Detailed Geology of Certain Areas in the Mineral Hill and Warm Springs Mining Districts, Blaine County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 90, 1950. [includes discussion of ore deposits]

Ballard, S. M. *Geology and Ore Deposits of Alturas Quadrangle, Blaine County, Idaho.* Idaho Bureau of Mines and Geology, Bulletin 5, 1922. [includes a discussion of a number of mines and prospects in the mining district]

Barrett, G. W. "Colonel E. A. Wall: Mines, Miners, and Mormons." *Idaho Yesterdays* 14 (summer 1970): 2-19. [follows the Idaho career of Enos Andrew Wall, superintendent of a mine in the Wood River area during the 1880s labor dispute]

Cook, Earl Ferguson. *Tungsten Deposits of South-Central Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 108, 1956. [includes general discussion of economic factors related to mineral development]

Darling, Robert S. "The Geology and Ore Deposits of the Carrietown Silver-Lead-Zinc District, Blaine and Camas Counties, Idaho." M.S. thesis, Idaho State University, 1987. [brief information on the history of the mining district]

Lingenfelter, Richard E. *The Hard-Rock Miners: A History of the Mining Labor Movement in the American West, 1863-1893.* Berkeley: University of California Press, 1974. [includes analysis of the conflicts between the miners' unions and mine owners in Silver City, Wood River, and Coeur d'Alene regions]

McLeod, George A. *History of Alturas and Blaine Counties, Idaho. Hailey, Idaho*: Hailey Times, 1938. [includes chapters on mining in the area]

Miller, Nancy. "Mining in the Sawtooths: the Story of Vienna and Sawtooth City." *Idaho Yesterdays* 9 (spring 1965): 10-16. [traces the history of these communities and their associated mines]

Mitchell, Victoria E. "History of the Boulder Mines Group, Blaine County, Idaho." Idaho Geological Survey, Staff Report 97-3, 1997.

_____. "History of the Minnie Moore Mine, Blaine County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-12, 2000.

_____. "History of the Triumph, Independence, and North Star Mines, Blaine County, Idaho." Idaho Geological Survey, Staff Report 97-1, 1997.

Park, William A. "The Geology and Ore Deposits of the Rook's Creek Stock, Blaine County, Idaho." M.S. thesis, Idaho State University, 1990.

Ross, Clyde P. *Geology and Ore Deposits of the Bayhorse Region, Custer County, Idaho.* U.S. Geological Survey, Bulletin 877, 1937. [detailed descriptions of many mines]

_____. *Mining History of South-Central Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 131, 1963. [good summary]

_____. *The Vienna District, Blaine County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 21, 1927. [descriptions of some of the mines and their histories]

Spence, Clark C. "The Boom of the Wood River Mines." *Idaho Yesterdays* 23 (summer 1979): 3-12. [describes the close link between the development of the Wood River towns and the area's silver mining activity]

_____. *For Wood River or Bust: Idaho's Silver Boom of the 1880s.* Moscow, Idaho: University of Idaho Press, 1999.

Thomason, Frank. "The Bellevue Stranglers." *Idaho Yesterdays* 13 (fall 1969): 26-32. [story of the miners union's struggles in Wood River in the 1880s]

Umpleby, J. B., L. G. Westgate, and C. P. Ross. *Geology and Ore Deposits of the Wood River Region, Idaho.* U.S. Geological Survey, Bulletin 814, 1930. [includes detailed histories of many of the mines in the region]

Wells, Merle William. "The Western Federation of Miners." *Journal of the West* 12 (Jan. 1973): 18-35.

Boise

Alexandrowicz, J.S. *The Centerville Archaeological Survey: Historical Archaeological Investigations of a Nineteenth-Twentieth Century Idaho Mining District.* Archaeological Consulting Services, Park City, Utah. Submitted to Bureau of Land Management, Boise District Office, Boise, 1989. [results of archaeological work in this Boise Basin district]

Anderson, Alfred Leonard. *Geology and Ore Deposits of Boise Basin, Idaho.* U.S. Geological Survey, Bulletin 944-C, 1947. [detailed descriptions of many mines and

prospects]
_____. *Geology of the Pearl-Horseshoe Bend Gold Belt, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 41, 1934. [includes information on a number of mines and prospects]
Angelo, Charles Aubrey. "Impressions of the Boise Basin in 1863." *Idaho Yesterdays* 7 (spring 1963): 5-13. [account of a newspaper correspondent, written 1863]
Ballard, Samuel Milroy. *Geology and Gold Resources of Boise Basin, Boise County, Idaho.* Moscow, Idaho: University of Idaho, 1924. [detailed discussion of the geology and placer and lode mines of Boise County]
Bird, Annie Laurie. *Boise: The Peace Valley.* Caldwell, Idaho: Caxton Printers, 1934. [contains sections on mining in Boise Basin]
Buckskin Mining Co. *The Buckskin Mining Company Limited.* Boise, Idaho, 1910. [Buckskin mine promotional booklet, with excellent photographs depicting various aspects of the operation of this relatively small mine and mill]
Chaffee, Eugene B. "Early History of the Boise Region, 1811-1864." M.A. thesis, University of California, 1931. [some information on the discovery of gold in Boise Basin]
Hart, Arthur A. *Basin of Gold: Life in Boise Basin, 1862-1890.* Idaho City, Idaho: Idaho City Historical Foundation, Historic Boise, 1986. [mostly about community life, but does contain some general information on mining in the Basin, plus some photographs and sketches]
Hite, Thomas Hugh. "Report on the Silver Gem Mine, Grimes Pass, Idaho." Typescript, 1935. [includes photographs of some of the mine developments]
Jones, Larry R. "Staging to the South Boise Mines." *Idaho Yesterdays* 29 (summer 1985): 19-25. [discussion of the interrelationship between the stage and freight lines to the mining district and the communities they were designed to serve]
Jones, Timothy W., Mary Anne Davis, and George Ling. "Idaho City: An Overview and Report on Excavation." University of Idaho Anthropological Research Manuscript Series 50, 1979.
Lindgren, Waldemar. *The Mining Districts of the Idaho Basin and the Boise Ridge, Idaho.* Washington, D.C.: GPO, 1898. [detailed, well-illustrated investigation of the geology and ore deposits of the Idaho Basin–Lower and Upper Moore Creek Valley, Grimes Creek, Granite Creek–and Idaho City and Quartzburg-Grimes Pass gold belts (lode mines), and Boise Ridge–Neal, Black Hornet, Boise, Shaw Mountain, and Willow Creek and Rock Creek mining districts, plus placers and silver deposits]
March, Clement Clair. "History and Production of the Boise Basin, Boise County, Idaho." B.S. thesis, University of Montana, 1935.
Metzger, O. H. *Reconnaissance of Placer Mining in Boise County, Idaho.* U.S. Bureau of Mines, Information Circular 7028, 1938. [good overview of the history and 1930s operations of the county's placer deposits]
Murray, Sharon. "A Bucket Full: Boise Basin's Dredging Heritage, 1898-1951." *Idaho Yesterdays* 34 (fall 1990): 2-14. [detailed history of the dredging operations in the Boise Basin]
Neil, Carl R. *Idaho City: A Study of the American Mining Frontier in the 1860's As It Developed at Boise Basin, Idaho.* Thesis, Yale University, 1954. [discussion of Boise Basin and Idaho City]
Ostrogorsky, Michael. *Cultural Resource Overview of the Boise National Forest, Idaho.* Boise, Idaho: Boise National Forest, 1978.
Romig, Robert L. "Stamp Mills in Trouble." *Pacific Northwest Quarterly* 44 (Oct. 1953): 166-76.
Ross, Clyde P. *A Disseminated Lead Prospect in Northern Boise County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 20, 1926. [describes a low-grade deposit opened because of demand for lead]
_____. *Some Lode Deposits in the Northwestern Part of the Boise Basin, Idaho.* U.S. Geological Society Bulletin 846-D, 1934. [discussion of a number of mines in the Boise Basin, with some history]
Skidmore, Joe H. *Gold Mining and Milling Methods and Costs at the Gold Hill Mine of Talache Mines, Inc., Quartzburg, Idaho.* U.S. Bureau of Mines, Information Circular 6985, 1938. [brief history of the Talache Mine and mill is included]
Smith, Elizabeth M. *History of the Boise National Forest, 1905-1976.* Boise, Idaho: Idaho State Historical Society, 1983. [contains summaries of various mining districts on the forest, including a detailed discussion of the history of Stibnite]
Waite, Thornton. *Union Pacific Rails to the Mines: The Boise, Nampa & Owyhee Railway.* Idaho Falls: Thornton Waite, 1999.
Zhu, Liping. "How the Other Half Lives: Chinese Daily Life in Boise Basin Mining Camps." *Idaho Yesterdays* 1995 38(4): 20-28. [concludes that the material life of the Chinese in Boise Basin was comfortable]

Bonner

Anderson, Alfred Leonard. *Geology and Ore Deposits of the Clark Fork District, Idaho.* Moscow, Idaho: University of Idaho, 1930. [detailed discussion of a number of the mines in this mining district]
Cork, Marylyn, ed. *Beautiful Bonner: The History of Bonner County, Idaho.* Dallas, Texas: Curtis Media Corp., 1991.
Etienne, John E. "Geology and Mineral Resources of the Lightning Mountain-Rattle Creek Area, Eastern Bonner County, Idaho." M.S. thesis, Eastern Washington University, 1987.
Klockmann, A. K. *The Klockmann Diary: The Quest for North Idaho's Legendary Continental Mine.* Sandpoint, Idaho: Keokee Co., 1990. [Idaho-Continental mine]
Kotschevar, Donald Dean. "Geology and Ore Treatment of the Keep Cool Mine, Lakeview, Idaho." B.S. thesis, University of Washington, 1938. [study of the geology and milling methods at the Keep Cool mine, which used flotation to treat the lead-silver-zinc ore]

Kun, Peter. *Geology and Mineral Resources of the Lakeview Mining District, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 156, 1974. [overview of the history of this Bonner County district]

Lorain, Sinclair H. *Clark Fork Lead Zinc District, Bonner County, Idaho*. Washington, D.C.: U.S. Bureau of Mines, Report of Investigations 3992, 1946. [gives some history of the three main producing mines in the district]

Mitchell, Victoria E. "History of Selected Mines in the Lakeview Mining District, Bonner County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-4, 2000.

Northern Idaho News: Industrial Souvenir Edition, 1905. Sandpoint, Idaho: Bonner County Historical Society, 1905. [includes sections on mines on Lake Pend d'Oreille and on the Panhandle Smelting Company and the Pine Creek, Blacktail, and Granite Creek mining districts, with some photographs]

Sampson, Edward. *Geology and Silver Ore Deposits of the Pend Oreille District, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 31, 1928. [includes a brief history of the district]

Savage, Carleton Norman. *Geology and Mineral Resources of Bonner County*. Idaho Bureau of Mines and Geology, County Report 6, 1967. [good histories of many metallic mines in the county]

Bonneville

Carney, Ellen, and Elain S. Johnson. *The Mountain: Carriboo and Other Gold Camps in Idaho*. Wayan, Idaho: Traildust Publishing Company, 1994. [history of Cariboo, based on documents and interviews]

"Gold Mines of Cariboo Mountain." *Idaho Yesterdays* 19 (winter 1976): 10-15. [overview of the history of the Cariboo Mountain mining district]

Savage, Carleton Norman. *Geology and Mineral Resources of Bonneville County*. Idaho Bureau of Mines and Geology, County Report 5, 1961. [some information on the history of mines in the area, particularly the Caribou Mountain area]

Boundary

Kiilsgaard, Thor H. *Descriptions of Some Ore Deposits and Their Relationships to the Purcell Sills, Boundary County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 85, 1951. [includes histories of particular mines]

Kirkham, Virgil Raymonde, and Drexel Wells. *Geology and Ore Deposits of Boundary County, Idaho*. Idaho Bureau of Mines and Geology, Bulletin 10, 1926. [detailed discussion of a number of placer deposits and lode mines in the county]

Mitchell, Victoria E. "History of the Idaho Continental Mine, Boundary County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-5, 2000.

Butte

Anderson, Alfred L. *Geology and Ore Deposits of the Lava Creek District, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 32, 1929.

Anderson, Roy A. *Reconnaissance Survey of the Geology and Ore Deposits of the Southwestern Portion of Lemhi Range, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 80, 1948. [primarily geology]

Mitchell, Victoria E. "History of the Lead Belt Mine, Butte County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 99-3, 1999.

_____. "History of the Wilbert Mine, Butte County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-1, 2000.

Roby, Robert Neil. *Investigation of the Hornsilver Lead-Zinc Property, Butte County, Idaho*. U.S. Bureau of Mines, Report of Investigations 4277, 1948. [includes a section on history and production]

Ross, Clyde P. *The Dome Mining District, Butte County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 39, 1933. [includes descriptions of mines]

Camas

Breckenridge, Robert N. *Cost and Development of the Oriential Placer Claims Near Fairfield, Idaho*. B.S. thesis, University of Idaho, 1938.

Campbell, Stewart. "The El Oro Mine, Camas County, Idaho." Typescript, 1923. [history and description of the mine]

Darling, Robert S. "The Geology and Ore Deposits of the Carrietown Silver-Lead-Zinc District, Blaine and Camas Counties, Idaho." M.S. thesis, Idaho State University, 1987. [brief information on the history of the mining district]

Johnson, Paul Howard. *An Evaluation of the Skyrocket and Croesus Claims, Camas County, Idaho*. B.S. thesis, University of Washington, 1956.

Milner, C. E. J. "Geology and Ore Deposits of the Princess Blue Ribbon Mine, Camas County, Idaho." M.S. thesis, University of Idaho, 1950.

Mitchell, Victoria E. "History of the Princess Blue Ribbon Mine, Camas County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-13, 2000.

Ross, Clyde P. *The Little Smoky and Willow Creek Mining Districts of Camas County, Idaho*. Fairfield, Idaho: Camas Press, 1948. [brief discussion of these two districts and some of the lode deposits]

Ross, Clyde P. *Geology and Ore Deposits of the Seafoam, Alder Creek, Little Smoky, and Willow Creek Mining Districts, Custer and Camas Counties, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 33, 1930.

Canyon

Savage, Carleton Norman. *Geology and Mineral Resources of Ada and Canyon Counties*. Idaho Bureau of Mines and Geology, County Report 3, 1958.

Cassia

Anderson, Alfred Leonard. *Geology and Mineral Resources of Eastern Cassia County, Idaho.* Idaho Bureau of Mines and Geology, Bulletin 14, 1931. [detailed report on a number of the deposits in the Stokes and Black Pine mining districts]

Clark

Anderson, Alfred L., and Warren R. Wagner. *Lead-Zinc-Copper Deposits of the Birch Creek District, Clark and Lemhi Counties, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 70, 1944. [includes information on history and production]

Oberg, Pearl M. *Between These Mountains: History of Birch Creek Valley, Idaho.* New York: Exposition Press, 1970. [Birch Creek valley, charcoal kilns, Gilmore & Pittsburgh railroad]

Shenon, P. J. *Geology and Ore Deposits of the Birch Creek District, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 27, 1928. [discusses the Scott mine in some detail]

Clearwater

Anderson, Alfred L. *Geology and Mineral Resources of the Region about Orofino, Idaho.* Idaho Bureau of Mines and Geology Pamphlet 34, 1930. [detailed discussion of placer and lode mines in the Chamberlain Meadows, Oxford, Lolo, Pierce, Burnt Creek, Harpster, Ruby Creek, and Blacklead mining districts]

Barton, Stoddard, & Milhollin. *Royalties and Gold Production Costs on the Nez Perce Indian Reservation, 1860-1867.* Prepared for U.S. Department of Justice, Indian Claims Section. Boise, Idaho, 1958. [detailed analysis of the costs of mining gold at Florence and Pierce, with a calculation of a royalty percentage for gold removed from the Nez Perce Reservation prior to 1867 and a reasonable cost of production of the gold mined]

Haines, Francis. "The Nez Perce Tribe Versus the United States." *Idaho Yesterdays* 8 (spring 1964): 18-25. [describes the process of determining the settlement paid to the Nez Perce for trespass on their lands in the 1860s]

Lewis, William S. "Reminiscences of Joseph H. Boyd, An Argonaut of 1857." *Washington Historical Quarterly* 15 (Oct. 1935): 243-262. [discusses Oro Fino in 1861 and 1862 and the Coeur d'Alenes in the 1880s]

Lindgren, Waldemar. "Mineral Deposits of the Bitterroot Range and Clearwater Mountains, Montana." In Emmons, S. F., and C. W. Hayes, *Contributions to Economic Geology*, U.S. Geological Survey, Bulletin 213, 1903.

Livingston-Little, D. E. *Economic History of North Idaho*, 1800-1900. Los Angeles: Journal of the West, 1965. [much information on mining, particularly the Nez Perce and Salmon River gold rushes and the Coeur d'Alene mining district]

Miller, John B. "Geology and Ore Deposits of Part of the Ruby Creek Mining District, Idaho." B.S. thesis, University of Idaho, 1936.

Pierce, Elias Davidson. *The Pierce Chronicle: Personal Reminiscences of E. D. Pierce.* Edited by J. Gary Williams and Ronald W. Stark. Moscow: Idaho Research Foundation, 1975.

Richter, Sara Jane. "Washington and Idaho Territories." *Journal of the West* 16 (April 1977): 26-35. [Idaho's early rushes and the Civil War]

S. M. Barton & Associates. *Report on Musselshell Placers*, Clearwater County, Idaho. Boise, Idaho: S.M. Barton & Associates, 1950. [mining engineers' report on placers near Pierce]

Spencer, Layne Gellner. *And Five Were Hanged; and Other Historical Short Stories of Pierce and the Oro Fino Mining District.* Lewiston, Idaho: Printcraft Print, 1968.

Staley, W. W. *Mining Activity in the North Fork of the Clearwater River Area.* Idaho Bureau of Mines and Geology, Pamphlet 54, 1940. [little detailed information on workings]

Stapp, Darby Campbell. "The Historic Ethnography of a Chinese Mining Community in Idaho." Ph.D. dissertation, University of Pennsylvania, 1990. [reports on seven sites in the Pierce area, analyzes the information the sites yielded, and poses future research questions]

Waggoner, George A. *Stories of Old Oregon.* Salem, Oregon: Statesman Publishing C., 1905. [reminiscences of the early days in Florence, Oro Fino, and Elk City by a participant]

Custer

Anderson, Alfred Leonard. *Silver-Gold Deposits of the Yankee Fork District, Custer County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 83, 1950. [includes some information on history and production]

Black, J. R. *History of Custer County, Idaho.* Boise, n.d.

Chambers, Arthur Edwin. "Geology and Mineral Deposits of part of the Bayhorse Mining District, Custer County, Idaho." Ph.D. dissertation, University of Arizona, 1966.

Choate, Raoul. *Geology and Ore Deposits of the Stanley Area.* Idaho Bureau of Mines and Geology, Pamphlet 126, 1962. [includes uranium and other strategic minerals]

Cook, Earl Ferguson. *Tungsten Deposits of South-Central Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 108, 1956.

Druss, Claudia. *A History of Mining on Bismarck Mountain, 1870-1940.* Basin & Range Research, 1988. [reports on survey of Sunbeam and Jesse James camps and gives a history of mining in this area of the Yankee Fork]

Druss, Mark, and Claudia Druss. *Archeological Investigations at the Sunbeam Mine, Central Idaho.* Submitted to USDA Forest Service, 1983. [evaluation of three mining sites in the Yankee Fork mining district]

Empire Mine, Mackay, Custer County, Idaho: Copper. U.S. Bureau of Mines, War Minerals Report 267, 1944.

Hillmann, Bob. "The Geology and Ore Deposits of the Clayton Silver Mine, Custer County, Idaho." M.S. thesis, Eastern Washington University, 1986.

Kern, B. F. *Geology of the Uranium Deposits Near Stanley, Custer County*. Idaho Bureau of Mines and Geology, Pamphlet 117, 1959. [includes one page on history and production]

Kern, Richard. "The Geology and Economic Deposits of the Slate Creek Area, Custer County, Idaho." M.S. thesis, Idaho State University, 1972.

Kiilsgaard, Thor H. *The Geology and Ore Deposits of the Boulder Creek Mining District, Custer County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 88, 1949.

_____. "The Geology and Ore Deposits of the Custer Mountain Area, Custer County, Idaho." M.A. thesis, University of California-Berkeley, 1949.

Leland, George R. "General Geology and Mineralization of the Mackay Stock Area." M.S. thesis, University of Idaho, 1957. [includes some information on the history and production of the Empire Mine]

Lockard, David W. "Evaluation of the Golden Sunbeam Gold Deposit, Custer County, Idaho." M.S. thesis, University of Idaho, 1970.

Lokken, John Carl. "A Metallurgical Investigation of the Ore of the Ramshorn Mine, Custer County, Idaho; and a Study of Classification and Gravity Concentration as Applied to the Pecos Ore." M.S. thesis, University of Idaho, 1925. [some historical information]

Luebbert, Nancy Carol. "A History of the Yankee Fork Mining District, Custer County, Idaho." M.A. thesis, Dartmouth College, 1978. [detailed discussion of Yankee Fork and some nearby districts, 1895-1911]

Major, Kris. "The Yankee Fork Dredge and Its Community." *Idaho Yesterdays* 32 (summer 1988): 22-34. [includes a section on the lives of the dredgemen and their families]

Melear, John D. "The Petrology and Ore Deposits of the Seafoam Mining District, Custer County, Idaho." M.S. thesis, University of Idaho, 1953.

Mitchell, Victoria E. "History of the Copper Basin Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 99-1, 1999.

_____. "History of the Greyhound Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-6, 1997.

_____. "History of the Hoodoo Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-8, 1997.

_____. "History of the Livingston Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-10, 1997.

_____. "History of the Lost Packer Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-11, 1997.

_____. "History of the Mines in the Bayhorse Area, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 99-8, 1999.

_____. "History of the Mines on Estes Mountain, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-12, 1997.

_____. "History of the Mountain King Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-13, 1997.

_____. "History of the Phi Kappa Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 99-4, 1999.

_____. "History of Selected Mines in the Alder Creek Mining District, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-2, 1997.

_____. "History of Selected Mines in the Custer Area, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 99-7, 1999.

_____. "History of the Sunbeam Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-18, 1997.

_____. "History of the Valley Creek Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-20, 1997.

_____. "History of the Wildhorse Mine, Custer County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 99-6, 1999.

Murray, Sharon A. "The Mount Vernon Dredge." 1992. Manuscript available at Idaho State Historic Preservation Office.

Packard, Howard A. *Gold Dredge on the Yankee Fork*. Great Falls, Mont.: Yankee Fork Publishing Co., 1983. [booklet giving the history of this dredge, with many photographs]

Ross, Clyde P. *Geology and Ore Deposits of the Bayhorse Region, Custer County, Idaho*. U.S. Geological Survey, Bulletin 877, 1937. [detailed descriptions of many mines]

_____. *Geology and Ore Deposits of the Seafoam, Alder Creek, Little Smoky, and Willow Creek Mining Districts, Custer and Camas Counties, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 33, 1930. [includes histories of selected mines]

Simms, Steven R. *Archeological Survey in the Bayhorse Mining District, Custer County, Idaho*. Salt Lake City, Utah: Archeological Center, Dept. of Anthropology, University of Utah, 1980. [an extensive mining site was recorded, and a history of the mining district is provided]

Stephens, George C. *A History of Gold Mining on the Yankee Fork River, Custer County, Idaho*. Moscow, Idaho: Idaho Geological Survey, University of Idaho, 1991. [good history of placer mining and dredging operations on the Yankee Fork and Jordan rivers]

Tailleur, Irvin L. "Abstract of Ore Deposits of the Clayton Area, Custer County, Idaho." M.S. thesis, Cornell University, 1948. [detailed information on a number of mines, with photographs]

Treves, Samuel B. *The Geology and Ore Deposits of the Seafoam Mining District, Custer County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 96, 1953. [includes some information on the Seafoam property]

Umpleby, Joseph Bertram, F.C. Calkins, and E.L. Jones, Jr. *Gold and Silver in Idaho: A Preliminary Account of the Ore Deposits of the Loon Creek District, Idaho*. U.S. Geological Survey, Bulletin 530-G, 1912. [includes

a section on the history of the area]
Vlasich, James A. "Bayhorse: A Sketch of Mining-Camp History. *Idaho Yesterdays* 27 (1983 no. 2): 25-32. [good overview of the history of mining at Bayhorse, up to the 1970s]
Walsworth, Claudia Taylor. "The Cultural Development of the Sawtooth National Recreation Area in Central Idaho." M.A. thesis, Sonoma State University, 1996. [includes a section on placer and lode mining in the Sawtooth Valley and Stanley Basin]
Yarber, Esther. *Stanley-Sawtooth Country*. Salt Lake City: Publishers Press, 1976. [includes information on the Seafoam mining district and mines in the Stanley Basin, with photographs]

Elmore

Allen, Rhesa M. "Geology and Ore Deposits of the Volcano District, Elmore County, Idaho." M.S. thesis, University of Idaho, 1940.
Anderson, Alfred L. *Geology and Ore Deposits of the Atlanta District, Elmore County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 39, 1939. [includes histories of selected deposits]
_____. *Geology of the Gold-Bearing Lodes of the Rocky Bar District, Elmore County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 65, 1943. [includes information on particular mines]
Ballard, S. M. *Geology and Ore Deposits of the Rocky Bar Quadrangle*. Idaho Bureau of Mines and Geology, Pamphlet 26, 1928. [detailed information on several mining districts]
Gardner, Eugene Delos. *Milling Methods and Costs at the Mine of the St. Joseph Lead Co., Atlanta, Idaho*. U.S. Bureau of Mines, Information Circular 6836, 1935. [describes 1930s practices at this gold and silver mine]
_____. *Mining Methods and Costs at the Mine of the St. Joseph Lead Co., Atlanta, Idaho*. U.S. Bureau of Mines, Information Circular 6823, 1935.
"The Goodrich Trail." *Idaho Yesterdays* 17 (spring 1973): 26-27. [brief description of the route and use of this miners' trail between Idaho City and Rocky Bar]
Mitchell, Victoria E. "History of the Atlanta Mining Area, Elmore County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-15, 2000.
Popoff, Constantine C. *Hermada Antimony Deposit, Elmore County, Idaho*. U.S. Bureau of Mines, Report of Investigations 4950, 1953. [description of history and current working by open pit]
Romig, Robert L. "The South Boise Quartz Mines, 1863-1892: A Study in Western Mining Industry and Finance." M.A. thesis, University of California, 1959. [explanation of shift in 1860s and 1870s from small-scale to large-scale lode mining, and the accompanying problems]
Wagner, Warren R. T. "The Geology and Ore Deposits of the Rocky Bar District, Idaho." M.S. thesis, University of Idaho, 1939.

Gem

Anderson, Alfred L. *Geology of the Pearl-Horseshoe Bend Gold Belt, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 41, 1934. [includes information on a number of mines and prospects]
Savage, Carleton Norman. *Geology and Mineral Resources of Gem and Payette Counties*. Idaho Bureau of Mines and Geology, County Report 4, 1961.

Idaho

Barton, Stoddard, & Milhollin. *Royalties and Gold Production Costs on the Nez Perce Indian Reservation, 1860-1867*. Prepared for U.S. Department of Justice, Indian Claims Section. Boise, Idaho, 1958. [detailed analysis of the costs of mining gold at Florence and Pierce, with a calculation of a royalty percentage for gold removed from the Nez Perce Reservation prior to 1867 and a reasonable cost of production of the gold mined]
Beckwith, Radcliffe H. "The Geology and Ore Deposits of the Buffalo Hump District." *Annals of the N.Y. Academy of Sciences* 30 (Oct. 17, 1928): 263-296.
Capps, Stephen Reid. *Gold Placers of the Secesh Basin, Idaho County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 52, 1940. [detailed information on the geology of this area]
Capps, S. R., and Ralph J. Roberts. *The Dixie Placer District, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 48, 1939. [detailed description of the mining district, with information on geology, specific placer grounds, and lode mines]
Chauvot, Isabelle. "Study of the Gold Deposits at the War Eagle Mine." M.S. thesis, Oregon State University, 1986. [includes some historical information]
Chedsey, Zona, and Carolyn Frei, eds. *Idaho County Voices: A People's History from the Pioneers to the Present*. Idaho: Idaho County Centennial Committee, 1990. [detailed local history, including information on mining in the county]
Cosper, Duane Leonard. *The American Gold Mine, Dixie, Idaho*. M.S. thesis, University of Washington, 1938.
Elsensohn, M. Alfreda. *Idaho Chinese Lore*. Caldwell, Idaho: Caxton Printers, Ltd., 1970. [some information on Chinese miners in Idaho County and elsewhere]
_____. *Pioneer Days in Idaho County*. 2 vols. Caldwell, Idaho: Caxton Printers, 1947-1951. [detailed history of this county, with much information on mining]
Fahey, John. *The Ballyhoo Bonanza: Charles Sweeny and the Idaho Mines*. Seattle: University of Washington Press, 1971. [traces the career of speculative mine promoter Charles Sweeny in the Coeur d'Alenes and Buffalo Hump]
Ferguson, Daryl E. *Lode Mining in Hells Canyon National Recreation Area: Historical and Archaeological Perspectives, Volume 1*. Rain Shadow Research Inc. Project Report 59, 2003. [Reviews lode mining in counties along the Idaho and Oregon sides of the Snake River in Hells Canyon.]
Fee, Jeffrey Michael. "A Dragon in the Eagle's Land: Chinese

in an Idaho Wilderness, Warren Mining District, ca. 1870-1900." M.S. thesis, University of Idaho, 1991. [good history of the Chinese in Warren, Idaho, including information on Chinese gardens]

Flagg, Arthur I. "The Elk City Mining District, Idaho County, Idaho." *American Institute of Mining Engineers Transactions* 45 (1913): 113-22. [focus is on geology, but includes some information on mills]

Gray, Dale M. Historic Resources of the Elk City Wagon Road National Register of Historic Places Multiple Property Documentation Form. Idaho State Historic Preservation Office, Idaho State Historical Society, Boise, 1999.

Haines, Francis. "The Nez Perce Tribe Versus the United States." *Idaho Yesterdays* 8 (spring 1964): 18-25.

Hogan, William. *Report of the Orogrande Gold Mine.* Orogrande, Idaho: Orogrande Gold Mining Co., 1921. [fairly detailed report, prepared by the mine owner]

Jellum, S. P. *Some Central Idaho Gold Districts.* Spokane, Wash.: Northwest Mining News, 1909. [gives details on many districts in Idaho, including Pierce, Elk City, Orogrande, Buffalo Hump, and Dixie]

Kiilsgaard, Thor. "The Mineral Resources and Mineral Industry of Idaho County." April 1947. [provides information on current activity]

Kirkpatrick, G. E. "Geology and Ore Deposits of the Big Creek Area, Idaho and Valley Counties, Idaho." M.S. thesis, University of Idaho, 1974.

Livingston-Little, D. E. *Economic History of North Idaho, 1800-1900.* Los Angeles: Journal of the West, 1965. [much information on mining, particularly the Nez Perce and Salmon River gold rushes and the Coeur d'Alene mining district]

Lorain, S. H. *Gold Mining and Milling in Idaho County.* U.S. Bureau of Mines, Information Circular 7039, 1938. [detailed account of mining activity in the Elk City, Red River, Newsome, Orogrande, South Fork of Clearwater, Florence, Dixie, Burgdorf, Warren, and Salmon River mining districts]

_____. *Mining and Milling Methods and Costs of the Golden Anchor Mining Co., Burgdorf, Idaho.* U.S. Bureau of Mines, Information Circular 7024, 1938.

Lorain, S. H. and O. H. Metzger. *Reconnaissance of Placer Mining Districts in Idaho County, Idaho.* U.S. Bureau of Mines, Information Circular 7023, 1938. [discusses the history of particular operations]

Mackenzie, Wayne Oliver. "To Live in Such a Time." Typescript, 1983-89. [includes reminiscences of working in the 1930s at the Lone Pine mine in Golden, on the Dixie placers, and also some information on other mining operations]

McKay, Kathryn L. *Cultural Resource Inventory and Evaluation of the Orogrande-Frisco Project Area.* Prepared for Cyprus Metals, Inc. by Tracks of the Past, 1998. [detailed history of Orogrande-Frisco mine and mill and of the Orogrande mining district]

_____. *Gold for the Taking: Historical Overview of the Florence Mining District, Idaho County, Idaho.* Prepared for the Nez Perce National Forest by Tracks of the Past, 1998. [history of the Florence mining district through World War II, with histories of many placer and lode mines in the area]

_____. *Hidden Treasure: Historical Overview of the Dixie Mining District, Idaho County, Idaho.* Prepared for the Nez Perce National Forest by Tracks of the Past, 1996. [history of the Dixie mining district through World War II, with histories of many placer and lode mines in the area]

Mitchell, Victoria E. "History of the Golden Anchor Mine, Idaho County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-11, 2000.

_____. "History of the Kimberly Mine, Idaho County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-10, 2000.

Murray, Sharon Ann. "The Marshall Lake Mines: Their History and Development." M.A. thesis, University of Idaho, 1979. [history of the mines in the district, with some color photographs of historic mine buildings and structures]

Purdy, Sarah E. Analysis of Dredge Tailings Pile Patterns: Applications for Historical Archaeological Research. M.A. thesis, Oregon State University, 2008.

Reed, John C. *Early and Recent Mining Activity in North-Central Idaho.* Idaho Bureau of Mines and Geology, Press Bulletin 18, 1936. [overview history of mining in this region, which the author defines as north and west of Thunder Mountain]

_____. *Geology and Ore Deposits of the Florence Mining District, Idaho County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 46, 1939.

_____. *Geology and Ore Deposits of the Warren Mining District, Idaho County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 45, 1938. [includes some history and production]

_____. *Gold-Bearing Gravel of the Nezperce National Forest, Idaho County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 40, 1934. [detailed information on particular placers, with some maps]

Reid, Rolland R. *Placer Deposits of the Elk City Region.* Idaho Bureau of Mines and Geology, Pamphlet 121, 1960.

Richter, Sara Jane. "Washington and Idaho Territories." *Journal of the West* 16 (April 1977): 26-35. [Idaho's early rushes and the Civil War]

Ross, Clyde P. *Ore Deposits in Tertiary Lava in the Salmon River Mountains, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 25, 1927. [detailed geology of the area]

Rossillon, Mary P. *An Overview of History in the Drainage Basin of the Middle Fork of the Salmon River.* University of Idaho Anthropological Research Manuscript Series 60, 1980. [some history of mining in the Yellow Jacket and Seafoam mining districts]

"The Salmon River Mines." *Idaho Yesterdays* 6 (spring 1962): 40-48. [rush to Florence]

Shenon, Philip J., and John C. Reed. *Geology and Ore Deposits of the Elk City, Orogrande, Buffalo Hump, and Tenmile Districts, Idaho County, Idaho.* U.S. Geological Survey, Circular 9, 1934. [detailed information on many of the mines in these mining districts]

Stevens, Rebecca A., and Christian J. Miss. *Cultural Resource Investigations of Florence and the Summit Creek Mining District, Idaho County*. USDA Forest Service, 1989. [reports on survey done of one section, including the townsites of Old and New Florence, and proposes several archaeological predictions for future work]

Stratton, David H., and Glen W. Lindeman. "A Study of Historical Resources of the Hells Canyon National Recreation Area." Prepared for the Hells Canyon National Recreation Area, 1978.

Striker, Michael, and Roderick Sprague. *Excavations at the Warren Chinese Mining Camp Site, 1989-1992*. University of Idaho Anthropological Report 94, 1993. [reports on the conclusions drawn from excavating a reported "Chinese store" near Warren]

Sweeney, Marian S. *Gold at Dixie Gulch*. Kamiah, Idaho: Clearwater Valley Publishing Co., Inc., 1982. [detailed history of people and mines in the Dixie mining district]

Thomson, Francis A., and Samuel M. Ballard. *Geology and Gold Resources of North-central Idaho*. Idaho Bureau of Mines and Geology, Bulletin 7, 1924. [detailed discussion of the geology of the area, with maps and information on specific mines]

Turnipseed, Donna L. "Lessons from a Ditch: A Study of Three Water Conveyance Systems Located in Idaho County, Idaho, 1860-1880." M.S. thesis, University of Idaho, 1997.

_____. "Skim Digging for Dignity: A Look at Placer Mining in Idaho County during the Great Depression." *Idaho Yesterdays* 42 (spring 1998): 18-24. [overview of 1930s-era placer mining in Idaho County, with emphasis on the small-scale operators]

Waggoner, George A. *Stories of Old Oregon*. Salem, Oregon: Statesman Publishing C., 1905. [reminiscences of the early days in Florence, Oro Fino, and Elk City by a participant]

Wagner, Warren R. *A Geological Reconnaissance Between the Snake and Salmon Rivers North of Riggins, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 74, 1945. [includes information on placer gold and copper deposits]

Wilbanks, Richardson. "The Gold Rush to Salmon River, 1861-1862: Some Aspects of the Development of an Orderly Society." M.A. thesis, University of Oregon, 1962. [discusses the rush to Florence, using newspapers as the main sources]

Wildesen, Leslie E. "The Farthest Frontier of All: A Cultural Resource Overview of the River of No Return Wilderness, Idaho." Ogden, Utah: USDA Forest Service Cultural Resource Report 8, 1982. [general information on mining and transportation in central Idaho]

Wylie, Jerry. *Cultural Resource Inventory of the Warren Wagon Road, Idaho and Valley Counties, Idaho, Payette National Forest*. Payette National Forest, 1981. [includes an overview of the history of the "Territorial Wagon Road" and an evaluation of the segments that were recorded]

Jerome

James, Ronald L. *Ruins of a World: Chinese Gold Mining at the Mon-Tung Site in the Snake River Canyon*. U.S. Bureau of Land Management, Idaho Cultural Resource Series 4, 1995. [detailed description of excavation of a dwelling occupied by a Chinese miner in late 1870s-early 1880s along Snake River]

Kootenai

Anderson, Alfred L. *Geology and Metalliferous Deposits of Kootenai County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 53, 1940. [provides a history of exploration and limited production of mines in Kootenai County]

Shane, Alfred E. and Betty J. Shane, comps. *Quartz Claims 1881 thru 1900, Kootenai County, Idaho*. Coeur d'Alene, Idaho: A.E. Shane, 1987. [arranged alphabetically by names of claimants]

Latah

Clayton, Austin B. "Copper Veins of the Mizpah Mines in the Hoodoo District near Harvard, Idaho." M.S. thesis, University of Idaho, 1934. [primarily geology]

Faick, John N. "Geology and Ore Deposits of the Gold Hill District." M.S. thesis, University of Idaho, 1937. [includes descriptions of mines, prospects, and placer deposits, with some history]

Forrester, J. Donald. *Mica and Beryl Occurrence in Eastern Latah County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 58, 1942. [discusses the uses and market for beryllium]

Hubbard, Charles R. *Mineral Resources of Latah County*. Idaho Bureau of Mines and Geology, County Report 2, 1957.

Mayo, Roy F. *Gold and Strichnine*. MW Publications, 1975. [stories about Chinese miners in Latah County]

Platt, Kenneth B. *Some Pioneer Glimpses of Latah County*. Moscow, Idaho: Latah County Museum Society, 1974.

Schrager, Sam., ed. *Guide to the Latah County, Idaho Oral History Collection*. Moscow, Idaho: Latah County Museum Society, 1977.

Waldbauer, Richard C. *Grubstaking the Palouse: Gold Mining in the Hoodoo Mountains of North Idaho, 1860-1950*. Pullman, Wash.: Washington State University Press, 1986.

_____. "An Historical and Archaeological Survey of the Hoodoo Mining District, Idaho." M.A. thesis, University of Idaho, 1981. [report on inventory of placer mining areas in the Hoodoo Mining District]

_____. *An Historical and Archaeological Survey of the Hoodoo Mining District, Idaho*. USFS Cultural Resources Report 7, 1981.

Lemhi

Anderson, Alfred L. *The Antimony and Fluorspar Deposits near Meyers Cove, Lemhi County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 62, 1943. [report on an antimony and several recently discovered fluorspar deposits]

_____. *Copper Mineralization Near Salmon, Lemhi County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 60, 1943. [history of production]

_____. *Geology and Mineral Resources of the Baker Quadrangle, Lemhi County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 112, 1957.

_____. *Geology and Mineral Resources of the Lemhi Quadrangle, Lemhi County*. Idaho Bureau of Mines and Geology, Pamphlet 124, 1961. [describes selected deposits]

_____. *Geology and Mineral Resources of the North Fork Quadrangle, Lemhi County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 118, 1959. [focus is on the geology]

_____. *Geology and Mineral Resources of the Salmon Quadrangle, Lemhi County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 106, 1956. [includes gold, copper, lead, and radioactive mineral deposits]

_____. *Gold-Copper-Lead Deposits of the Yellowjacket District*. Idaho Bureau of Mines and Geology, Pamphlet 94, 1953. [detailed information on mines in this district]

_____. *A Preliminary Report on the Cobalt Deposits in the Blackbird District, Lemhi County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 61, 1943. [includes a historical sketch of the deposits]

_____. *Uranium, Thorium, Columbium, and Rare Earth Deposits in the Salmon Region, Lemhi County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 115, 1958. [discussion of exploration work in various deposits since 1950]

Anderson, Alfred L., and Warren R. Wagner. *Lead-Zinc-Copper Deposits of the Birch Creek District, Clark and Lemhi Counties, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 70, 1944.

Austin, S. R., et al. *Mineralogy of the Lemhi Pass Thorium and Rare-Earth Deposits*. Idaho Bureau of Mines and Geology, Mineral Resources Report 11, 1970. [discusses the geology and economics of the largest rare-earth deposits in the United States]

Bell, Robert N. *Mine and Ore Resources of Lemhi County, Idaho*. Salmon, Idaho: Business Men's Association, 1918. [detailed discussion of the Harmony, Pope-Shenon, Greenhorn (Tormey), Bull of the Woods, and Ranger mines and the Blackbird copper and cobalt district]

Bennett, Earl H. *Reconnaissance Geology and Geochemistry of the Blackbird Mountain–Panther Creek Region, Lemhi County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 167, 1977. [includes a history of the mining district]

Blue Wing Mining District, Lemhi County, Idaho: Tungsten. Washington, D.C.: U.S. Bureau of Mines, 1943. [description of the mines and mills in this district, primarily the Ima Mines Corporation property]

Bryant, Frank B. "Happy Days and Happy Men." *Idaho Yesterdays* 9 (fall 1965): 8-15.

Dice, C. M. *Methods and Costs of Concentrating Hubnerite Ores at the Ima Tungsten Mine, Lemhi County, Idaho*. U.S. Bureau of Mines, Information Circular 7230, 1943. [describes the evolution of the milling process at this mine]

Earls, Amy C., et al. *Leesburg Historic Mining District, Lemhi County, Idaho: A Cultural Resource Investigation*. Reno, Nev.: Mariah Assoc., Inc., 1993. [report on studies of placer mining resources and dwellings in Leesburg mining district]

Fenne, Frank Karl. "Geology and Mineral Deposits of the Central Part of the Parker Mountain Mining District, Lemhi County, Idaho." M.S. thesis, University of Idaho, 1977. [some historical information is included]

Gardner, R. Duncan. *Milling Methods and Costs at the Harmony Mines, Baker, Idaho*. U.S. Bureau of Mines, Information Circular 6285, 1930. [detailed information on concentration of copper-bearing ore at this mine]

Gray, F. A. "Ore Deposits of the Mineral Hill District, Lemhi County, Idaho." Ph.D. dissertation, University of Minnesota, 1927.

Longhurst, Lyle. *The Gilmore & Pittsburgh: Lemhi County's Only Railroad*, 1989.

Lorain, S. H., and O. H. Metzger. *Reconnaissance of Placer Mining Districts in Lemhi County, Idaho*. U.S. Bureau of Mines, Information Circular 7082, 1939.

Mitchell, Victoria E. "History of the Goldstone Mine, Lemhi County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-5, 1997.

_____. "History of the Harmony Mine, Lemhi County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-7, 1997.

_____. "History of the Ima Mine, Lemhi County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 99-2, 1999.

_____. "History of the Mines in the Texas Mining District near Gilmore, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-19, 1997.

_____. "History of the Pope-Shenon Mine, Lemhi County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-15, 1997.

_____. "History of the Queen of the Hills Mine, Lemhi County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-16, 1997.

_____. "History of the Silver Star Mine, Lemhi County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-17, 1997.

_____. "History of the Spring Mountain Mine, Lemhi County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 99-5, 1999.

_____. "History of the Viola Mine, Lemhi County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 99-9, 1999.

_____. "History of the Yellowjacket Mine, Lemhi County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 97-21, 1997.

Myers, Rex C. "The Gilmore & Pittsburgh: Lemhi Valley's Railroad." *Idaho Yesterdays* 15 (summer 1971): 18-23. [overview of the history of this branch line that served mines in the Lemhi Valley area]

Oberg, Pearl M. *Between These Mountains: History of Birch Creek Valley, Idaho*. New York: Exposition Press, 1970. [Birch Creek valley, charcoal kilns, Gilmore &

Pittsburgh railroad]
Polk, Michael R., ed. *Test Excavations at the Haidee Mine Complex and Site SL-562, Lemhi County, Idaho.* Prepared for American Gold Resources Corporation by Sagebrush Archaeological Consultants, 1995. [gives results of excavations at Haidee Mine and Mill and a nearby log cabin, and defines modifications to future archaeological testing based on these results]
Purdue, G. L. "Geology and Ore Deposits of the Blackbird District, Lemhi County, Idaho." M.S. thesis, University of New Mexico, 1975.
Ream, Lanny R. *Idaho Minerals: The Complete Reference and Guide to the Minerals of Idaho with Special Chapters on the Coeur d'Alene Mining District, the Blackbird Mining District, and the Sawtooth Mountains.* Coeur d'Alene, Idaho: L. R. Ream Publishing, 1989.
Reed, G. C., and J. A. Herdlick. *Blackbird Cobalt Deposits, Lemhi County, Idaho.* U.S. Bureau of Mines, Report of Investigations 4012, 1947. [includes a section on history and production]
Ross, Clyde P. *The Copper Deposits Near Salmon, Idaho.* U.S. Geological Survey, Bulletin 774, 1925. [discusses several deposits and gives a brief history]
Sagebrush Archaeological Consultants. "Cultural Resources Management Plan and Haidee Mine Complex Treatment Plan, the Haidee Mine Project, Lemhi County, Idaho." Prepared for American Gold Resources Corporation, 1993. [mitigation plan, including research questions, for this historic mine in the Leesburg mining district]
Schipper, Warren Bailey. "The Tendoy Copper Queen Mine." M.S. thesis, University of Idaho, 1955. [includes a history of the mine and a discussion of its potential]
Shenon, P. J. *Geology and Ore Deposits of the Birch Creek District, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 27, 1928.
Shockey, Philip N. *Reconnaissance Geology of the Leesburg Quadrangle, Lemhi County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 113, 1957. [discusses the possibility of finding cobalt in this quadrangle]
Shoup, George E. *History of Lemhi County.* Boise, Idaho: Idaho State Library, 1969. [reprint of lengthy 1940 newspaper article on the history of Lemhi County, with information on mining at Leesburg, Yellow Jacket]
Starr, Robert Brewster. "Geology of the Twin Peaks Mine, Lemhi County, Idaho." M.S. thesis, Cornell University, 1955. [some information on the history of the mine]
Thune, Howard Willis. "Mineralogy of the Ore Deposits of the Western Portion of the Little Eightmile Mining District, Lemhi County, Idaho." M.S. thesis, University of Idaho, 1941.
Umpleby, J. B. *Geology and Ore Deposits of Lemhi County, Idaho.* U.S. Geological Survey, Bulletin 528, 1913. [includes history and development of ore deposits and detailed information on many mining districts in the county, including gold, lead-silver, copper, tungsten, cobalt-nickel, and tin deposits]
Wells, R. R., et al. *Concentration of Copper-Cobalt Ores from the Blackbird District, Lemhi County, Idaho.* U.S. Bureau of Mines, Report of Investigations 4279, 1948. [some history of the Blackbird mining district, plus information on processing the ore and on marketing cobalt]

Minidoka

Minidoka County Historical Society. *A History of Minidoka County and Its People, 1985.* Minidoka County Historical Society, 1985. [includes one page on dredging for gold on the Snake River]

Nez Perce

Ferguson, Daryl E. *Lode Mining in Hells Canyon National Recreation Area: Historical and Archaeological Perspectives, Volume 1.* Rain Shadow Research Inc. Project Report 59, 2003. {Reviews lode mining in counties along the Idaho and Oregon sides of the Snake River in Hells Canyon.]
Hubbard, Charles R. *Geology and Mineral Resources of Nez Perce County.* Idaho Bureau of Mines and Geology, County Report 1, 1956.

Owyhee

Adams, Mildretta Hamilton. *Historic Silver City; the Story of the Owyhees.* Nampa, Idaho: Schwartz Print. Co., 1969. [informal history of Silver City and its mines, drawn from city directories, standard histories, newspaper articles, and interviews]
Asher, R. R. *Geology and Mineral Resources of a Portion of the Silver City Region, Owyhee County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 138, 1968.
Barrett, G. W. "When Big Money Came to Owyhee." *Idaho Yesterdays* 13 (spring 1969): 2-9. [mine developer Joseph DeLamar]
Blackburn, George M. and Sherman L. Ricards. "Unequal Opportunity on a Mining Frontier: the Role of Gender, Race, and Birthplace." *Pacific Historical Review* 62 (1993 no. 1): 19-38. [the authors used 1870 census data for Owyhee County and Silver City to assess opportunity for economic and social achievement on the mining frontier]
Caywood, Janene, Theodore Catton, and David Putnam. *Comprehensive Historical Overview and Results of Archaeological Test Excavation at Selected Historical Mining Sites on Florida Mountain, Owyhee County, Idaho.* Prepared for CH2M Hill, Corvallis, Oregon, 1993. [contains an excellent overview history of the Owyhee mining district]
Chadwick, Alta Grete. *Tales of Silver City.* Boise: Boise Printing Company, 1975. [reminiscences of Silver City by a native, with photographs]
Derig, B. "A History of Silver City, Idaho." M.A. thesis, Montana State University, 1939.
Gray, Dale M. "War on the Mountain." *Idaho Yesterdays* 1986 29(4): 24-32. [1868 labor war on War Eagle Mountain]
Hanley, Mike. *Owyhee Trails.* Caldwell, Idaho: The Caxton Printers, Inc., 1993. [history of the Owyhees,

illustrated, with some information on the mining camps]

A Historical, Descriptive and Commercial Directory of Owyhee County, Idaho. Silver City, Idaho: Press of the Owyhee Avalanche, 1898. [includes descriptions and photographs of several mines, and biographies of residents of the county]

Hyslop, Julie J. *Foundations of Silver City, Idaho*. 3 vols. Nampa, Idaho, 1985.

McIntosh, Clarence Fredric. "The Chico and Red Bluff Route: Stage Lines from Southern Idaho to the Sacramento Valley, 1865-1867." *Idaho Yesterdays* 6 (fall 1962): 12-15, 18-19.

Morton, Linda. "The Mills of Owyhee County." *Idaho Yesterdays* 29 (summer 1985): 14-18. [brief overview, with illustrations]

Nettleton, Helen. *Sketches of Owyhee County*. Nampa, Idaho: Schwartz, 1978. [collection of stories about people, towns, and activities in the county, including some information on mining]

Parkins, Mac. *Ballads of Owyhee Mine Days: Impressions of Today and Yesterday*. Homedale, Idaho: Owyhee Chronicle, 1964. [contains some historic photographs of mining operations, mixed with poems about the area]

Peterson, Stacy. "Silas Skinner's Owyhee Toll Road." *Idaho Yesterdays* 10 (spring 1966): 12-21. [overview of this important toll road]

Piper, Arthur Maine, and Francis B. Laney. *Geology and Metalliferous Resources of the Region about Silver City, Idaho*. Idaho Bureau of Mines and Geology, Bulletin 11, 1926. [detailed discussion of a number of the mines in the area]

Romig, R. "Florida Mountain Mining." Prepared for the Idaho State Historic Preservation Office, 1990. [discussion of Lindgren's 1899 report on the Florida Mountain mines, with comments on the need for ore specimens]

Science Applications International Corporation. *Plan to Mitigate Adverse Effects to Historic Properties at the Stone Cabin Mine Project, Owyhee County, Idaho*. Submitted to Kinross DeLamar Mine Company, March 14, 1995. [contains site descriptions, research design, and mitigation plan]

Science Applications International Corporation, The Arrowrock Group, and Western Resources Consulting. *Historic Mining on Florida Mountain: Data Recovery at the Stone Cabin Mine Study Area, Owyhee County, Idaho*. Prepared for Kinross DeLamar Mining Company and Bureau of Land Management, 1996 (draft). [analysis of the results of documentary research and archaeological excavations at thirteen historic mining sites on Florida Mountain]

Sorenson, Robert E. *The Geology and Ore Deposits of the South Mountain Mining District, Owyhee County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 22, 1927. [excellent maps of the Coeur d'Alene mines, including a vertical section, with information on development at specific mines]

Waite, Thornton. *Union Pacific Rails to the Mines: The Boise, Nampa & Owyhee Railway*. Idaho Falls: Thornton Waite, 1999.

Welch, Julia Conway. *Gold Town to Ghost Town: The Story of Silver City, Idaho*. Moscow: University of Idaho Press, 1982. [history of Silver City and surrounding mines, written by a native, well illustrated]

Payette

Savage, Carleton Norman. *Geology and Mineral Resources of Gem and Payette Counties*. Idaho Bureau of Mines and Geology, County Report 4, 1961. [includes some information on active mines in the two counties]

Shoshone

Aiken, Katherine G. "Bunker Hill Versus the Lead Trust: The Struggle for Control of the Metals Market in the Coeur d'Alene Mining District, 1885-1918." *Pacific Northwest Quarterly* 84 (1993 no. 2): 42-49. [describes the competition between ASARCO and Bunker Hill management]

_____. "'It May Be Too Soon to Crow': Bunker Hill and Sullivan Company Efforts to Defeat the Miners' Union, 1890-1900." *Western Historical Quarterly* 24 (August 1993): 308-331. [overview of miner/owner relationships during this period of labor unrest]

_____. "Mining in the Coeur d'Alenes." pp. 16-18, in *Idaho Humanities Council. Idaho and the American West*. Boise, Idaho: Idaho Humanities Council, 1994. [discusses labor unions and smelting in the Coeur d'Alenes]

_____. "'Not Long Ago a Smoking Chimney Was a Sign of Prosperity': Corporate and Community Response to Pollution at the Bunker Hill Smelter in Kellogg, Idaho." *Environmental History Review* 18 (summer 1994): 67-86. [focuses mostly on the 1970s, but does provide background information]

_____. "Odyssey of a Union: Communism and the Rise of the Northwest Metal Workers, 1960-1971." *Montana The Magazine of Western History* 47 (1997 no. 3): 46-61.

_____. "'When I Realized How Close Communism was to Kellogg, I was Willing to Devote Day and Night': Anti-Communism, Women, Community Values, and the Bunker Hill Strike of 1960." *Labor History* 36 (no. 2, 1995): 165-86.

Anderson, Alfred L. *A Geological Reconnaissance in the St. Maries Region, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 30, 1928. [limited historical information]

Bankson, Russell A., and Lester S. Harrison. *Beneath These Mountains*. N.Y.: Vantage Press, 1967. [history of Coeur d'Alene mining district; no bibliography or footnotes]

Banister, D'Arcy, and H.R. Wellman. *Methods and Costs of Rock Drilling at the Silver Summit Mine, Hecla Mining Co., Shoshone County, Idaho*. U.S. Bureau of Mines, 1963. [discusses underground drilling equipment and methods and costs for 1952-58; alloy steel and tungsten carbide bits were introduced to the mine in 1952]

Barnard, Thomas Nathan. *Coeur d'Alene, Towns, Mines,*

Mountains & Lakes. Wallace, Idaho: 1891. [small book of sketches of mines, mills, towns, and placer diggings in the Coeur d'Alene area]

Barnard Studio. Barnard-Stockbridge Photograph Collection, 1886-1964. Special Collections and Archives, University of Idaho, Moscow, Idaho. [approximately two hundred thousand images of the Coeur d'Alene mining district, 1889-1964, with many photographs of mines and mills]

Berg, J. E. *Mining Methods at the Page Mine of the Federal Mining and Smelting Co., Page, Idaho.* U.S. Bureau of Mines, Information Circular 6372, 1930. [discussion of this lead-silver-zinc mine five miles west of Kellogg]

Brainard, Wendell. *Golden History Tales from Idaho's Coeur d'Alene Mining District.* Kellogg, Idaho: Wendell Brainard, 1990. [popularly written stories about the Coeur d'Alene mining district, no bibliography]

Brown, U. E. *Mining Methods of the Bunker Hill and Sullivan Mining and Concentrating Co., Kellogg, Idaho.* U.S. Bureau of Mines, Information Circular 6407, 1931. [good description of underground mining methods, including stoping]

Buenneke, Troy D. "Burke, Idaho, 1884-1925: the Rise and Fall of a Mining Community." *Idaho Yesterdays* 35 (spring 1991): 26-39. [overview of the history of Burke, with good historic photographs of some of the mines]

Bunker Hill Company. *The Bunker Hill Company, Kellogg, Idaho: A Story of Progress from Mines to Metals.* Kellogg, Idaho: Bunker Hill Company, 1958. [clear explanation of the technical processes of mining, concentrating, and smelting the company's lead-zinc-silver ores]

Butler, L. F. *The Coeur d'Alene Mines: A Concise Description....* Chicago: Cushing, Thomas & Co., 1884. [booklet advertising the recently discovered Coeur d'Alene mines, with some history of their discovery and early development]

Butner, D. W. *Method and Cost of Driving the Rock Creek Tunnel, Hecla Mining Company, Shoshone County, Idaho.* U.S. Bureau of Mines, Information Circular 7525, 1949. [discussion of costs and methods of driving a 4,500-foot tunnel]

_____. *Mining Methods and Costs at the Highland Surprise Mine, Shoshone County, Idaho.* U.S. Bureau of Mines, Information Circular, 1950. [good summary of current and past operations]

Canfield, Oscar. "Oscar Canfield's Pioneer Reminiscences." Recorded by William S. Lewis. *Washington Historical Quarterly* 8 (Oct. 1917): 251-56. [Coeur d'Alenes in the 1880s]

Carpenter, Thomas. "Labor Conflict in the Mining Industry of the Coeur d'Alenes, 1892 and 1899." Ph.D. dissertation, New York University, 1973.

Casner, Nicholas A. "Leaded Waters: A History of Mining Pollution on the Coeur d'Alene River in Idaho, 1900-1950." M.A. thesis, Boise State University, 1989. [detailed discussion of pollution in the Silver Valley due to mill tailings]

_____. "Toxic River: Politics and Coeur d'Alene Mining Pollution in the 1930's." *Idaho Yesterdays* 1991 35(3): 2-19. [very good summary of the early court cases and steps taken over the decades to reduce mining pollution in this area]

Chapman, Ray. *Uncle Bunker: Memories in Words and Pictures.* Kellogg, Idaho: Chapman Pub., 1994. [account of the Bunker Hill Company by an employee, with production tables and many photographs]

"Coeur d'Alene Mining District; the Visual Record." *Pacific Northwest Quarterly* 78 (1987 no. 3): 83-90.

Coeur d'Alene River and Lake Commission. *Report and Recommendations of the Coeur d'Alene River and Lake Commission to the Twenty-Second Session of the State Legislature of Idaho.* 1933.

Corcoran, Thomas F. "Labor Unions in the Coeur d'Alene Mining District, 1887-1900." *Pacific Northwesterner* 26 (1982 no. 2): 17-32.

Culver, Edward Harold. *Culver Mining Company Limited, Kellogg, Idaho: Report on Property.* Wardner, Idaho: News Press, 1911.

Dahlgren, Dorothy. *In All the West, No Place Like This: A Pictorial History of the Coeur d'Alene Region.* Coeur d'Alene, Idaho: Museum of North Idaho, 1991.

Dalton, M. P. *Milling Methods and Costs at the Morning Concentrator of the Federal Mining and Smelting Co., Mullan, Idaho.* U.S. Bureau of Mines, Information Circular 6587, 1932. [details the progression of treatment methods for lead, silver, and zinc at this mill]

Davis, Corinne M. "One Union Against a Town: Local 18 of the International Union of Mine, Mill and Smelter Workers at the Bunker Hill Company, Kellogg, Idaho, 1941-1960." M.S. thesis, University of Idaho, 1991.

Day, Henry L. "Mining Highlights of the Coeur d'Alene District." *Idaho Yesterdays* 7 (winter 1964): 2-9. [overview written by one of the major mine owners in the district]

Day, Henry L., et al. *The Coeur d'Alene Mining District in 1963.* Idaho Bureau of Mines and Geology, Pamphlet 133, 1963. [series of articles, including many on the history of the area and its mines, mills, and smelters]

Dolph, Jerry, and Arthur Randall. *Wyatt Earp and Coeur d'Alene Gold: Stampede to Idaho Territory.* Post Falls, Idaho: Eagle City Publications, 1999. [chronological biography of Wyatt Earp, information on Eagle City, illustrated]

Domijan, George. "Historic American Engineering Record: Bunker Hill Lead Smelter." 1993. [detailed description and photographs of the processes and significance of the Bunker Hill lead smelter, 1917-81]

_____. "Historic American Engineering Record: Sullivan Electrolytic Zinc Plant." 1993. [detailed description and photographs of the processes and significance of the Sullivan zinc plant, 1928-81]

_____. "Land Status and Mining Development in the Coeur d'Alene Mining District of Northern Idaho." M.S. thesis, University of Idaho, 1986. [discusses the complex world of mining claim ownership and

the effects of laws concerning tailings on the mining landscape]

Dort, Wakefield, Jr. *Gold-Bearing Gravels Near Murray, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 116, 1958. [contains some history, along with a discussion of the future outlook of placer mining in the area]

Ellis, Max Mapes. "Pollution of the Coeur d'Alene River and Adjacent Waters by Mine Wastes." U.S. Bureau of Fisheries, typescript, 1932. [investigation of the effects of mine wastes on the South Fork and main Coeur d'Alene River, finding devastating impacts on the fishery]

Fahey, John. *The Ballyhoo Bonanza: Charles Sweeny and the Idaho Mines.* Seattle: University of Washington Press, 1971. [traces the career of speculative mine promoter Charles Sweeny in the Coeur d'Alenes and Buffalo Hump]

_____. "Coeur d'Alene Confederacy." *Idaho Yesterdays* 12 (spring 1968): 2-7. [traces the purpose and actions of the Mine Owners Association in the Coeur d'Alenes]

_____. *The Days of the Hercules.* Moscow, Idaho: University Press of Idaho, 1978. [detailed history of the Hercules mine and of the Day family that owned it]

_____. *Hecla: A Century of Western Mining.* 1990. [detailed history of the Hecla mine near Burke]

_____. *The Inland Empire: Unfolding Years, 1879-1929.* Seattle: University of Washington Press, 1986. [chapter on impact of Coeur d'Alene mines on Spokane]

_____. "The Milwaukee-Youngstown Connection: Midwestern Investors and the Coeur d'Alene Mines." *Pacific Northwest Quarterly* 81 (2): 42-49.

Finlay, James Ralph. *The Mining Industry of the Coeur d'Alenes, Idaho.* New York: American Institute of Mining and Metallurgical Engineers, 1902. [good description of 1902 practices in mining and milling]

Forster-Priesmeyer, Emma Louise. *Gunfighter Ethic on the Industrial Frontier: A Social and Cultural History of the Coeur d'Alene Mining District.* M.S. thesis, University of Idaho, 1991. [capital/labor violence in the Coeur d'Alene mining district, 1887-1903]

Fraternal Order of Eagles. *Eagles Souvenir of the Coeur d'Alene Mining District."* Wallace, Idaho: Press-Times Publishing Company, 1928. [a few photos, and history of selected mines in the district]

_____. *Souvenir Coeur d'Alene Mining District.* Wallace, Idaho: Idaho Press, 1906. [good photos and discussion of some mines]

Fulkerson, Frank B. *Economic Aspects of Silver Production in the Coeur d'Alene Mining Region, Shoshone County, Idaho.* U.S. Bureau of Mines, Information Circular 8207, 1964. [analysis of recent trends in production of silver, with some background information]

Gaboury, William Joseph. "From Statehouse to Bullpen: Idaho Populism and the Coeur d'Alene Troubles of the 1890's." *Pacific Northwest Quarterly* 58 (Jan. 1967): 14-22. [analysis of Shoshone County labor-management relations in the 1890s]

Gammell, Robert M., and Robert J. Hundhausen. *Sidney Mine, Pine Creek Area, Shoshone County, Idaho.* U.S. Bureau of Mines, Report of Investigations 4188, 1948. [report on milling and mining operations at this mine]

Gerwels, Richard P. "A Study of the Golconda Lead Mines, Shoshone County, Idaho." M.S. thesis, University of Utah, 1951.

Gin, Thon Too. "Mineralization in the Pine Creek Area, Coeur d'Alene Mining Region, Idaho." Ph.D. dissertation, University of Utah, 1953.

Goble, Dale D., and Paul W. Hirt, eds. *Northwest Lands, Northwest Peoples: Readings in Environmental History.* Seattle, Wash.: University of Washington Press, 1999. [two essays on the northern Idaho mines–one on the damage suit filed by ranchers downstream of the mines in the early 1900s, and the other on smelter smoke disputes]

Gold Strikes and Silver Linings: A Collection of Stories on the Development of North Idaho's Mineral Wealth. Wallace, Idaho: Silver Valley Economic Development Corp., 1995. [history of Silver Valley, including some specific mines]

Goodrich, Robert Rhea, and Norman E. Holden. *Experiments in the Recovery of Tungsten and Gold in the Murray District, Idaho.* Reprint of Transactions of the American Institute of Mining Engineers, St. Louis meeting, Oct. 1917, 1173-1180.

Greenough, W. Earl. *First 100 Years: Coeur d'Alene Mining Region, 1846-1946.* Mullan, Idaho: W.E. Greenough, 1947. [short history of the Coeur d'Alene mines, with photographs]

Handy, R. S. *Milling Methods and Costs at the Northern Idaho Mills of the Bunker Hill and Sullivan Mining and Concentrating Co.* Washington, D.C.: U.S. Bureau of Mines, Information Circular 6314, 1930. [detailed description of five mills in the Coeur d'Alenes]

Hart, Patricia, and Ivar Nelson. *Mining Town: The Photographic Record of T. N. Barnard and Nellie Stockbridge from the Coeur d'Alenes.* Seattle: University of Washington Press, 1984. [photographs drawn from the Barnard-Stockbridge photograph collection at the University of Idaho, and text discusses the period from the late 1880s to World War I]

Herdlick, J. A. *Little Pittsburg Lead-Zinc Mine: Shoshone County, Idaho.* U.S. Bureau of Mines, Report of Investigations 3999, 1947.

Hobson, George C., ed. *Gems of Thought and History of Shoshone County.* Kellogg, Idaho: Evening News Press, 1940. [includes chapters on lode and placer mining]

Howard, Joseph K. "The Coeur d'Alene: Vulnerable Valley." pp. 55-77 in Ray B. West, Jr., ed., *Rocky Mountain Cities*, New York: 1949.

Hufstetler, Mark, and Dale Martin. *The Union Pacific Railroad to the Silver Valley: A Cultural Resource Reconnaissance Study.* Submitted to Union Pacific Railroad by Renewable Technologies, Inc., 1999. [includes historic context and evaluation of the Mullan and Wallace branches]

Hundhausen, R. J. *Mining and Milling Methods and Costs at the Little Pittsburgh Lead-Zinc Mine, Shoshone County, Idaho.* U.S. Bureau of Mines, Information Circular

7428, 1948. [contains detailed information on the mine and mill]

Jackson, Charles F., et al. *Lead and Zinc Mining and Milling in the United States: Current Practices and Costs.* U.S. Bureau of Mines, Bulletin 381, 1935. [comprehensive discussion of lead and zinc mining and milling procedures and of several mines in the Coeur d'Alenes]

Jensen, Vernon H. *Heritage of Conflict: Labor Relations in the Nonferrous Metals Industry up to 1930.* New York: Cornell University Press, 1950. [includes chapters on the Coeur d'Alene labor disputes of 1892 and 1899 and on the trials related to the 1905 murder of former Idaho governor Frank Steunenberg]

Johnson, Chris. "Bunker Hill: The Company That Made a Town." *Idaho Yesterdays* 41 (1997 no. 1): 2-6. [brief summary of the history of the company, focusing on more recent years]

Jones, Edward L. *A Reconnaissance of the Pine Creek District, Idaho.* U.S. Geological Survey, Bulletin 710-A, 1919. [detailed histories and descriptions of many mines]

Julihn, C. E., and F. W. Horton. *Mineral Industries Survey of the United States–Idaho, Shoshone County, Coeur d'Alene District: The Silver Belt and the Sunshine Mine of the Coeur d'Alene District.* U.S. Bureau of Mines, Information Circular 6876, 1936. [some information on current production]

Kensel, W. Hudson. "Inland Empire Mining and the Growth of Spokane, 1883-1905." *Pacific Northwest Quarterly* 60 (April 1969): 84-97.

Krempasky, George T. *Methods and Costs of Driving Drifts, Crosscuts and Raises in the Coeur d'Alene Mining District, Shoshone County, Idaho.* U.S. Bureau of Mines, Information Circular 7964, 1960.

Laurie, Clayton D. "The United States Army and the Labor Radicals of the Coeur d'Alenes: Federal Military Intervention in the Mining Wars of 1892-1899." *Idaho Yesterdays* 1993 37(2): 12-29.

Lead Blossom Mining and Milling Company. *Mines at Wardner, Idaho.* Wallace, Idaho: 1928. [stockholders' report, several pages, on the Lead Blossom operation]

Lewis, William S. "Reminiscences of Joseph H. Boyd, An Argonaut of 1857." *Washington Historical Quarterly* 15 (Oct. 1935): 243-262. [discusses Oro Fino 1861 and1862 and Coeur d'Alene in the 1880s]

Lieb, Keyston & Co. *An Analysis of the Position, History, and Outlook for Bunker Hill and Sullivan Mining and Concentrating Company.* San Francisco: Recorder Printing and Publishing Co., 1936. [good summary history of the company over the decades]

Lingenfelter, Richard E. *The Hard-Rock Miners: A History of the Mining Labor Movement in the American West, 1863-1893.* Berkeley: University of California Press, 1974. [includes discussion of the labor movement in Idaho]

Livingston-Little, D. E. "The Bunker Hill and Sullivan: North Idaho's Mining Development from 1885 to 1900." *Idaho Yesterdays* 1963 7(1): 34-43. [detailed examination of the early history of the Bunker Hill & Sullivan in the context of northern Idaho and Inland Empire development]

_____. *Economic History of North Idaho, 1800-1900.* Los Angeles: Journal of the West, 1965. [much information on mining, particularly the Nez Perce and Salmon River gold rushes and the Coeur d'Alene mining district]

Magnuson, Richard G. *Coeur d'Alene Diary: The First Ten Years of Hardrock Mining in North Idaho.* Portland: Metropolitan Press, 1968. [chronological history of the Coeur d'Alene mining district up to 1893, based largely on newspaper accounts]

Marshall, Julian. "Placer Deposits of Murray, Idaho." *Pacific Northwesterner* 16 (winter 1972): 1-11.

McCarl, Robert. *Contested Space: The Above and Below Ground Landscape of Idaho's Coeur d'Alene Mining District.* Salt Lake City, Utah: University of Utah, 1997. [analysis of the cultural landscape of mining in the Coeur d'Alene region]

McElroy, G. E. *Mine Ventilation in the Coeur d'Alene Mining District.* U.S. Bureau of Mines, Information Circular 6382, 1931. [good description of earlier and ca. 1930 ventilation methods]

McWilliams, John R. *Methods and Costs of Shaft Sinking in the Coeur d'Alene District, Shoshone County, Idaho.* U.S. Bureau of Mines, Information Circular 7961, 1960. [contains much information on the development of particular mines]

Mitchell, Victoria E. "History of the Bear Top, Ione, and Orofino Mines, Shoshone County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-8, 2000.

_____. "History of the Black Horse, Paragon, and St. Peter Mines, Shoshone County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-7, 2000.

_____. "History of the Jack Waite Mine, Shoshone County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-6, 2000.

_____. "History of Selected Mines in the Pine Creek Area, Shoshone County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-2, 2000.

Mitchell, Victoria E., and Earl H. Bennett. "Production Statistics for the Coeur d'Alene Mining District, Shoshone County, Idaho, 1884-1980." Moscow, Idaho: Idaho Geological Survey, Technical Report 83-3, 1983.

Oscarson, P. E. "Report on the Property of the Vulcan Silver-Lead Corporation, Wallace, Shoshone County, Idaho." Typescript, 1954. [includes history of the property]

Peterson, Richard H. "Simeon Gannett Reed and the Bunker Hill and Sullivan: The Frustrations of a Mining Investor." *Idaho Yesterdays* 23 (fall 1979): 2-8. [discusses issues faced by Reed as owner of the Bunker Hill and Sullivan mine]

Phipps, Stanley S. "The Coeur d'Alene Miners' Unions in the Post Bullpen Era, 1900 to 1916: the Socialist Party and I.W.W. Connections." M.A. thesis, University of Idaho, 1980. [traces the evolution of miners' unions in the Coeur d'Alenes]

_____. "From Bull Pen to Bargaining Table: The

Tumultuous Struggle of the Coeur d'Alenes Miners for the Right to Organize, 1887-1942." Ph.D. dissertation, University of Idaho, 1983.

Price, G. S. *Milling Methods and Costs at the Page Concentrator of the Federal Mining & Smelting Company, Kellogg, Idaho.* U.S. Bureau of Mines, Information Circular 6590, 1932.

Quivik, Fredric L. *Expert Report of Fredric L. Quivik: United States v. ASARCO, et al Civil Action 96-0122-N-EJL.* 1999. [provides a detailed history of the movement of tailings and other potential contaminants through the Coeur d'Alene River basin and a history of physical and/or chemical changes the tailings and other potential contaminants may have undergone, based on the historical record]

Ransome, Frederick Leslie. *The Geology and Ore Deposits of the Coeur d'Alene District, Idaho.* U.S. Geological Survey, Professional Paper 62, 1908. [includes a good history of the mining district and detailed descriptions of many of the mines]

Reynolds, John R. *Mining Methods and Costs at the Morning Mine, American Smelting & Refining Co., Shoshone County, Idaho.* U.S. Bureau of Mines, Information Circular 7743, 1956. [detailed examination of the Morning Mine]

Rickard, T. A. "The Bunker Hill Enterprise." Ca. 1959. Available on microfilm at University of Idaho library. [detailed history, with photographs and sketches]

Russell, Bert, and Marie Russell. *Rock Burst.* Moscow: University of Idaho Press, 1998. [interviews with people of the Coeur d'Alene area, many of them miners]

Ryden, Kent Clinton. *Mapping the Invisible Landscape: Folklore, Writing, and the Sense of Place.* Iowa City: University of Iowa Press, 1993. [traces the topography and invisible landscape of Coeur d'Alene area as a case study, with extensive interviews]

Sampson, Sigurd Laurence. *The Milling Practice of the Coeur d'Alene District.* B.S. thesis, University of Idaho, 1923. [detailed analysis of a number of mills within twelve miles of Wallace, with descriptions of the facilities and processes]

Scamahorn Air Photo Company. *The Coeur d'Alene Mining District as Seen Through the Aerial Camera of Scamahorn Air Photo Company.* Spokane, Wash.: Scamahorn Air Photo. Co., 1948. [excellent aerial photographs of many of the mines, mills, and smelters in the Coeur d'Alene mining district, with brief text accompanying each photograph]

Shenon, Philip J. *Geology and Ore Deposits Near Murray, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 47, 1938.

Shenon, P. J., and R. H. McConnel. *The Silver Belt of the Coeur d'Alene District, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 50, 1939. [primarily geology]

Simmons, W.H. "Report on the Hunter Creek Mine, Hunter District, Shoshone County, Idaho." Typescript, 1952. Available at University of Idaho Library.

Sisson, David. *Pine Creek Rehabilitation Project, ID6-96-43.* Prepared for Bureau of Land Management, Coeur d'Alene District, 1996. [detailed information on several mill sites in the Pine Creek area, plus some general context]

Smalley, Eugene V. "The Great Coeur d'Alene Stampede of 1884." *Idaho Yesterdays* 11 (fall 1967): 2-10. [overview of the early placer rush to the Coeur d'Alenes]

Smith, Robert Wayne. *History of Placer and Quartz Gold Mining in the Coeur d'Alene District.* Fairfield, Wash.: Ye Galleon Press, 1993. [reprint of Smith's 1932 thesis, with good photographs of mining communities]

_____. "The Idaho Antecedents of the Western Federation of Miners." Thesis, University of California, 1937. [covers the Coeur d'Alene labor crisis of 1892 that led to the organization of the Western Federation of Miners]

Smolak, George. "Report on the Western Union Mine." B.S. thesis, University of Idaho, 1922. [silver-lead producer in the Coeur d'Alene mining district]

Sorenson, Robert E. "Deep Discoveries Intensify Coeur d'Alene Activities." Originally published in *Engineering and Mining Journal*, Oct. 1947. [summary of mining activities as of 1947]

Spence, Clark C. *Mining Engineers and the American West: The Lace-Boot Brigade, 1849-1933.* New Haven: Yale University Press, 1970. [examination of professional mining engineers and their impact on the West prior to the 1930s, with some specific information on the Coeur d'Alenes]

Stoll, William T., and Katherine G. Aiken. *Silver Strike: The True Story of Silver Mining in the Coeur d'Alenes.* Moscow: University of Idaho Press, 1991. [reminiscences of an attorney involved in the labor disputes in Silver Valley]

Sunset, Amazon-Manhattan, Carlisle-Virginia Vein Systems, Shoshone County, Idaho: Zinc, Lead. Washington, D.C.: U.S. Bureau of Mines, 1943. [report investigating possibilities of increased zinc-lead production from the Beaver mining district]

Vernon, James Wesley. "Geology of the Douglas Mine, Idaho." M.A. thesis, University of California, 1953. [discusses the history of this mine in the Pine Creek area]

Wardner, Jim. *Jim Wardner of Wardner, Idaho.* New York: 1900. [autobiography]

Wagner, Warren R. *The Geology of Part of the South Slope of the St. Joe Mountains, Shoshone County, Idaho.* Idaho Bureau of Mines and Geology, Pamphlet 82, 1949. [includes discussion of mines]

Wai, C. M., et al. *A Bibliography of Environmental Studies of the Coeur d'Alene Mining Area, Idaho.* Moscow: University of Idaho, 1985.

Wells, Merle William. "The Western Federation of Miners." *Journal of the West* 12 (Jan. 1973): 18-35. [traces its development in various states and the reasons for its inability to represent a majority of miners]

Wethered, Charles E., and Leo J. Coady. *Mining Methods at the Morning Mine of the Federal Mining and Smelting Company, Mullan, Idaho.* U.S. Bureau of Mines, Information Circular 6238, 1930. [includes a section on the history of the mine]

Williams, Roy E., and Leroy L. Mink. *Settling Ponds as a Mining Wastewater Treatment Facility*. Idaho Bureau of Mines and Geology, Pamphlet 164, 1975. [reports on a study of settling basins established in the Coeur d'Alenes in 1968 to treat mine effluent]

Wolff, Fritz E. "Driving the Kellogg Tunnel: Two Miles to Glory–or Ruination?" *Mining History Journal* 7 (2000): 24-34. [history of this tunnel, constructed 1897-1902]

Wood, John A. *Railroads through the Coeur d'Alenes*. Caldwell, Idaho: Caxton Printers, 1983.

Zeigler, W. L. *Milling Methods and Costs at the Lead Concentrator of the Hecla Mining Co., Gem, Idaho*. U.S. Bureau of Mines, Information Circular 6600, 1932. [detailed discussion of the gravity and flotation methods used at this mill]

Valley

Bailey, Robert Gresham. *River of No Return (the Great Salmon River of Idaho)*. Lewiston, Idaho: Bailey-Blake Printing Co., 1983.

Bradley, J. D. *Mining and Milling Methods and Costs at the Yellow Pine Mine, Stibnite, Idaho*. U.S. Bureau of Mines, Information Circular 7194, 1942. [good description of mining and milling practices, with some history]

Cole, John W., and H.D. Bailey. *Exploration, Development, Mining, and Milling of a Unique Tungsten Ore Body at the Yellow Pine Mine, Stibnite, Idaho*. U.S. Bureau of Mines, Information Circular 7443, 1948. [describes the mining and milling operation, 1930s-1940s]

Cook, Earl Ferguson. *Tungsten Deposits of South-Central Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 108, 1956.

Currier, L. W. *A Preliminary Report on the Geology and Ore Deposits of the Eastern Part of the Yellow Pine District, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 43, 1935. [includes histories of selected mines]

The Homestake Mining Company of Thunder Mountain. New York: Alden A. Butterfield, 1902. [promotional booklet, with information on various mine properties]

Kirkpatrick, G. E. "Geology and Ore Deposits of the Big Creek Area, Idaho and Valley Counties, Idaho." M.S. thesis, University of Idaho, 1974.

Lamb, Viola. "A Woman in the Gold Fields of Idaho: Viola Lamb and the Thunder Mountain Gold Rush of 1902." *Idaho Yesterdays* 39 (summer 1995): 11-17. [1902 reminiscence of a trip to Thunder Mountain in 1902]

Larsen, Esper S., and D.C. Livingston. *Geology of the Yellow Pine Cinnabar-Mining District, Idaho*. U.S. Geological Survey, Bulletin 715-E. [discussion of several mines]

Mitchell, Victoria E. "History of the Stibnite Mining Area, Valley County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-3, 2000.

Montgomery, James M., Consulting Engineers, Inc. *Cultural Resources Inventory/Assessment Package Environmental Impact Statement, Stibnite Mining Project Gold Mine and Mill*. 1981. [history of Stibnite, and report on survey]

Progressive Idaho: The Story of a New State. New York, 1903. [includes an article with photographs about Thunder Mountain]

Reed, John C. *Geology and Ore Deposits of the Warren Mining District, Idaho County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 45, 1938. [includes some history and production]

Rossillon, Mary P. *An Overview of History in the Drainage Basin of the Middle Fork of the Salmon River*. University of Idaho Anthropological Research Manuscript Series 60, 1980.

Shenon, Philip J., and C. P. Ross. *Geology and Ore Deposits Near Edwardsburg and Thunder Mountain, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 44, 1936. [includes information on selected mines]

Smith, Elizabeth M. *History of the Boise National Forest, 1905-1976*. Boise, Idaho: Idaho State Historical Society, 1983. [contains summaries of various mining districts on the forest, including a detailed discussion of the history of Stibnite]

Storch, R. H. *Ilmenite and Other Black-Sand Minerals in the Gold Fork Placer Deposit, Valley County, Idaho*. U.S. Bureau of Mines, Report of Investigations 5395, 1958. [concludes the deposit is not economical to develop]

Swanson, Kenneth J. *Thunder Mountain Mining Project Cultural Resource Investigation*. Prepared for James M. Montgomery, Consulting Engineers, 1984. [fairly detailed history of Thunder Mountain mining district, and inventories of several mining properties]

U.S. Bureau of Mines. *Bonanza (Hermes) Mercury Mines, Valley County, Idaho*. U.S. Bureau of Mines, War Minerals Report 106, 1943. [detailed description of the workings and discussion of potential for open-cut mining]

Umpleby, J. B., and D. C. Livingston. *A Reconnaissance in South Central Idaho Embracing the Thunder Mountain, Big Creek, Stanley Basin, Sheep Mountain, and Seafoam Districts*. Idaho Bureau of Mines and Geology, Bulletin 3, 1920. [discussion of many mines and prospects in these mining districts]

Waite, Bob. *To Idaho's Klondike: The Thunder Mountain Gold Rush, 1901-1909*. Payette National Forest, 1994. [includes a history of the rush to Thunder Mountain]

Wildesen, Leslie E. *The Farthest Frontier of All: A Cultural Resource Overview of the River of No Return Wilderness, Idaho*. Ogden, Utah: USDA Forest Service Cultural Resource Report 8, 1982. [general information on mining and transportation in central Idaho]

Washington

Anderson, Alfred L. *Geology of the Idaho Almaden Quicksilver Mine Near Weiser, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 55, 1941. [includes information on the mine's history]

Anderson, Alfred L, and Warren R. Wagner. *Reconnaissance Geology and Ore Deposits of the Mineral District, Washington County, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 95, 1952. [includes some history and production]

Derig, Betty Belle. *Weiser, the Way It Was*. Weiser, Idaho: Rambler Press, 1987. [includes a chapter on the mining districts "tributary" to Weiser]

Fronk, Ruth E. "Men, Money, and Mineral." *Idaho Yesterdays* 1967 11 (summer 1967): 8-15. [Mineral City]

Lickes, Margaret R. *Mining, Processing, and Costs: Idaho Almaden Mercury Mine, Washington County, Idaho*. U.S. Bureau of Mines, Information Circular 7800, 1957. [detailed description of the operations]

Livingston, D. C. *A Geologic Reconnaissance of the Mineral and Cuddy Mountain Mining District, Washington and Adams Counties, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 13, 1925. [includes some information on ore deposits and development]

Mitchell, Victoria E. "History of the Idaho Almaden Mine, Washington County, Idaho." Moscow, Idaho: Idaho Geological Survey, Staff Report 00-9, 2000.

_____. "History of Selected Mines in the Mineral District, Washington County, Idaho." Idaho Geological Survey, Staff Report 00-14, 1994. [detailed history of some of the mines in this district, also known as the Washington mining district]

Snake and Salmon Rivers

Bailey, Robert Gresham. *River of No Return (the Great Salmon River of Idaho)*. Lewiston, Idaho: Bailey-Blake Printing Co., 1983.

Bruder, J. Simon, et al., eds. *American Falls: Cultural and Paleontological Resources Inventory on the Snake River Plain*. Submitted to Bureau of Reclamation by Dames & Moore, 1999. [describes historic recovery processes for Snake River fine gold in some detail]

Bureau of Land Management. *Our Cultural Heritage: A Fragile Record of the Last 10,000 Years Along the Lower Salmon River*. 1987. [brochure for the public that includes an overview of mining along the Lower Salmon]

Carrey, John, and Cort Conley. *River of No Return*. Cambridge, Idaho: Backeddy Books, 1978. [history of Salmon River, with some information on mining activities along the river, by a lifelong resident and a river guide]

Egleston, T. "The Treatment of Fine Gold in the Sands of Snake River, Idaho." New York: American Institute of Mining Engineers, 1890.

Hill, James M. *Notes on the Fine Gold of Snake River, Idaho*. U.S. Geological Survey, Bulletin 620 (1916): 271-94. [discussion of placer mining along the river]

James, Ronald L. *Ruins of a World: Chinese Gold Mining at the Mon-Tung Site in the Snake River Canyon*. U.S. Bureau of Land Management, Idaho Cultural Resource Series 4, 1995. [detailed description of excavation of a dwelling occupied by a Chinese miner in late 1870s-early 1880s along Snake River]

_____. "Why No Chinamen are Found in Twin Falls." *Idaho Yesterdays* 36 (1993 no. 4): 14-24. [overview of Chinese miners in the Snake River Canyon, with discussion of why they began to leave the area in the 1880s]

Lorain, S. H. *Gold Mining and Milling in Idaho County*. U.S. Bureau of Mines, Information Circular 7039, 1938. [detailed account of mining activity in the Elk City, Red River, Newsome, Orogrande, South Fork of Clearwater, Florence, Dixie, Burgdorf, Warren, and Salmon River mining districts]

Minidoka County Historical Society. *A History of Minidoka County and Its People, 1985*. Minidoka County Historical Society, 1985. [includes one page on dredging for gold on the Snake River]

Murphey, Kelly A., M. J. Freeman, and Peter Bowler. *Valley of the Mighty Snake: An Overview of the Cultural and Natural History of Hagerman Valley, Southwestern Idaho*. Hagerman, Idaho: Hagerman Valley Historical Society, n.d. [contains a few pages on placer mining along the Snake River]

Powell, F. "Gold Dredging on Snake River, Idaho." *Engineering and Mining Journal* 70 (Oct. 6, 1900): 395-96. [describes the burlap method of saving the fine gold of the Snake River, and the evolution of dredges used on the river]

Sisson, David A. *Lower Salmon River Cultural Resource Management Plan*. Prepared for Bureau of Land Management, Coeur d'Alene District, 1983. [overview of the history of the area, including mining, plus recommendations for management of the cultural resources]

Staley, W. W. *Fine Gold of Snake River and Lower Salmon River, Idaho*. Idaho Bureau of Mines and Geology, Pamphlet 72, 1945. [includes information on the history of mining along the rivers]

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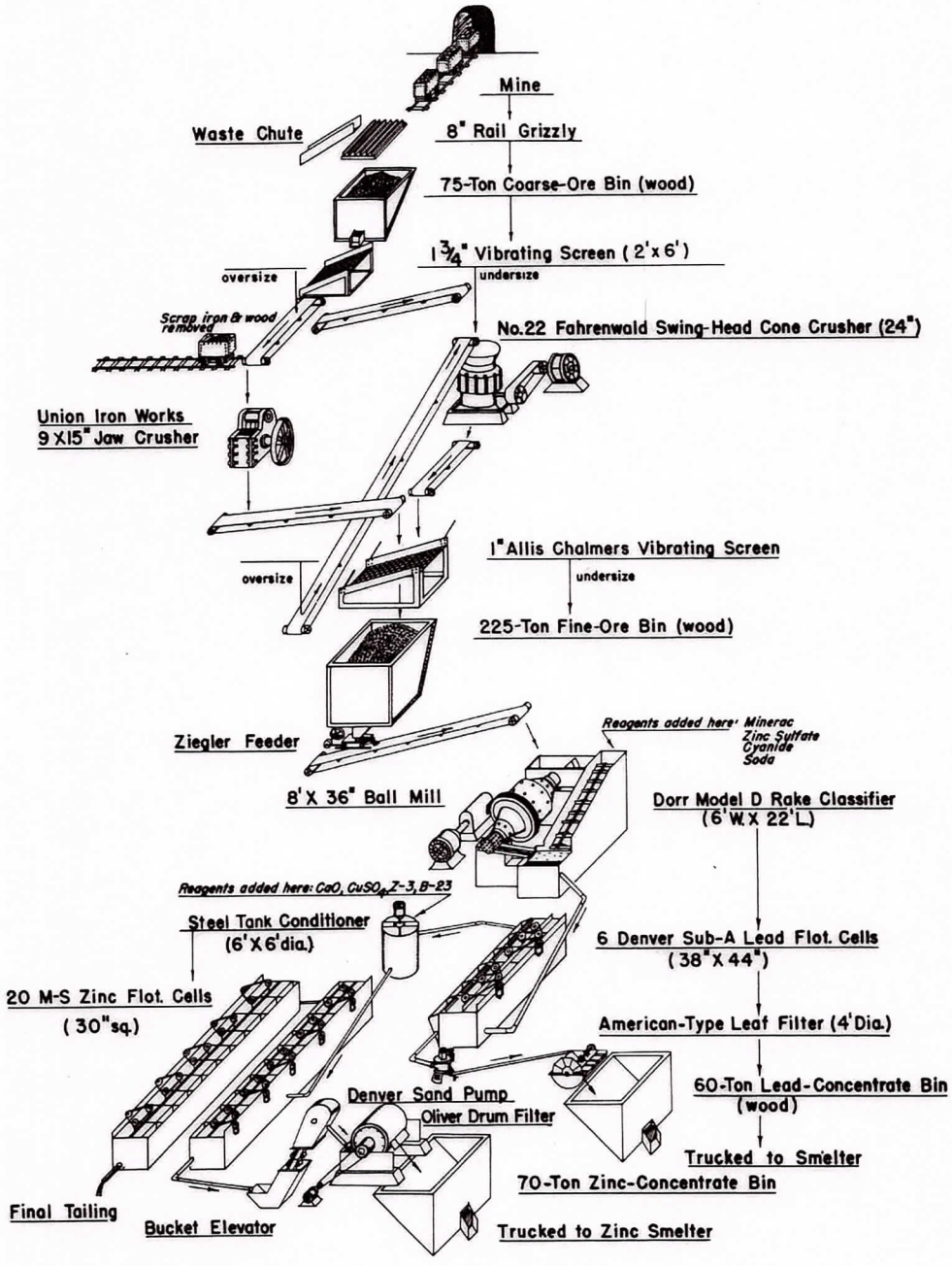
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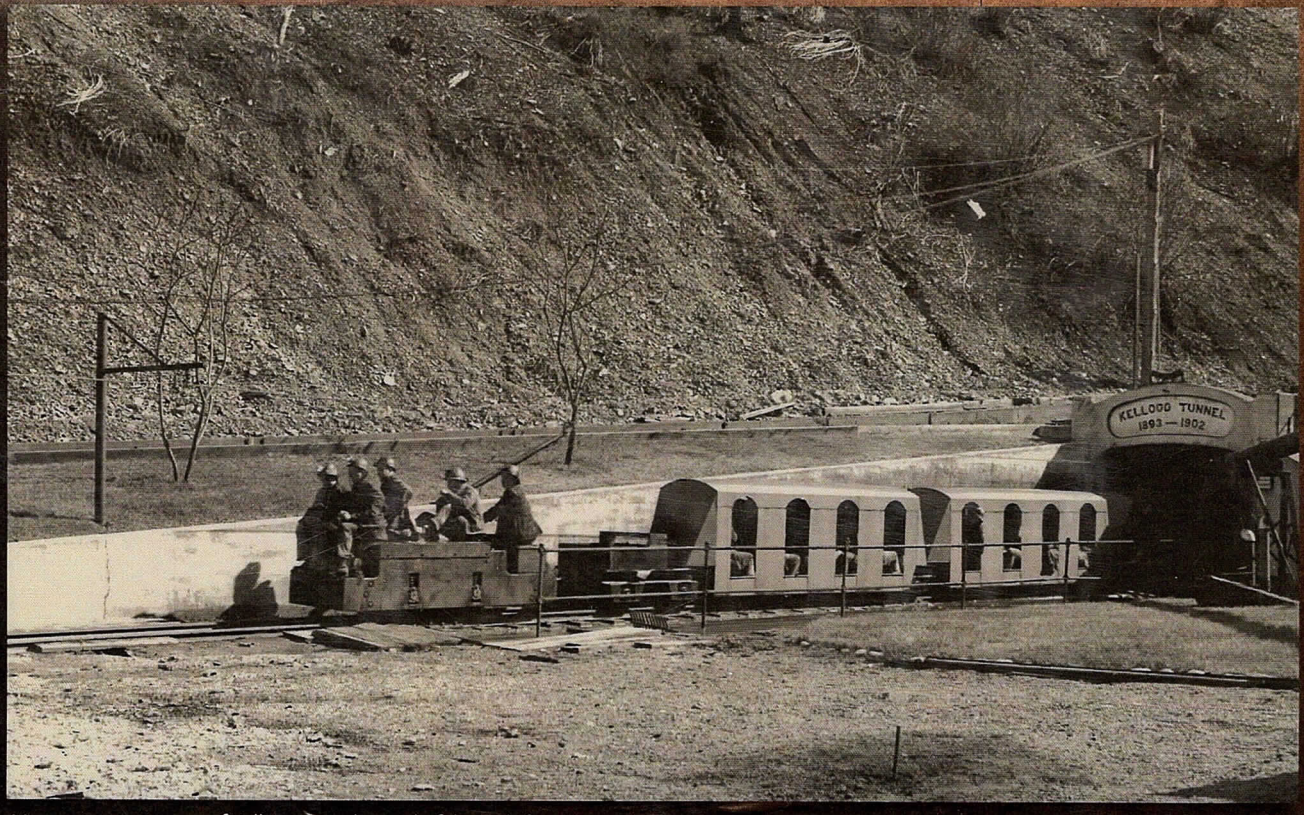
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Flow sheet of Little Pittsburg Mill, ca. 1948. (Hundhausen, Little Pittsburg).



Shaft, hoist, and ore car rail at Pearl mine, ca. 1899. ISHS 540-D



Man train coming out of Kellogg tunnel at end of day's shift.