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# Introduction



Gold is where you find it, is an old mining saying. Whenever it is found, it appears in its natural form in two different ways, depending on the geologic environment. One form is in hard-rock lode deposits, deposits that may have had different origins but which remain locked within the original solid rock formations. Even if a lucky prospector located a so-called quartz mine, it was clear that development was for corporate, not individual, effort and might take years before it returned a profit. The work called for more and more capital for tunneling, timbering blasting ore, transporting it underground, and hoisting it to the surface. Moreover, gold in hard-rock ores was often difficult to remove—"refractory" in the language of the engineers. In the worst cases, it might be in combination with other elements, which meant more intricate and costly processes would be needed. These kinds of deposits have produced the bulk of the world's gold to date.

The second type is the secondary deposit, which occurs in several forms. Residual deposits are usually found where rocks have weathered and deteriorated, but without water. They have not yet been washed away, nor have

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they moved. Generally, the residual lies near the site of the lode. Another type, bench deposits, is created when gold reaches a waterway, which subsequently dries up or changes course, leaving an old streambed on higher ground that drains into valleys. Stream or alluvial deposits are much more common and often contain more precious metal. As such, they constitute collections of loose particles of gold that are freed from their enclosing lode deposits by erosion, disintegration, or decomposition and then slowly washed down slopes into streams that quickly winnow out the lighter material. Thus, heavy minerals, including gold, platinum, tin, and some gemstone, are concentrated near or even within bedrock in such a way as to constitute workable deposits.[1]

From ancient times, such placer deposits were easier to find and work than lode mines, and more than one technique would carry over into early gold mining in the American West. The panning of gold was the simplest way for the prospector to test for placer gold. The early Romans had used a pan of some sort for that purpose, and widespread usage continued through the ages. By the time Californians brought it to Idaho, the pan had become standardized in sheet iron, eighteen inches in diameter and four inches deep, with sides slanting outward at an angle of thirty-seven degrees.[2] The miner threw a few handfuls of gold-bearing soil or gravel into the pan, poured two or so inches of water over it, then swirled the contents in a sideways rotary motion, thus washing the lighter material over the side and leaving the heavier gold behind. It took ten to twelve minutes to wash a pan, and a man could do fifty of them in a good day, but it was strenuous work, and unless the ground was exceptionally rich, it was hardly profitable.[3] Fortunately for the early comers, gold was plentiful and easily panned in the early days of all of Idaho's high-country placers—Pierce, Florence, Elk City, Warren, Salmon City, Stanley Basin, Boise Basin, and on the South and Middle Forks of the Boise River.

The rocker or cradle was a considerable improvement over the pan. This was a rectangular box, set at a downward angle and mounted on a rocking mechanism like that of a rocking chair. At the top was a removable hopper with a mesh screen or perforated iron plate; at the bottom was a series of cleats or "riffles." The gravel was dumped into the top, followed by a bucket of water, after which the cradle was rocked by hand to agitate the mixture. Any rocks were caught by the screen or perforated plate; the smaller wasted exited at the lower end with the water, and the heavy gold fell into the bottom of the box and was caught in the riffles. The machine was easily transported and did not require a constant flow of water. One man could operate it, but a team of three or four made it much more efficient: one or two to dig, one to dump the paydirt and water into the hopper, and another to work the rocker handle with vigor.[4]

The machine was an advancement over the sluice, which in its most primitive form was simply a long ditch with its bottom cleated with rocks, gravel, and holes to act as riffle bars; more often it took the shape of a long tom. Built of wood, the latter was ten feet to twenty feet long, a foot-and-a-half deep, and tapered at one end so that a number of them might be fitted together to form a sluice sometimes several hundred feet long. The lower end of the long tom, called the riddle, replaced the hopper of the cradle, and a heavily perforated iron strained out the large debris while allowing water and small gravel to fall into a riffle box where the gold was captured. Widely used throughout the West, such equipment needed an available running stream of water, which was usually supplied by running a flume from a nearby river or creek.[5]



Another approach, hydraulic mining, added a more sophisticated modern twist to a Roman technique described by Pliny the Elder in the first century. The episode pictured by Pliny involved a violent stream of water used to undermine a hill in a gold mining operation: "Then all at once . . . the mountain cleaveth in sunder and making a long chink, falleth down with such a noise and crack that is beyond the conceit of man's understanding."[6] As devised by Connecticut Yankee Edward Matteson in California in 1853, hydraulicking has been likened to directing a fire hose against a sand pile. By dropping a stream from a small reservoir above the mining site through a crude rawhide or canvas hose, miners could shoot a powerful head of water under strong pressure from a pivoting nozzle (a monitor) and literally wash away the sides of a gravel bank, then run the gravel through a long sluice for recovery of its gold. Within a few years, improvements in hoses and monitors allowed even more pressure—so strong that more than one worker died when struck by their stream. In 1870 the monitor manufactured by the Hoskins factory and called the "Little Giant" lent its name to any monitor, which became a "giant." The historian of California's great hydraulicking controversy referred to Hoskins's "Little Giant" as "essentially a piece of artillery and reminiscent of the Civil War."[7] Available water and hilly terrain were prerequisites. If the initial cost of equipment was high, operating costs were low. On the basis of outlay per square yard, hydraulic mining was cheaper than any other method.

A big disadvantage was that the technology left in its wake destruction far greater than that previously experienced by placer miners in the western United States. In California, because of the impact of river-borne debris, which was engulfing farmlands downstream, legal restrictions on hydraulicking in 1884 all but eliminated it as a serious mode of gold mining in that state.[8] Not so in Idaho: by the 1863 season in the Boise Basin, one group of miners had already installed a hydraulic giant on Elk Creek.[9] In early Idaho, all of these traditional placer methods and devices were used—the pan, the rocker, the long tom, sluicing, and hydraulic mining—often, when available, using mercury for amalgamation of the gold.



White miners were not alone in Idaho. The Chinese were very much in evidence. With hard times in their native land, countless numbers had been migrating to mining regions elsewhere in the world. In the West, they had appeared during the California Gold Rush and been brought in during the 1860s to help build the Central Pacific rail line. When the rich Idaho placer deposits were discovered, thousands of Chinese eventually came north to the new diggings, although white miners made it clear that the interlopers were not welcome. In a few years, once the easy ground was no longer producing much, the whites were happy to sell it to the newcomers. According to the 1870 US Census, there were 3,853 Chinese miners in the state and only 2,719 white miners.[10]

The Chinese were frugal, productive, and resourceful men who squeezed the most from their worked-out claims. Moreover, they brought old technology to the scene and adapted it to new uses. An example was the so-called chain-pallet pump, a device previously used to drain and irrigate Asian rice fields. Now it proved invaluable as a means of de-watering flooded ground or diverting water to a sluice on a higher level. Soon, the Chinese pump and new types of water wheels caught on among white miners as well.[11]

In many Idaho placer areas, the days of easy mining were short. Reachable deposits were soon exhausted; bedrock was deeper underground and beyond the current digging range. One alternative was to contrive a new technology to handle the deeper gravels efficiently in large quantities, applying economies of scale. Such equipment was usually lumped under the name *dredge*, a generic term that might mean any one of a number of mechanical systems that involved digging auriferous gravel, separating the gold from it, and discarding the waste. It is with these "dredges" and their application in the state of Idaho that this study is concerned.

Among the many innovations in mineral technology in the late nineteenth and early twentieth centuries, several would truly revolutionize the industry. Cyanidation and flotation would contribute quiet but deep changes in milling. The low-grade copper technique initiated by Daniel Jackling and others would bring bulk handling to previously useless ores, at a time when the new automotive and electrical industries were increasing their demand for that metal. Gold dredging would apply Henry Ford's mass production to placer deposits, again enabling the lucrative working of ground that was earlier untouchable.

In terms of numbers and the production of precious metal, the so-called bucket-line dredge was most important in the American West, including Idaho. It was depicted by an early contemporary as consisting of "a floating hull with a superstructure, a digging ladder, endless chain of digging buckets, screening apparatus, gold-saving devices, pumps and stacker. It could be described as a floating mill with the addition of an apparatus for excavating and elevating the ore."[12]

The first successful gold dredge in the United States was built in Montana. Constructed by the Bucyrus Steam Shovel and Dredge Company under the supervision of Samuel S. Harper, it was a bucket-line dredge for the Gold Dredge Company of Chicago. The boat slipped into the waters of Grasshopper Creek at Bannack in May 1895, after the wife of the firm's president, Herman Reiling, broke a bottle of champagne and christened it the *Fielding L. Graves*. This was the first workable machine of its kind in America. Bucyrus also built a second Montana dredge, the *A. F. Graeter*, the following year. Both Harper and Reiling subsequently played roles in Idaho's dredge mining history.[13]

Since the 1850s, Californians had tinkered with the idea of harnessing the long-established harbor dredge for digging gold, but despite a plethora of efforts—some bizarre—forty years later they had still not achieved their goal.[14] They had failed to build on each other's work. It was ingenious New Zealanders who led the dredge parade. At first they used current-wheel bucket-line machines run by paddle wheels driven by a swift current; next, by 1881, steam-powered dredges were doing the work. In 1895, the year of the first workable American dredge, New Zealand had eighty-four dredges in operation.[15] By that time, skilled technicians as well as the latest versions of dredges were being exported to the far corners of the mining world.

One of the technicians, Robert Postlethwaite, manager of the New Zealand Engineering Company, migrated in 1896 to San Francisco, where he became chief dredge designer for Risdon Iron Works. Risdon was one of the most important firms in developing mining machinery in the late nineteenth and early twentieth centuries. Postlethwaite's first Risdon bucket dredge was completed in 1897 and set to work on the Yuba River, but unfortunately it sank in the stream's turbulent water. The following year a second bucket dredge fared much better: built for Thomas Couch, a Montana miner of some means, that machine performed very well on the Feather River. It not only started Yuba Manufacturing Company's Wendell Hammon, Couch's partner, on his way to becoming a major figure in the gold mining industry; it also launched a large-scale dredging boom that totally revolutionized placer mining.[16]



In time, after much experimentation, the New Zealand and Montana approaches would come together to produce a hybrid California type vastly superior to either of the two earlier approaches. The awkward double-lift system of the Bannack boat gave way to Postlethwaite's single-lift arrangement, in which the bucket line carried the gravel to its highest point, eliminating the need for pumping the fine material an additional distance for screening or washing. Close-connected buckets of special steel were substituted for the open-connected type championed by Risdon, so that, linked one to another, they gathered the material loosened and dropped by previous buckets. The four-sided upper tumblers, which served as a huge sprocket to power the bucket line, now became pentagonal, hexagonal, or even round and were eventually cast in one piece, body and shaft together, weighing as much as twenty tons.

The smaller lower tumblers that kept the line in place at the bottom of the digging ladder also evolved, with a new type of steel alloy flanges and bearings for underwater use and high abrasion. First high-carbon and then chrome, vanadium, and especially manganese steel was used to lengthen the life of parts subject to wear. Time brought improved scrubbing and screening devices, huge revolving perforated cylinders called trommels (also called grizzlies), washed by jets of water. The double banks of gold-saving tables over which the fines were sluiced, which had replaced the New Zealand shaking screens, remained the most primitive part of the apparatus.[17]

Because of the need to dig tough terrain that might contain boulders, the California-type dredge had to be heavier and stronger. These machines abandoned the older system of cable headlines to keep their position and relied on steel or wood pointed spuds, massive posts dropped into the soil under the pond to provide a pivot around which the dredge could swing "like a dancer turning on her toe." Using one spud as an axis and manipulating the pressure on shorelines, the dredge chewed up the ground in an arc, seesawing along. To discharge the leavings—the tailings—the belt stacker became standard, replacing the early Montana machines that had used flumes and the Risdons, which had used a bucket conveyor to handle the debris. At first, the wooden hulls of the dredges were beautifully crafted by shipbuilders, then they were built by ordinary carpenters, but as more and more of the machines were exported to the tropics and the frozen North, steel hulls were used.[18] Because of its low cost and the versatility of variable-speed motors, electricity was the preferred source of power for dredges, either from individual generating plants or from local utility companies. Isolation often forced the use of steam or diesel engines, however.

By around 1910, it was clear that placer mining was about to be revolutionized and that the California-type bucket dredge would increasingly play a key role. Wendell Hammon's Yuba Manufacturing Company led the way, but the other major manufacturers fell in line: Bucyrus of south Milwaukee, the Marion (Ohio) Steam Shovel Company, the New York Engineering Company, and Risdon Iron Works, which had been absorbed by Union Iron Works and later by Bethlehem Shipbuilders. It was obvious that the boom in dredge construction was not merely domestic but global in scope. Wherever it was built in America and whether it was used at home or abroad, the California-type dredge came to be accepted as the standard of excellence.

Like others, Idaho dredge operators quickly learned to abandon the rivers themselves and to float their dredges in pits "inland," bringing in water using ditches or pumps to create a pond that moved forward with the dredge. The also quickly discovered the value of using the Keystone drill to dig test holes before sinking substantial capital into machinery or property. Both were admonitions of Robert Postlethwaite.[19] That caution does not mean there could not be failures: in the early years there were many as a result of poor judgment, incompetence, bad machinery, or chicanery. With careful testing, continuous operation, and a little luck, many bucket-dredge owners were able to make a profit from ground that would yield only ten or fifteen cents a cubic yard to individual miners. For repairs, any dredge enterprise of any size kept its own machine shop, with a stock of spare parts. Dredge operators hoped to work twenty-four hours a day but usually averaged about eighteen hours. Their schedule called for digging approximately 360 days of every year. Thus, dredgemasters kept a wary eye on the clock and the calendar and made a meticulous record of downtime, which might result from removal of a rock or a piece of timber or from bad weather tying up work for several days or, at worst, a month or two. In addition, if a dredge sank, not an unusual occurrence, it could be inoperable for weeks or even months.

As indicated earlier, the bucket dredge was not the only machine that bore the name *dredge* in the nomenclature of mining men and mining journals. (There was even a dry-land dredge.) Hydraulic dredges, better known as suction dredges, were used in various places throughout Idaho. Mounted on a flat scow, this equipment utilized a powerful centrifugal pump to suck material from the bottom of a stream, after which the gold was separated either on the scow or on a separate dredge. Modern, more sophisticated hydraulic dredges could also have a digging ladder attached to the suction pipe, with a motor-driven cutter head to chop and loosen the muck.[20] Such dredges had little success in Idaho; only one company that used a basic suction dredge ever paid a dividend in the state.



Any mechanized crane with a two-part bucket was a clamshell dredge; one with four parts was an orange peel dredge. Both were tried in the Idaho placer but to no avail—they lost too much gold. Early steam shovels, also called dredges, were extremely successful in the open-pit iron, copper, and coal mines but much less so in gold mining. When modernized with electricity or diesel fuel, they found a niche in some parts of the state for digging gravel and filling trucks, which they took to a separate washing plant—not always the most economical procedure.

Finally, in the Great Depression of the 1930s, after the federal government had raised the price of gold to thirty-five dollars an ounce, a worthy competitor appeared for the bucket-line machine. It came in the form of the dragline



FIGURE 0.1. Like clamshell and orange peel dredges, this ineffective dipper dredge failed to save gold, although it seems to have caught on with the smart set. Courtesy, Idaho State Historical Society, Boise, ISHS 72-112.b.

dredge, first devised by an imaginative Californian. Draglines were not new. They were well-known for moving dirt on construction sites, and during hard times many of them were standing idle. Earlier, they had been tried in placer mining but had failed. But now, when modernized especially for mining, they soon proved successful.

A dragline dredge consisted of two units—one for digging, the other for washing and processing the gravel. Digging was done by a self-propelled power shovel equipped with a scraper bucket suspended from a structural steel boom fifty or more feet in length. Buckets ranged in capacity from three-quarters of a cubic yard to three yards and were pulled toward the shovel, to be swung in any direction by a separate hoist drum on the machine. The second unit was one of three kinds of washing and gold-saving plants: stationary, movable, or floating. The stationary plant usually required trucking the gravel, an extra expense. The movable plant was on its own caterpillar

Figure 0.2. This dragline dredge was built in 1936 on Red Horse Creek, a tributary of the Red River. Workers are still constructing the washing plant. Courtesy, Idaho Gold Fields Historical Society, Smith Collection, Elk City, ID.



treads but was awkward. The most efficient was the floating plant. In general, all of the plants copied the machinery of the bucket dredge for separating the gold, but on a smaller scale.[21]

The dragline had several advantages. Initial cost was lower than that of the bucket dredge, and it was more maneuverable in working tight pieces of ground. Areas best suited for the dragline were shallow deposits too small for a bucket dredge and too low-grade to be worked by hand. But the dragline could not dig under water, and the bucket-line dredge was superior in saving gold, not to mention its much lower cost of handling a cubic yard of gravel.[22]

Idaho's first dredges, both bucket and hydraulic, came on the Snake River in a frantic boom from the 1880s to about 1910. Dozens of dredges were involved, and millions of dollars were spent in a futile attempt to save the river's fine gold. Successful gold dredging in the state started early in the twentieth century, in the high placers around Pierce, Florence, Elk City, Warren, Salmon City, Boise Basin, Stanley Basin, and Yankee Fork. The richness of these deposits had been skimmed by hand, then by various other processes, including hydraulicking. Most of these deposits experienced dredging efforts in the late 1890s, but not until the California-type machine became a reality did the bucket dredge really find its place in the Idaho mineral industry. When that happened, the state generally ranked fourth in the United States in the production of dredge gold, behind California, Alaska, and Montana.

Gold dredging was a messy business. The dredge, even at its best, was an ugly, graceless, tireless metal monster that clanked noisily and relentlessly along in its own dirty pool, tearing paydirt from bedrock twenty or thirty feet below the surface. At the same time, these seemingly insatiable leviathans left in their wake ruin and destruction, especially along the banks of streams where they left their tailings in huge windrows. John Gunther described a dredge that left behind "the kind of furrow that an enormous obscene un-house-broken worm might leave."[23] The damage to waterways inevitably brought efforts to regulate dredging in the late 1930s, with the farm element initially taking the lead and other groups, such as fish and wildlife interests, conservationists, and the press, gradually following suit. The Idaho Mining Association was a formidable foe, and it took until 1954 for a weak law to be enacted and another fifteen years before a statute that had teeth became law. By that time, gold dredging had virtually ended in the state.

Then came the aftermath: the cleanup. The aim was to return streams as much as possible to their native condition prior to dredging. Often, stream flow had been modified to eliminate meandering, leaving little cover for fish. The process of dredging also eradicated most of the vegetation on the banks, leaving no shade for salmon or other species. All types of dredges left tailings, sometimes in the waters, sometimes on the edges of streams. At first, restoration was haphazard; then, in 1980, a congressional law mandated that the Bonneville Power Administration spend a portion of its profits to mitigate the adverse effects of the Columbia River dam system on fish and wildlife in Idaho, Montana, Oregon, and Washington. This arrangement brought billions of dollars to renovate stream in Idaho alone, much to the benefit of several Native American tribes, although, as of 2014, work is still ongoing.



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