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PLACER GOLD MINING IN WASHINGTON

By
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Placer gold was discovered in Washington in the 1850's, but placer mining did not become particularly active until discoveries were made in the 1860's on Peshastin Creek in Chelan County and on Swauk Creek in Kittitas County. During those early years and into the 1900's prospecting was general, and it is doubtful if many streams were overlooked in the search for worthwhile placer locations. In several parts of the state interesting strikes were made, and many individuals and a few companies received good returns from their time and labor, but compared to other gold-producing states, the deposits were not notably rich.

It is impossible at this time to determine the total amount of placer gold produced in Washington. The major production was during the early days when, by intensive prospecting, the richest ground was sought out and worked. The records for that period, prior to 1900, are fragmentary at best and are not broken down to a county basis, or, for that matter, to placer as distinct from lode operations. Since 1900, however, records are fairly complete. The statistics of the U.S. Geological Survey and U.S. Bureau of Mines show a placer-gold production of $938,525 from 1900 to 1967, inclusive. The lode-gold production, during this same period, was $85,104,357. Again, the relative insignificance of placer mining in late years is indicated by production figures for the 10-year period from 1900 to 1909, inclusive, when $350,541 was produced as compared with figures for the similar period from 1944 to 1954, inclusive, when only $20,314 was produced, or 5 3/4 percent of the earlier amount. From 1960 to 1967, only $70 in placer gold was sold to the United States Mint. However, several thousand dollars in placer gold was mined but sold to individuals who were willing to pay a higher price for the gold than the government price of $35 per ounce. Small amounts of placer gold have been mined yearly since 1967, but the amounts are not known.

Placer mining is still carried on sporadically in a few places, such as on Swauk, Williams, and Boulder Creeks, Kittitas County, where virgin ground, if it can be found, can be worked profitably; and on the bars of the Similkameen and Snake Rivers, where each year a new supply of gold dust is deposited. Continued prospecting along the streams of the northern counties of the state will doubtless discover areas where good returns can be obtained. Some will be places overlooked by earlier prospectors, others will be places now made available to possibly profitable operation by newly built roads and trails. The fact that the early-day miners did not recover all the gold in the streambeds that they worked is substantiated by a recent placer operation at Liberty. Reworking of the gravels of a small part of the streambed resulted in the recovery of over 100 pounds of gold. Although most of the gold occurs as small nuggets, several nuggets up to one inch across have been recovered. Many deposits of placer gold occur along the banks of the Columbia River between Grand Coulee Dam and the Canadian border. However, many of these deposits are now covered by

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TABLE 1.—Placer gold localities

Asotin County
- Snake River bars

Benton County
- Columbia River bars

Chelan County
- Blewett area
- Bridge Creek
- Chiwawa River
- Columbia River bars
- Entiat River
- Lakeside (Lake Chelan)
- Leavenworth
- Negro Creek
- Peshastin Creek
- Railroad Creek
- Wenatchee River

Clallam County
- Cedar Creek
- Ozette Beach
- Sand Point
- Shi Shi Beach
- Yellow Banks

Clark County
- South Fork Lewis River

Douglas County
- Columbia River bars

Ferry County
- Bridge Creek
- Columbia River bars
- Covada district
- Danville area
- Kettle River bars
- Republic
- Sanpoil River

Garfield County
- Snake River

Grant County
- Columbia River bars

Grays Harbor County
- Cow Point
- Damons Point
- Moclips River
- Point Brown

Jefferson County
- Ruby Beach

King County
- Denny Creek
- Money Creek
- Tolt River

Kittitas County
- Cle Elum River
- Columbia River bars
- Liberty
- Manastash Creek
- Naneum Creek
- Swauk Creek
- Teanaway River
- Yakima River

Lincoln County
- Columbia River bars

Okanogan County
- Columbia River bars
- Mary Ann Creek
- Methow River
- Myers Creek
- Nighthawk
- Oroville
- Park City
- Similkameen River
- Squaw Creek
- Twisp
- Wauconda

Pacific County
- Fort Canby

Pend Oreille County
- Pend Oreille River bars
- Russian Creek
- Sullivan Creek

Pierce County
- Silver Creek

Skagit County
- Skagit River

Skamania County
- Camp Creek
- McCoy Creek
- Texas Gulch

Snohomish County
- Darrington area
- Granite Falls
- Sultan River

Stevens County
- Columbia River bars
- Kettle Falls
- Kettle River bars
- Marcus
- Meyers Falls
- Northport district
- Orient

Whatcom County
- Acme vicinity
- Mount Baker
- Ruby Creek
- Silesia Creek
- Slate Creek

Whitman County
- Snake River bars

Yakima County
- American River
- Morse Creek
- Summit district
- Surveyors Creek

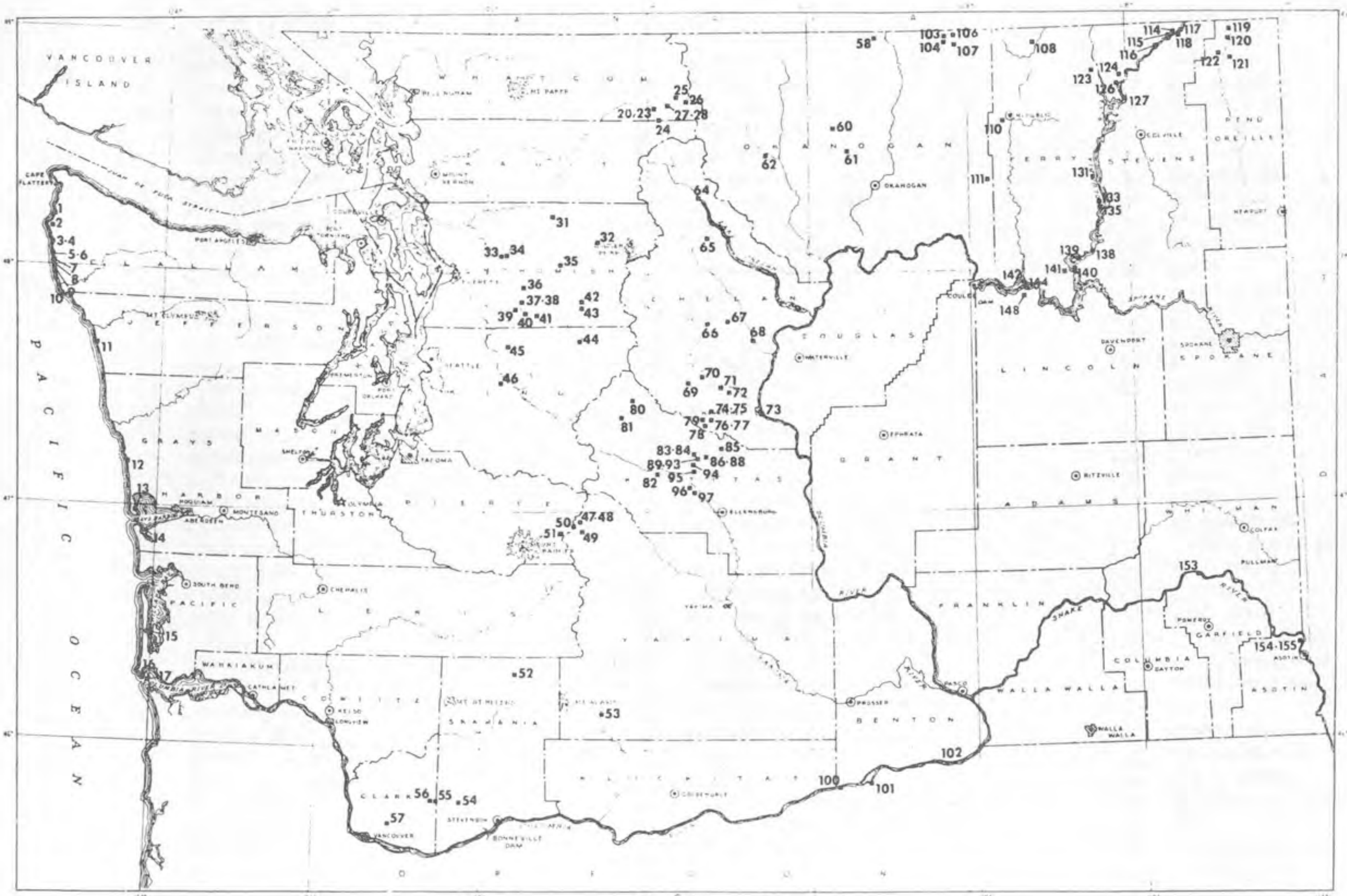


FIGURE 1.—Placer gold occurrences in Washington.

PLACER GOLD PROPERTIES

1. Shi Shi Beach
2. Ozette Beach
3. Little Wink
4. Morgan
5. Morrow
6. Yellow Banks
7. Main and Bartnes
8. Johnson Point
9. Cedar Creek
10. Sunset Creek
11. Ruby Beach
12. Moclips River
13. Oyhut
14. Point Brown
15. Ocean Park
16. Fort Canby
17. Sand Island
20. Combination
21. Lazy Tar Heel
22. Nip and Tuck
23. Alice Mae
24. Woodrich
25. Farrar
26. Slate Creek
27. Johnnie S.
28. Old Discovery
31. Darrington
32. Deer Creek
33. Granite Falls
34. Peterson
35. Alpha and Beta
36. Sultan Canyon
37. Aristo
38. Horseshoe Bend
39. Sultan River
40. Sultan
41. Gold Bar
42. Bench
43. Phoenix
44. Money Creek
45. Tolt River
46. Raging River
47. Elizabeth
48. Gold Links
49. Gold Hill
50. Ogren
51. Silver Creek
52. McCoy Creek
53. Surveyors Creek
54. Texas Gulch
55. Lewis River
56. McMunn
57. Brush Prairie
58. Similkameen
60. Meadows
61. Ballard
62. Methow River
64. Stehekin River
65. Railroad Creek
66. Deep Creek
67. Mad River
68. Entiat River
69. Icicle Creek
70. Leavenworth
71. Wenatchee River
72. Wednesday
73. Wenatchee
74. Ingalls Creek
75. Ruby Creek
76. Bloom
77. Solita
78. Shaser Creek
79. Nigger (Negro) Creek
80. Fortune Creek
81. Big Salmon La Sac
82. Cle Elum
83. Bear Cat
84. Baker Creek
85. Naneum Creek
86. Boulder Creek
87. Nugget
88. Old Bigney
89. Becker
90. Bryant Bar
91. Dennett
92. Swauk Mining & Dredging
93. Williams Creek
94. Gold Bar
95. Swauk Creek
96. Yakima River
97. Perry
100. Artesian Coulee
101. Gone Busted
102. Berrian Island
103. Cuba Line
104. Walker
106. Deadman Creek
107. Mary Ann Creek
108. Goosmus Creek
110. Alva Stout
111. Crounse
114. Reed and Roberts
115. Nigger Creek Bar
116. Northport Bar
117. Nigger Bar
118. Evans
119. Schierding
120. Harvey Bar
121. Sullivan Creek
122. Schultz
123. Kettle River
124. China Bend
126. Bossburg Bar
127. Valbush Bar
131. Daisy
133. Johnson
135. Turtle Rapids
138. Rogers Bar
139. Wilmont Bar
141. Ninemile
142. Covington Bar
144. Hellgate Bar
148. Keller Ferry
153. Indian Bar
154. Clarkston
155. Snake River

waters of Roosevelt Lake. At times of extreme low water in the lake, some placer gold deposits are exposed but cannot be mined because they fall within the boundaries of Roosevelt Lake National Recreation Area.

The many localities (see fig. 1 and table 1) where placer gold has been reported or mined in the past indicate the parts of the state where prospecting may be advantageous. The occurrence of only trace amounts of placer gold accounts for some of the localities being included; small amounts of gold are reported to have been obtained at some of the other places; and fairly large profitable operations have been carried on at a few of the localities listed. The list, of course, is not complete.

Information on specific placer gold deposits of the state can be found in "Gold in Washington," (Washington Division of Mines and Geology Bulletin 42, by Marshall T. Huntting; out of print but available in some public libraries) and "Inventory of Washington Minerals, Part II, Metallic Minerals," (Washington Division of Mines and Geology Bulletin 37, Part II, by Marshall T. Huntting. Price $4.50). Bulletin 37 may be purchased from the Department of Natural Resources, Olympia, Washington 98504.

PLACER DEPOSITS

A placer deposit is "a mass of gravel, sand, or similar material resulting from the crumbling and erosion of solid rock and containing particles or nuggets of gold, tin, platinum, or other valuable minerals that have been derived from rocks or veins." Gold in placer deposits is recovered by panning the gold-bearing material, or by using a rocker or a sluice box. In large-scale mining operations, washing plants and dredges are used. For the purposes of this report, the recovery of placer gold will be limited to panning, rocking, and sluicing.

Because gold has a high specific gravity and is chemically inert, it becomes concentrated in placer deposits, where it commonly is found associated with magnetite, ilmenite, chromite, monazite, rutile, zircon, garnet, and other heavy minerals. These minerals are the principal constituents of the so-called "black sands." The gold-bearing sands and gravels in placers may be derived from lode gold deposits, but the gold in many placers originated not in lode gold ores but as sparsely disseminated gold in rock too lightly mineralized to be classed as ore. Because of this and the fact that lode deposits from which some placers have been derived have been completely destroyed by erosion, a search for the "mother lode"—the "hard-rock" source of the gold—may be futile in many placer districts. Placer deposits may be of many kinds, as (1) residual deposits from weathering of rocks in place, (2) river gravels in active streams, (3) river gravels in abandoned and often buried channels, (4) eolian deposits, (5) ocean beaches at sea level, and (6) ancient ocean beaches now raised and inland.

Beach placers form through the agency of ocean waves reworking beach sands and gravels and concentrating the heavy minerals. These sands and gravels may represent alluvium brought to the coast by streams, or they may originate from the erosion of the bedrock of the sea cliffs or erosion of unconsolidated glacial or other sediments which overlie the bedrock along the shore. Gold present in minute amounts in the eroded material is released by this process and accumulates with other heavy minerals in the beach sands. Beach placers are frequently found to be enriched when examined directly following storms, when wave action has been especially vigorous.

Stream placers usually are restricted to present-day valleys, but there are numerous examples of bench placers in bars and terraces high above present stream channels and of placers in old valleys not now occupied by streams. Gold in streams usually accumulates at places of slackened stream velocity, as in a broader valley below a narrow gorge, at junctions of tributaries, near the heads of quiet reaches, and on the inside of bends. Furthermore, placer values are almost always concentrated on or near bedrock or on a "false bedrock," which may be a hard clay bed.

Consolidated placers are formed through the same processes that produce ordinary unconsolidated placer gravels and sands, but the consolidated placer deposits originated in pre-Pleistocene time and have subsequently been converted to conglomerates, sandstones, and even quartzites by cementation, compaction, and sometimes recrystallization. The beds comprising these deposits usually are overlain by other sedimentary rocks or by flows of volcanic rocks.

As can be seen in figure 1, placer gold has been found at many localities in Washington. There is no guarantee that gold will be found at any of the localities or deposits. Many deposits have been worked out and other deposits are no longer accessible. This is especially true of the deposits along the Columbia River, most of which are now covered by the waters of several lakes. However, at times of extreme low water, some placer-gold-bearing river bars are exposed and may be panned for gold.

Only the general location of placer gold deposits, is shown in figure 1. For a more precise location, as well as general information on the deposits, the reader should consult the section on placer gold occurrences in Inventory of Washington Minerals, Part II, Metallic Minerals (Huntting, 1956), Gold in Washington (Huntting, 1955), Handbook for Gold Prospectors in Washington (Moen and Huntting, 1975).

WHERE TO PAN

The chances of discovering new placer deposits in Washington are remote, because almost all streams have, in the past, been prospected and mined for placer gold. The best chance that an amateur panner has in finding placer gold is to check areas where placer gold has been found in the past (table 1) If gold does occur in a stream channel, it usually occurs in that part of the streambed where there has been a sudden decrease in stream velocity. A decrease in velocity lowers the carrying power of the stream, and the heaviest particles, including gold, will be dropped first. Concentrations of gold can be expected where the stream widens, along bends in the channel (fig. 2), or in slack-water areas below rapids. Most coarse gold ends up on or near bedrock, which may be true bedrock or false bedrock (fig 4). In placer gold districts, most bedrock was worked during the early-day mining operations; however, much bedrock was carelessly or improperly cleaned and some gold was usually left behind. On true bedrock, crevices and protrusions of bedrock act as natural traps for gold. In recent years, significant amounts of placer gold have been recovered by carefully cleaning up the bedrock in placer gold districts. Another place to look for placer gold is at the base

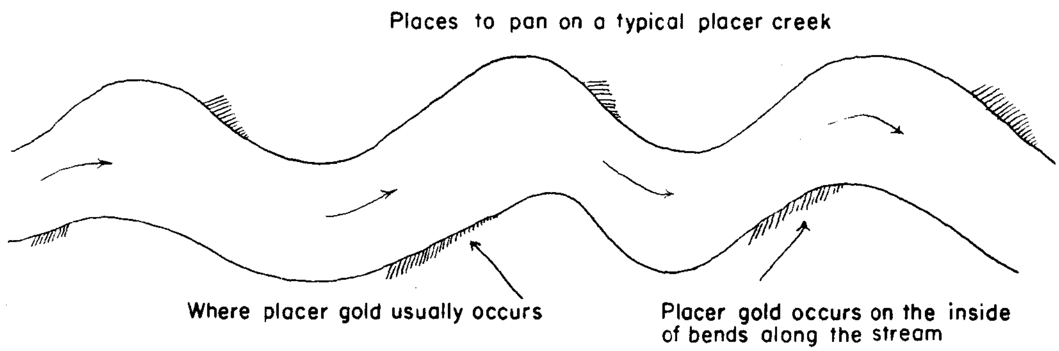


FIGURE 2.—Placer gold deposits along stream channels.

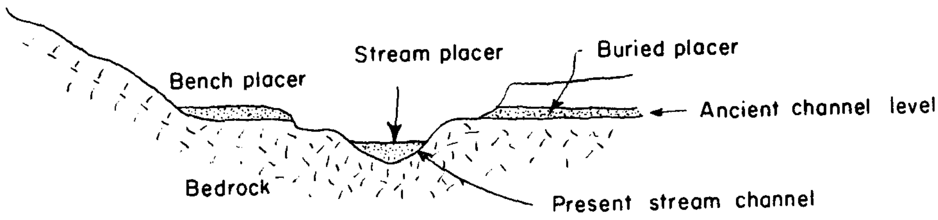


FIGURE 3.—Several types of placer deposits.

of large boulders in the stream channels. Inasmuch as boulders offer an obstruction to the movement of materials in stream channels, gold and other heavy materials tend to lodge around them. Old tailings, which have been left behind by early-day placer miners, offer another possible source for gold. On several occasions, large nuggets have been found in the tailings. These nuggets were too large to pass through screens that were used to remove the coarse gravels during sluicing operations. In addition to gold that occurs along channels of present-day streams, placer gold has been found in bench placer deposits and buried placer deposits (fig. 3). These deposits represent ancient stream channels, which were abandoned when the stream cut its channel to lower levels. Although some bench and buried placer deposits have yielded significant amounts of gold, most deposits of this type are difficult for the amateur to work. Abundant water is usually not available, or underground mining methods are required.

Inasmuch as many weekend gold panners will do their panning on river bars, the following discussion by an unknown author concerning pay streaks on river bars should be of interest:

Pay Streaks on River Bars

Most of you who arrive at the river where you are going to work the bars, have a good imagination. You know how to daydream as you have daydreamed about this trip, and what you were going to find. Now that you have arrived at the place you are going to work, keep that imagination working. Do not look at the bar as just a lot of sand and rocks. You know that those rocks were placed there by the action of the water, and

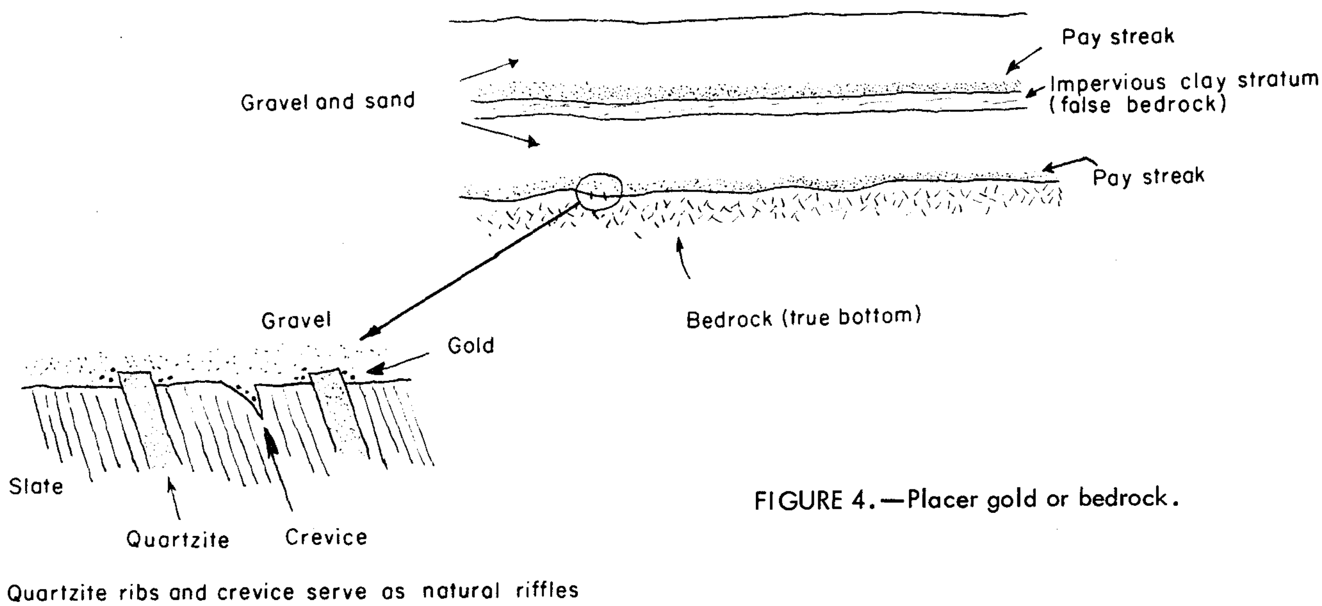


FIGURE 4.—Placer gold or bedrock.

if you are on a gold bearing stream, there was gold running at the same time those rocks were deposited.

Gold travels with the heavy rocks, and is deposited in the same places the heavy rocks are. Now is the time to daydream a little, imagine how the water must have run to place those rocks where they are.

In most all of the bars on the rivers, in the gold bearing districts, there are pay streaks, and if you dig a hole straight down you will find one or more of them; some good, some not so good. They will vary from a foot to 5 or more feet apart. When digging your test hole, pan a sample every foot as you go down. You will find the pay streak starts, just above the larger rocks, which are usually on the same level, and ends just below them, sometimes a foot below, but more often 6 inches.

Nearly always, the bottom of the pay streak can also be found two other ways, one is that the rocks are white and also that there is not so much fine gravel or dirt between the rocks and the digging is much harder for that reason.

You will find as you reach the pay streak that the digging gets harder, but as soon as you come to the bottom of it and below the white rocks, the gravel is not cemented as hard. Now use your imagination again; the white rocks that you find at the bottom of your pay streak were at one time the top of the bar. The sun bleached them white, and the ground around them was hardened by the action of the sun and water.

Along came the next heavy flow of water and flowed over the top of the bar. The gold, concentrates, and large rocks were traveling on the bottom of that flow, and the top of the bar that had been hardened acted as a false bedrock and more or less of the gold and concentrates were deposited as the rocks sticking up acted as natural riffles.

As the flow of water lost its force, it started depositing lighter material and that lighter material is the overburden above the pay streaks. How long the flow of water was strong enough to carry this lighter material and not strong enough to carry the gold and concentrates determines how far above the pay streak the new top of the bar is formed, and also how much overburden there will be on top of the pay streak.

Sometimes the flow of water is so heavy that it takes a large part of the bar along with it and deposits other pay streaks farther down the bar or on a bar farther down the river. That is how those pay streaks are formed, and if you know how they are formed, you should know how to find them.

Always test the ground right at the edge of the water that is running; do this on the inside of the arc that the bends make, half way down the bend and from there on down. That is where the gold that is moving with the natural flow of water will be found concentrated.

Always make two or three tests of a good looking spot, and be sure all the material in that one pan comes from the same spot. One pan of dirt might be from a spot that has a large rock in front of it, which you cannot see; you could get a very good pan right there and the ground for distance around there might not have enough values to make the ground worth working. You must not expect to find the gold evenly deposited, a whirl or an eddy may concentrate most of the gold that came by it, and there will not be any gold for some distance below that place.

If the river has cut into the bar on the inside of the bend and left the edge exposed, you can sometimes see where the pay streak is without doing any digging for it, and again you can sometimes start right at that point to work back into the bar or up along the edge of it.

There are many times that the river will cut out a bar when the first heavy flow comes; then it will make a good deposit where it starts to build in a new bar, as the best deposits are made during the heavier flow of water. Then, due to an obstruction of some kind or due to a lighter flow of water, it will build that bar right back to where it was in the first place. You therefore cannot go by existing conditions wholly; you must use your imagination.

If you find a place on the bar where there is a deposit of washed sand, even though it is nowhere near the river, it is a good place to prospect. There was some kind of an obstruction that caused an eddy to wash that sand into one place and that same obstruction could have caused a deposit of gold somewhere near it.

When you do find a place on the bar that has good values, study the ground conditions good before starting to work. Figure how you can work it the easiest and at the same time keep from covering up any ground with tailings or rocks that could later prove good workable ground. Beginner prospectors will invariably cover up ground that they will later want to work.

Unless you just want to work for fun or exercise, don't do your prospecting close to highways or any place you can drive to; you can almost gamble there has been a lot of prospectors there before you. You will find that the farther you get away from the roads and the harder it is to get to a place the more chances there is that you will find something worthwhile.

If you are prospecting the little bars in the gulleys, don't let the growth that is there at present fool you. Where there is now a bend, the creek may have originally come straight across that bend; some obstruction or a slip may have changed the course, and the good deposit will lie where the growth now is.

"Flood gold" deposits are another source of gold for the amateur gold panner. Flood gold is finely divided gold that travels long distances during flood conditions and ends up on "skim bars" in stream channels. Skim bars (fig. 5) occur where streams sweep

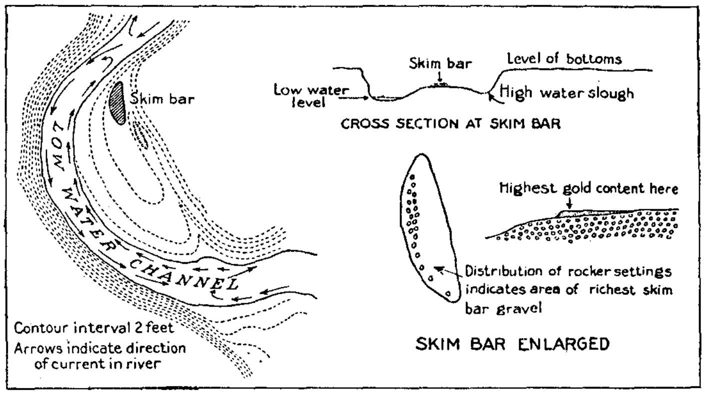


FIGURE 5.—Skim bar and distribution of gold in skim-bar gravels. From Hill, 1916, p. 280.

around curves. During flood stages these bars are under water, and as the flood waters recede, finely divided gold is deposited on the skim bars. This gold is so small that it make take up to 40,000 flakes to make an ounce.

The amateur gold panner is likely to make many mistakes on his first time out. Some common mistakes are as follows:

1. Do not pan on ground that has been staked by others. If the ground belongs to others, ask permission to pan.
2. Avoid streams adjacent to highways and well-traveled roads because these areas have been panned many times in the past.
3. Pan at that time of the year when the water level in the stream is lower and the bedrock channel is exposed.
4. Avoid shallow-gradient streams because the current of these streams is usually too weak to transport gold.
5. Avoid potholes in bedrock because the gold that ends up in these holes has usually been ground to a very fine powder and carried away by the stream.
6. Do not pan in swift water because much of the fine gold in your pan will be washed away.
7. Avoid sand bars because the gold is usually so small that it is difficult to save.

HOW TO PAN GOLD

Gold panning is the least expensive, but the hardest way to wash gold from sand and gravel. The gold pan's principal function is to locate gold-bearing sand and gravel, or to clean up concentrates from placer mining operations. An experienced panner can handle around 100 pans (16-inch-diameter pan) in 10 hours, which is about 6 tenths of a cubic yard. Because of the small amount of material that can be handled in a day, only the richest material is panned.

The technique of panning gold is not difficult, but requires practice. Standard gold pans are 10, 12, and 16 inches in diameter; the 12-inch pan is probably the most widely used. Frying pans and other flat pans have been used as gold pans, but are less effective. In panning sand and gravel for gold, these steps should be followed (Savage, 1934, p. 35-36):

1. Fill the pan nearly full of the gravel or crushed rock from which large stones have been screened.
2. Place the pan under water and be sure that all the material gets wet. This may be done by mixing the contents of the pan with the hands.
3. Quickly rotate the pan from side to side without tipping it, either under water or while it is full of water. This action gives the gold a chance to settle to the bottom and the larger rocks to come to the top.
4. Now, while continuing the motion from side to side, tip the pan to the front. This will cause the lighter material and the larger pieces which have come to the top in procedure 3 to go to the front of the pan.
5. With the thumb of either hand, scrape a portion of the lighter material and the larger pieces over the brim of the pan.

6. Continue the motion as described in procedure 4, allowing water to wash some of the lighter material over the brim. It will be necessary to add water to the pan.
7. Now continue procedures 3, 4, 5, and 6 until the amount of material has been reduced to a quantity that will cover only a small portion of the bottom of the pan. This is the concentrate.
8. To feather the concentrates so as to separate the gold from the lighter material, pour out water until only enough is barely present to cover the concentrates.
9. Start this water swirling around the lower part of the pan so as to wash over the concentrates. The lighter material will be washed farther than the heavier particles, so that the gold will finally be left as a "tail" at the end of the concentrate and may be collected.

The film of grease that is put on new gold pans to prevent rusting must be removed before use. The pan may be cleaned by scrubbing it with fine silt from a streambed, or by using a commercial cleansing powder, such as Ajax or Old Dutch cleanser. The grease on a new gold pan can also be removed by passing the pan over a gas or other suitable flame until the metal turns blue. Bluing a pan makes it easier to see the fine flakes of gold in the pan.

The use of a perforated pan often speeds up the process of panning. In this operation a pan, the same size as the one used for panning, is perforated with $\frac{1}{4}$-inch holes and placed inside of the regular pan. The perforated pan acts as a sieve and allows only the minus $\frac{1}{4}$-inch material to pass into the regular pan. The plus $\frac{1}{4}$-inch material is discarded and the material that passed into the regular pan is panned in the usual way.

The final separation of the gold from the concentrate is done in a number of ways. Tweezers or the point of a knife can be used to pick up the larger pieces, whereas the small flakes or colors can be picked up by pressing down on them with a dry finger tip or with the end of a wooden match. The gold is removed by placing the finger tip over the vial of water and washing it off with a splash of water, or by dipping the end of the match in the water. A small pointed water-color brush can also be used to pick up small flakes of gold. The brush is most efficient when its tip is moistened and pressed against a dry flake of gold.

A small globule of clean mercury will also pick up gold, providing the gold is untarnished and free of oil. After the gold has been picked up by the mercury, the mercury can be dissolved in nitric acid, leaving only the gold. However, it should be pointed out that mercury penetrates the surface of the gold and causes the gold to become brittle and silvery in color. In some cases, heating the gold to a dull-red color will drive off the remaining mercury. When dissolving mercury in acid or exposing it to heat, be certain to work in a well-ventilated area. Mercury fumes are poisonous and should not be breathed.

The lighter particles of a concentrate may be blown away from the gold; however, this technique requires a special skill. After the concentrate is dried, and the magnetite has been removed with a magnet, the remaining material is placed on a stiff piece of paper or a piece of tin. While holding the paper or tin level, blow lightly across the concentrate while tapping the paper or tin. With practice, a clean separation of the gold and the lighter sands can be made.

BLACK SAND

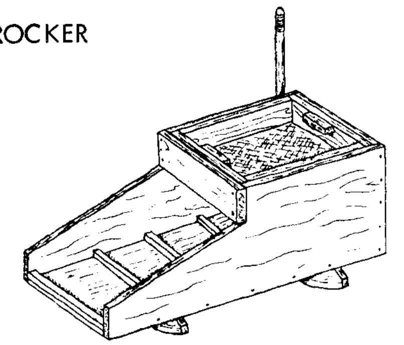
Placer gold may be accompanied by black sand, but not all black sand contains placer gold. Black sand is usually made up of several dark-colored minerals, such as magnetite, chromite, ilmenite, garnet, cassiterite, and other heavy, dark minerals. However, in some deposits the black sand may consist only of grains of magnetite or chromite.

Although black sand may at times hinder the recovery of placer gold by clogging the riffles of the rocker or sluice box, some black sand is desirable because it allows you to determine the efficiency of your placer-mining operation. Generally speaking, if you recovered black sand, you should have also recovered any gold that was present.

When using a rocker or a short sluice box, it is time to clean up when black sand starts going over the second and third riffles. When panning, if you have trouble sloughing the black sand from your gold pan and preventing small flakes of gold from going with it, you are better off to let the fine gold go than to spend the extra time trying to separate it. It takes nearly as much time to carefully pan a single pan, as it does to pan two pans rapidly. You will not lose the coarser gold by working fast, but only the very small flakes that make up a small part of the gold you recover. If you wish, you may save the black sand, and recover the fine gold at a later time.

The rocker is commonly used in small-scale placer work and for testing placer grounds. Using a rocker, a person can handle about twice as much material per day as he could by panning. Rockers are usually hand made and hand operated; however, some

THE ROCKER



rockers are operated by small gas engines. Rockers are usually set up on the banks of streams where gold-bearing material and water is available. One man can operate a rocker but it is more efficient when operated by two men. One man fills the hopper with gravel, and dumps it when the gravel is washed. The other man bails water into the hopper and does the rocking. Water, sand, silt, and gold pass through holes in the hopper and fall upon a canvas apron where most gold is caught. From the apron the screened material passes over riffles where more gold is caught. Material remaining in the tray is examined for nuggets that are too large to pass through the holes in the tray and is then discarded. If the material that is being washed contains much gold or

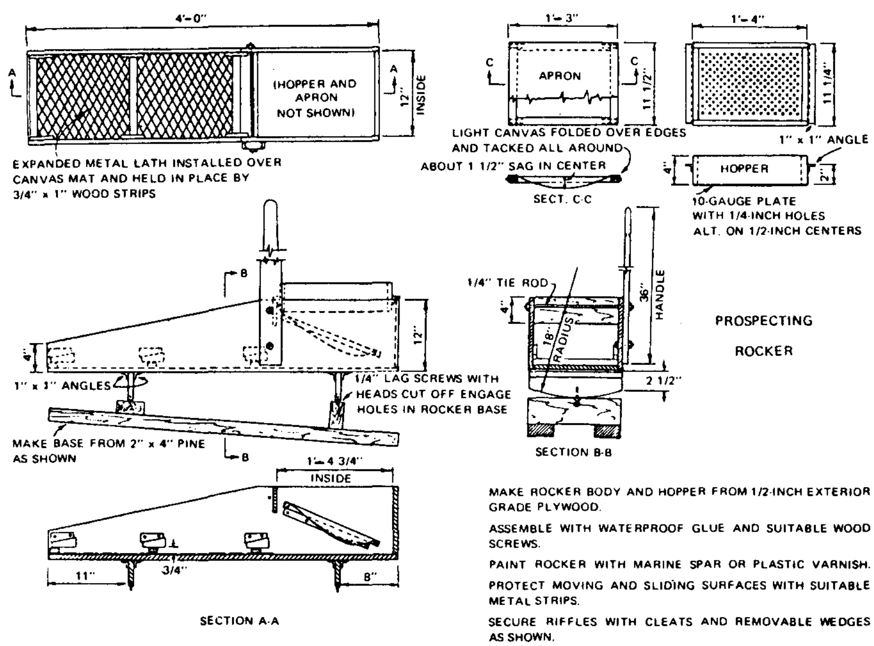
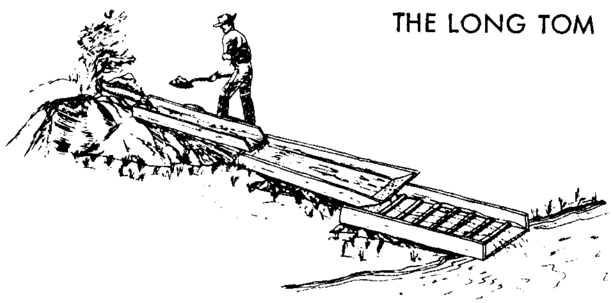


FIGURE 6.—Prospecting rocker suitable for general use. With this rocker, one working under normal conditions can wash the equivalent of eight 80-pound samples per day. This includes the time needed for clean ups, panning, and logging sample data. From Wells, 1969, p. 78.

black sand, the canvas apron and riffles should be cleaned frequently, otherwise gold will escape over the clogged apron or riffles. The concentrate from the apron and riffles is usually washed in a tub of water and later panned. Figure 6 shows plans for a wooden rocker.

THE LONG TOM



The long tom is a trough for washing gold-bearing material. It has a greater capacity than a rocker and does not require rocking; however, it is not as portable as a rocker. A tom consists of three parts: (1) a receiving hopper, (2) an open washing box with a perforated or screened end, and (3) a short sluice box with riffles (fig. 8). The three boxes are set on slopes ranging from 1 to $1\frac{1}{2}$ inches per foot. Material to be washed is fed into the receiving hopper along with a good supply of water. The sand, fine gravel, and gold passes through the screen in the middle box and the coarse gravel is forked out. Gold, black sand, and any other heavy minerals are caught by the riffles in the lowest box. The riffle concentrates are removed when they pack up behind the riffles and allow no place for gold to lodge. When time permits, the concentrates are further concentrated by panning them in a gold pan. The long tom is most efficient when operated by four men. Two men shovel material into the hopper, one man forks out the gravel, while the last man shovels tailings away from the end of the tom. As much as 10 cubic yards of unconsolidated gravel can be washed by four men in 10 hours.

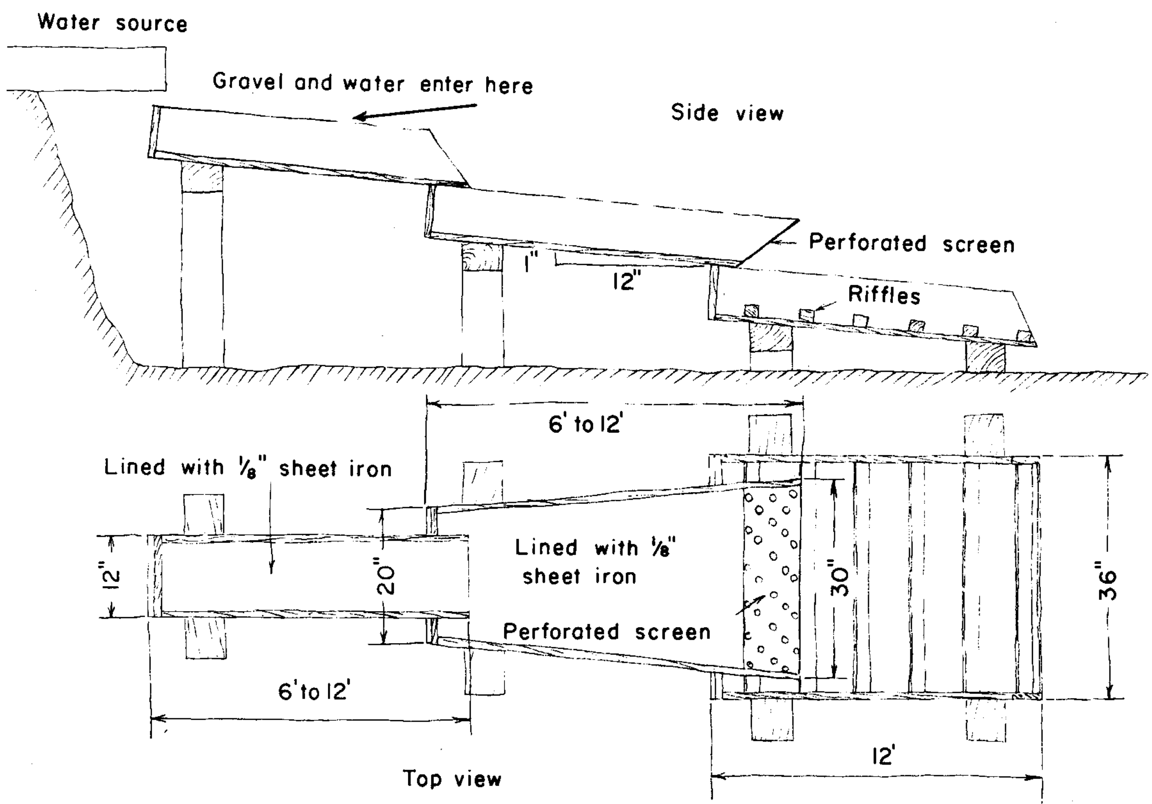
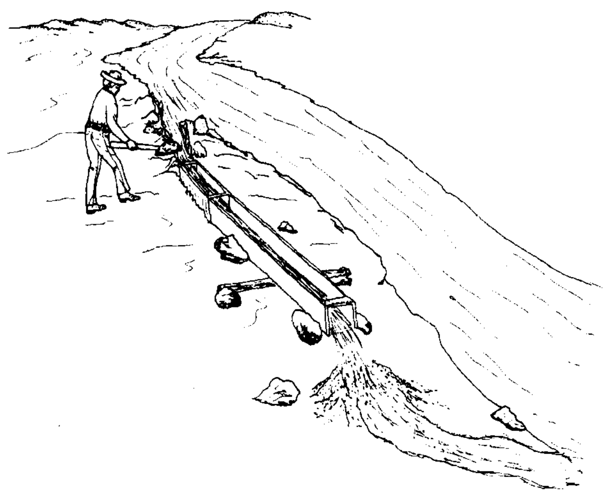


FIGURE 7.—The long tom. From West, 1971, p. 26.

THE SLUICE BOX



A sluice box is an inclined trough containing riffles in the bottom that provide a lodging place for gold and other heavy minerals. The material to be concentrated is carried through the sluice by water; thus it is important that abundant water is available for sluicing operations. Sluice boxes range from 6 inches to 6 feet in width, and from 4 to several hundred feet in length. For ease in handling, long sluices are usually made up in 12-foot sections. A common sluice box is around 12 inches wide, 12 inches high, and 12 feet long (fig. 8). However, for ease in handling, a prospecting sluice box may be 8 inches wide, 6 inches high, and as little as 4 feet long. The riffles in the bottom of the boxes are commonly made of ½- to 2-inch-square wood strips that are placed 1 to several inches apart. Riffles might also consist of poles, expanded metal, mats, and burlap, or anything that will create an eddying action in the water and trap gold while allowing waste material to pass through the boxes. Hungarian and pole riffles are shown in figure 9.

Sluice boxes are set on grades that allow the sand and gravel to move and at the same time permit gold to settle in the boxes. The grade will depend upon the character of the gravel, character of the gold, kind of riffles, and the amount of available water. Common grades for sluice boxes range from ½ to 1 inch per foot. The capacity of a sluice depends upon its size and the amount of water available. Two men shoveling by hand can handle 10 to 15 cubic yards of unconsolidated sand and gravel in a 10-hour shift.

Water for sluicing operations is usually directed to the head sluice box by means of a ditch. In some operations, water is pumped to the box. In general, 7 to 13 times as much water as gravel will be required to move unconsolidated sand and gravel through a sluice box.

Length of sluices depend mainly upon the character of the gold. Coarse gold settles quickly and is easily held in the riffles, while fine and porous gold is carried long distances by the current. Long sluices aid in the breakdown of clayey and cemented gravels and also give the fine gold a chance to settle. Long sluices are also used to carry the waste material away from the working area. In general, sluices should be long enough to break up the sand and gravel and free the gold, which in some cases may require several hundred feet of sluices. Crude operations often use only 3 to 6 boxes (30 to 72 feet); however, no attempt is made to save the very fine gold.

After the sluice boxes are set up at the proper grade and sufficient water is flowing through the sluice, all material that will run through the sluice is shoveled into the head box. Boulders are usually stacked outside the working area. Some operators place a sloped screen or bars (a "grizzly") across the box where the gravel enters, which permits the coarse material to roll off to one side. The openings in the screen or bars is commonly ¼ to 1 inch; ½-inch openings are probably the average size. Feeding the sluice continues until the riffles are filled with concentrate, then the process of "cleaning up" commences. Clear water is usually run through the boxes until the tops of the riffles are clear of gravel. The riffles are lifted from the boxes, beginning with the first box, allowing the concentrate to remain on the bottom of the box. After the riffles have been removed, a light flow of water, just sufficient to move the concentrate, is allowed to flow into the sluice. As the concentrate works downstream, gold and other heavy minerals remain behind. This material is care-

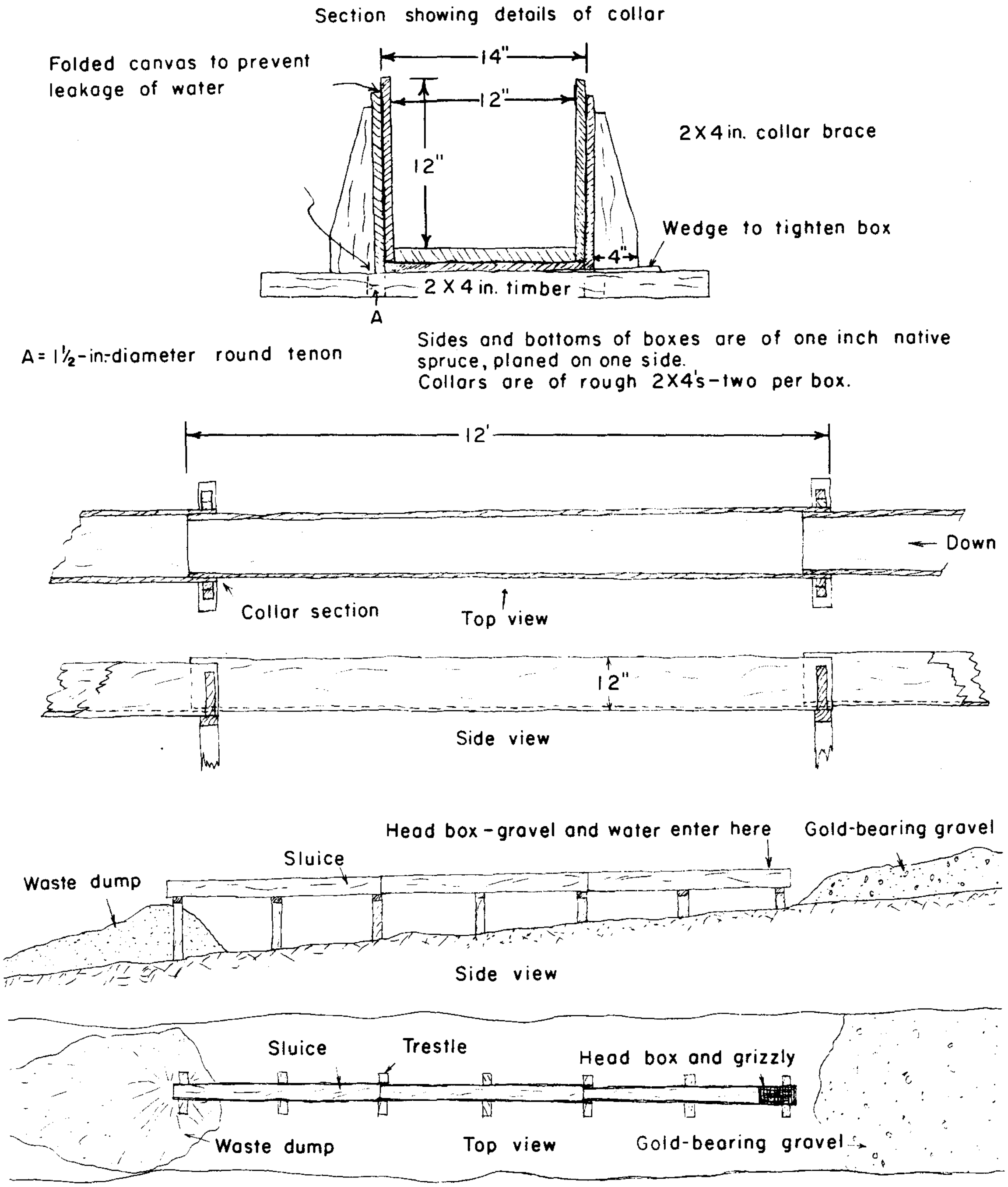


FIGURE 8.—The sluice box. From Masson, 1953.

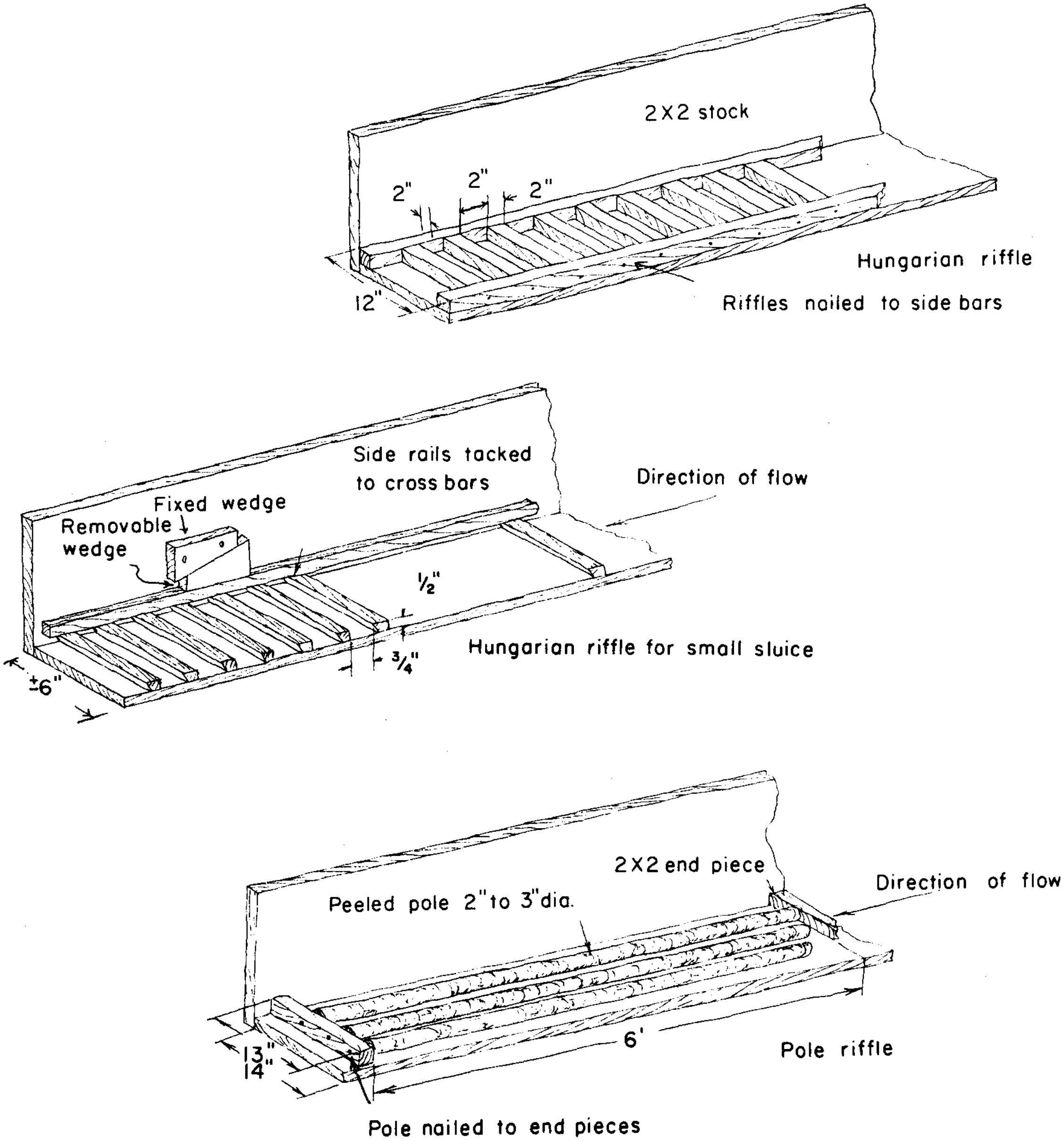


FIGURE 9.—Common riffles for sluice boxes. From Wells, 1969, p. 75.

fully collected, and further concentrated in a pan or rocker. Any fabric or matting that is used on the bottom of the boxes under the riffles is carefully removed and washed in a tub of clear water.

The clean up of sluices varies and depends on the amount of concentrate. The upper boxes may be cleaned up daily or weekly, whereas the lower boxes may require only a monthly clean up. Because of the danger of theft, in rich placer grounds clean ups of the upper boxes should be made daily because most of the coarse gold will be found here.

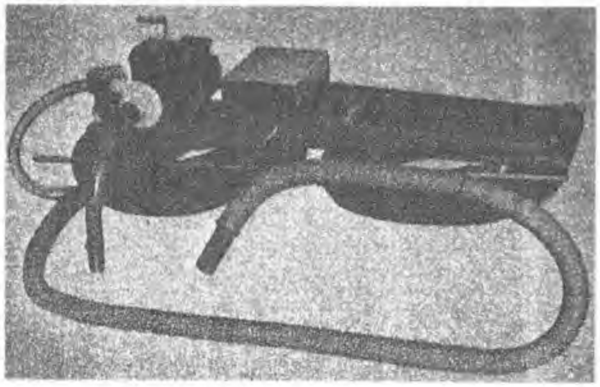


FIGURE 10.—Typical suction dredge. From Keene Engineering, Northridge, California.

PORTABLE SUCTION DREDGES

In recent years portable suction dredges have been widely used in recovering placer gold from the bottom of stream channels. The suction dredge consists of a portable sluice box with an attached suction hose that is capable of sucking up sand and gravel. The basic components of a suction dredge consists of (1) a suction hose, (2) a suction nozzle, (3) a gasoline-driven jet pump, (4) a hopper or baffle, (5) a sluice box, and (6) a flotation assembly (fig. 10).

In the operation of the dredge, water is pumped under pressure by the jetting pump into the suction nozzle where a vacuum is created that sucks up sand and gravel. The sand and gravel enters a hopper or baffle where the larger gravel is screened out while the finer material passes through a sluice box where gold and heavy minerals settle out behind riffles. Matting is usually present beneath the riffles and aids in collecting any fine gold that is present. Most suction dredges are designed to operate for several hours without cleaning.

Small suction dredges having 2-inch-diameter suction hoses, and weighing only around 30 pounds, can handle up to 3 cubic yards of loose-pack sand and gravel per hour. A 150-pound suction dredge with a 5-inch-diameter suction hose can handle as much as 18 cubic yards of material per hour.

Inasmuch as most suction dredge mining operations take place in water, the operators of these dredges usually wear skin diving equipment consisting of a wet suit, weights, face mask, and an air supply. In place of the portable air tanks commonly used in skin diving, air is supplied to the underwater man on a suction dredge crew through an airline that is connected to an air compressor on shore, or one that is part of the portable dredge. Many suction dredges have air compressors that are powered by the same gasoline engine that runs the jetting pump.

Although a portable suction dredge is a very efficient piece of placer gold mining equipment, it is costly when compared to the simple sluice box. However, the suction dredge can work placer ground that cannot be worked by conventional placering methods. Currently (1975), portable suction dredges range in price from a low of \$195 for a $1\frac{1}{2}$-inch-size suction hose to as much as \$2,000 for an 8-inch dredge.

THE SNIFTER

A snifter is a poor man's suction dredge and may consist of nothing more than a turkey baster, a metal tube with a rubber bulb at one end, or an old grease gun with a flexible nozzle. The snout of a snifter is poked into a crevice, and any concentrate that has collected in the crevice is sucked out and later panned for gold. In shallow waters, only a swim suit, diving mask, and a snorkel may be needed to work crevices. However, in deep waters, skin diving suits and portable air tanks are required.

STREAM POLLUTION

Certain federal and state agencies have established rules and regulations for the protection of water purity and fish life in streams. Any mining operation that would seriously disturb a stream would be objectionable and would require permits from the Department of Ecology and the Department of Fisheries. Gold panning and small-scale operations that use rockers or small sluice boxes do not require permits. However, if large-scale sluicing is planned, or if you decide to use a suction dredge and pump up material from the streambed, a permit will be required.

Prior to dredging or doing any other work in state waters, applicants must obtain a hydraulic project approval (RCW 75.20.100) from the Departments of Fisheries and Game. Where fish-bearing streams are involved, the approvals for gold dredging will most always contain provisions for the following:

(1) Timing - usually June 1 to September 15.

(2) Work will be done around large rocks along vertical faces, and cracks in bedrock.

(3) No spawning gravels or any gravel bars will be removed or disrupted in any manner.

(4) Water quality will not be degraded to the detriment of fish life as a result of the project.

It must be emphasized that because of physical and biological variances of streams, provisions of hydraulic project approvals may also vary according to the merit of each stream. The required permits may be obtained from:

Millard Deusen
Washington Department of Fisheries
Stream Improvement and Hydraulics
3939 Cleveland
Olympia, WA 98501 Ph. (206) 753-2984

Washington Department of Ecology
7272 Clearwater Lane
Olympia, WA 98504 Ph. (206) 753-2353

SIZE OF GOLD PARTICLES

The size of individual gold particles ranges widely. Commonly the gold in lode deposits occurs in particles of submicroscopic size. In placer deposits the finest flour gold may be too tiny for individual particles to be seen without the aid of a magnifier, but they may range upward in size to nuggets weighing several pounds each. The largest nugget known is the Welcome Stranger, weighing 190 pounds, found in 1869 near Ballarat in Australia. The largest nuggets yet found in Washington are from the Swauk district in Kittitas County. A 73-troy-ounce nugget was found in 1900 at the Elliott placer on Williams Creek, and a 77-troy-ounce nugget on a bench of Swauk Creek above the mouth of Baker Creek.

Placer gold particles are classified as follows:

Coarse.—more than 0.06 inch in diameter (about the size of a grain of rice).

Medium.—less than 0.06 inch but more than 0.03 inch in diameter (about half the size of a pinhead).

Fine.—less than 0.03 inch but more than 0.015 inch in diameter (about a quarter of the size of a pinhead).

Very fine.—less than 0.015 inch in diameter. Fine gold averages 12,000 colors (particles) per ounce, and very fine averages 40,000 colors per ounce. Gold particles that require 300,000 or more colors per ounce are called flour gold, and about 100 particles of this size are required to have a value of 5 cents. Some flour gold is so small that it takes 1,000 colors to be worth 1 cent, and about 14 million colors are needed to weigh 1 ounce. Tiny as they are, each of these individual particles can be seen when placed on a black surface. At $150 per troy ounce gold price, a particle of gold the size of a common pinhead has a value of about 9 cents; a particle the size of a grain of rice has a value of about 85 cents; and a particle the size of a navy bean has a value of about $15.00. One troy ounce of pure gold has a volume equal to that of a cube a little less than half an inch (0.464 in.) on a side. Table 2 gives the value of several sizes of gold nuggets based on different market prices.

TABLE 2.—Value of gold nuggets at several market prices

Approximate size of nugget	Market price of gold per troy ounce				
	$ 35	$ 70	$ 150	$ 200	$ 250
Pinhead (.0185 gram)	.02	.04	.09	.12	.15
Rice grain (.178 gram)	.20	.40	.85	1.14	1.43
Match head (.267 gram)	.30	.60	1.30	1.70	2.25
Navy bean	3.50	7.00	15.00	20.00	25.00

IDENTIFICATION TESTS

Many times the novice prospector is undecided whether the "yellow stuff" he is looking at is really gold or is something else. The yellow minerals that are most commonly mistaken for gold are pyrite, chalcopyrite, and golden-colored mica flakes. Pyrite, or "fool's gold," is heavy, but not as heavy as gold; it is hard and brittle and crushes to a black powder when hammered, whereas gold is soft (almost as soft as lead) and malleable and can be easily beaten into very thin sheets that are flexible (can be bent a number of times without breaking). Pyrite is soluble in concentrated nitric acid; gold is insoluble. Chalcopyrite, also sometimes mistaken for gold, is similar to pyrite in these properties. Pyrite commonly occurs as cubic crystals, but gold almost always is found in irregular shapes, and in those rare places where it does occur as crystals the crystals are always in intergrown masses.

Tiny golden-colored mica flakes sometimes look deceptively like gold, but the luster of mica is different from that of gold; mica has laminations that can be split with a knife; and mica flakes, like gold, are flexible, but, unlike gold, the flakes are elastic, so that when bent they tend to return to their original shape. Gold is malleable, but mica is not; when mica is hammered it breaks up into numerous tiny flakes. Gold is heavy, but mica is light. Thus, when panned, gold becomes concentrated in the very lowest part of the pan, but mica will be washed out of the pan, although because of its flakiness, it does tend to segregate somewhat from other light minerals. Mica fuses with difficulty; gold, pyrite, and chalcopyrite fuse easily in a blowpipe flame (gold at 1063° C.); and gold when roasted is odorless, but the sulfides, pyrite and chalcopyrite yield sharp-smelling sulfur dioxide fumes.

The gold telluride minerals are comparatively rare and are not easily recognizable. Furthermore, they usually occur as small, sparsely disseminated grains that are difficult to isolate for testing. They vary in color from silver white, yellow, and steel gray to nearly black. Gold in the tellurides may be recognized by its physical properties after the tellurides have been roasted, but it can best be detected by fire assay.

There are no simple, easily performed chemical tests for gold but Savage (1934, p. 97) describes several qualitative tests as well as several wet assay methods. The "purple of Cassius" test, often referred to as the most easily performed test for gold, may be satisfactory as a means of confirming the identification of an unknown metal suspected of being gold, but as a means of detecting gold in an ore it can not ordinarily be relied on.

"Purple of Cassius" Test for Gold

1. Place 1 oz. of finely crushed ore in a glass tumbler or beaker.

2. Add to it 50 cc. aqua regia and stir well.

3. Boil this mixture almost to dryness.

4. Add 20 cc. dilute hydrochloric acid, 30 cc. water; boil and filter.

5. Make filtrate or clear solution basic by adding ammonium hydroxide until it indicates a basic condition on red litmus paper.

6. If a precipitate is present, filter. Treat filtrate or clear unfiltered solution by procedure 7.

7. Add dilute hydrochloric acid, a few drops at a time, until the solution is acidic, then add about 5 cc. stannous chloride solution.

8. If gold is present, a blue or purple precipitate will be thrown down. This is known as the "purple of Cassius." As little as one-quarter ounce per ton in gold can be detected.

Note: If the ore is low grade, it should first be concentrated in a gold pan and then the concentrate should be tested. If the ore is a sulfide, it should be thoroughly roasted before testing.

Spectrographic methods are not very satisfactory for the detection of gold because the gold concentration in many ores is below the limit of spectrographic observation (±0.50 oz/ton).

The standard method for the analysis of gold is the fire assay, and, in view of the modest charge ($10 to $15) made for gold assays, the prospector would be well advised to send his samples to a reputable assayer rather than attempt "home assays." The main steps in a fire assay are: First the specimen is fused in a suitable alkali-flux mixture, containing lead oxide and sodium carbonate and(or) borax. A lead "button" is obtained from this fusion in which is alloyed all the gold and silver that was in the sample. This is then cupeled by heating in a bone-ash container in an oxidizing atmosphere to eliminate the lead by volatilization and by oxidation and absorption into the body of the container. The bead remaining is made up of the precious metals, from which the silver is extracted by "parting" in nitric acid. The residual gold "sponge" may then be melted down and weighed.

The prospector may in some instances wonder whether a given specimen is worth assaying. The identification service offered by the State Division of Geology and Earth Resources may then be of value. The Division examines at no cost to the sender samples of rocks or minerals that occur in Washington and notifies the sender what the material is. Assays or chemical analyses are not made, but mineralogic and petrographic determinations are. If an assay appears warranted, the sender is so advised, so that he may submit a sample of the material to a commercial assayer if he desires.

SELLING GOLD

Gold, like any other metal, may be bought and sold at any price agreed upon between the buyer and the seller, which is based upon the free market value for refined gold. For many years, United States mints were the principal purchasers of gold, but since 1968 the mints have not purchased gold (by amendment to Gold Regulations, March 17, 1968). On December 31, 1974, for the first time in 40 years, U.S. citizens were once again allowed to purchase and sell gold bullion without a Treasury Department license.

Possible outlets for gold include private buyers, refiners, and some banks. Private buyers appear to be the best outlets for gold nuggets as there is no middleman commission nor delays between the sales and the returns. Also, private buyers will generally pay higher premiums over world market prices of gold for large nuggets that are used for specimens and jewelry. Unrefined gold, such as retort sponge or gold bullion from lode gold mining operations, is usually sent to refiners. Refiners pay for the actual gold content of unrefined gold, but charge for assaying, melting, and refining. It is not advisable to ship small lots because minimum handling charges may exceed the value of the gold. It is always advisable to contact the refiner before shipping any gold because to ship gold without confirmation can result in delays. If your gold is high in silver, request payment for the silver, otherwise the refiner may not pay you for it.

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An authorative guidebook on the subject of underwater prospecting.

1/ Publications in print are available from the Department of Natural Resources, Division of Geology and Earth Resources, Olympia, WA 98504. Those publications no longer in print may be seen at our division reference library in Olympia or at many of the public libraries.