The Red Point Drift Gravel Mine.

Abstract from Paper Read Before Technical Society of the Pacific Coast by Chas. F. Hoffman, M. E. Printed by Permission of the Society.

Before the Technical Society of the Pacific Coast, Friday, January 5, 1894., a valuable paper on the " Red Point Drift Gravel Mine," by Charles F. Hoffman, M. E., was read by Ross E. Browne, M. E. The mine was opened and worked under the direction of Mr. Hoffman, and he therefore had exceptional facilities for securing accurate and desirable information as to the cost and method of development. These he presented in very complete form to the society. The Red Point is a fine example of the systematic and economically worked drift mine, and a synopsis of Mr. Hoffman's paper, which follows, will be instructive to all interested in this branch of mining.

The Red Point Is a drift mine in one of the ancient lava-capped channels of the Forest Hill divide, Placer county California. The elevation is about 3875 above sea level. It belongs to the Golden River Mining Company, of Paris. The channel is blue gravel and consists of bowlders principally of metamorphic chists and porphyries, with a small percentage of quartz, Intermixed with small pebbles and sand, and occasionally fine particles of iron pyrites. The gravel is "free," and is washed without crushing. Blasting; however, is required to facilitate extraction. The depth of gravel is from a few inches to 16 feet—generally seven or eight feet at the center of the channel. It is immediately capped with volcanic cement, which forms a good roof to work to. The overlying cement has a depth of 500 to 1000 feet. The washed and rounded bowlders are often two or three feet, and occasionally six or eight feet, in diameter. The gravel often has a glistening appearance and is found to be coated with infinite quartz crystals. Here the gravel is barren. The gold is mostly in the form of " scale gold." In places there are streaks of coarser gold, and occasional nuggets of one or two ounces in weight.

The yield of gold may be divided into the following percentages: Coarse, 15.68; medium, 48; fine, 36; powder, 0.32. The gold varies in fineness from .928 to .937, valued at $18.90 net per ounce. Most of the gold is found near bedrock. In some sections, however, it is mainly in the gravel above. The richest spot in the mine was found in a layer of gravel from 6 to 12 inches above bedrock. At this point the bedrock was hard and smooth and the channel straight. Some of the gravel was scraped up by hand, and contained as much as 33 ounces to the pan. For two months the average yield was $7.50 per carload of 22 cubic feet. There is one rule which applies to this channel and perhaps to others with beds of stratified rocks. The consecutive strata having different degrees of hardness will form riffles, so to speak, along or across the channel according to its course. When the gold-dust strikes these riffles it is washed along them in the direction deflecting least from the course of the stream, and concentrates toward the rim. If it strikes at right angles, it lodges in the center or scatters to right and left. This rule holds good for the main bodies of pay gravel. Of course, if the bedrock is once covered, it no longer governs the travel of the gold in this way, and this rule applies only to the pay streaks on the bedrock. In these main bodies the quantity of gold varies much locally. It is generally more abundant in cracks, formed by the cleavage of the rock, at right angles with the strike, also around quartz veins, which are rough on the surface and hold the gold more readily, or where the slate is soft and thinly foliated.

The lowest rut in the channel contains very little gold—sometimes some coarse gold—but the bulk is thrown on the sides or higher rock. It is also more plentiful on the down-stream side of islands and very large rocks.

The tunnel was driven through slate bedrock in the blue channel, being tapped by means of an upraise 1840 feet in the tunnel. It is 7x8 in the clear, has a grade three inches in 100 feet, and when originally run, had a double track for the first 100 feet, with a drain ditch in the center, and, from there on, a single track, with drain ditch in one side and switches every 500 feet. The switches and double track have since been removed. The rails are 16-pound steel, with gauge of track of 20 inches. The air compressor, located 200 feet vertically above and about 300 feet from the mouth of the tunnel, conveys air through a three-inch pipe. A wagon road, 6500 feet in length, was necessary to be built to the compressor site; also, it was necessary to bring water 2800 feet in a two-inch pipe to supply the works.

Work on the tunnel proper was begun July 2, 1886; six men ran 108 feet by hand; the compressor was started August 5th, and had reached a length of 1552 feet by January 31, 1887. The last 1444 feet were run with an average of 20J men per day. Delays and accidents made the time of work on the 1552 feet exactly 61 months, or an average of 234.1 feet per month, including hand work. For two consecutive weeks the larges runs were 71 and 84 feet, respectively (six days each), or 11.82 and 12 feet per day, respectively. The tunnel runs diagonally across the strike of the rocks, which consist of strata of metamorphic slate, alternating with sheets of diabase diorite and barren white quartz. The regular force consisted of 15 miners (8 hours), 2 engineers, 2 drivers (12 hours), 2 blacksmiths, and 1 timberman (10 hours). The two latter worked only in the daytime. The cost of surface improvements was as follows:

Road	$ 963.00
Yards, dump and trails	508.05
Boarding-house, office and other buildings	2,310. 10
Water works	604,94
Air compressor, tank, pump, drills, etc	7,819.86
Air compressor (labor)	970.00
Eight iron cars	1,200.00
Two tunnel horses, team horses, etc	705.00
Total cost of plant	$15,080.95

ACTUAL COST OF TUNNEL.

	Total Cost.	Per Running Foot
Labor	$11,418 47	$7 36
Powder	2,641 47	1.70
Fuse.	263 07	.27
Wood	1,105 50	.72
Charcoal	320 80	,21
Candles	290 40	.19

Footplank and Ties	147 10	.09
Timbers	46 76	,03
Steel Rails	510 00	.33
Horse Feed	281 25	.18
Materials, steel, oil, etc	693 00	.45
Freights	1,000 00	.64
Totals:	$19,239 85	$12 40

With present reduced prices for powder, etc., such tunnel would now be run for $11.25 or less Per running foot.

From the upraise in the tunnel (at 1840 feet) the channel was worked both up and down stream. A branch tunnel was run up stream for 1300 feet, and two upraises made to the gravel. The second upraise is 3040 feet from the mouth. At this point a slope was raised into the channel with a grade one foot in two and one-half, and work on the extension of lower tunnel abandoned.

The system of workings is by a main gangway in the lowest part of the channel, with diagonal crosscuts every 100 feet. No logging is needed in timbering. Only posts and caps are required. Natural pillars of gravel are occasionally left. About one-third of the grave], being of boulders over five feet, is not removed.

Two Baker blowers (4 and 4 ½) are used for ventilation. One is run by steam, the other (just installed) by water for one-half the year.

Four horses are needed for transportation of the gravel. The cars have 22 cubic feet capacity. The gangway trams are six cars; the tunnel trams are ten cars. There is a self-dumping chair at the dump. The total distance from the breasts to the dump is 6514 feet, or nearly one and one quarter miles, 3273 feet being in the gangway and 3241feet along the tunnel. The number of cars raised is 30.

The average number of men employed daily is 58.5 (22 white, 38.5 Chinese); average cost of labor per man, $2.23; average number of carloads extracted per day's labor, 1.87. This estimate includes all hands, A man breasting gravel will average 2.80 to 3 carloads a day, sometimes more; the maximum by the whole force is 220 carloads.

The pay roll for six months, omitting labor for ventilation and transportation, shows an average of $3169.75 per month. This gives for 3064 carloads a labor expense of $1.03 per carload.

The cost of materials used for one month is, on an average:

1191 pounds powder, No. 2, at 10 cents. . . .	$119 10
4800 feet fuse at $6 per M	28.80
1766 caps at $5 per M	8.83
615 pounds candles at 10 ½ cents	64.57
11 gallons coal oil at 26 cents	2.86
5 gallons engine oil at 65 cents	3.25
1½ gallons cylinder oil at 90 cents	1.35

6 gallons lard oil at 90 cents	5.40
11 gallons car oil at 35 cents	3.85
131 bushels charcoal at 20 cents	26.20
3662 pounds hay at $25 per ton	45.77
1669 pounds barley at $1.80 per cental	30.04
33 cords wood at $2.87	94.71
Timbers, lumber, hardware, air pipe, rails, car wheels and sundries	236.00
Total average one month	$670 73

Total expense per carload is:

Ventilation	$0 11
Transportation	.16
Labor	1.03
Materials	.14 ½
Management	.19 ½
Total per carload .	$1.64

Total production daring five years from January 1, 1888, to December 31, 1892, was 140,345 carloads averaging $308,245.40, or $2.20 per carload. The total production of the mine has been $363,473.60 from 5073 running feet of channel, or $71.65 per running foot.

The following percentages of the total yield are obtained from the different sluices (average of 12 months):

	Percentage.
Upper sluice (without quicksilver) -.	82,48
Lower sluice (with quicksilver)	3.89
Canon sluice (36 feet quicksilver) -	2.80
Canon sluice {182 feet quicksilver)	3.24
Tailings	5.72
Panning tub	1.63
Blowings (back sand) .-	.18
Total	100%

Mining and Scientific Press, V. 68, 1/13/1894, p. 22

The Red Point Drift Gravel Mine.*

By C. F. Hoffmann, Mem. Tecb. Soc'y., In Three Parts.— Part 1

In starting the work of this mine the writer could find no published data upon which to base any estimates, and concluded to keep a full record during the progress of the work for future use.

The Red Point is a drift mine in one of the ancient lava-capped river channels of the Forest Hill Divide, Placer county, California, located at an elevation of 3875 feet above sea level, or 2000 feet above the North Fork of the American river. It belongs to the Golden River Mining Co. of Paris. The channel is known as a " blue channel," from the color of the gravel.

Discovery.—This channel was first discovered in the Mountain Gate mine, at Damascus, about a mile and a quarter distant from Red Point. The Mountain Gate was originally located on a channel of white quartz gravel known as the "white channel," which the owners followed in a southerly direction into the hill for a distance of 6500 feet, where they found it sharply cut off by a flow of lava or volcanic cement. The words " lava" and " volcanic cement" are used as commonly applied by gravel miners. The material in this section is composed of consolidated sediments from a volcanic mud flow, which have been variously described as tufts, tufas, breccias, conglomerates and cements. There is little or no evidence of a molten lava flow in this section except perhaps on the summit, where the lava is crystalline. The bedrock, with the volcanic cement resting upon it, pitched sharply to the south. After drifting to and fro along the contact, hoping to find the continuation of the white channel, the bedrock was followed down on its pitch, and the gold found to continue as far as the exploration extended. A drift was then ran into the volcanic cement, and a winze sunk 90 feet down to bedrock, disclosing what is known as the blue channel. This channel was worked up and down stream for 1400 feet of its length, establishing its approximate course as southwesterly, or nearly at right angles to the white channel. It had not only cut away a large section of the older channel, but had worn down its bed to 90 feet greater depth. Soon after this the extension of the white channel was discovered on the opposite hillside, several miles to the south, where the Hidden Treasure mine was located. From this point of discovery it was followed up stream into the hill to the north for a distance of 10,000 feet. Here again it was cut off by the same lava flow covering the blue channel. It is this blue channel that the Red Point mine Is located upon.

The Gold River Mining Co., having secured the ground to the northeast, had careful surveys made of the Mountain Gate mine and also of the rimrock (contact between the volcanic cement and bedrock) exposed on the surface for a distance of 8 or 9 miles to the northeast, along the Forest Hill Divide. These surveys, including levels, furnished an assurance of the confinement of the channel within the company's ground. There were no points of the rimrock low enough to permit of the escape of the channel; It was virtually hedged in. Upon the basis of these surveys a point was located, and the Red Point tunnel started to tap the blue channel. The data here presented concern this tunnel and the developments made through it. It was driven through slate bedrock in a southerly direction, the blue channel being tapped by means of an upraise 22 feet high, started at a point 1840 feet in the tunnel. The general features of the Forest Hill Divide are described in the State Mineralogist's report of 1890, and the map accompanying that report is partly based on the surveys made for the purpose just described.

Appended to this paper is a reduced copy of a portion of the above map, which will show the location of the Mountain Gate and Hidden Treasure developments in the white and blue channels, and the work of the Golden River Mining Co., from the Red Point tunnel.

The Tunnel.—The tunnel is 7x8 feet in the clear, has a grade of 3 inches in 100 feet, and when originally run had a double track for the first 100 feet, with a drain ditch in the center, and from that point on, a single track with the drain ditch on one side, and switches every 500 feet. The switches and double track have since been removed, as there was no further use for them.

The rails used are 16-pound steel rails, with a gauge of track of 20 inches. The air compressor is located 200 feet vertically above, and about 300 feet distant from the mouth of the tunnel, the air being conveyed through a 3-inch pipe which, in the tunnel, has valves and blowouts every 500 feet for the purpose of ventilation. There were no other pipes in the tunnel, except a i-inch water pipe for drilling use (as at the time of running the tunnel).

After the location of the tunnel it was necessary to build a wagon road 6500 feet in length, leading from the summit to the compressor site, a difference in level of about 700 feet, also to bring water a distance of 2800 feet in a 2-inch pipe, to supply the works. The steepness of the canyon in which the tunnel is located made it necessary to do a great deal of grading, and to build crib work to make room for a framing yard, blacksmith's shop, etc., the cost of which is given further on, under the heading of " Yards, Dumps and Trails."

Work on the tunnel proper commenced on the second day of July, 1886, and 108 feet were run by hand with an average force of 6 men per day. The compressor was started on the fifth day of August, and on the 31st of January, 1887, the tunnel had reached a length of 1552 feet. The last 1444 feet were run with an average force of 20 ½ men per day. During the seven months the compressor was Idle for 15 ½ days, on account of an accident to the air valves and the cracking of a casting, making it, therefore, only 6 ½ months work on the 1552 feet, or an average of 234. 1 feet per month, Including the hand work. The two largest runs made for two consecutive weeks were 71 feet for the week ending August 28th (six days work), and 84 feet for the week ending September 4th, or respectively 11.82 and 12 feet per day. The tunnel runs diagonally across the strike of the rock, which consists of strata of metamorphic slate, alternating with sheets of diabase, diorite and barren white quartz.

The regular force of men employed (when full) consisted of

15 miners working	8 hours per day.
3 engineers working	12 " " "
2 drivers working	12 " " "
2 blacksmiths working	10 " " "
1 timberman working	10 " " "

divided into three shifts and working two air drills on columns. The blacksmiths and timberman only worked in daytime, unless on account of hard rock, it was necessary for the blacksmiths to work extra time.

COST OF SURFACE IMPROVEMENTS, PLANT AND TUNNEL.

Total Cost.

Road.—6,500 feet long; average grade 1 foot in 10 feet; commenced May 26, 1886; completed July 1, 1886.

Average force of men per day, 9.2; cost including surveys and powder $ 963.00

Yards, Dump and Trail.—Commenced June 2r, completed July 3rst. Average force of men, 5.6; cost including crib work, timber and powder 508.05

Boarding house, office, blacksmith shop, stable, powder house, wood shed, framing sheds, snow sheds, etc 2,310. 10

Water Works.—Log Dam, 2-inch pipe, line 2,800 feet long in ditch and covered; commenced May 30th and completed July 30th. Average force of men per day, 2.74.

Cost, including surveys, powder and pipe 604.94

Air Compressor—Erection commenced July 1st; completed with pipe line to tunnel July 30th. Average force of men per day, 5. Cost of labor 970.00

One No. 44 Ingersoll straight-line compressor, 16x16x24; one 54"x 16” steel boiler, complete; air tank, pump, three 3 ½ -inch Eclipse drills and extras, freight and building 30 x 40 feet 7,8`9.86

Eight iron cars 1,200.00

Two tunnel horses, two team horses and buckboard 705.00

Total Cost of Plant: $15,)80.95

ACTUAL COST OF 1552 FEET OF TUNNEL, 7x8 FEET, UP TO FEBRUARY I, 1887, EXCLUSIVE OF MANAGEMENT, INCLUDING
43 TIMBER SETS.

	Total Cost.	Cost per Running Foot.
Total labor (payroll)	$11,418.47	$7.56
Powder.—10,567 pounds Giant No. 2, and 335 pounds No. r, at 26% c, 4rJ4c, 10 per cent off	2,641.64	1.70
Fuse.—39,650 feet at $5.50 per M., and aps $45	263.07	0.17
Wood.—402 cords at $2.75 delivered	1,105.50	0.71
Charcoal— 1,604 bushels at 20c, delivered	320.80	0.21
Candles.—1,760 pounds at 16 ½ c., delivered	290.40	0.19
Foot plank and ties.—7,355 feet of lumber at $30 per M., delivered	147.10	0.09
Timbers.—43 sets at 6c. per running foot, delivered	46.76	0.03
Steel Rails.—16,640 pounds at $60 per ton	510,00	0.33
Air and Water Pipes.—3 and 1 inch at 18c. and 5 ½ c. per foot	521.86	0.35
Horse feed	281.35	0.18
Material.—Steel, oil, tools, etc	693.00	0.45
Freights, at $1.25 per 100 pounds	1,000.00	0.64
Total cost pf plant	$19,239.85	$12.40

With present reduced prices of powder, candles, etc., such a tunnel could now be run for $11.25 or less per running foot.

From the upraise, 1840 feet in the tunnel, the channel was worked for a distance of 500 feet down stream to the west, and for a much greater distance up stream to the east. A branch tunnel was run at the same time under the easterly extension for a distance of 1300 feet, and two upraises made into the channel to be used as gravel chutes. The second of these is 3040 feet from the mouth of the tunnel.

This point reached, it was apparent that the gravel was not rich enough to warrant the extra expense of a bedrock tunnel and upraises. A slope was therefore raised from the end of the branch tunnel into the channel with a grade of 1 foot in 2J to serve as a fjotway for horses. The upstream work in the channel was then continued as before, but without a tunnel underneath.

The Channel.—The gravel occupies a typical river-bed with all its windings, bars, islands, pot holes, branches, etc., which only differs from the present rivers in its volcanic cement capping and somewhat greater grade. Its general course is southwesterly. It has a uniform grade of about 70 feet to the mile. Its bottom width is from 75 to 650 feet; average 200 feet. There have been encountered several islands, reaching heights of 12 or 14 feet above the average bed, and three large pot holes 80 to 120 feet long and 50 feet wide and 9 to 14 feet deep. As a rule, such holes are filled with large boulders and sand, and contain no gold; but in this case two of them contained rich gravel—one in its southerly half, the other in its northerly quarter, and the third was entirely barren. These holes were all found In hard bedrock. The soft rock is generally more uniformly graded, and has a level surface. Large trees, pines and cedars, almost unaltered, are of common occurrence. in the volcanic cement immediately overlying the gravel, and this fact proves that this material was delivered in the form of a mud, and not as molten lava. Pine cones (apparently Pinus Contorta) and small branches have been found In the gravel. No fossil bones of any kind have so far been discovered.

The Bedrock.—The bedrock is principally metamorphic slate, often carrying large crystals of iron pyrites, and interstratified with calcareous schists, sheets of diabase and diorite and quartz veins. The general strike of the strata varies from N. 25° to 32° W., and the dip from 45" to 80° to the northeast.

The Gravel.—The gravel consists of boulders, principally of metamorphic schists and porphyrites with a very small percentage of quartz, intermixed with small pebbles and sand, and occasionally fine particles of iron pyrites. In some places the gravel of the old water courses is loose, with very little fine material between the boulders, and the latter are often covered with iron pyrites. As a rule, the gravel in the mine has a bluish color, which gave rise to the name of " blue channel;" but there are places where it is nearly black or red, and evidently discolored by percolating waters. When delivered to the surface and dried, it has more of a grayish color. The gravel is "free"—that is, it is soft enough to be washed without crushing, although blasting is resorted to as a means of facilitating extraction. The depth of the gravel is from a few inches to 16 feet, generally seven or eight feet in the center of the channel, thinning out to a mere seam on the rims. It is immediately capped with the volcanic cement, which forms a fine roof to work to.

The overlying cement has a depth of 500 to 1000 feet, and is in the form of beds with intervening layers of gravel. The latter sometimes are also gold-bearing. The washed and rounded boulders are often two or three feet, and occasionally six or eight feet in diameter.

*The accompanying paper, of which an abstract was printed in the Press on Jan, 13, 1894, is a most Important contribution to literature on the subject of drift mining. In response to numerous inquiries, and by permission of the Technical Society of the Pacific Coast (before which the paper was read), the full text is given.

Mining and Scientific Press, V. 68, 3/10/1894, p. 151

The Red Point Drift Gravel Mine.

By C. F. Hoffmann, Mem. Tech. Soc'y., In Three Parts.— Part ll.

The gold is mostly in the form of what is known as "scale gold," consisting of flakes resembling fish scales, or the scaly particles in bran. In places, however, there are streaks of coarser gold and occasional nuggets of one or two ounces weight.

Size .—A number of "cleanups" were passed through a series of sieves of different meshes to determine the percentage of coarse, medium and fine gold. The; were included under the heading:

Coarse Gold.—All that will not pass a sieve of 10 meshes to the inch. There are required from 600 to 700 of the finer colors of this class to weigh one ounce, and in these are included all colors, from the weight indicated up to the largest nugget.

Medium.—The remaining part that will not pass a 20-mesh sieve. This is more scaly and uniform in size, average 2200 colors to the ounce.

Fine.—The remaining part that will not pass a 40-mesh sleve, average 12,000 colors to the ounce.

Powder.—The remaining part having passed the 40-mesh sieve, colors too fine to count, average 40,000 or more to the ounce.

The following are the percentages by weight: Coarse, 15.78 per cent; Medium, 48 per cent; Fine, 36 per cent; Powder, 0.32 per cent.

Value.—The gold varies in fineness (purity) from .928 to .937, and the ounce is valued at $18.90 net. The purest gold has been found where the largest streams of percolating water were encountered in the gravel breasts.

Distribution.—The distribution of the gold in the channel is very Irregular. Most of the gold Is found on the bedrock. In some sections, however, it is mainly in the gravel above. The richest spot in this mine was found in a layer of gravel from 6 to 12 inches above the bedrock. At this point the bedrock was hard and smooth, and the channel straight. Some of the gravel was scraped up by hand, and contained as much as 33 ounces to the pan. For two months the average yield was $7.50 per carload of 22 cubic feet. It appeared as if the gold had been carried by a freshet which spent its force at this particular place.

Again, the gold Is found in paying quantities in an upper layer, from 40 to 10 feet above pay streak on the bedrock. There Is one rule which applies to this channel, and perhaps to others with beds of stratified rocks. The consecutive strata having different degrees of hardness will form riffles, so to speak, along or across the channel according to its course. Now, when the gold dust strikes these riffles it is washed along them in the direction deflecting least from the course of the stream and concentrates toward the rim. If it strikes at right angles it lodges in the center, or scatters to the right and left. (See Fig. 1.)

This rule holds good for the main bodies of pay gravel. Of course, if the bedrock is once covered it no longer governs the travel of the gold in this way, and this rule applies only to the pay streaks on the bedrock. In these main bodies the quantity of the gold again varies very much locally. It is generally found more abundant in cracks formed by the cleavage of the rock, at right angles with the strike, also around quartz veins, which are rough on the surface and hold the gold more readily, or where the slate is soft and thinly foliated. The gold dust will lodge in small pockets or pot holes and in cracks, to the depth of a foot or more. The lowest rut in the channel contains very little gold, sometimes a little coarse gold, but the bulk of it is thrown on the sides or higher rock. It is also found more plentifully on the down-stream side of Islands and very large rocks.

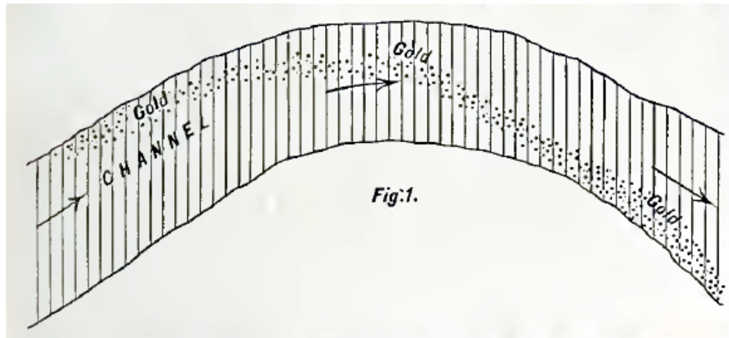

Fig:1.

SYSTEM OF WORKING.

A main gangway is run as near as possible in lowest part of the channel, avoiding turns as much as possible. Cross cuts are run from this gangway every hundred feet, if practicable, toward each rim. They are not driven at right angles to the channel course, but diagonally across it, so as to avoid cutting too much bedrock to keep the grade down. Arriving near the rim, where the bed raises rapidly, the grade is abandoned, and the rock followed up high enough to make sure that the true rim is reached. Generally the rim is Indicated by sand and fragments of lose bedrock (float). The bedrock is so uneven and steep in places that car tracks on a higher level become necessary to facilitate the delivery of the gravel from the breasts to the cross cuts or gangway. These are about four feet above the normal grade, high enough to dump from one car into another. The cars running on these higher levels are of smaller size. In some places wheelbarrows are resorted to, and this makes the extraction expensive. The main gangway is kept ahead of the breasts as far as possible, and most of the breasting is done from the cross cuts and small car tracks. Blasting occurs only twice a day, at noon and 11 P. M., just before meal times. The roof being firm cement, no lagging Is needed in timbering, only posts and caps are required. The posts, measuring not less than ten inches in diameter, are placed from six to eight feet apart, and sills are put under them where the bedrock Is soft. Natural pillars of gravel are occasionally left along the sides of the main gangway and cross cuts, and at other points when the channel is wide. About one-third of the gravel consists of bowlders exceeding five inches in diameter, and these are not removed from the mine, but are used in building walls between the timbers along the sides of the gangway and cross cuts to give further security against flaking and caving of the roof.

VENTILATION.

Heretofore the ventilation of the mine has been accomplished by a No. 4 Baker blower run by steam power, requiring 7.5 indicated horse power. However, quite recently a second blower (No. 4/2 Baker) has been introduced. This is attached to a Pelton wheel, and will be run by water power for at least six months in the year. The air pipe used Is eleven inches in diameter, and only one such pipe is required for ventilation, excepting where the channel is very wide. In such places a seven-inch distributing pipe Is carried into the breasts, but usually the cross cuts and connections cause a sufficient circulation without such aid. The monthly cost of ventilation by steam power is as follows: (Average of six months.)

Two engineers at $3.50	$193 00
Thirty-three cords of wood at $2.87	94 71
Oil, 6 ½ gallons	4.60
Eighty feet of new 1 r-inch pipe at 46 cents	36 80
Total	$329 11

This shows for 3064 carloads, 17 cents per carload.

TRANSPORTATION.

Four horses are needed for the transportation of the gravel, two on the day shift and two on the night shift. One extra horse is kept for reserve. One horse takes a train of six cars through the gangway to the chute, where the gravel is dumped. From the bottom of the chute, in the bedrock tunnel 44 feet below, the gravel is drawn in a train of ten cars, and the second horse takes it out to the dump house. The channel cars are iron dumpers of 22 cubic feet capacity. The tunnel cars have the same capacity, are also of iron, but the front ends are inclined and they are not dumpers. The latter are run out to the surface on to a self-dumping chair designed by Mr. H. C. Behr. The chair turns upon an eccentric axis, and the gravel is dumped to the washing floor 30 feet below. The driver does the dumping. Each train has a break car attached to it. The total distance from the breasts to the dump house is 6514 feet, or nearly 1.25 miles, 3273 feet being in the channel gangway, and 3241 feet along the tunnel to the surface. The number of cars used in the mine at present is 30. The monthly cost is as follows: (Average of six months.)

Feed for horses	$62 50
Wages of four drivers, at $3	324 00
Wages of two Chinamen, at $1.75	98 00
Car wheels, oil, etc	20 00
Total	$504 50

This gives for 3064 carloads 16 cents per carload.

COST OF LABOR.

The average cost of materials, transportation, ventilation and management is easily calculated, but the item of labor is more difficult to determine. It varies with the width and depth of the pay gravel, with the number of Chinese employed, with the unevenness of the bedrock, with amount of work in erecting new buildings and making other improvements, and with the labor required to protect the company's property in times of heavy snows and freshets.

The results of a number of figures give the following averages: Average number of men employed daily, 58.5
(22 whites and 38.5 Chinese). Average cost of labor per
man, $2 23. Average number of carloads extracted, per day's labor, 1.87.

This estimate includes all hands employed on the works, underground and on the surface.

A man breasting gravel will take out from 2.80 to 3 carloads a day, and sometimes a little more. This also depends on the depth and compactness of the gravel. As many as 220 carloads have been taken out in one day by the above-cited force.

The pay roll for six months, omitting the labor already cited under the headings "Ventilation" and "Transportation," shows an average of $316975 per month. This gives for 3064 carloads extracted a labor expense of $103
per carload.

COST OF MATERIALS

Of which only yearly inventories are taken (for the year 1892):

Timbers	$931 87
Lumber	300 00
Hardware	585 18
Rails	291 90
Air pipe	342 00
Car wheels, eta	241 00
Sundries	120 93
Freight	575 47
Total	$3,48835
On hand (estimate)	656 28
	$2,832 07
For one month. .	$236 00

MATERIALS USED IN ONE MONTH,

With an average extraction of 3064 carloads:

1191 pounds powder, No. 2, at 10 cents (average of 6 mos.)	$119 IO
4800 feet fuse at $6 per M	28 80
1766 caps at $5 per M	8 83
615 pounds candles at 10 ½ cents	64 57
11 gallons coat oil at 26 cents	2 86
5 " engine oil at 65 cents	3.25
1 ½ " cylinder oil at 90 cents	1.35
6 " lard oil at 90 cents	5.40
11 " car oil at 35 cents	3.85

13 [bushels charcoal at 20 cents	26.20
3662 pounds hay at $25 per ton	45.77
1669 pounds barley at $1.80 per hundred	30 04
33 cords of wood at $2 87	94.70
Timbers, lumber, hardware, air pipe, rails, car wheels, sundries, freight, cited in the above yearly inventory	236 00
Total	$670 73

This gives, after deducting materials already entered in estimates of "Transportation" and "Ventilation," $443.41, or 14 ½ cents per carload.

COST OF MANAGEMENT.

The monthly cost of management, including superintendent's salary, office expenses, traveling expenses, cablegrams, expressage on gold, taxes, etc., average of six months, $649 or 19 ½ cents per carload. Total expense per carload is therefore as follows:

Ventilation	$0.11
Transportation	.16
Labor	1.03
Materials, etc	.14 ½
Management	.19 ½
Total	$1.64

PRODUCTION.

The total production during five years, from January 1st, 1888, to December 31, 1892, was 140,345 carloads, yielding $308,245.40, or $2.20 per carload. The total production of the mine has been $363,473 60 from 5073 running feet of channel, or $71.65 per running foot.

WASHING THE GRAVEL.

The dump house, in which the gravel is washed, has a floor 31 feet below the car track. This floor slopes from the two sides toward the center, which is provided with a sluice box 16 inches wide in the bottom, and having a grade of 15 inches to 12 feet. The gravel is dumped on to this floor and washed with the stream from a three-inch nozzle under 25 feet pressure.

The line of sluices, drops, etc., is as follows (beginning at the washing floor): 157 feet sluice boxes, vertical fall or drop, 30 feet; 11 feet ground sluice, 36 feet sluice boxes, 10 feet drop; 24 feet ground sluice, 182 feet sluice boxes. After this the gravel washes down a steep canyon with several falls and short sluices for a distance of 1500 feet, then passes through a double flume and over an under current.

The upper sluice is nominally divided into sections, the upper 59 feet being called the " Upper Sluice," and the lower 98 feet the "Lower Sluice." The next two sluices of 36 and 182 feet are called the "Canyon Sluices," and everything below them is credited to the " Tailings."

In the " Upper Sluice" no quicksilver is used, and it is cleaned up every three days, or oftener If the gravel is very rich. All the other sluices are supplied with quicksilver. The "Lower sluice" and "Canyon Sluices" are cleaned up at the end of each month, and the "Tailings" once a year.

The riffles used in the sluices are made of wooden strips 3 inches high by 1 ½ inches thick, topped with strap iron half an inch thick. In the "Upper Sluices" they are 6 feet long, which is a convenient length for frequent handling. In the "Lower Sluices " they are 12 feet long. Six of these sluices fit into one sluice box, and leave an inch space between each. Every 12 feet a Hungarian riffle (an Iron grating) is introduced to disturb the current of water. In the "Canyon Sluices" ordinary riffles, wooden blocks, old car wheels, and cobble stones are used, all forming good gold catchers.

The following percentages of the total yield are obtained from the different sluices, etc. (taken from an average of 12 months):

	Per cent.
Upper Sluice (without quicksilver)	82.48
Lower Sluice (with quicksilver) . . .	3.89
Canyon Sluice, 36 feet (with quicksilver)	2.86
" " 182 feet " "	3-24
Tailings (with quicksilver)	5.72
Panning Tub (with quicksilver)	1.63
Blowings (black sand), with quicksilver	.18
	100.00

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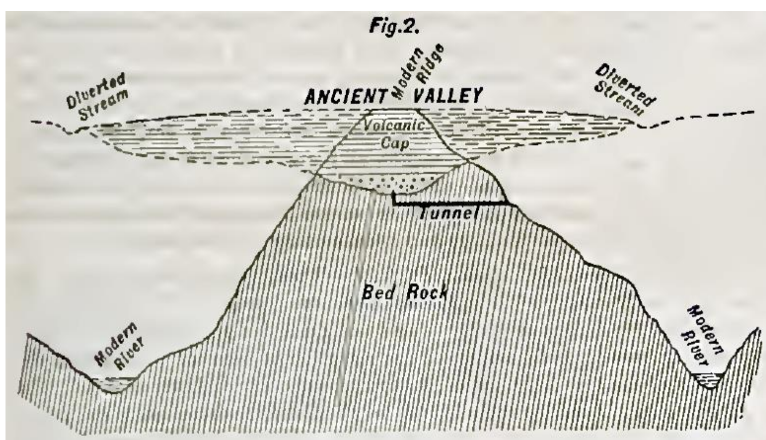
The Red Point Drift Gravel Mine.

By C. F. Hoffmann, Mem. Tech. Soc'y., In Three Parts.— Part III.

DISCUSSION.

Before reading the paper Mr. Browne said:

The drift mine of which Mr. Hoffmann's paper treats, is in one of the ancient river beds of the westerly flank of the Sierra Nevada. These are found in a striking topographical position, occupying the summits of the modern ridges, high above the present streams. This apparently anomalous position Is due to the displacement of the ancient streams by lava and mud flows from volcanic eruptions In the high Sierra. These flows filled the old river beds and diverted the streams, which cut new beds to gradually greater and greater depths, leaving eventually portions of the gravels of the ancient rivers, with their volcanic caps, to form the modern ridges, as shown in the following cross section (Fig. 2).



The gold is contained mostly in the bottom layer of gravel under the volcanic cap. The method of mining is by driving a tunnel in from the hillside to tap the bed and drain off the water, and to serve as a tramway for delivery to the surface. The auriferous gravel is excavated, carried to the surface, and dumped on to a sloping floor at the mouth of the tunnel, and washed thence through a line of sluices, provided with riffles to catch the loose particles of gold—the gold dust.

Much of the data furnished by Mr. Hoffmann cannot be found in a published form, and is of special value to engineers in making estimates for similar enterprises.

After reading the paper Mr. Browne added: Aside from the figures giving working results, Mr. Hoffmann has observed several occurrences which I have not heretofore heard described, and which appear to me as having special interest. These are particularly: the poverty of the gravel where the boulders are coated with microscopic crystals of quartz; the effect of the strike of the natural riffles relatively to the course of the river in determining the position of the pay streak; and the greater the purity of the gold where large quantities of percolating water were encountered in the gravel breast.

This latter observation indicates that the gold particles have undergone a slow process of purification by prolonged washing.

There is no doubt in the minds of those most familiar with the occurrence of auriferous gravels that the gold dust was derived from the degradation of the gold-bearing quartz veins. But it is a matter of common Information that the placer gold is purer than the gold in the quartz veins, and this fact gave rise to disputes concerning its origin. It was asserted by some theorists that the greater purity showed a difference in origin. However, the evidences of the derivation of the placer gold from the quartz veins are conclusive, and it remains only to explain the greater purity. I have for some time past been collecting information on this subject, and find the following averages from a large number of our California mines: Gold taken from placers, .890 fine; from quartz veins, .820 fine. The other constituents are mainly silver, partly baser metals.

The theory has been advanced that the silver and baser constituents when exposed to the action of the air and water are partially oxidized and dissolved, while the gold remains unaltered. In this way there results a purification of the outer film. The aggregate effect on the fine particles would be greater than on the large nuggets, and in fact the greater purity of the fine dost and of the outer films of nuggets is well known to dealers in placer gold.

Mr. Hoffmann tells me that, In the Red Point mine, in passing from a comparatively dry into a very wet section the purity of the gold dust always increases, generally from .003 to .005, or say one-half per cent. Though something of the sort might have been anticipated, It is the first time I have heard of its being actually observed. Mr. Manson.—Aside from the technical Interest that the mining engineer would take In this paper, there is a great deal in It and in Mr. Browne's explanation of the occurrence of these two sets of river channels and the obliteration of one set with the lava overflow that interests the geologists.

I have had occasion to examine the western slope of the Sierras from a few dozen miles south of the point so interestingly described in this paper, to Mt. Shasta, and the western slope of the Rocky mountains in eastern Washington, Idaho and Montana. In that area, embracing parts of California, Washington, Oregon, Idaho and Montana, there are about 150,000 square miles, which are or have been covered with lava. Toward the northern edge, up in Montana, Idaho and Washington, the lava Is from half a mile to a mile and a half thick, and is of dense basalt. Toward the southern edge or limit it appears to have degenerated, or certainly decreased in hardness as well as in thickness, and in some instances it is a mud lava that can be picked and handled without any very great trouble. In the Sierras the first set of river channels appears to have been formed during the period of denudation that followed that upheaval.

The denudation of portions of the Sierras amounts to about two miles in thickness, and in some instances to more. As that two miles was denuded from the western slopes of the Sierras, which was a line of lighter crust in process of upheaval, the amount of denudation lightened the load upon the crust and destroyed the state of isostatic equilibrium that the crust is always In. This caused the crust to upheave more. The denuded materials transported down the sides of the Sierras by water and gravity were deposited In the great valley of California, and this already In process of sinking was more heavily loaded. The additional load on the sinking area caused it to settle still farther; so that denudation acted in a double way to accentuate the difference of elevation between the valley and the mountains—that Is, the continuous denuding of the one caused the building up of the other. At the same time, the process caused the valley to settle more and the mountains to upheave to a greater extent. Toward the latter part of the Tertiary, and probably running well Into the Quaternary period, the process of denudation seems to have been interrupted by this lava flow, as Mr. Browne described, and a new set of river channels started in. In most instances these ran across the others, and in the modern rivers the richest deposits have been found just below where they had cut through the ancient river channels, the gold in the modern channels being the result of a double set of concentrations, first in the denudation and filling up of the ancient river channels, and finally in being reconcentrated in the modern rivers, leaving the enormously rich deposits that the forty-niners worked with such good results.

I regard this paper as an exceedingly valuable one, because it describes mining as a business enterprise. Mining in the early days, and even up to 1877, was largely a gambling operation; after the mine was located, the stock was put on the market, and it made but little difference whether the mine was valuable or not. So the mines were not systematically worked, and in many of the old river channels there are wonderful deposits yet; and I believe that the mining engineer and the geologist have before them a field of wonderful fertility in following up these river channels not only in the high Sierras, where they are covered by the lava caps, but by following them down into the plains below the level of the present alluvial surface of the valleys and also in the drift mines well under the surface of the present rivers. And I believe that this is going to be a line of mining which will be followed very largely in this country, and that projects of this nature will ultimately prove very attractive to capitalists.

Mr. Striedinger.—Mr. Hoffmann's paper fills, in a masterly manner, a long-felt gap in the literature on gravel mining. How thoroughly and economically the exploitation of the Red Point drift mine Is carried on under his superintendence is shown by this abstract from his reports.

Mr. Browne has not mentioned the fact that he and Mr. Hoffmann executed the original survey of this mine, and subsequently located the tunnel, which, by crossing the ancient river channel about 20 feet below its deepest point, causes a perfect drainage of the underground workings. There are very few drift mines which are so well laid out. Drift mines are not confined to the Pacific Slope of our Sierra. Not quite a year ago I discovered some drift mines on the westerly foothills of the Andes, near Barbacoas, Republic of Colombia, S. A. Drier drift mines than the "Red Point" are usually opened by means of inclined shafts with drifts extending from their bottoms. Mr. Browne.—The deep drain tunnel is necessitated by the amount of water contained in the channel. In the Red Point this amounts to 35 or 40 miner's inches, In the Mountain Gate and Hidden Treasure to 40 inches each, in the Mayflower, farther down the ridge, to 75 inches. If mined through deep shafts the handling of such quantities of water would eat up the profits.

There are a series of drift mines in the Harmony ridge, near Nevada City, however, where the gravel is almost dry, and the work there is most profitably carried on, as stated by Mr. Striedinger, through inclined shafts. The advantage of the inclined shaft is that it is shorter, and it may be run down on the rim rock until the bottom is reached, and it is not necessary to rely upon a vague estimate of the depth or position of the channel bed, as might be the case in driving a tunnel. But it should be borne in mind that every miner's inch means about 70 tons of water per 24 hours, and that the expense of lifting a very few inches will often amount to more than the expense of hoisting the total amount of gravel extracted. For example, the Mayflower mine delivers about 140 tons of gravel per day, and there runs through its drain tunnel nearly 40 times this weight of water.

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