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A. W. Fahrenwald, Director

A METALLURGICAL STUDY OF IDAHO PLACER SAND

By

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INTRODUCTION

The occurrence of placer gold in Idaho is widespread. The accompanying map gives a good idea of the geographical distribution. Since the discovery of gold in Idaho in 1860, there has been an estimated total production of 7,112,687 fine ounces* valued at more than $152,083,448.00. More than half of this production has been from placer operations. In 1937, placer operations alone produced 40,540 fine ounces. In this same year, nearly 79 per cent of the gold produced from placers came from the Boise Basin, Warren, Carson, and Pierce districts, where dredges were operated. Ten floating (bucket) dredges recovered 28,962 ounces.

For the most part, the bulk of the placer gold taken now may be classed as "coarse" gold. It is recovered by screening, washing, jigging and sluicing, and amalgamation. The recoveries, in most instances not accurately known, are considered reasonably satisfactory.

In the work leading to this report, interest primarily was centered on recovery of gold from placer sands in which the gold is in a very fine state of division. Much of the gold is of a fineness termed "flour" gold. Gold in this form obeys only sluggishly the laws of gravity - its recovery always has, and does now present a problem difficult, indeed, with which to cope. A hundred and one machines and contraptions have been invented, and many are still being invented every year, to recover flour gold. Not all are good, some are bad, and none has satisfactorily met the problem. Because of the low gold content of the run of these river sands, large yardages per day must be handled. Good and satisfactory recovery with large volume operations has not yet met with success - where flour gold is involved.

SCOPE OF THE INVESTIGATION

This study was undertaken to learn more of the physical characteristics of fine and flour gold affecting its recovery. The investigation sought to examine the following items:

1. The gold content of the placer sample.
2. The fineness (purity) of the gold.
3. The ease of recovery by panning.
4. The number of gold colors to the pan.
5. The physical form of the gold.
6. The contamination, if any, on the gold colors.
7. The rate of dissolution in cyanide solution.
8. The amenability of the gold to recovery by flotation.

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* U. S. Bureau of Mines Minerals Yearbook, p. 308, 1938.

SOURCES OF SAMPLES STUDIED

For the work, thirteen placer samples were available, most of which were taken by Mr. S. H. Lorain, mining engineer, U. S. Bureau of Mines, headquarters at Moscow. The geographic sources of these samples are as follows:

Sample No. 1

From the north fork of the Salmon River near Gibbonsville, Idaho. Material from a bar deposit on the Cregg-Bently claim.

Sample No. 2

From the Salmon River near Shoup, Idaho. Material from a bench deposit on the Golden Queen placer property.

Sample No. 3

From the Snake River near Asotin, Washington. Material from a bar deposit.

Sample No. 4

From Panther Creek near Forney, Idaho. Material from bank-deposited gravel.

Sample No. 5

From the Snake River near Homestead, Oregon. Material from bank-deposited gravel.

Sample No. 6

From the Snake River near Robinette, Oregon. Material from Carpenter Bar.

Sample No. 7

From the Snake River near Walter's Bridge, Idaho. Material from a bank deposit of gravel.

Sample No. 8

From Nappias Creek near Leesburg, Idaho. Material from a bench deposit of gravel on the Shoup Placer property.

Sample No. 9

Sample from the Snake River near King Hill, Idaho. Material from a bench deposit of gravel on the Prout Placer property

Sample No. 10

Sample from the Snake River near Twin Falls, Idaho. Material from a bench deposit of gravel.

Sample No. 11

Sample from the Snake River near Grandview, Idaho. Material from a bench deposit of gravel.

Sample No. 12

Sample from the Snake River near Blackfoot, Idaho. Material from the Welch Bar gravel deposit.

Sample No. 13

Sample from the Snake River near American Falls, Idaho. Material from the Bonanza Bar gravel deposit.

The sources of the samples are also shown on the accompanying map.

METHODS USED

A standard procedure was used with all samples. The sample was dried and screened on a 3-mesh sieve. The oversize was washed free of fines, dried, and weighed. The undersize product was split into samples of approximately 2,000 grams.

One of the 2000-gram samples was panned and the black sand concentrate dried and weighed. This concentrate was then examined under the binocular microscope. The gold colors were then picked out and examined under another microscope where the size and thickness of the colors were measured. To measure the thickness, a small piece of molding clay was placed on a glass slide, then, by the use of a needle, the gold color was turned on edge in which position it was held by the clay.

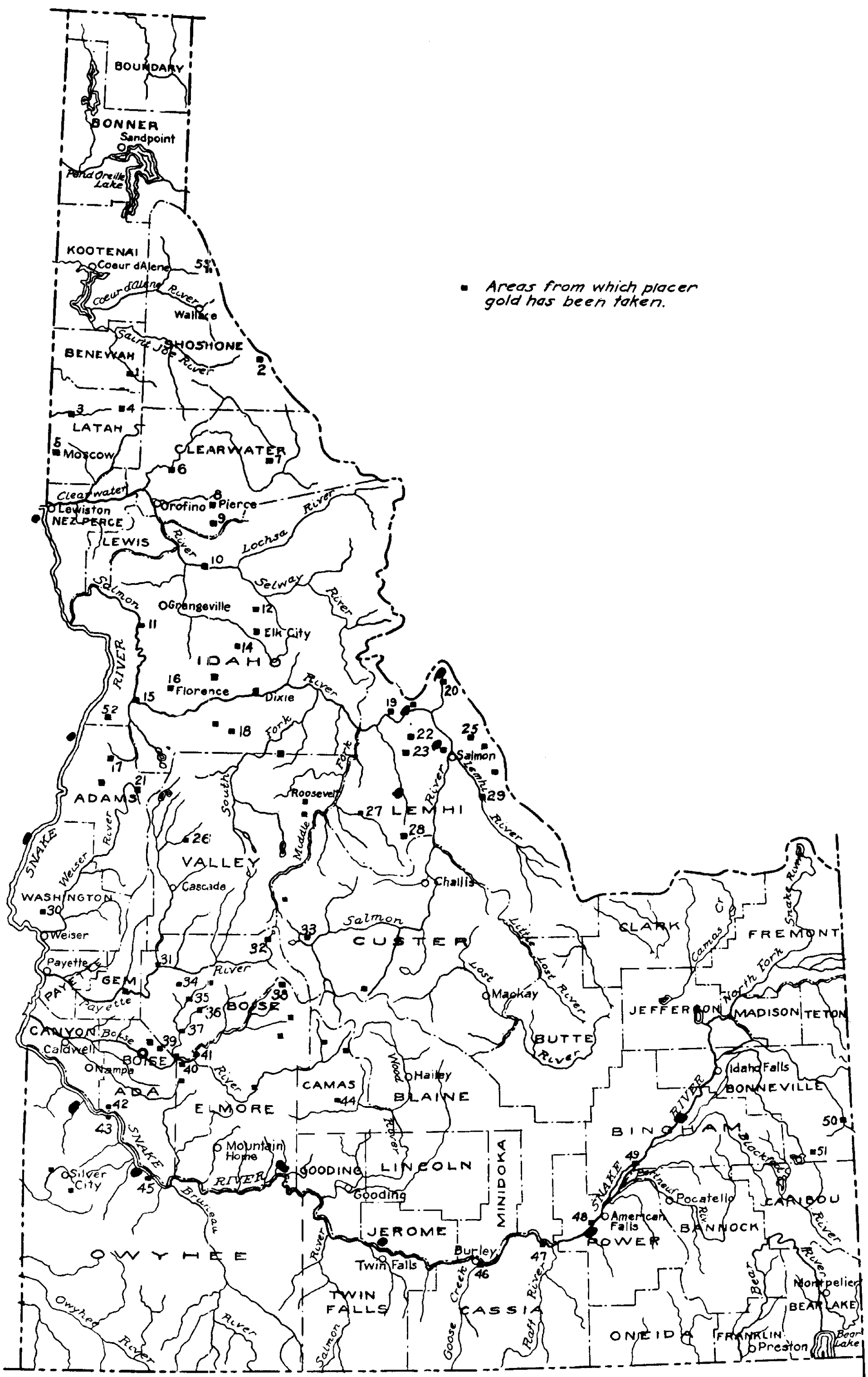
After measuring the gold colors in the black sand concentrate, the clay was removed from the glass slide, placed back in the black sand and the sample assayed for gold content and fineness.

Another sample of the fine material was used to make a wet screen analysis. In each test the part retained on the 35-mesh screen was panned to see if it contained any values in gold. The minus 35-mesh part was dried, weighed, and a flotation test made. The concentrate was dried, weighed, and assayed. The tailings were panned until a small concentrate was obtained. This tailing concentrate was screened through 48-mesh, the undersize dried and assayed, and the oversize examined for gold values.

The value per cubic yard of material was then calculated from the assay returns. The weight of a cubic yard of gravel in place was assumed to be 3,000 pounds.

If, in the preliminary flotation test, the recovery was below 95 per cent, further work was done to raise the recovery. This further work consisted of desliming the minus 35-mesh material before flotation and the use of cyanide on both slime and deslimed samples. The cyanide was used as a cleaning agent for the gold surface and as depressant of the mud slimes.

In two samples, there was considerable cemented gravel. In treating these, the procedure followed was nearly the same as for the other samples with the exception that the tailings were ground in a pebble mill to liberate the values and then refloated.



MAP OF IDAHO SHOWING LOCATION OF PLACER AREAS

Taken in part from U.S.G.S. Bul. 507

PLACER MINING DISTRICTS OF IDAHO

No.	County	Mining District
1	Kootenai	Camas Cove (Tyson)
2	Shoshone	St. Joe
53	Shoshone	Beaver (Coeur d'Alene)
3	Latah	Gold Creek (Potlatch)
4	Latah	Hoodoo (Blackbird)
5	Latah	Moscow
6	Clearwater	Burnt Creek
7	Clearwater	Moose Creek
8	Clearwater	Pierce
9	Clearwater	Musselshell Creek (Weippe)
10	Idaho	Maggie
11	Idaho	Salmon River Placers (Simpson)
12	Idaho	Newsome
13	Idaho	Elk City
14	Idaho	Orogrande
15	Idaho	Salmon River Placers (Simpson)
16	Idaho	Florence
18	Idaho	Warren
52	Idaho	Crooks Corral
17	Adams	Black Lake
21	Adams	Meadows
19	Lemhi	Mineral Hill (Shoup)
20	Lemhi	Gibbonsville
22	Lemhi	Mackinaw
23	Lemhi	Leeburg (Arnett Creek)
24	Lemhi	Kirtley Creek
25	Lemhi	Pratt Creek
27	Lemhi	Yellowjacket
28	Lemhi	Gravel Range (Forney)
29	Lemhi	McDevitt
26	Boise	Gold Fork (Roseberry)
31	Boise	Payette River Placers (Jacobs Gulch)
32	Boise	Deadwood
34	Boise	Quartzburg (Idaho Basin)
35	Boise	Centerville (Idaho Basin)
36	Boise	Idaho City (Idaho Basin)
37	Boise	Monroe Creek
41	Boise	Twin Springs
30	Washington	Monroe Creek (Weiser)
33	Custer	Stanley Basin
38	Elmore	Atlanta
40	Elmore	Highland Valley
39	Ada	Black Hornet (Highland Valley, Shaw Mt.)
42	Ada	Snake River Placers
43	Owyhee	Snake River Placers
45	Owyhee	Snake River Placers
44	Blaine	Soldier
48	Blaine	Snake River Placers
46	Cassia	Snake River Placers
47	Cassia	Snake River Placers
49	Bingham	Snake River Placers
50	Bonneville	Snake River Placers
51	Bonneville	Mt. Pisgah (Caribou)

PRESENTATION OF DATA

The results of the experimental work are given in Tables 1 to 8. Table 1 is a typical screen analysis of several samples of the gravel. Table 2 gives the number of gold colors in a 12-inch pan of gravel, the number of average size gold colors to equal one cent in value, the value per cubic yard of gravel, and the fineness of the gold found. Table 3 gives the size and thickness of typical gold colors, ranging from the smallest to the largest found. Table 4 gives the results of a cyanidation test on a sample of high-grade black sand concentrate. Table 5 gives a summary of the results of the preliminary flotation test. Table 6 gives the results when the samples were deslimed before flotation. Table 7 is the final flotation tests on the samples containing large amounts of mud slimes. Cyanide was used as a cleaning agent for the gold and as a depressant for the slimes. Table 8 shows the effect of pH (alkalinity) on the ratio of concentration and per cent recovery.

All flotation tests were made on minus 48-mesh material. Gold coarser than this was considered too coarse to be dependably floated and to be easily recovered by gravity methods.

When minus 48-mesh gold was not recovered by flotation, the non-flotability was assumed to be due to surface contamination of some sort. In most of the samples tested, the gold was clean, but in some the gold surface was contaminated and the recovery by flotation poor. The composition of the contamination was not determined. It was thought that the fine silt and mud present in some of the samples might be the cause of low recovery. A series of tests was made, using these samples, but desliming them before flotation. After the froth was removed on the tests in this series, cyanide was added to the tailings, the pulp conditioned for five minutes, then new frother added and a second concentrate removed. The assays of these concentrates showed that desliming the sample did not increase the recovery, and that the use of cyanide after the first concentrate was removed made possible the flotation of nearly all the values remaining in the tailings. A series of tests was then made on the two samples containing the largest amounts of silt which previously had shown the poorest recovery. The silt was left in the samples and cyanide used as a preliminary reagent with the result that the recovery was increased to a satisfactory point. In these tests, the addition of a small amount of cyanide rendered the gold floatable either by dispersing the slimes, thereby destroying them as contaminants, or by cleansing the gold colors of films of sub-microscopic thickness.

In all preliminary flotation tests, the reagents used were the same, namely, 0.02 pound amyl xanthate, 1.0 pound soda ash, and 0.1 to 0.15 pound of G.N.S. No. 5 pine oil per ton. In the tests employing cyanide, the same reagents were used with the addition of 0.5 pound of potassium cyanide per ton. A conditioning period in all tests was five minutes, the frother was then added, and concentrate removed for three minutes. The pulp density in all cases was of 2.5.

The flotability of the gold, as shown in Table 8, was little affected over a wide range in alkalinity.

SUMMARY STATEMENT AND SUGGESTIONS

The finest gold colors encountered in this study were recovered by skillful panning; the operation, however, is slow. A clean separation of the colors from the black sand concentrate could not be made.

Screening effected a very large concentration of the gold and this operation would play an important part in the flotation recovery of flour gold. Briefly, the plant should include screening to, say, 8 or 10 mesh; classification of the screen troughs; sluicing and/or jigging of the classifier sand product; thickening and flotation of the classifier overflow product.

The use of cyanide in small concentration renders the slime (mud) harmless to flotation and increases the flotability of the gold colors.

It should be strongly emphasized that successful exploitations of placer deposits, in which the values are largely in the form of flour gold, should include thorough sampling to delimit the volume of the deposits and competent testing to determine the assay content and the recoverability of the gold and the process to be used.

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TABLE 1

Typical screen analyses

Sample No. 1

Mesh	Wt. Grams	Per cent	Per cent Cumulative
+3	540	34.60	34.60
+10	270	17.30	51.90
+14	190	12.18	64.08
+20	80	5.12	69.20
+28	85	5.45	74.65
+35	100	6.41	81.06
-35	295	18.94	100.00

Sample No. 2

Mesh	Wt. Grams	Per cent	Per cent Cumulative
+3	406.1	40.61	40.61
+10	204.8	20.48	61.09
+14	74.8	7.48	68.57
+20	55.5	5.55	74.12
+28	50.6	5.06	79.18
+35	40.7	4.07	83.25
-35	167.5	17.75	100.00

Sample No. 8

Mesh	Wt. Grams	Per cent	Per cent Cumulative
+3	2095	49.98	49.98
+10	685	16.35	66.33
+14	270	6.45	72.78
+20	120	2.86	75.64
+28	98	2.34	77.98
+35	100	2.38	80.36
-35	827	19.64	100.00

Sample No. 13

Mesh	Wt. Grams	Per cent	Per cent Cumulative
+3	836	34.98	34.98
+10	546	22.32	57.30
+14	111	4.54	61.84
+20	41	1.67	63.51
+28	52	2.12	65.63
+35	101	4.12	69.75
-35	743	30.25	100.00

TABLE 2

The number of colors per pan, the value per yard, and the fines

Sample No.	Number of colors to a 12-inch pan of gravel	Number of colors to have a value of one cent	Value in dollars per cubic yard of gravel	Fineness of the gold in sample
1	9	73	0.96	800
2	10	30	3.53	858
3	2	1080	0.23	825
4	12	2220	0.01	828
5	122	268	1.05	910
6	24	635	0.07	900
7	6	254	0.28	825
8	7	207	0.26	870
9	80	605	0.36	900
10	398	772	4.27	935
11	66	255	1.40	900
12	38	258	0.55	882
13	124	383	1.44	906

TABLE 3

Sample No.	Size, Millimeters	Thickness Millimeters
1	0.12500 x 0.06300	0.00825
	0.18750 x 0.08300	0.01791
	0.25000 x 0.12500	0.03710
	0.37500 x 0.18750	0.06225
	0.66600 x 0.31300	0.09625
2	0.11569 x 0.08847	0.00825
	0.24498 x 0.22048	0.05444
	0.37428 x 0.25859	0.12793
	1.17046 x 0.81592	0.23137
	1.36100 x 1.63320	1.36100
3	0.12500 x 0.12500	0.00825
	0.18750 x 0.12500	0.01791
	0.31300 x 0.16600	0.02350
	0.31300 x 0.25000	0.07625
	0.37500 x 0.18750	0.96250
4	0.07139 x 0.13730	0.07430
	0.12135 x 0.07432	0.02250
	0.12357 x 0.16437	0.03844
	0.15103 x 0.08238	0.07625
	0.26087 x 0.10984	0.06865

TABLE 3 (Cont'd)

Sample No.	Size, Millimeters	Thickness, Millimeters
5	0.13860 x 0.12540	0.01732
	0.17550 x 0.09860	0.01823
	0.24930 x 0.10110	0.01641
	0.33210 x 0.13100	0.06315
6	0.11832 x 0.13621	0.01765
	0.13580 x 0.11732	0.01823
	0.21300 x 0.16320	0.01683
	0.22680 x 0.11628	0.02695
	0.30297 x 0.20135	0.01932
7	0.11832 x 0.11384	0.08316
	0.23841 x 0.18354	0.09003
	0.35481 x 0.18731	0.10875
	0.50431 x 0.31812	0.09625
	0.71351 x 0.37281	0.11098
8	0.20315 x 0.19320	0.05416
	0.22189 x 0.18755	0.08321
	0.30851 x 0.20415	0.04652
	0.33855 x 0.33624	0.10398
	0.55621 x 0.40318	0.09761
9	0.12521 x 0.23818	0.01905
	0.13610 x 0.15299	0.01366
	0.16332 x 0.17013	0.01669
	0.20415 x 0.21856	0.01633
	0.34150 x 0.39614	0.01361
10	0.02722 x 0.19054	0.01402
	0.12521 x 0.15026	0.01361
	0.14563 x 0.28581	0.05444
	0.15026 x 0.17693	0.01633
	0.20415 x 0.25859	0.01629
11	0.10135 x 0.20015	0.01252
	0.13815 x 0.15721	0.01361
	0.16180 x 0.10315	0.01632
	0.20185 x 0.15872	0.00988
	0.24130 x 0.20187	0.01421
12	0.07543 x 0.05312	0.01561
	0.08505 x 0.06315	0.01217
	0.10120 x 0.10325	0.01312
	0.12031 x 0.10215	0.01087
	0.12510 x 0.13861	0.01421
13	0.04312 x 0.05612	0.01125
	0.09370 x 0.10850	0.01325
	0.18321 x 0.16532	0.01821
	0.25180 x 0.08325	0.01938
	0.36800 x 0.17500	0.01632

TABLE 4

Cyanide tests

Sample	Time, hours	KCN, lb. per ton	Na_2CO_3, lb. per ton	Per cent extraction
a	6	2	0.25	54.9
b	6	4	0.25	75.8
c	6	6	0.25	71.0
d	6	8	0.25	69.5
e	6	10	0.25	80.0
f	6	12	0.25	74.4
g	6	14	0.25	78.5
h	6	16	0.25	79.5
i	6	18	0.25	78.1
j	6	20	0.25	74.6

TABLE 5

Preliminary flotation tests

Sample No.	Weight of concentrate, grams	Weight of tailing, grams	Ratio of concentration	Per cent recovery
1	4	496	125-1	100.00
2	7	503	73-1	98.50
3	14	3336	240-1	96.80
4	5	450	90-1	100.00
5	20	1065	93-1	87.20
6	8	552	70-1	77.00
7	16	814	50-1	86.60
8	16	1759	110-1	70.00
9	19	1881	99-1	81.70
10	3	847	282-1	95.40
11	12	1060	89-1	96.00
12	12	940	78-1	95.00
13	20	740	37-1	89.40

TABLE 6

Samples deslimed and the tailing treated with cyanide

Sample No.	Weight of concentrate, grams	Weight of tailing, grams	Ratio of concentration	Per cent recovery
5 a	2	823	412-1	88.50
b	1	822	822-1	89.00
Total	3	822	274-1	98.70
6 a	3	557	186-1	82.50
b	2	535	275-1	99.99
Total	5	555	111-1	99.99
7 a	4	806	201-1	90.50
b	1	805	805-1	83.30
Total	5	806	161-1	98.50
8 a	4	696	174-1	98.40
b	-	-	-	-
Total	4	696	174-1	98.40
9 a	5	805	161-1	91.50
b	2	803	401-1	99.99
Total	7	803	114-1	99.99
13 a	7	530	76-1	53.20
b*	2	500	250-1	86.50
c'	1	498	498-1	90.00
Total	10	530	53-1	99.99

a Test on the original sample which was deslimed.
b Test of the tailing from "a" with the addition of cyanide.
* Tailing ground in pebble mill to liberate values in cemented gravel.
' Cyanidation of the reground tailings.

TABLE 7

Flotation tests, using cyanide without desliming

6	5	835	167-1	99.99
8	10	1680	168-1	92.00

TABLE 8

Effect of pH on recovery

Sample No. 3 used	Na_2CO_3, lb. per ton	pH Value	Ratio of Concentration	Per cent recovery
Test 1	0.0	7.2	93-1	99.99
Test 2	0.5	8.6	105-1	99.99
Test 3	1.0	9.1	93-1	99.99
Test 4	2.0	9.5	89-1	99.99
Test 5	3.0	9.8	93-1	99.99
Test 6	4.0	10.2	105-1	99.99
Test 7	5.0	10.3	105-1	99.99