UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Snake River gold in Idaho: distribution, grain size, grade, recovery, and composition

By

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Open-File Report 88-0352

1988

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ABSTRACT

Fine-grained native gold occurs in Pleistocene and Holocene sand and gravel deposits throughout the length of the Snake River in Idaho. Most studies have shown that the occurrences are of very low grade and that the gold is very difficult to recover by most gravity-hydraulic methods. There have been no prior reports that have delineated specific areas with high potential for large quantities of near-surface resources. This has been largely due to the lack of information for resource evaluation of shallow subsurface gold occurrences.

Previous and present studies show that the weight of individual native gold grains recovered by gravity-hydraulic methods is generally in the range of about 2 to 20 micrograms. The average weight of 8,767 native gold grains counted in 24 samples is 5 micrograms for material recovered in the laboratory using the Gemeni[1] table. Most of these grains have morphologies that indicate long-distance fluviatile transport.

About 90 percent of the native gold is recovered by flotation methods, according to prior and present studies. For the Blackfoot area, concentrates obtained by flotation recovery yield low fineness by fire-assay analysis because silver tellurides are also recovered. In contrast, hydraulic-gravity recovery methods lose the fine-grained silver tellurides because of their tendency to float. This is probably the reason that the very sparse silver tellurides in the Blackfoot area were not recognized previously.

Prior studies have suggested that late Mesozoic and early Cenozoic conglomerates in the Snake River headwaters of western Wyoming were the source(s) of Snake River placer gold. We find evidence in the Blackfoot area that there is (or was) also a local lode source that contributed native gold, silver and gold tellurides, and native mercury to the placer deposits. The mineral assemblage of the lode source includes hessite (Ag_2Te), stuetzite ($Ag_{5-x}Te_3$), petzite (Ag_3AuTe_2), coloradoite (HgTe), hydrothermal amalgam, and native mercury, as well as common sulfides and native gold.

INTRODUCTION

Very fine grained native gold was recovered from Snake River placer deposits downstream from Blackfoot, Idaho (fig. 1), more than a century ago (Maguire, 1899; Washburn, 1900). Because of low-grade but ubiquitous occurrence, morphology of the gold grains, consistently small grain size and narrow range of fineness of gold recovered along the Snake River, it has been inferred that most, if not all, of the gold was reworked from fossil placers and that it was derived from late Mesozoic and early Cenozoic clastics in western Wyoming (Iddings and others, 1899; Antweiler and Love, 1967; Phillips, 1985). All of the records of fineness of recovered gold in the eastern half of the Snake River drainage in Idaho show finenesses above about 900. In Snake River headwaters, Quaternary deposits of Teton County, Wyo., average about 220 mg[2] of gold per cubic yard (Antweiler and Love, 1967). Schultz

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[2]One mg = 1×10^{-3} gram, 31.1 grams = 1 troy ounce.

(1907) reported an average recovery of about 280 mg of gold/yd^3 for 194 pit samples from 17 claims in the Minidoka area downstream from American Falls Reservoir. Hill (1916) reported that between 1901 and 1910, gold recovered from Welch placer deposits near Blackfoot was about 600 mg/yd^3; thickness of the mined gravel was 18 ft. A sample from there studied by Fahrenwald and others (1939) assayed 488 mg/yd^3. We cannot verify the relatively high grades reported by Hill (1916) for the Welch placer. However, about 24,200 troy ounces of gold were produced from deposits in this area prior to about 1930 (Bergendahl, 1964, table 5). There is no recorded gold production along the Snake River between Blackfoot, Idaho, and Jackson Hole, Wyo.

We have done a preliminary study of the occurrence, distribution, size, fineness, and recoverability of native gold in the near-surface gravel and sand deposits for several localities in the Blackfoot area and at a few other places along the Snake River (fig. 1). The size of bulk samples studied was mostly in the range of 60 to 80 lb (27 to 36 kg). Most samples were wet screened to remove the plus-18-mesh (1 mm) fraction; the minus-18-mesh fraction was processed on a Gemeni table to obtain a heavy concentrate. For many of these concentrates the gold grains were counted with a binocular microscope prior to submitting the concentrate for fire-assay analysis. Grains recovered from some concentrates were studied by scanning electron misscroscopy, others were mounted and polished for reflected light microscopy and electron microprobe studies.

GRAIN WEIGHT AND FINENESS OF GOLD

Considerable interest and attention has been given to the small size and weight of the gold in the Snake River drainage of Idaho and Wyoming (Washburn, 1900; Schultz, 1907; Hill, 1916; Hite, 1933, 1934; Fahrenwald and others, 1939; Antweiler and Love, 1967; and Antweiler and Lindsey, 1969). Table 1 gives the estimated and measured weight of gold grains reported from prior studies. The narrow range of gold grain weight is noteworthy and it is also significant that flotation recovery yields a much smaller size of gold grains. Table 2 gives the results obtained for nearly 10,000 grains of gold that we recovered from 35 samples using the Gemeni table for gold recovery. Weight of gold grains was determined by weighing and by calculations based on the amounts of gold recovered by fire-assay analysis and amalgamation recovery of gold, divided by the number of native gold grains counted in each analyzed concentrate. Fineness data (Au/Au+Ag x 1,000) are given for fire-assayed concentrates so that if one assumes that all of the silver is in native gold, a slightly larger average weight for gold grains could be obtained. We preferred to use recovered gold only because of the presence of silver tellurides in the Blackfoot area. Except for four samples that were preconcentrated by field methods prior to laboratory gold recovery, the range of average weights for native gold grains is very small and indicates that most grains weigh less than about 10 micrograms, even if all of the silver recovered by fire assay of each concentrate is added to the average weights that were calculated here on the basis of gold assays alone.

We believe that our data for the average weight of gold grains recovered in our study is a good indication of the maximum average weight because our recovery method is not efficient for gold grains that weigh less than about 1 microgram. Similarly, the grain size or weight data for gold recovered in the

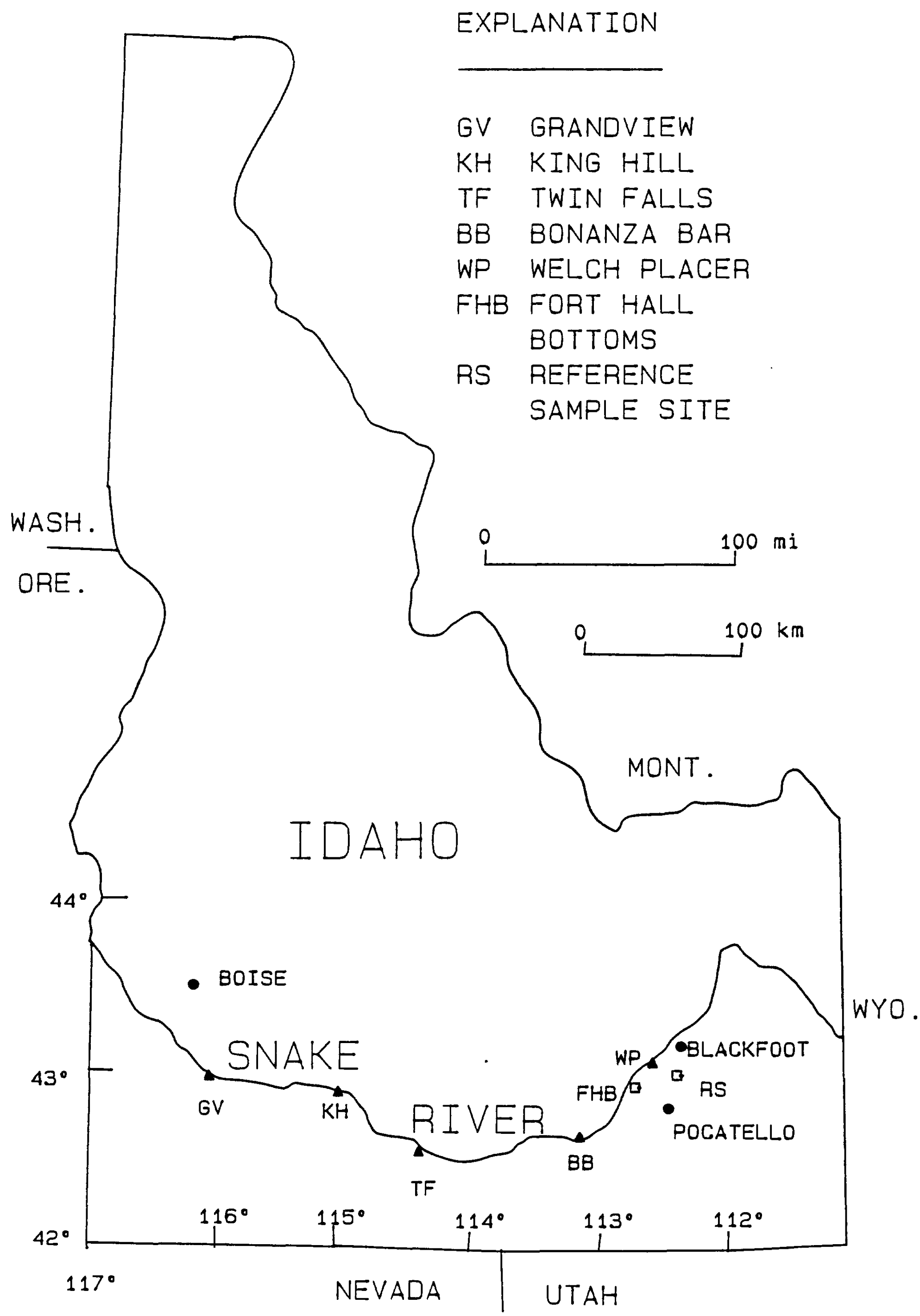

Figure 1.--Some placer gold localities along the Snake River in Idaho.

Table 1.--Estimated weight of Snake River gold grains recovered in previous studies in Idaho and western Wyoming

Locality	Grain weight (micrograms)	Recovery method	Basis	Reference
Upstream from Boise River in Idaho	12.4[1]	Rockers and sluices	1,200 grains/cent	Washburn, 1900, p. 610.
Minidoka area, Idaho	9.3-15.5[1]	Rockers, dredge, and sluices	1,000-1,500 grains/cent	Bell, 1907, _in_ Schultz, 1907, p. 81.
Minidoka area, Idaho	12[1]	-do-	1,300 grains/cent	Hill, 1916, p. 279.
Western Wyoming	8	Panning	Weighed grains	Antweiler and Love, 1967, p. 10.
Jackson Hole, Wyoming	10	-do-	-do-	Antweiler and Lindsey, 1969, p. 6.
Twin Falls, Idaho	5	-do-	-do-	-do-
King Hill, Idaho	1.8	Flotation	Weighed 100 grains	Hite, 1934, p. 687.

[1]Calculated from number of grains required to be worth \$0.01 @ \$20.00 per troy ounce of gold.

Table 2.--Calculated and measured weight of Snake River gold grains recovered in the present study

[All grains recovered with Gemeni table. n.d. = not determined; fc = field concentrate prior to Gemeni table recovery. Grain weight based on gold only, except for fused grains]

Locality	Grain weight (micrograms)	Fineness (Au/Au+Agx1,000)	No. of grains
Fused hand-picked grains and weighed aggregate on microbalance			
Between Welch placer and Bonanza Bar, Idaho	6.0	n.d.	100
-Do-	5.0	n.d.	100
-Do-	3.0	n.d.	200
-Do-	5.0	n.d.	200
-Do-	3.5	n.d.	300
Fire assay of gold grains counted in concentrate			
Blackfoot, Idaho	5.9	800	128
-Do-	3.3	931	2,800
-Do-	5.9	530	27
-Do-	4.1	891	289
Between Welch placer and Bonanza Bar, Idaho	5.1	905	15
-Do-	5.0	828	40
-Do-	4.3	868	50
-Do-	3.7	889	26
-Do-	3.0	595	120
-Do-	20.5fc	747	56
-Do-	5.5fc	877	115
-Do-	8.8fc	637	20
-Do-	10.8fc	662	100
Moreland, Idaho (gravel pits)	5.3	830	45
-Do-	4.9	639	30
Amalgamation of gold grains counted in concentrate			
Between Blackfoot and Pocatello, Idaho (gravel pits)	2.4	n.d.	130
-Do-	4.4	n.d.	60
-Do-	2.1	n.d.	600
-Do-	7.6	n.d.	6
Moreland, Idaho (gravel pits)	2.0	n.d.	70
-Do-	4.4	n.d.	12
Hoback Junction, Wyoming	6.1	n.d.	16
Fire assay of gold grains counted in concentrate			
Gibson Canal, south of Blackfoot, Idaho	2.0	549	191
-Do-	1.7	402	2,468
-Do-	1.6	884	1,031
Wapello, Idaho (gravel pit)	2.5	789	234
Basalt, Idaho (gravel pit)	2.1	789	107
-Do-	2.6	801	202
Shelly, Idaho (gravel pit)	3.9	703	36
Register Rock (Minidoka area)	3.7	717	28

Snake River drainage around the turn of the century reflects the inefficiency of the gravity recovery methods to capture the smallest grains. In contrast, flotation recovery of native gold seems to capture many of the smaller gold grains (Hite, 1933, 1934).

FLOTATION RECOVERY OF GOLD

Almost 50 years ago, Fahrenwald and others (1939) performed metallurgical tests for gold recovery from several samples of Snake River gravels. Both flotation recovery and cyanide recovery methods were used. Samples of interest to the present study include the Welch placer near Blackfoot, Bonanza Bar in the Minidoka area, an area near Twin Falls, the King Hill area, and an area near Grandview (fig. 1, table 3). According to fire-assay analysis, grades ranged from 320 mg/yd^3 to 3,794 mg/yd^3 of gold. Fineness ranged from 882 at Welch placer to 935 near Twin Falls. The average grade was 1,425 mg/yd^3 and the average fineness was 905. Data shown in table 3 reveal that flotation recovery values for gold are reasonably high and average 91.5 percent.

Because of the small size of the gold grains and the presence of silver tellurides associated with native gold south of Blackfoot, tests were run to determine the efficiency of flotation recovery methods. Table 4 shows the recovery of gold and silver by flotation, prior to treatment of the flotation tailings for gold recovery by gravity methods. Tests on large samples (several hundred pounds) were run by company A, and tests on small samples were done in our laboratories. One analyst did all of the separate fire assays on each of the flotation concentrates and on each of the gravity concentrates. Company A used a Diester table for the gravity concentrate and we used a Gemeni table to obtain the gravity concentrate. Also we used a different flotation reagent (Aerofloat) than that used by company A. Company A used a much larger flotation cell that the 1-liter flotation cell that we used. Table 4 shows the amounts of gold and silver recovered, the fineness and the percent of the total recovered by flotation. Company A recovered 73.6-95.8 percent of the gold and 63.2-99.8 percent of the silver by flotation for six samples. The average amount of gold recovered by company A by flotation, for the six samples, was about 87 percent; the average amount of silver recovered was 89 percent. The amounts recovered in our laboratories by flotation ranged from 51.5 to 71.6 percent for gold and 39.3 to 74.8 percent for silver. Our much lower amounts of flotation recovery may be due to the different flotation reagent used and/or lack of experience with the method. In view of the good results obtained by flotation of gold by company A, this method seems highly amenable to the recovery of Snake River gold.

Wenqian and Poling (1983) have provided an excellent summary and discussion of flotation and gravity methods for recovering fine placer gold such as that along the Snake River in Idaho. Their report shows that gold grains of the size and the shape of Snake River gold is most effectively recovered by flotation methods.

Table 3.--Grade, fineness, and flotation recovery of Snake River gold from five localities between Blackfoot and Grandview, Idaho

[Data are from Fahrenwald and others (1939, tables 2 and 4)]

Locality	Fire assay mg Au/yd^3	Fineness (Au/Au+Agx1,000)	Percent recovered by flotation
King Hill area	320	900	81.7
Twin Falls area	3,794	935	95.4
Grandview area	1,244	900	96.0
Welch placer	488	882	95.0
Bonanza Bar, Minidoka area	1,279	906	89.4

Table 4.--Comparison of flotation and gravity recovery of gold and silver from Snake River placer deposits between Welch placer and Bonanza Bar

[All concentrates were analyzed by fire-assay methods by the same analyst; data are as reported by analyst. Flotation recoveries were done first; flotation tailings were processed for gravity recovery]

Sample No.	Flotation recovery					Gravity recovery		
	Au, mg	Ag, mg	Fineness*	% of total recovered Au	% of total recovered Ag	Au, mg	Ag, mg	Fineness*
COMPANY A								
USGS	7.198	1.504	827	78.0	63.2	2.032	0.876	699
37	13.999	61.133	186	97.7	99.0	0.330	0.611	351
38	14.337	18.732	434	82.9	86.0	2.948	3.047	412
39	10.345	121.858	78	95.8	99.8	0.450	0.182	712
41	36.880	75.103	321	93.1	97.0	2.725	2.313	541
42	4.050	15.476	207	73.6	89.8	1.453	1.754	453
USGS								
38	0.564	0.065	897	70.1	40.1	0.240	0.097	712
39	0.259	0.241	518	69.1	63.8	0.116	0.137	458
41	2.105	0.184	920	71.6	74.8	0.834	0.062	931
47	0.173	0.114	603	51.5	39.3	0.163	0.176	481

*Fineness = Au/Au+Ag x 1,000.

AREAS STUDIED

Minidoka gold placers along the Snake River in Blaine and Power Counties, Idaho

Prior to the time of building the Minidoka Dam that now forms Lake Walcott in Blaine and Power Counties, the U.S. Geological Survey did extensive sampling and analysis of recoverable placer gold from many placer claims in that area (Schultz, 1907). The highest yields of gold were from claims that are now beneath Lake Walcott in the Minidoka National Wildlife Refuge. These include the Diamond Bar, Nebraska, Boise, and Bessie Hannah claims (Schultz, 1907, p. 84-85). The average grade of gold for these claims was between about 178-590 mg/yd^3; 99 samples were analyzed (Schultz, 1907). Upstream along the river, many other samples were taken in the Bonanza Bar area that now borders the Minidoka National Wildlife Refuge; however, these areas that were studied by Schultz (1907) are above the dam level of Lake Walcott. Amounts of gold recovered from 18 pit samples on six claims north of the Snake River in the Bonanza Bar area (fig. 1) are given in table 5; data are from Schultz (1907). Values for samples from each claim range from 124 mg/yd^3 (0.004 troy ounces/yd^3) to 466 mg/yd^3 (0.015 troy ounces/yd^3); the weighted mean for all 18 pits is 208 mg/yd^3 (0.0067 troy ounces/yd^3). The depth of these pits ranged from only 4 to 13 ft; the average depth was 8 ft. Schultz (1907) used a factor of 2,600 lb/yd^3 in calculations based upon assays of per ton value of recovered gold; thus, these grade estimates are low by about 7 to 12 percent, based on our measurements of the density of both sand and gravel that weighs, on a dry basis, between about 2,800 and 2,950 lb/yd^3. Seven water-well logs show about 50 to 100 ft (15 to 30 m) of unconsolidated gravel, sand, and clay in the Bonanza Bar area that is thinly mantled by about 3 to 18 ft (1 to 5.5 m) eolian sand.

Dixie Ranch mine

The Dixie Ranch mine is a gravel and sand operation that recovers gold as a byproduct. It is located near the Snake River and near the town of Grandview, about 50 mi southeast of Boise (fig. 1). In 1981, Mr. Thomas Ferree (written commun., 1985) presented a paper in Toronto, Ontario, describing the application of the Reichert cone concentrator that is used to make a heavy-mineral concentrate from the minus-1-mm material; the cone concentrate is fed to a 14 ft Diester table for further concentration of native gold. The table concentrate is treated in a small amalgamation drum for gold recovery. The gold content reported for bank-run gravels averages about 150 mg/yd^3 (0.1 grams per ton) and recovery of gold is about 85 percent. Screen analysis showed that about 44 percent of the gold was in the minus-200-mesh (74 micrometer) fraction. In 1985, Mr. Larry Mashburn reanalyzed the size distribution of gold in a 448 lb (203 kg) sample of minus-1-mm material (written commun., 1985). The concentrates, middlings, and tailings were studied; 89 percent of the gold was in the concentrate and the minus-1-mm fraction contained 330 mg/yd^3 of gold.

We studied two samples from the Dixie Ranch mine; one was a bulk gravel sample and the second was a sample of undersize tailings (sand). Both samples weighed about 80 lb (36 kg). Concentrates obtained from the Gemeni table for the gravel sample yielded 136 mg/yd^3 for gold and 8.2 mg/yd^3 for silver (fineness = 943) by fire assay. Concentrates recovered from the Gemeni table

Table 5.--Gold recovered from 18 pits on six placer claim areas along the north side of the Snake River, Bonanza Bar area, Power County, Idaho

[Data are modified from Schultz, 1907]

Number of pits	Average depth (ft)	Claim name	Average amount of gold recovered by fire assay	
			mg/yd^3	$troy\ oz/yd^3$
6	9	Goldleaf	267	0.0086
6	9.4	March Morning	127	0.0041
2	6	Grasshopper	202	0.0065
2	9	Excelsior	271	0.0087
1	6	Gold Crown	124	0.0040
1	6.5	Montana P	466	0.0150
Weighted mean for 18 pits			208	0.0067

for the undersize tailings sample yielded 57 mg/yd^3 for gold and 9.3 mg/yd^3 for silver (fineness = 866) by fire assay. A count of individual gold grains (561) indicates that the average weight of the gold grains that we recovered from the tailings is 2.9 micrograms.

Reference sample areas

Several bulk samples of gravel were taken from one site between Blackfoot and Pocatello (fig. 1) for various laboratory studies. Three of these were processed for gold and heavy-mineral recovery by company A; fire-assay results for two of these are shown in table 6. The third concentrate was provided to us for mineral study. A fourth bag of the reference sample was wet-screened for removal of plus-18-mesh (1 mm) material. The minus-18-mesh material was wet-screened into four fractions and each of these was split into four to eight separate parts (table 7). Each of these 24 parts was analyzed using the HBr digestion method; results are shown in table 7. Total gold extracted was only 34 mg/yd^3; almost 98 percent of the extracted gold is in the minus-60-mesh fraction. The great disparity between the gold obtained by flotation and gravity recovery with fire-assay analysis of concentrates, versus that recovered by HBr extraction may be due to actual differences in the gold contained in the samples, and/or because considerable free gold is intergrown with tellurides, sulfides, or other minerals.

Concentrates from one bag of the reference sample were found to contain an unusual array of minerals and some native gold grains with crystalline morphologies that are inconsistent with a history of long-distance fluviatile transport. Minerals identified by ore microscopy methods and quantitative electron microprobe analysis for this single concentrate include native gold, hessite, stuetzite, petzite, acanthite, native mercury, hydrothermal amalgam (Au-Ag-Hg), native tellurium, and coloradoite. In addition, the common sulfides in the concentrate include pyrite, galena, sphalerite and chalcopyrite; however, none of these are abundant. Polymineralic grains composed of intergrown or attached grains include: native gold-hessite-stuetzite, native gold-quartz-pyrite, sphalerite-stuetzite-hessite-native gold, galena-stuetzite-hessite, chalcopyrite-sphaletite-stuetzite-hessite, hessite-pyrite-stuetzite, chalcopyrite-hessite, petzite-native gold, native gold-hydrothermal amalgam, hydrothermal amalgam-(Ag-Sb-Hg) alloy, hessite-native gold-hydrothermal amalgam and native tellurium-coloradoite. Some petzite and hessite grains contain 0.2-0.4 wt percent mercury; in other grains mercury is not detectable. An acanthite grain has 10 wt percent copper and 0.1-0.2 wt percent mercury. Grains that we consider to be hydrothermal amalgam are the most mercury-rich grains of Au-Ag-Hg natural alloy reported for intermediate composition Au-Ag alloys; Au/Au+Ag atomic ratios are in the range of about 0.20 to 0.45 and mercury is in the range of about 16 to 22 at. percent. Hydrothermal amalgam forms a 10-micrometer-thick rim on native gold that contains 18-25 at. percent silver. Coloradoite forms a thin rim on a native tellurium crystal. The occurrence of these minerals, and the intergrowth of both silver tellurides and sulfides with native gold explains the very high silver content of the fire-assay results for flotation concentrates (table 6). Similarly, the low recovery of gold by HBr extraction (table 7) may be due to the intergrown occurrence of native gold with other minerals, as well as the occurrence of gold in petzite.

Table 6.--Gold analyses of reference samples

Number	Bulk weight lb (kg)	Flotation and gravity mg Au/yd^3	mg Ag/yd^3	Comments
		Company A		
10	115 (52.1)	361	180	Fire assay.
11	95.5 (43.3)	566	3,670	Fire assay.
		USGS Analysis		
4	83 (37.6)	34		HBr extraction on minus-18-mesh (minus-1 mm) fraction.

Table 7.--HBr digestion of reference sample 4 for recovery of free gold

[Analyst: James G. Crock, USGS]

Sample No.	Mesh size (ASTM)	Dry weight (grams)	Gold concentration (ppm)	Weight percent of gold	Weight percent of bulk sample
	18-35				
1-4		394	<0.01		
2		441	<0.01	0.0	4.3
3		394	<0.01		
4		386	<0.01		
	35-60				
1-8		447	<0.01		
2		390	<0.01		
3		378	<0.01		
4		423	<0.01	2.2	9.4
5		441	<0.01		
6		491	0.03		
7		449	0.02		
8		504	0.03		
	60-120				
1-8		378	0.04		
2		492	0.09		
3		404	0.15	36.8	9.5
4		473	0.01		
5		469	0.13		
6		430	0.10		
7		399	0.05		
8		419	0.08		
	minus 120				
1-4		667	0.25		
2		787	0.24	61.0	7.05
3		619	0.23		
4		581	0.24		

Calculated content of gold in bulk sample based on HBr recovery is 0.0256 ppm or 34 mg/yd^3.

COMPOSITION OF NATIVE GOLD AND HYDROTHERMAL AMALGAM

Compositions of 61 individual gold grains from four samples were determined by electron microprobe analysis. Native gold grain cores and rims were analyzed for each grain in order to determine if the grain borders had lower silver values than the cores. It is well known that many gold grains in placer occurrences in the Western United States have grain borders with a lower silver content than the cores of the grains (Desborough, 1970). The range of silver content for each of 24 grains from the reference sample is shown on figure 2; also indicated are those gold grains that have attached petzite, hessite, and hydrothermal amalgam. Only one grain of the group has a silver-depleted rim. Figure 3 shows the range of silver content of 37 grains from three other localities from the Fort Hall Bottoms (fig. 1), between Welch placer and Bonanza Bar. Although there are only seven grains that have conspicuous low silver rims, we suspect that the grains with no low-silver rims were not medially bisected in the polished surfaces. We also note three grains in the group (fig. 3) that have reverse zoning--i.e., the highest gold content is in the core of the grain.

We infer that the compositional data for silver content indicates that some gold grains with less than about 10 wt percent silver and most of those with low-silver rims were probably derived from the conglomerates and sandstones of Mesozoic and Cenozoic age in the headwaters of the Snake river in Wyoming; these grains have no attached or intergrown tellurides or other minerals. Conversely, those grains that have attached petzite, hessite, or hydrothermal amalgam, and those grains with silver-rich borders and most of the grains with more than about 12 wt percent silver are thought to have originated from some local lode source because they have surface morphologies inconsistent with long distance fluviatile transport.

We have noted hydrothermal amalgam on one grain recovered from the reference sample. The very small crystals of amalgam on the grain margins and the high content of mercury are believed to indicate an origin in a hydrothermal environment. Most of the low-temperature amalgam that we find in the placer environment, that apparently formed from incidental contact of free mercury and native gold, has less than about 10 atomic percent of mercury, according to electron microprobe analysis. This low-temperature amalgam forms a thin, white, spongy or porous rim on gold grains. Compositions determined for the two amalgam grains that we believe formed in a hydrothermal environment are richer in mercury that any reported for intermediate Au-Ag ratios (fig. 4). Because the most gold-rich amalgam (15 analyses) mantles a core of argentiferous native gold on three sides, we suspect that the gold was exposed to mercury-rich fluid in a hydrothermal environment. The second grain has a core (five analyses) of Ag-rich alloy (84-93 at. percent Ag, 5.3-5.7 at. percent Sb, 2-4 at. percent Hg); the three silver-rich amalgam data points are for material bordering the Ag-rich alloy (fig. 4). The α-phase (fig. 4) is a cubic Au-Ag-Hg alloy. The occurrence of a euhedral crystal of native tellurium bordered entirely by a 2-micrometer-thick rim of coloradoite (HgTe) in the same sample is evidence of a post-telluride event that involved Hg-rich fluid.

Although the compositions of the amalgam grains on figure 4 lie on or near the α + liquid line for equilibrium conditions calculated (Nysten, 1986; Basu and others, 1981) for 450 °C, we do not necessarily believe the

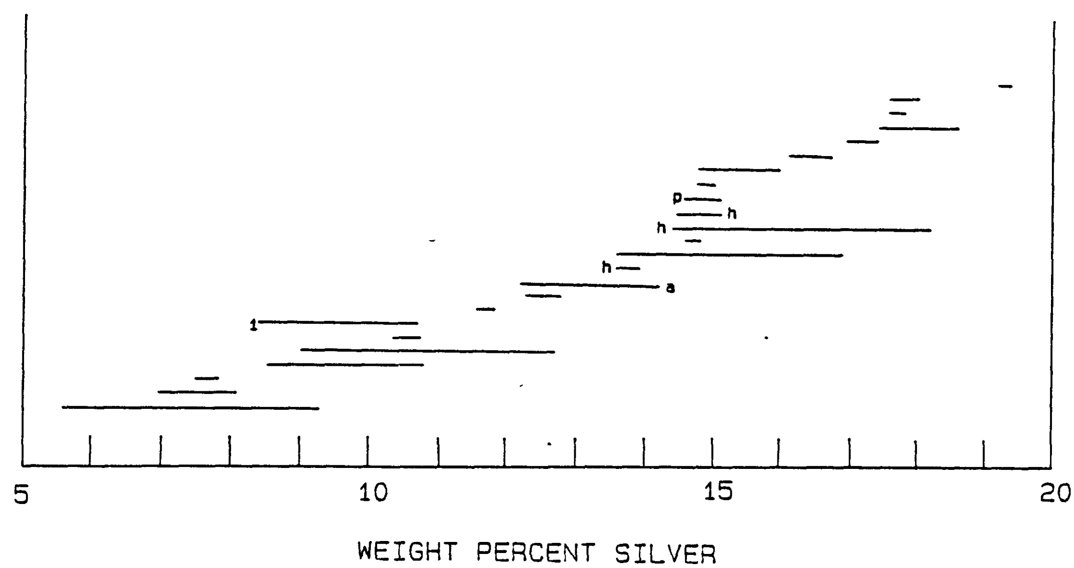

Figure 2.--Silver content of native gold from reference sample. Grains attached or intergrown with gold are indicated by p = petzite, h = hessite, a = hydrothermal amalgam; 1 indicates grain has a silver depleted margin.

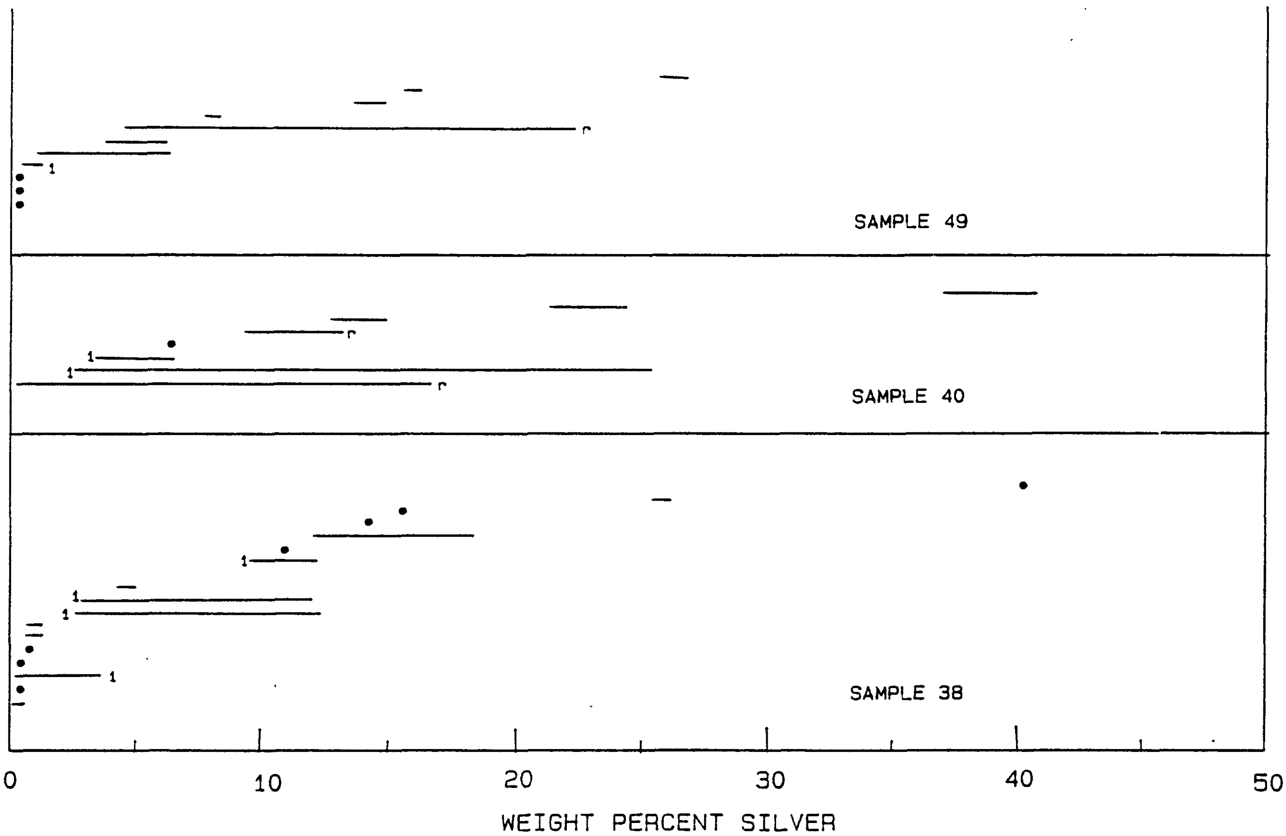

Figure 3.--Silver content of 37 grains of native gold from three samples from the Fort Hall Bottoms, between Welch placer and Bonanza Bar. Solid circles are for grains with invariant composition. 1 indicates grain has a silver depleted margin. r indicates that the grain core has the highest content of gold, and the margin has the highest content of silver.

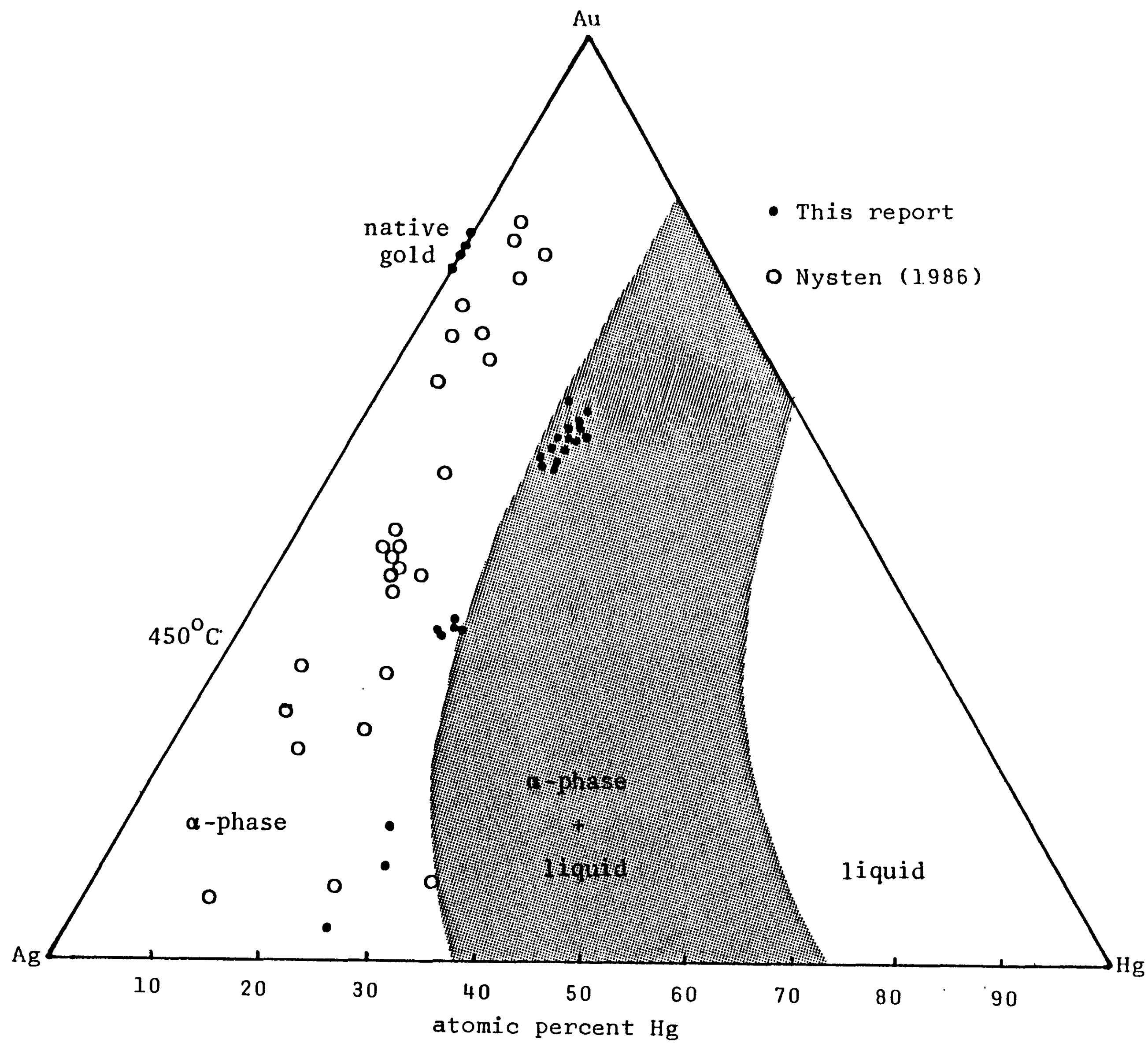

Figure 4.--Comparison of composition of natural ternary amalgams of the present study and of those shown by Nysten (1986). The composition of native gold mantled by the most gold rich amalgam is also shown. Phase relations from Nysten (1986). The α-phase is a cubic alloy of Au-Ag-Hg.

temperature of formation of the amalgam and coloradoite was that high, because the relations portrayed for the Au-Hg-Ag ternary were only calculated (Basu and others, 1981) rather than determined experimentally.

SUMMARY

Our preliminary studies of Snake River gold show that there is (was) a local lode source upstream from Blackfoot that contributed some native gold as well as silver tellurides to fluviatile Pleistocene sediments downstream. We do not know whether this local source contributes significantly to the Snake River gold derived from Mesozoic and Cenozoic strata in Wyoming.

The average weight of gold grains recovered in laboratory studies using a hydraulic-gravity method (Gemeni table) is about 5 micrograms. We doubt that this method recovers as much fine gold as flotation, based on both prior studies and our studies.

Although there have been no large-scale placer-gold exploration efforts in the Snake River drainage of Idaho, the grades of gold reported in prior studies are of interest if large, near-surface, sand and gravel deposits are present. We note that Lewis (1984, p. 36) reviewed the Yuba-Placer Gold Company operation at Hammonton, Calif., that operates a 10,000-yd^3/day dredge and recovers less than 300 mg of gold per cubic yard.

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