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Fine-grained gold in stream sediments of east-central Lemhi County, Idaho

by

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Illustrations

FINE-GRAINED GOLD IN STREAM SEDIMENTS OF EAST-CENTRAL LEMHI COUNTY, IDAHO

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ABSTRACT

Fine-grained native gold is present in what appears to be anomalous concentrations (0.25 ppm) in a few samples of stream sediments collected south of Salmon in east-central Lemhi County, Idaho. Native gold was recovered from numerous samples using a mechanical panning method in the laboratory; gold grains were counted and their sizes estimated using a binocular microscope. Most of the gold grains were in the size range of 50-200 micrometers, although a few were as large as 400 micrometers. Samples with apparently anomalous gold concentrations occur in areas that have not previously been considered to have high potential for occurrence of gold. Samples of mineralized rock from the area contain from 0.01 to 1.25 ppm of gold.

INTRODUCTION

Many of the major lode gold mines in North America were discovered by tracing their associated placer gold occurrences upstream using field panning techniques. Most lode gold mines in the contiguous United States that were found by this method were developed and mined prior to about 1920. The classic field panning techniques of the best prospector--though admirable--do not seem to be adequate for the discovery or recognition of occurrences of very fine-grained gold (gold grains less than about 100-150 micrometers; see Antweiler and Love, 1967).

The very fine-grained gold in lode and disseminated deposits is recoverable using mining methods and leaching techniques that have been developed during the past two decades. This circumstance is chiefly the result of a much higher price of gold. Also it has been recognized that relatively rich gold deposits occur in areas where "field-pannable gold" has not been abundant enough to recognize an economic lode gold deposit.

Gold grain size has end members in economic lode gold occurrences. One end member is where the metal occurs on an atomic scale in minerals such as arsenopyrite or pyrite (refractory ores) as shown by Cabriand others (1989) for the Elmtree deposit, New Brunswick, and the Sheba mine, Transvaal. Another is the "invisible" Carlin-type (sedimentary-rock hosted) for which recent studies (Bakken and others, 1989) have shown that gold particles as small as 50-200 angstroms in diameter are present in unoxidized ore. These types of gold cannot normally be recognized by any gravity separation techniques. At the other end of the spectrum are those quartz-gold deposits where gold grains may be as coarse as several centimeters.

In view of the wide range of gold grain sizes in lode gold occurrences, some must have particulate gold grains that are intermediate in size between "Carlin-type" and the field-pannable native gold (greater than 100-150 micrometers) that led to the many North American lode gold discoveries. English and others (1987) have described a simple and efficient method of gravity concentration of free gold (and other heavy minerals) from unconsolidated sediments or crushed rock samples. This is a method of mechanical panning where particulate material is placed in a gold pan with water and then agitated on a Wilfley table to concentrate the heavy minerals. This method has proven to be effective for recovering native gold and other heavy minerals from small bulk samples (kg) after sieving to appropriate sizes. Gold grains as small as 50-100 micrometers are readily recoverable by a careful operator, but it is recognized that some unknown quantity of grains smaller than about 50-75 micrometers are also lost during wet screening and handling.

With these concepts and methods of recovery considered, we have used laboratory gravity-recovery methods for recovery of gold from stream sediments collected from an area in eastern Lemhi County, Idaho.

RECOVERY OF GOLD FROM STREAM SEDIMENTS IN THE SALMON AREA

Stream sediment samples were collected from 56 sites (fig. 1) for laboratory studies of heavy minerals (all figures and tables are at end of report). Two samples were collected at each of 50 sample sites; one sample was small, about 500-1300 grams, the other was larger and weighed 4-10 kilograms. At six of the 56 sites only the larger (4-10 kg) sample was collected.

A total of 50 small bulk samples averaging 886 grams (range: 470-1280 grams) was processed in the laboratory for study of heavy minerals, including gold. These were washed and sieved to produce a +18 mesh, an 18-35 mesh and a -35 mesh fraction; each of these was panned in a small gold pan using the mechanical panning method of English and others (1987). Concentrates were examined with a binocular microscope at magnifications of 20 or 40X for each size fraction. For samples with visible native gold, the number of gold grains was recorded and the size of the grains was estimated visually using a 75 micrometer diameter fiber to touch each grain for size comparison.

An additional six bulk samples were taken from localities for which small samples were not taken; these ranged from 4.4-9.9 kg. These samples were wet sieved to produce five fractions (+ 18, 18-35, 35-60, 60-120 and -120 mesh); each fraction was mechanically panned. Data for both the small and large samples are given in Table 1.

Gold was found in 40 of the 56 bulk samples. In order to normalize the data for the variations in bulk sample weight, we calculated the number of grains that would be contained in a 1-kg sample. This provides a convenient number that can be related to grain size, particle weight and gold concentration shown on the nomogram of Clifton and others (fig. 2, 1969). Based on the observed size of the native gold grains and the number of gold grains, one can estimate that the gold concentrations in the gold-bearing samples is between about and 0.25 ppm. We recognize that the number of gold grains present in the original bulk samples is underestimated to some degree due to losses during wet sieving. The largest native gold grains recovered from these small samples were about 400 micrometers in diameter, but these grains were very thin (20 micrometers). Most gold grains are larger than 75 micrometers in the largest dimension, but a few are between 50 and 75 micrometers. We believe that gold grains smaller than about 50 micrometers cannot be effectively recovered using this method; in addition, it is difficult to see gold grains smaller than about 25 micrometers at magnifications of 20X.

Based on the number of gold grains counted in each sample, and the estimated size of the grains, the nomogram of Clifton and others (fig. 2, 1969) was used to determine that 30 samples have less than 0.01 ppm, 17 have between 0.02 and 0.09 ppm, and 4 have about 0.20 and 0.25 ppm of gold. These estimates are based on the assumption that the mean diameter of all gold grains counted is 80 micrometers and that they have an average mass of 6 micrograms (see Clifton and others, fig. 2, 1969). Figure 2 is a histogram showing the calculated number of native gold grains per kilogram of sample given in Table 1. These are probably minimum values because we assume that all gold grains were not recovered from each sample and that all recovered grains were not visible for counting due to the masking effect of other minerals in the concentrate.

Four of the samples have more than twice the number of gold grains of the other 54 samples; these four samples have more than five times the mean (6 grains/kg) of all samples. Because of these relations, these four samples are considered to contain anomalous gold that is estimated to be in the range of 0.20-0.25 ppm, based on the nomogram of Clifton and others (fig. 2, 1969) and an estimated mass of 6 micrograms per gold grain.

Five other samples with 11-14 native gold grains per kilogram (fig. 2) may also have anomalous gold concentrations depending upon what is considered as "background" gold concentrations. On the basis of more than 70 gold analyses of Middle Proterozoic rocks in the area, J. J. Connor (personal commun., 1990) estimates that background values for gold are at most, a few parts per billion. Mines and prospects sampled by J. J. Connor (personal commun., 1990) have as much as 0.2 ppm of gold.

Based on the assumption that the mean mass of the gold particles counted is about 6 micrograms, 10 grains/kg would yield a concentration of 0.064 ppm (Clifton and others, fig. 2, 1969). If this is correct, then five stream sediment samples have between 0.07 and 0.09 ppm of gold.

Thirteen samples of mineralized rock in the area range from 0.01 to 1.25 ppm of gold (table 2) and the locations of these are shown on figure 1. Although sampling of stream sediments was done independently and without knowledge of the locations of the mineralized samples, three of the stream sediments samples with the most abundant gold are in drainages in which mineralized samples contain anomalous gold--Mulky Creek, Allison Creek and Poison Creek (fig. 1). The anomaly in Lake Creek is in an area where mineralized rocks have not yet been recognized.

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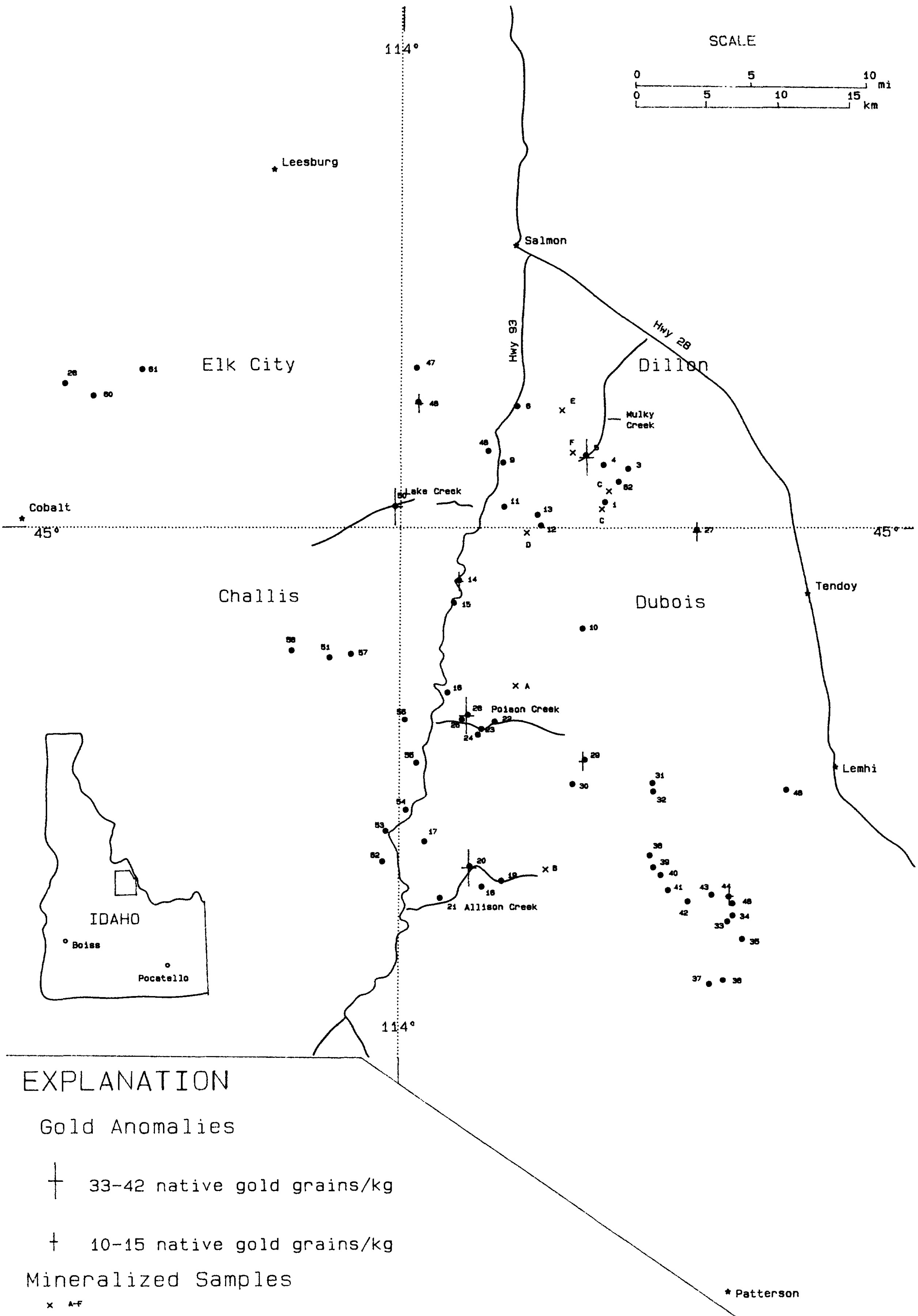

Figure 1.--Location of stream sediment samples in east-central Lemhi County, Idaho (1°X2° quadrangles are named).

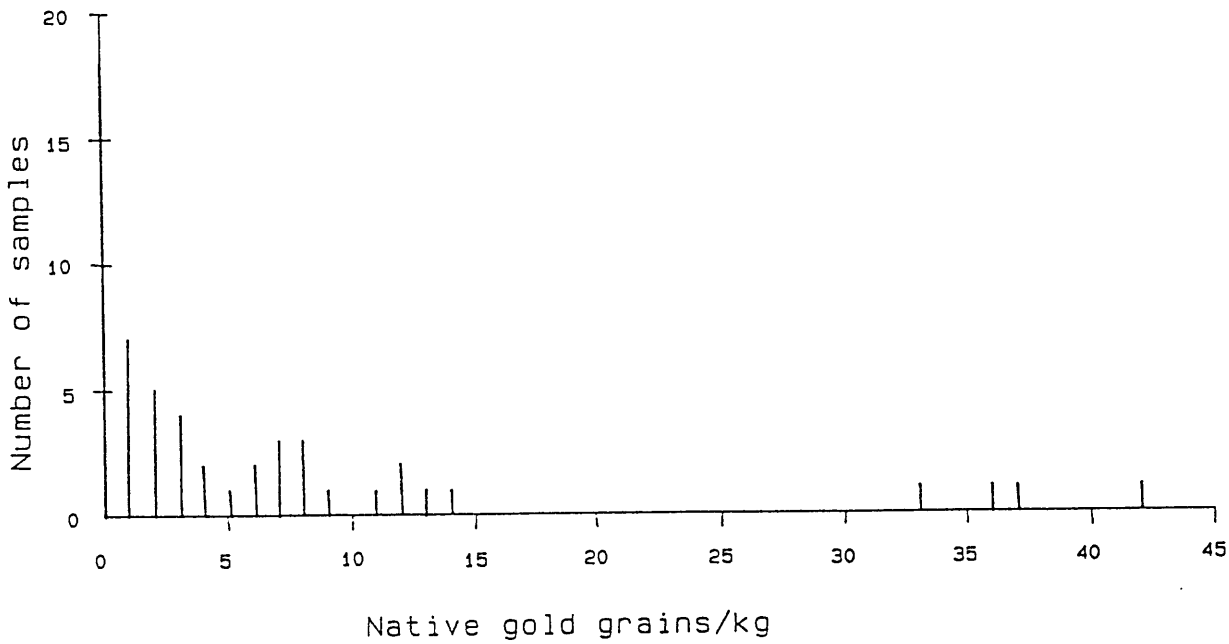

Figure 2. Histogram showing the number of samples and the number of gold grains per kilogram of sample.

Table 1.--Location, weight and estimated minimum concentration of native gold separated by laboratory mechanical methods for bulk stream-sediment samples in eastern Lemhi County, Idaho.
[Estimated minimum gold concentration is based on the bulk dry weight, number of gold grains observed (counted), the size and shape of gold grains, calculated gold grains per kilogram and use of the nomogram of Clifton and others (1969, fig. 2)]
Second entry of sample number corresponds to number on Figure 1.

Sample No.	Drainage (location)	Dry wt. (kg)	Au grains per kg	Estimated minimum gold concentration (parts per million)
IC-1T-89	Withington Creek	0.83	1	< 0.005
IC-3T-89	Withington Creek	0.80	8	0.05
IC-4T-89	Withington Creek	0.64	8	0.05
IC-5B-89	Mulky Creek	9.91	36	0.22
IC-8T-89	Sevenmile Creek	0.85	0	<0.005
IC-10B-8	Twelvemile Creek	0.80	5	0.03
IC-11T-8	Twelvemile Creek	0.96	6	0.035
IC-12T-8	Twelvemile Creek	0.80	5	0.03
IC-13B-8	Twelvemile Creek	4.44	4	0.025
IC-14B-89	Briney Creek	8.32	13	0.08
IC-15B-89	Second Creek	5.89	9	0.05
IC-16B-8	Warm Spring Creek	8.46	7	0.04

IC-17T-89	McKim Creek	1.10	4	0.025
IC-18T-89	Cow Creek	1.00	3	0.02
IC-19T-89	Allison Creek	0.95	3	0.02
IC-20B-89	Allison Creek	6.80	40	0.25
IC-21T-89	Allison Creek	0.80	3	0.02
IC-22T-89	Poison Creek	0.74	0	<0.005
IC-23T-89	Poison Creek	1.10	4	0.025
IC-24T-89	Poison Creek	1.05	0	<0.005
IC-25T-89	Poison Creek	0.60	33	0.20
IC-26T-89	Poison Creek	0.88	0	<0.005
IC-27T-89	Haynes Creek	0.72	11	0.07
IC-28T-8	Blackbird Creek	0.75	0	<0.005
IC-29T-89	Trail Creek	0.84	12	0.07
IC-30T-8	Basin Lake Creek	0.88	2	0.01
IC-31T-89	Basin Creek	0.87	6	0.035
IC-32T-89	McNutt Creek	1.18	0	<0.005
IC-33T-89	Hayden Creek	0.70	9	0.055

IC-34T-89	Hayden Creek	0.98	7	0.04
IC-35T-89	Tobias Creek	0.67	0	<0.005
IC-36T-89	Cooper Creek	1.19	7	0.04
IC-37T-89	Hayden Creek	1.07	1	<0.01
IC-38T-8	Bear Valley Creek	0.98	0	<0.005
IC-39T-89	Deer Creek	0.98	2	0.01
IC-40T-89	Short Creek	0.62	0	<0.005
IC-41T-89	Wright Creek	0.96	1	<0.01
IC-42T-89	Kadletz Creek	0.80	1	<0.01
IC-43T-89	Ford Creek	0.98	0	<0.005
IC-44T-8	Bear Valley Creek	0.75	12	0.07
IC-45T-89	Hayden Creek	1.28	0	<0.005
IC-46T-89	Hayden Creek	1.18	0	<0.005
IC-47T-89	Perreau Creek	0.73	7	0.04
IC-48T-89	Williams Creek	0.56	14	0.085
IC-49T-89	Henry Creek	0.82	0	<0.005
IC-50T-89	Lake Creek	0.47	42	0.25

IC-50B-89	Lake Creek	2.27	33	0.20
IC-51T-89	Iron Creek	1.00	0	<0.005
IC-52T-89	Hat Creek	1.10	0	<0.005
IC-53T-89	Shep Creek	0.89	2	0.01
IC-54T-89	Ezra Creek	0.96	2	0.01
IC-55T-89	Ringle Creek	0.98	1	<0.01
IC-56T-89	Cabin Creek	1.01	3	0.02
IC-57T-89	Badger Creek	0.82	0	<0.005
IC-58T-89	Iron Creek	1.00	1	<0.01
IC-60T-8	Blackbird Creek	0.97	8	0.05
IC-61T-89	Panther Creek	0.80	1	<0.01
IC-62T-8	Withington Creek	0.85	0	<0.005

Table 2.--Gold content of mineralized samples from the northern Lemhi Range. Sample locations are shown on Figure 1.
[Analysts: E. Welsch, J. G. Crock, B. Roushey, K. Kennedy and R. O'Leary]

Map symbol (fig. 1)	Gold (ppm)	Sample description, age of host rock and (sample number)	General location
A	0.25	jasperoid in Saturday Mountain Formation (?) (8KE043B)	Poison Creek drainage
B	1.25	mineralized Big Creek Formation (8KE045A)	Head of Allison Creek near Lem Peak
B	0.10	mineralized mafic sill/dike (8KE045B)	
C	0.10	mineralized rock in Yellowjacket Formation (9KE001A)	Harmony mine area
C	0.034	mineralized rock in Yellowjacket Formation (9KE001B)	-do-
C	0.012	mineralized rock in Yellowjacket Formation (9KE002A)	-do-
D	0.25	quartz-veined and copper-stained Yellowjacket Formation (9KE015C)	Twelvemile Creek
D	0.37	Yellowjacket Formation (9KE044A)	-do-
D	0.60	Yellowjacket Formation (9KE057A)	-do-
D	0.10	Yellowjacket Formation (9KE058A)	-do-
E	0.01	Yellowjacket Formation (9KE029A)	Pope-Shenon mine
F	0.05	Yellowjacket Formation (9KE120A)	Crest of Lemhi Range, north of Sal Mountain
F	1.1	Yellowjacket Formation (9KE121A)	