United States Department of the Interior
U.S. Geological Survey

Areal and textural distribution of particulate gold in sediments from Bluff Beach, Alaska

by

Gretchen Luepke and Kam W. Leong

Open File Report
81-1085

CONTENTS

ILLUSTRATIONS

APPENDICES

Areal and textural distribution of particulate gold in sediments from Bluff Beach, Alaska

by

Gretchen Luepke and Kam W. Leong

INTRODUCTION

From 1967 to 1971, the Heavy Metals Project of the U.S. Geological Survey focused on the study of the distribution of gold and other precious metals in nearshore and offshore areas (U.S. Geological Survey, 1968, 1969). Of primary concern were coasts adjacent to such historic gold-producing regions as southwestern Oregon (Clifton, 1968) and Alaska. Present economic conditions, reflected in the rapidly rising price of gold, warrant continued examination of gold distribution in both traditional and non-traditional settings (e.g., Gulbrandsen and others, 1978) regardless of whether such deposits are currently profitable to exploit. The present paper describes the areal distribution of gold in beach sediments at Bluff, Alaska, and the textural distribution of gold within the sediment-size fraction of each sample.

PREVIOUS WORK

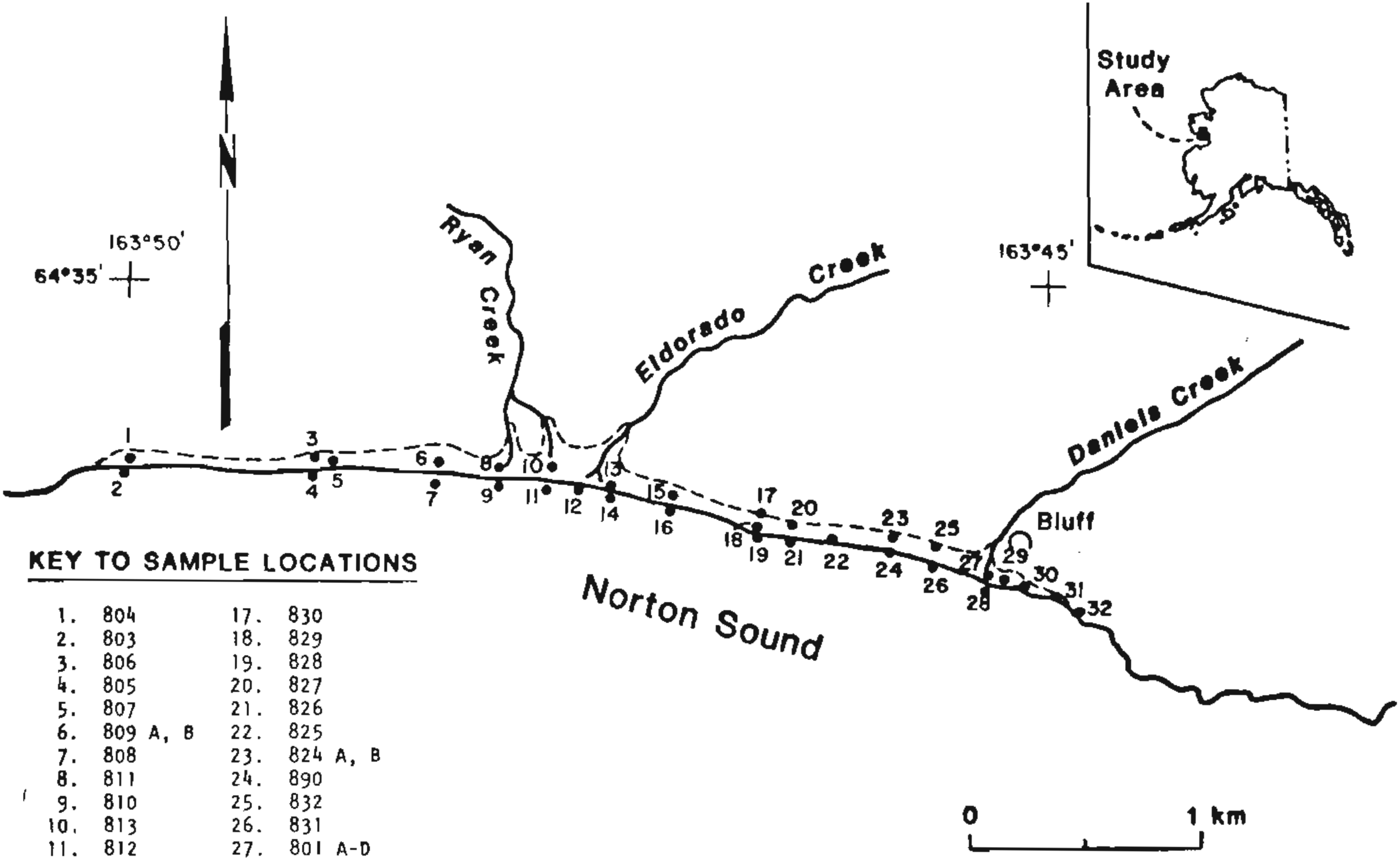
The U.S. Geological Survey began studying the Nome region in 1898, after the discovery of gold on Anvil Creek (Moffitt, 1907). Interest in this region was rekindled in the late 1960's, when the Survey began to examine gold content of nearshore and offshore sediments. The richest concentration of gold was found offshore in coarse, relict sediments near Nome (U.S. Geological Survey, 1969). Nelson and Hopkins (1972) made a detailed study of gold distribution in the northern Bering Sea and related its distribution to sedimentary processes in the area. They found the the relict lag gravels that lie as a veneer over glacial drift near Nome to contain the highest gold content.

SETTING

Bluff, Alaska, lies 50 miles east of Nome in a deep bight on the southern coast of the Seward Peninsula, between Cape Nome on the west and Rocky Point on the east (Fig. 1). The town itself lies at the mouth of Daniels Creek, where the original placers were discovered in September 1899. Bluff quickly became a major gold-producing area. From January to July 1900, a strip of beach less than 1000 feet long yielded $600,000 in gold; in 1904, total gold production exceeded $1 million (Brooks, 1908).

METHODS OF ANALYSIS

Most samples in this study were taken in either the swash zone or at mid-beach. Surface samples were taken with a shovel in the upper 1 inch (2.5 cm) of beach sediment. For subsurface samples, a trench was dug and individual units within the exposed section were sampled according to procedures of stratified sampling. No samples were taken at the contacts between subsurface units. For specific depths at which samples were taken, see Appendix I.



KEY TO SAMPLE LOCATIONS

1.	804	17.	830
2.	803	18.	829
3.	806	19.	828
4.	805	20.	827
5.	807	21.	826
6.	809 A, B	22.	825
7.	808	23.	824 A, B
8.	811	24.	890
9.	810	25.	832
10.	813	26.	831
11.	812	27.	801 A-D
12.	814	28.	819
13.	816	29.	802 A-E
14.	815	30.	823 A
15.	818	31.	821 & 822 A, B
16.	817	32.	820

Figure 1. Index map showing location of study area and sample locations at Bluff, Alaska (U.S. Geological Survey Solomon C-4 Quadrangle).

Black and garnetiferous sands were identified as such from field descriptions (Appendix I). Percentages of heavy minerals were not determined for any sample in this study.

In order to avoid the effects of particle sparsity when analyzing a sample for gold, it is necessary to have an initial sample of at least 25 kg (Clifton and others, 1969). Forty-three samples, ranging in weight from 34.4 to 65.3 kg, were sieved at 1/2 ø intervals from 1.000 mm to 0.044 mm. Most samples were composed of sand- and gravel-size sediment, with less than 2 grams of a size less than 0.044 mm (coarse silt). The 1/2 ø portions from 0.500 mm to less than 0.044 mm of these samples were burned in a Thelco oven at 700°C to destroy all organic content. The samples were then analyzed for gold by atomic-absorption analysis (Van Sickle and Lakin, 1968).

Four samples (802-E, 806, 809-A, and 809-B) contained more than 10 g of material of a silt and clay. These samples were processed slightly differently from the others (see Fig. 2), in order to see if a combination of wet and dry sieving, plus reconstitution of the silt and clay fraction after pipette analysis, resulted in a significant difference in the amount of gold in the 0.044 mm and less than 0.044 mm sizes.

Statistical parameters were calculated with a computer program using the formulas of Folk and Ward (1957). In twelve samples the statistical parameters were bypassed by the computer because the distribution of the sediments was too open-ended for them to be significant (See Appendix I).

Histograms of the size-frequency of sediments and gold and individual plots of the amounts of gold in ppm against the grain-size fraction were drawn for each sample. Four of the 43 histograms are not complete because a given fraction was lost during analysis (see Appendix II).

By convention, sediment size is generally referred to in millimeters (mm), while gold is commonly referred to in microns (μ). Translating these units is simple: 1000μ = 1 mm.

Three calculated values of gold are referred to in this paper, each with a particular significance:

1. The concentration of gold in ppm in each size fraction of a sample:

$$\frac{\text{g Au in size fraction}}{\text{wt. (g) of size fraction of sediment}}$$

2. The weight percent of total gold for each size fraction of a sample:

$$\frac{\text{g Au in size fraction}}{\text{total wt. of gold } (\mu\text{g}) \text{ in sample}}$$

3. The concentration of gold in ppm for each sample:

$$\frac{\text{total } \mu\text{g Au in sample}}{\text{total weight (g) of sediment in sample}}$$

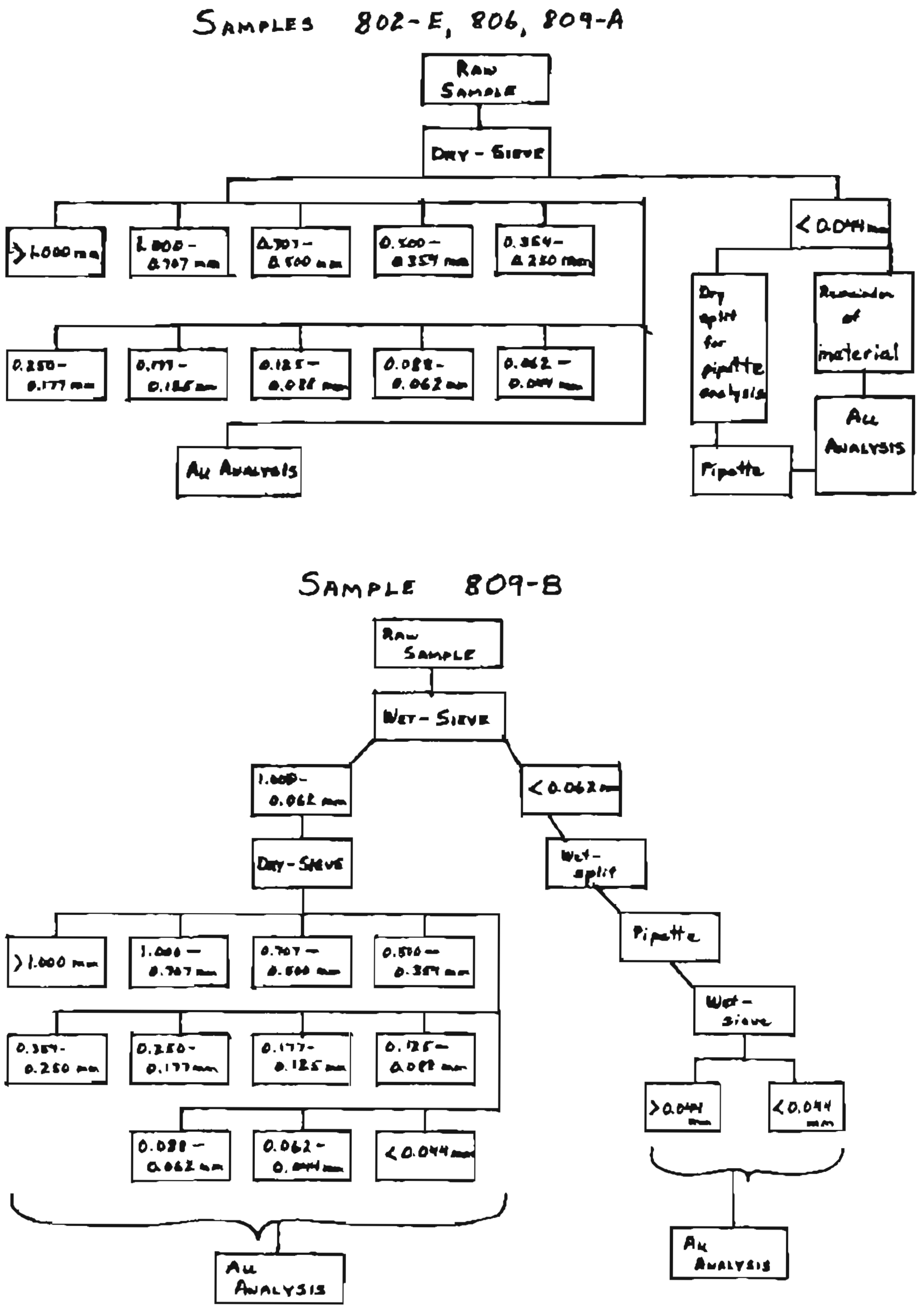


Figure 2. Flow diagram of alternate processing for samples containing more than 10 grams of silt and clay. All other samples in this study needed only to be dry-sieved, because they did not contain enough silt and clay to require wet-sieving. The grain-size ranges in millimeters (mm) in the figure represent ½Ø intervals.

RESULTS

The grain-size and gold content data for all the samples are tabulated in Appendices I and II. A Student's t (sample means) statistical test comparing the gold content in ppm of all samples against those samples with open-ended grain-size distribution showed no significant difference in the gold content between these groups, although only two of these twelve samples contained more than 1.0 ppm gold. There was no significant difference in the amounts of gold detected in the size fractions 0.044 mm and less than 0.044 mm of the four samples processed as illustrated in Figure 2.

Grain Size of Sediments and Gold

Histograms of the grain-size distributions in weight percent for both the sediment and the gold for each sample appear in Appendix III. Twenty-four of the 43 samples have a mean grain size coarser than the mean size of the gold within that sample; an additional 15 samples have approximately equal mean sediment and gold sizes. The remaining 4 samples have a mean grain size finer than the mean size of the gold contained in them.

The mean grain size of the 31 samples for which statistics were calculated is 1.46 Ø (0.36 mm), with a standard deviation of 0.43 Ø (0.74 mm). Only one of these samples (811) was bimodal. The size range which commonly contained the greatest concentration of gold in parts per million (ppm) in all samples was 62 microns (0.062 mm) (Fig. 3a; Appendix IV). However, the greatest weight percent of gold for the sample was in the 250 microns (0.25mm) size fraction (Fig. 3b).

The mean grain size of the 31 samples was compared by a Student's t statistical test with the following groupings of these samples:

1. Samples containing very wide ranges of gold values in ppm among the size fractions,

2. Samples with differences of greater than 10 ppm gold content among the analyzed fractions,

3. Samples with differences of less than 10 pm gold content among the analyzed fractions.

When these three groups were cross-compared, no significant difference could be detected. Grain-size of sediment does not appear to be a significant predictor of how much gold a sample will contain, although coarser-grained samples tend to have higher gold contents overall.

Most of the samples containing the highest concentrations overall of gold are confined to the area from the mouth of Daniels Creek to a point 1 km to the west (Fig. 1). Three samples containing relatively high concentrations were collected near the mouth of Ryan Creek.

While almost no bimodality was detected in the size-frequency of the sediments, the size-frequency of the gold showed bimodality in 19 of the 43

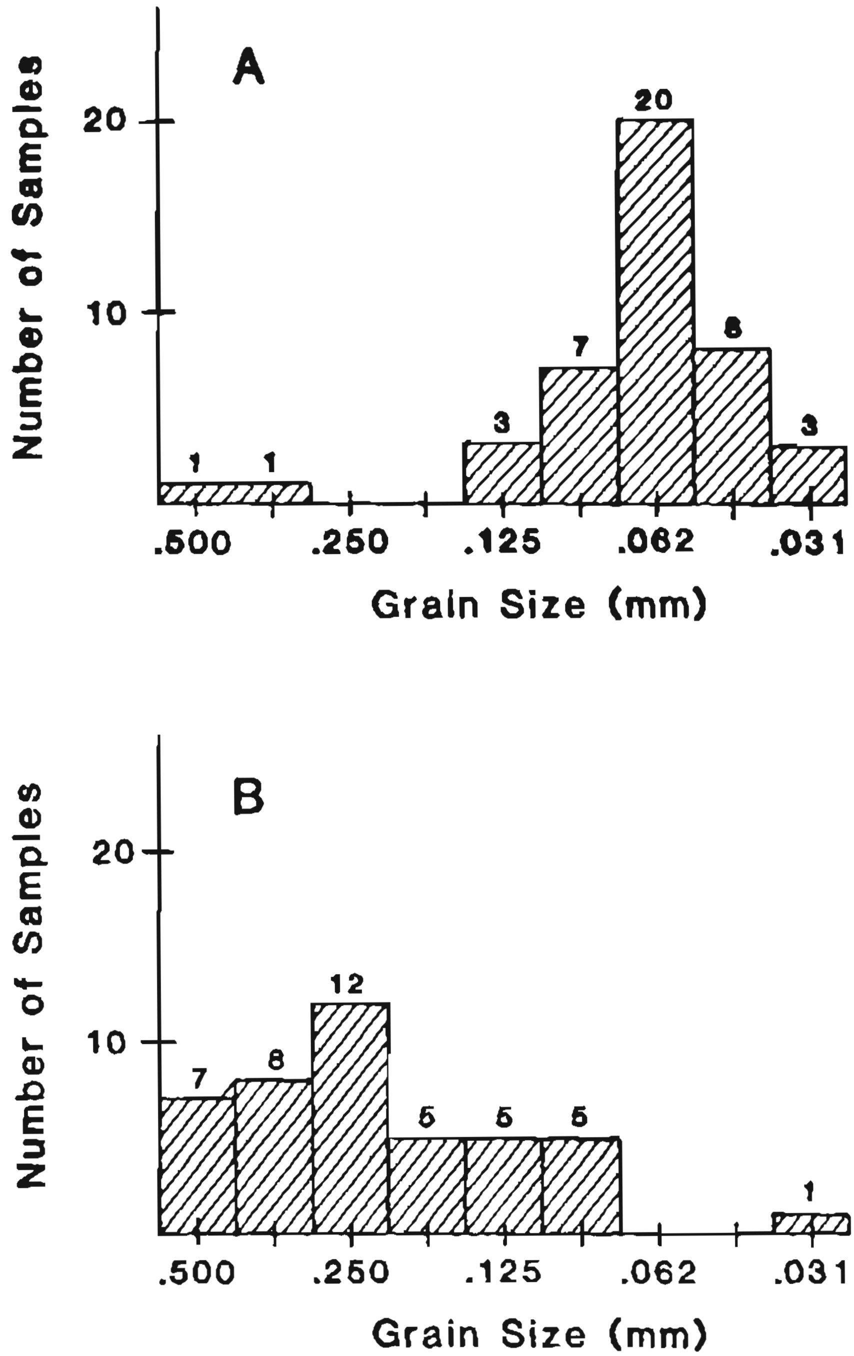


Figure 3. A) Sample fraction containing the highest concentration of gold in ppm. One sample (822-A) had an equally high gold content in both the 0.044 and 0.031 mm fractions.

B) Sample fraction containing the highest weight-percent of gold. Two samples (810 and 828) had equally high weight-percents of gold in the 0.250 and 0.177 mm fractions.

analyzed samples (see Appendix III). This bimodality does not appear to be confined to any one type of sediment, nor is it restricted in geographical distribution of the samples. No previous studies of bimodality of particulate gold are known.

None of the samples in this study were examined microscopically. However, certain assumptions about the gold are probably valid. In sizes greater than 0.5 mm, the weight of gold in micrograms may represent a single flake. With a heavy metal such as gold, the relationship between particle mass and grain size is a function of the metal's specific gravity (Clifton and others, 1969, p. 16, fig. 9). Thus samples which contain 100-500 micrograms of gold in the 0.707 - 0.5 mm range --that gold probably represents a single flake, and possibly a flake attached to an individual sediment grain. On the other hand, gold in samples containing 2500 - 12,000 micrograms in this same size range, represents several flakes of gold, probably both free and attached.

Ten of the samples analyzed contained 100-500 g of gold in the 0.707 - 0.500 mm grain-size fraction. These samples are not geographically restricted. Only four samples (801-D, 802-E, 824-A, and 827) contain over 25 µg of gold within this grain-size fraction. These high "coarse gold" values, however, are found only in samples taken in samples rich in black sand and are confined to an area near the mouth of Daniels Creek at mid-beach.

Concentration of Gold Versus Sediment Texture

Appendix IV contains graphs plotting the concentration of gold in ppm against the grain-size of the sediment containing it for each sample. As noted earlier, the greatest concentration of gold appears around 62 microns (0.062 mm) in the majority of samples. Similar patterns of concentration have been observed in Oregon beach sands (Clifton, Hubert and Phillips, 1967), where most of the gold is concentrated in grain-sizes less than 124 microns (0.124 mm).

The values in ppm of gold were examined as to the type of sediment. The samples were grouped as follows:

1. Very-coarse-sand or gravel samples

2. Black or garnetiferous sand

3. All others (mostly swash-zone samples).

These were compared by a Student's t test to each other and also compared to the average gold in ppm of all samples. The samples collected in the swash zone were significantly lower in gold concentration when compared to the average of all gold values. The greatest range of concentration was found in the black/garnetiferous sands (range from 0.04 to 13.97 ppm), as compared to the range of 0.015 to 0.599 ppm for very-coarse-sand/gravel samples. The highest amounts of gold in ppm were also recorded from the black/garnetiferous sands.

SUMMARY

Particulate gold in the sediments of Bluff Beach, southeast of Nome, Alaska, is concentrated most commonly in the 62-micron size. In samples containing greater than 1 percent of silt and clay-sized material, no significant quantities of gold were found in material of less than 44 micron size. There appears to be no relationship between the mean grain size of a sample and the total amount of gold contained in it. Samples containing significant amounts of black or garnetiferous sand contained the highest amounts of particulate gold. Bimodality in the size-frequency of gold is seen in over half the samples analyzed, while almost no bimodality is detected in the size-frequency of the sediments.

The distribution of gold in the beach sediment near Bluff, Alaska is definitely complex. No unequivocal conclusions about this distribution can be reached at this time.

ACKNOWLEDGMENTS

We thank Frank F.-H. Wang, who collected the samples analyzed in this study; Paula Quinterno, who prepared most of the samples for analysis and assisted in data compilation; A. Graig McHendrie and William C. Todd, who wrote the computer programs used to analyze and plot the data; and Peter W. Barnes for helpful discussions.

REFERENCES

Brooks, A.H., 1908, The Bluff region, in Collins, A.J., Hess, F.L., Smith, P.S., and Brooks, A.H., The gold placers of parts of the Seward Peninsula, including the Nome, Council, Kougawk, Port Clarence, and Goodhope precincts, U.S. Geological Survey Bulletin, 328, p. 283-293.

Clifton, H.E., 1968, Gold distribution in surface sediments on the continental shelf off southern Oregon -- a preliminary report: U.S. Geological Survey Circular 587, 6 p.

Clifton, H.E., Hubert, A., and Phillips, R.L., 1967, Marine sediment sample preparation for analysis for low concentrations of fine detrital gold: U.S. Geological Survey Circular 545, 11 p.

Clifton, H.E., Hunter, R.E., Swanson, F.J., and Phillips, R.L., 1969, Sample size and meaningful gold analysis: U.S. Geological Survey Professional Paper 625-C, 17 p.

Folk, R.L. and Ward, W.C., 1957, Brazos River bar, a study in the significance of grain-size parameters: Journal of Sedimentary Petrology, v. 27, n. 1, p. 3-27.

Gulbrandsen, R.A., Rail, Norma, Krier, D.J., Baedecker, P.A., and Childress, Anne, 1978, Gold, silver, and other resources in the ash of incinerated sewage sludge at Palo Alto, California -- a preliminary report: U.S. Geological Survey Circular 784, 7 p.

Moffitt, F.H., 1907, The Nome region, in Report on progress of investigations of mineral resources in Alaska in 1906, U.S. Geological Survey Bulletin 314-G, p. 126-145.

Nelson, C.H., and Hopkins, D.M., 1972, Sedimentary processes and distribution of particulate gold in the northern Bering Sea: U.S. Geological Survey Professional Paper 689, 27 p.

U.S. Geological Survey, 1968, U.S. Geological Survey Heavy metals program progress report, 1966 and 1967: U.S. Geological Survey Circular 560, 24 p.

U.S. Geological Survey, 1969, U.S. Geological Survey Heavy Metals program progress report 1968 -- field studies: U.S. Geological Survey Circular 621, 34 p.

Van Sickle, G.H., and Lakin, H.W., 1968, An atomic-absorption method for determination of gold in large samples of geologic materials: U.S. Geological Survey Circular 561, 4 p.

APPENDIX I

Field descriptions and grain-size data for analyzed samples, using statistical parameters of Folk and Ward (1957). Where statistics are not given, the grain-size distribution was too open-ended to be meaningful, so the computer did not calculate it. A copy of the Wentworth grade scale, comparing millimeter and phi (ø) units, precedes the data in this Appendix.

GRAIN SIZE SCALES FOR SEDIMENTS

The grade scale most commonly used for sediments is the Wentworth scale (actually first proposed by Udden), which is a logarithmic scale in that each grade limit is twice as large as the next smaller grade limit. For more detailed work, sieves have been constructed at intervals $\sqrt[2]{2}$ and $\sqrt[4]{2}$. The ø (phi) scale, devised by Krumbein, is a much more convenient way of presenting data than if the values are expressed in millimeters, and is used almost entirely in recent work.

U.S. Standard Sieve Mesh #	Millimeters	Millimeters	Microns	Phi (ø)	Wentworth Size Class	
		4096		-12		GRAVEL
		1024		-10	Boulder (-8 to -12ø)	
Use		256		-8		
wire		64		-6	Cobble (-6 to -8ø)	
squares		16		-4	Pebble (-2 to -6ø)	
5		4		-2		
6		3.36		-1.75		
7		2.83		-1.5	Granule	
8		2.38		-1.25		
10		2.00		-1.0		
12		1.68		-0.75		SAND
14		1.41		-0.5	Very coarse sand	
16		1.19		-0.25		
18		1.00		0.0		
20		0.84		0.25		
25		0.71		0.5	Coarse sand	
30		0.59		0.75		
35	1/2	0.50	500	1.0		
40		0.42	420	1.25		
45		0.35	350	1.5	Medium sand	
50		0.30	300	1.75		
60	1/4	0.25	250	2.0		
70		0.210	210	2.25		
80		0.177	177	2.5	Fine sand	
100		0.149	149	2.75		
120	1/8	0.125	125	3.0		
140		0.105	105	3.25		
170		0.088	88	3.5	Very fine sand	
200		0.074	74	3.75		
230	1/16	0.0625	62.5	4.0		
270		0.053	53	4.25		MUD
325		0.044	44	4.5	Coarse silt	
		0.037	37	4.75		
	1/32	0.031	31	5.0		
	1/64	0.0156	15.6	6.0	Medium silt	
Analyzed	1/128	0.0078	7.8	7.0	Fine silt	
by	1/256	0.0039	3.9	8.0	Very fine silt	
		0.0020	2.0	9.0		
Pipette		0.00098	0.98	10.0	Clay	
		0.00049	0.49	11.0		
or		0.00024	0.24	12.0		
		0.00012	0.12	13.0		
Hydrometer		0.00006	0.06	14.0		

From Folk, R.L., 1965, Petrology of sedimentary rocks: Hemphill's, Austin, Texas, p. 25.

Appendix I Grain-Size data, statistical parameters of Folk and Ward (1957)

Sample No.	Description	Mean Grain Size,φ	Sorting,φ	Mode(s),φ
801-A	cse gray sand w/granules; upper 2 in.	1.67	0.507	1.75
801-B	cse black sand, from a 2-in. thick bed 1 ft. below surface	1.70	0.333	1.75
801-C	cse black sand, from a 1-ft. thick bed 1.75 ft. below 801-B	1.23	0.415	1.25
801-D	basal gravel w/ black sand; about 4 ft. below surface			1.25
802-A	cse gray sand; upper 2 in.	1.34	1.060	1.75
802-B	cse black sand w/gray sand laminations; from a 4-in. thick bed below 802-A	1.01	0.592	1.25
802-C	pebbly gray sand; from a 4-in. thick bed below 802-B			1.25
802-D	pebbly gray sand; from a 6-in. thick bed below 802-C			1.25
802-E	gravel and gray sand from a worked-out paystreak below 802-D			0.75, 4.25, 5.50
803	cse gray sand from swash zone; upper 1 in.	2.33	0.344	2.25
804	vcg gray sand w/granules in a sand patch above swash zone; upper 1 in.			2.25
805	cse gray sand from swash zone; upper 1 in.	1.97	0.731	2.25
806	pebbly cse gray sand from mid-beach; upper 3 in.			4.25, 5.50
807	cse garnetiferous sand w/ some pebbles; upper 1 in.	1.20	0.548	1.25
808	gravelly cse gray sand from swash zone; upper 1 in.			1.75
809-A	vcg olive-brown sand 3/granules, pebbles & brown clay; upper 2 in.			4.25, 6.50
809-B	olive-brown silty clay w/ few granules; 1 ft. below 809-A			3.25, 4.25
810	cse sand w/ black and garnetiferous grains from swash zone; upper 1 in.	1.34	0.814	1.75
811	garnetiferous sand w/ cse yellow sand layers from mid-beach; upper 2 in.	1.26	0.475	0.25 and 1.25
812	gray sand from swash zone; upper 1 in.	1.94	0.842	2.25
813	vcg gray sand from mid-beach; upper 3 in.	0.93	0.730	1.25
814	gray sand from swash zone; upper 1 in.	2.04	0.520	2.25
815	gray sand from swash zone; upper 1/2 in.	1.78	0.493	1.75
816	vcg gray sand w/ granules from mid-beach; upper 1 in.			1.25
817	gray sand from swash zone; upper 1 in.	1.68	0.431	1.75
818	vcg gray sand w/ granules from mid-beach; upper 2 in.	0.66	0.680	0.75
819	vcg gray sand w/ granules from swash zone; upper 1 in.	1.30	0.771	1.75
820	gray and black sand from swash zone among boulders; upper 1 in.	0.96	0.646	0.75
821	gray sand from swash zone; upper 1 in.	1.55	0.634	1.75
822-A	cse gray sand w/ dark laminations from mid-beach; upper 2 in.	1.52	0.761	1.75
822-B	vcg sand and granules; 6 in. below 822-A			1.25
823-A	cse black sand from mid-beach; 2 in. below surface	1.16	0.538	1.25
824-A	black sand w/ few gray laminations; upper 2 in.	0.91	0.578	0.75
824-B	olive-brown sand w/ black grains below a 5-in. thick gravel bed below 824-A	0.76	0.636	0.75
825	black sand from mid-beach; upper 1/4 in.	1.87	0.332	1.75
826	gray sand from swash zone; upper 1 in.	1.86	0.556	2.25
827	black sand from mid-beach; 3 in. below surface	1.03	0.542	1.25
828	gray sand from swash zone; upper 1 in.	1.85	0.438	1.75
829	thin veneer of black sand from beach ridge	1.85	0.456	1.75
830	black sand pocket among boulders; 2 in. below surface			0.25
831	gray sand from swash zone; upper 1 in.	1.77	0.739	1.75
832	black sand w/ gray laminations; 5 in. below surface	0.92	0.542	0.75
890	gray sand from swash zone; upper 1 in.	1.80	0.555	1.75

Notes: cse = coarse-grained
vcg = very coarse-grained
Samples taken in "upper x inches" are surface samples.

APPENDIX II

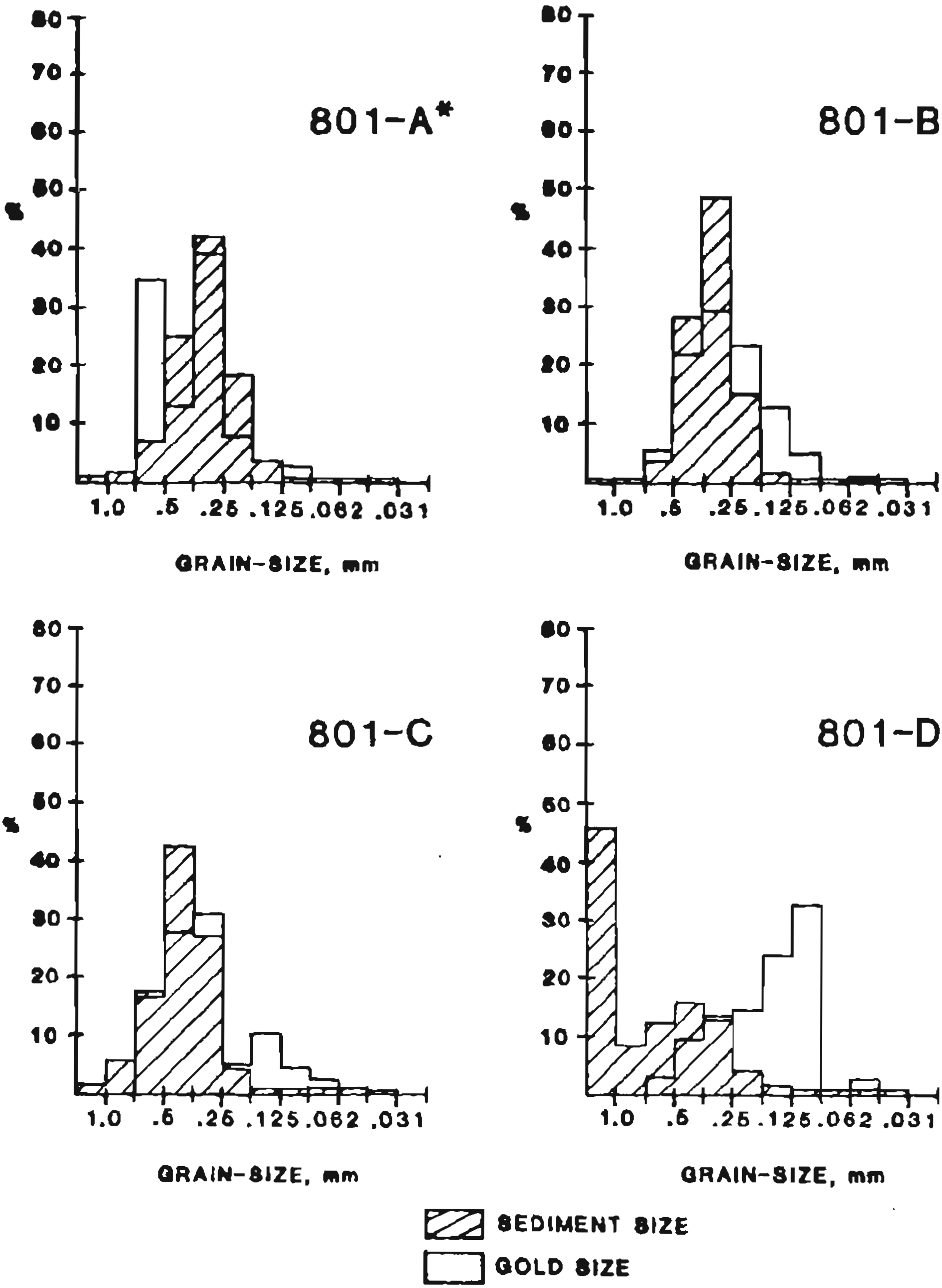
Gold data for analyzed samples. Some samples lack values for certain size fractions, because the test tube containing the sample was broken during the atomic-absorption analysis. Therefore total values for these starred samples are minimum values.

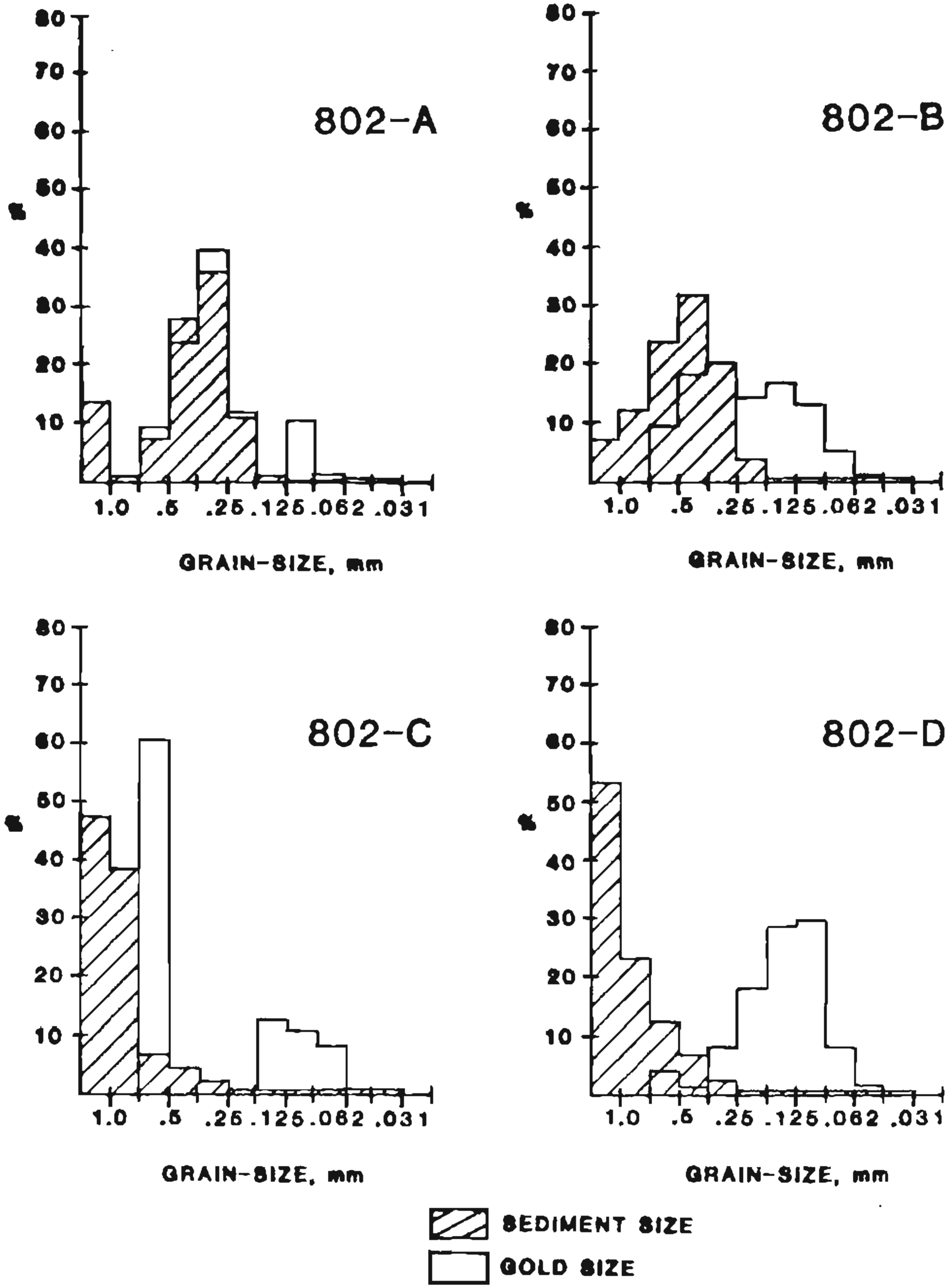
Appendix II - Gold data

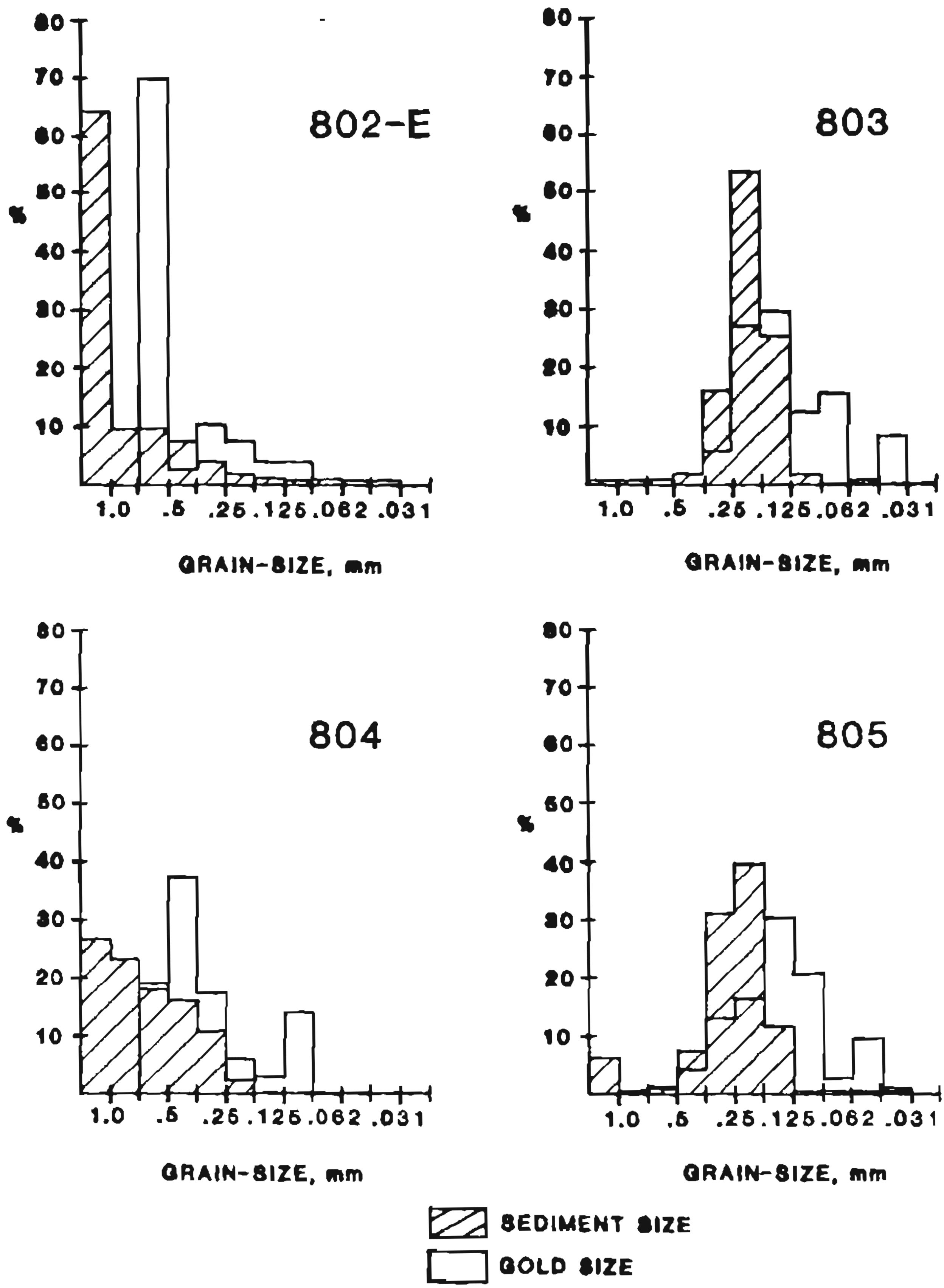
Sample No	Initial wt. of sample for Au analysis (g)	Total µg Au	Total ppm Au	Range of ppm Au	Size fraction (mm) containing largest concentration of Au in ppm.
801-A	4905	548.1	0.1117	0.05-0.87	.088 (62,44 & <44 portions lost)
801-B	4848	807.9	0.1438	0.11-16.8	.044
801-C	5091	1014.6	0.1993	0.20-42.5	.062
801-D	5266	73,522.0	13.97	4.1-314.3	.125
802-A	4907	447.4	0.0912	0.08-9.3	.062
802-B	6003	7790	1.2977	0.52-650.1	.062
802-C	5204	318.3	0.0610	0.06-45.1	.062
802-D	5257	3146.8	0.5986	0.11-343.0	.062
802-E	5928	17,230.4	2.91	0.68-21.35	.500
803	5456	74.3	0.128	<0.003-11.4	.062
804	5349	33.7	0.0061	0.01-2.4	.088
805	5271	47.5	0.0085	0.003-12.9	.044
806	6039	693.2	0.1148	0.05-2.15	.177
807	6460	1369.2	0.2119	0.08-48.0	.088
808	6179	610.9	0.0989	0.01-204.0	.044
809-A	5178	863.6	0.1668	0.03-4.0	.125
809-B	3449	46.2	0.0134	0.008-0.099	.062
810	6116	1461.6	0.2390	0.05-138.6	.062
811	6046	5117.6	0.8464	0.24-37.0	.125 (88,62,44 and <44 portions lost)
812	5287	154.5	0.0293	0.003-56.4	.044
813	4997	73.3	0.0146	0.01-8.3	.062
814	5054	139.7	0.0270	0.0006-32.2	.044
815	4884	88.8	0.0182	0.008-8.8	.062
816	5339	106.0	0.0197	0.02-3.3	.088
817	4810	114.4	0.0238	0.02-3.7	.062
818	5427	309.6	0.0569	0.05-5.6	.088
819	4822	103.4	0.0214	0.01-15.6	.062
820	5551	869.2	0.1566	0.011-10.6	.062
821	5098	110.3	0.0216	0.01-8.6	.044
822-A	4907	200.6	0.0409	0.02-0.13	.044 and <.044 (equal amounts)
822-B	5275	569.6	0.1080	0.09-10.0	.062
823-A	5537	4557.6	0.8231	0.05-303.3	.062
824-A	6526	6127.4	0.9389	0.37-144.0	.062
824-B	3923	2345.0	0.5978	0.11-80.0	.062
825	5388	4376.2	0.8122	0.31-227.6	.062
826	4813	184.9	0.0384	0.01-3.0	<.044 (62 portions lost)
827	6275	16,344.0	2.6046	1.0-1640.0	.088
828	4203	252.3	0.0600	0.068-8.6	.062 (88 portions lost)
829	5703	5967.6	1.0464	0.25-460.0	.062
830	5639	699.7	0.1241	0.08-0.82	<.044
831	4458	617.2	0.1373	0.06-28.9	.062
832	4695	16,760.0	3.5697	0.35-1117.7	.088
890	3970	136.4	0.0344	0.02-2.5	.062

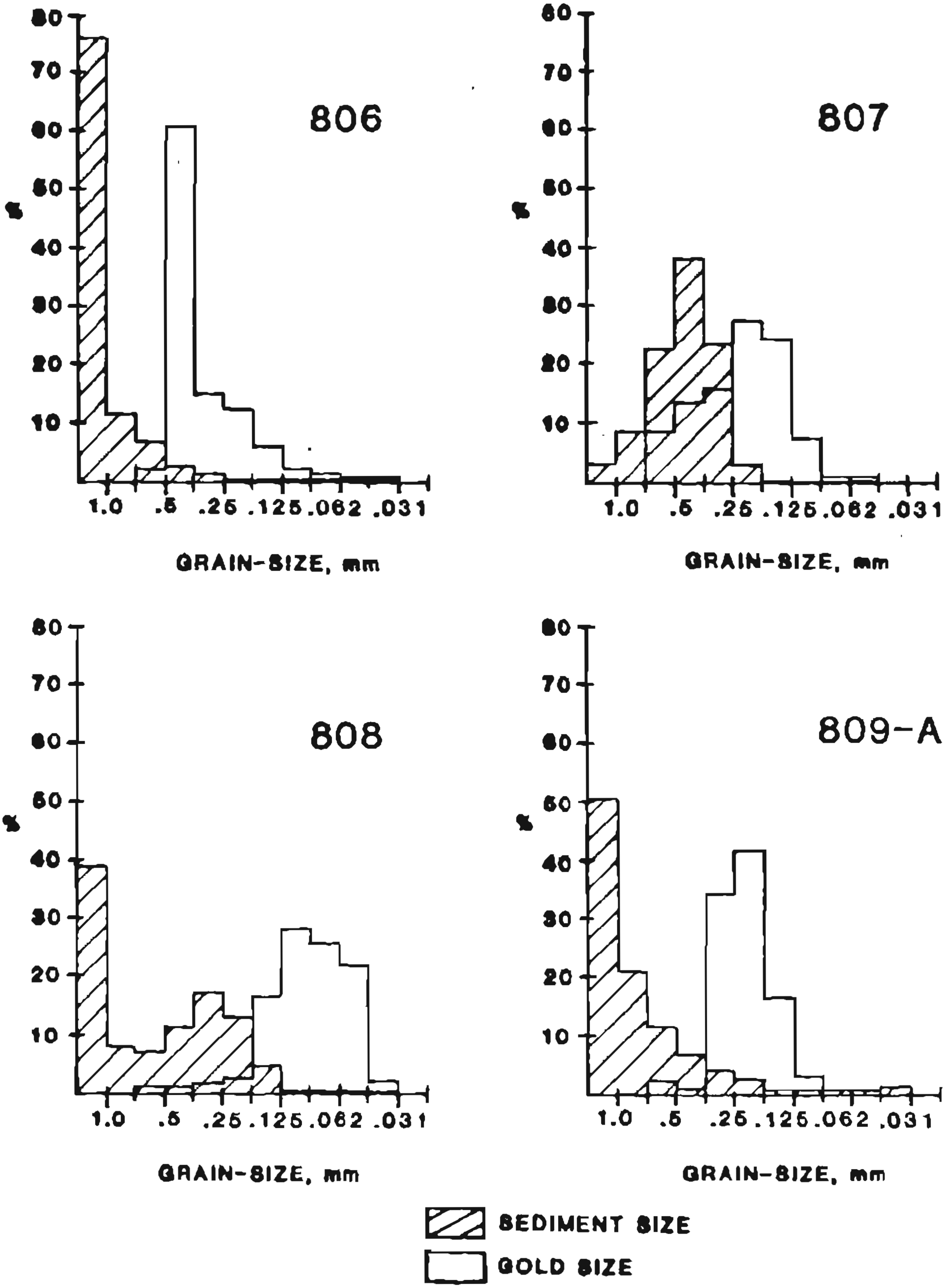
APPENDIX III

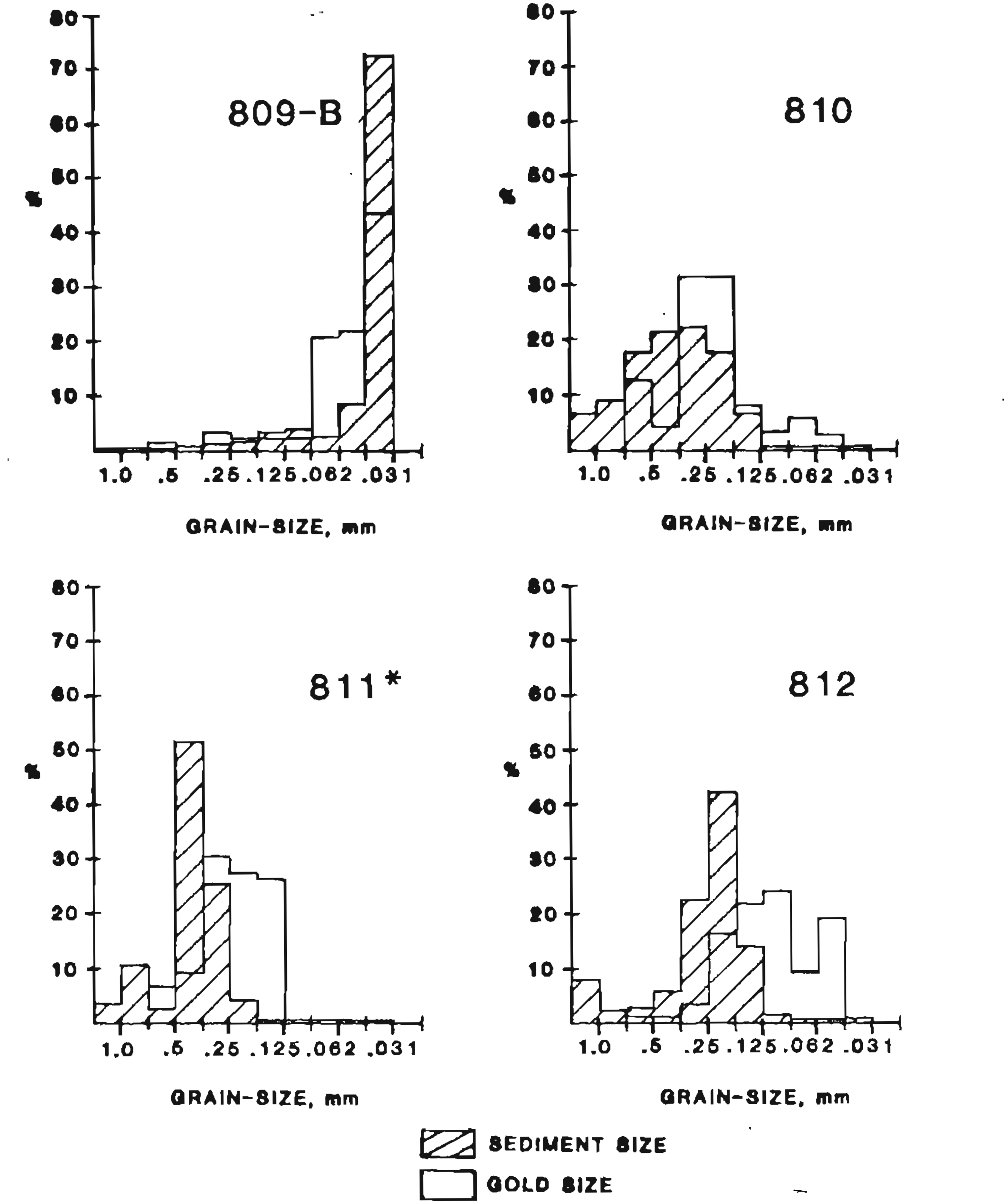
Histograms comparing the size-frequency of the sediment and gold for each sample. Four samples do not show complete gold histograms because one or more portions of the sample were lost during atomic absorption analysis. These samples are designated with asterisks. See also Appendix II.

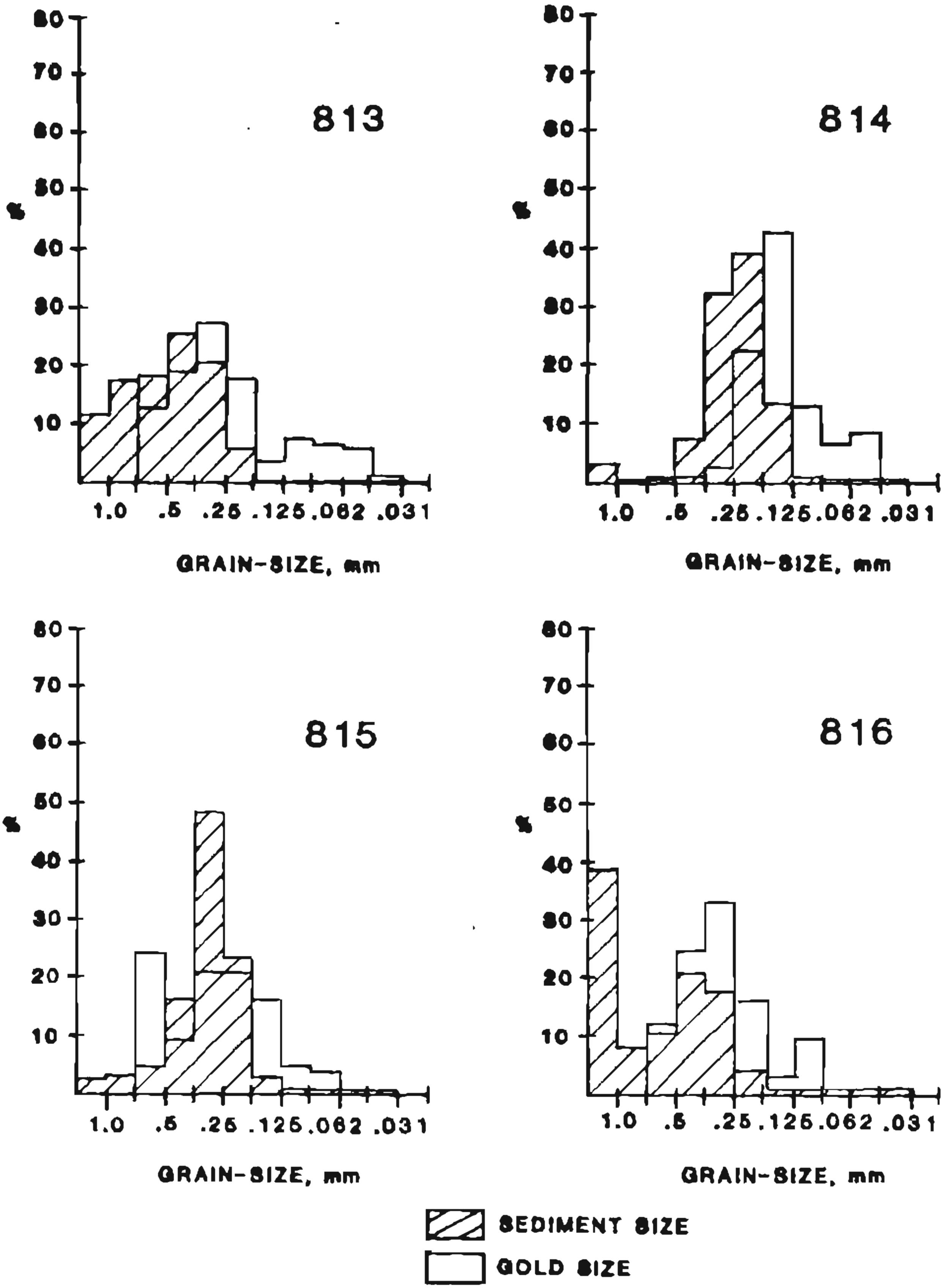

801-A*
801-B
801-C
801-D
%
GRAIN-SIZE, mm
1.0 .5 .25 .125 .062 .031
SEDIMENT SIZE
GOLD SIZE

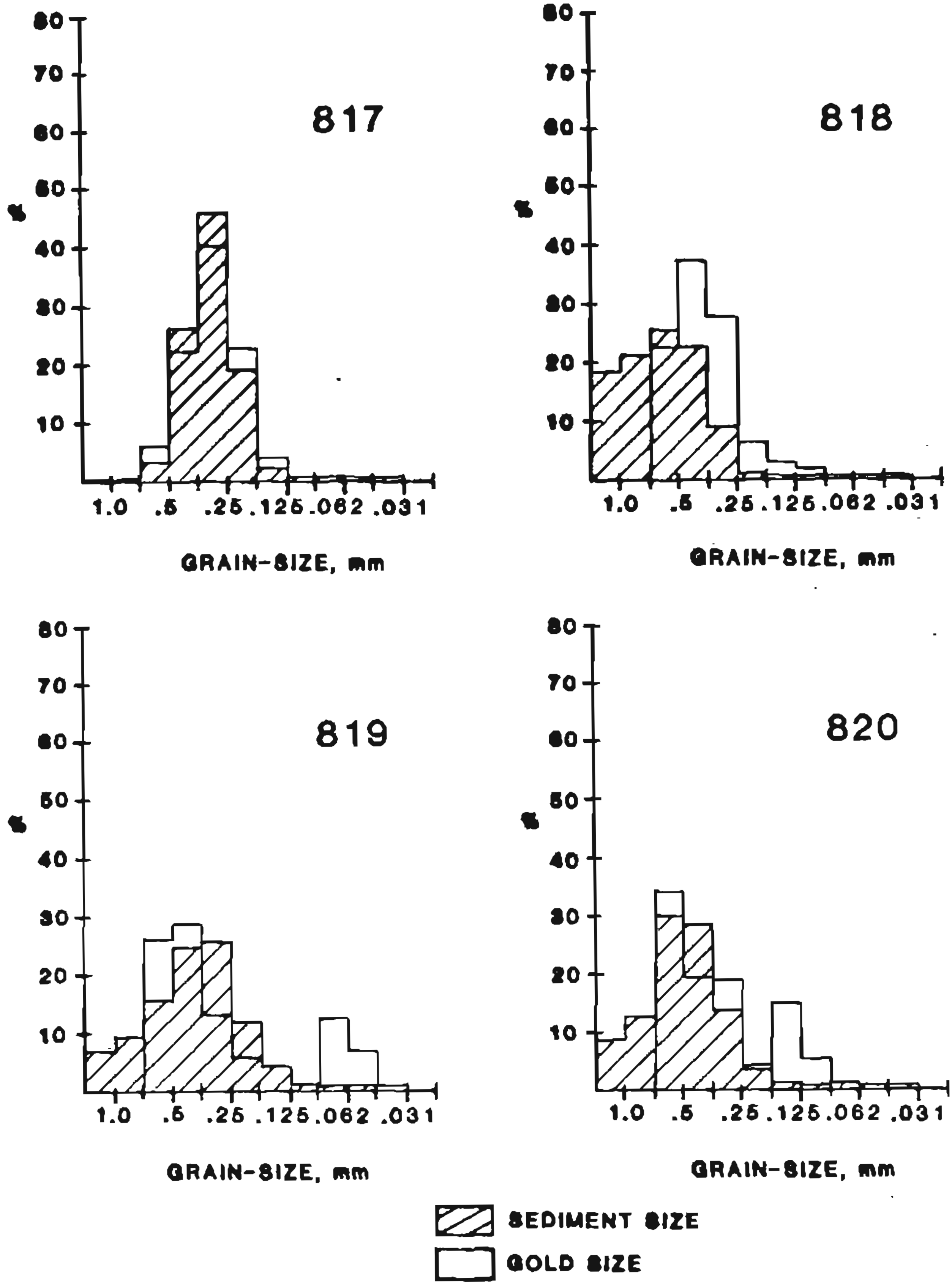

802-A
802-B
802-C
802-D
%
80
70
60
50
40
30
20
10
1.0
.5
.25
.125
.062
.031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE

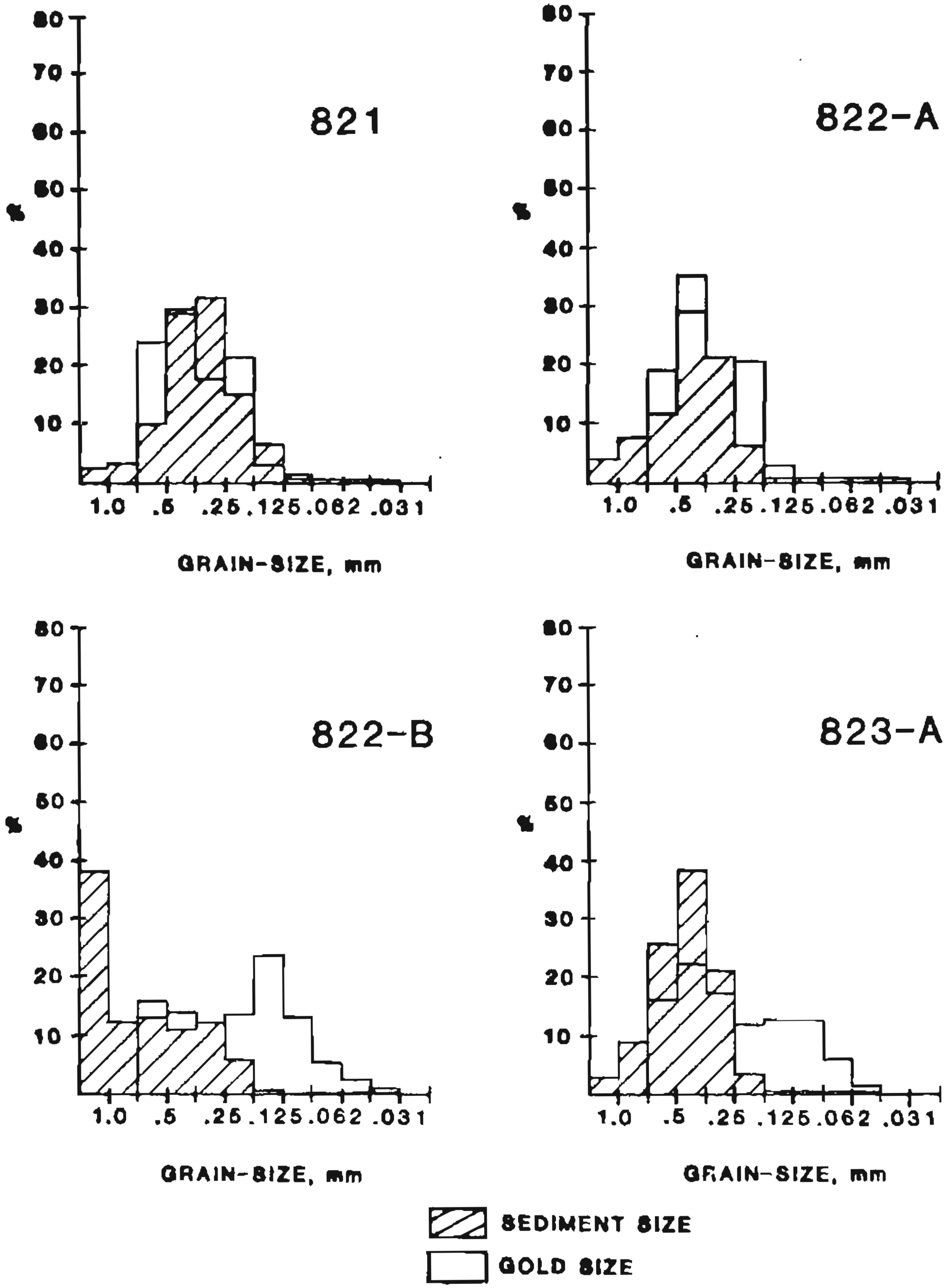

802-E
803
804
805
%
80
70
60
50
40
30
20
10
1.0 .5 .25 .125 .062 .031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE

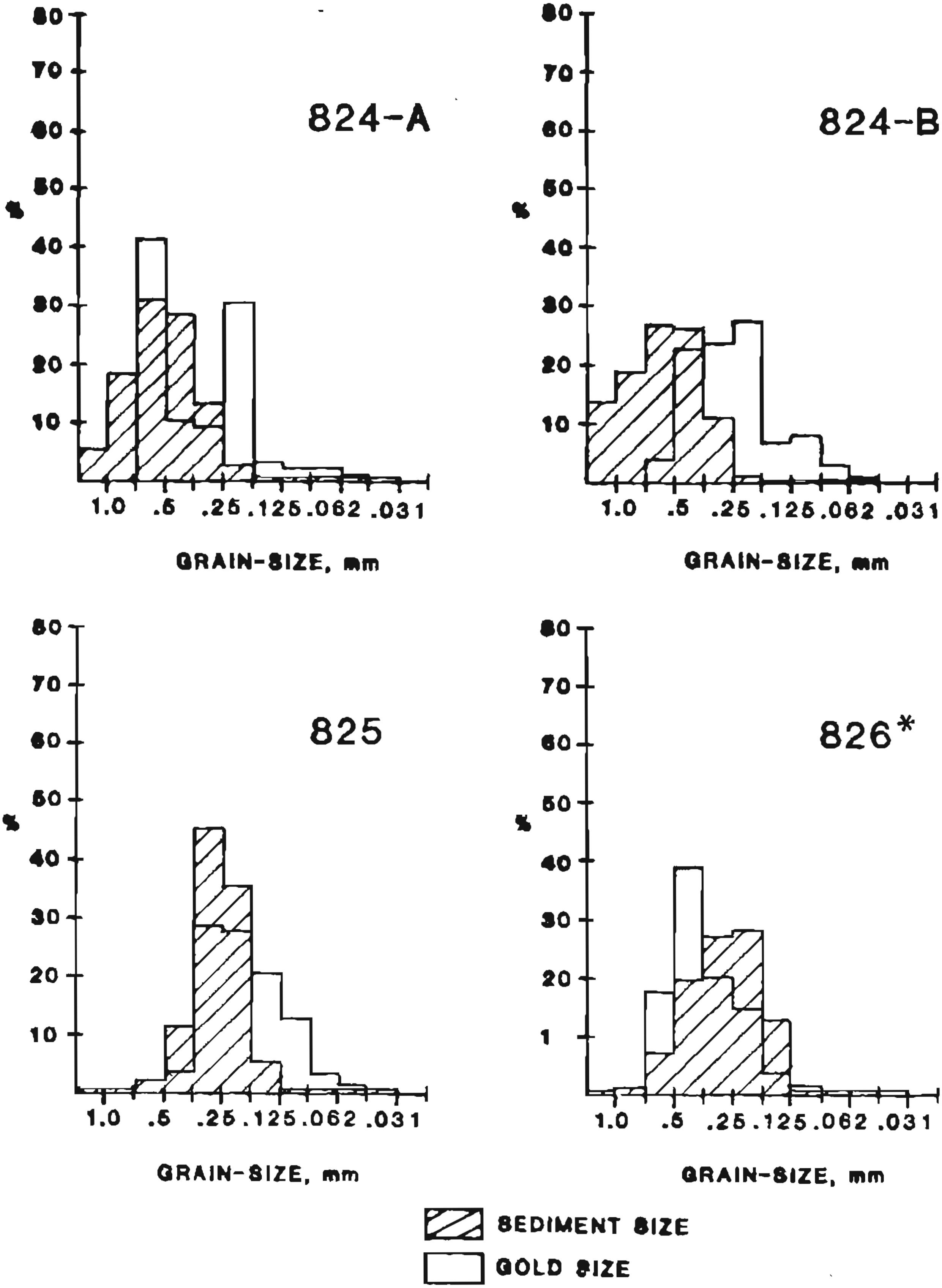

806
807
808
809-A
%
80
70
60
50
40
30
20
10
1.0 .5 .25 .125 .062 .031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE

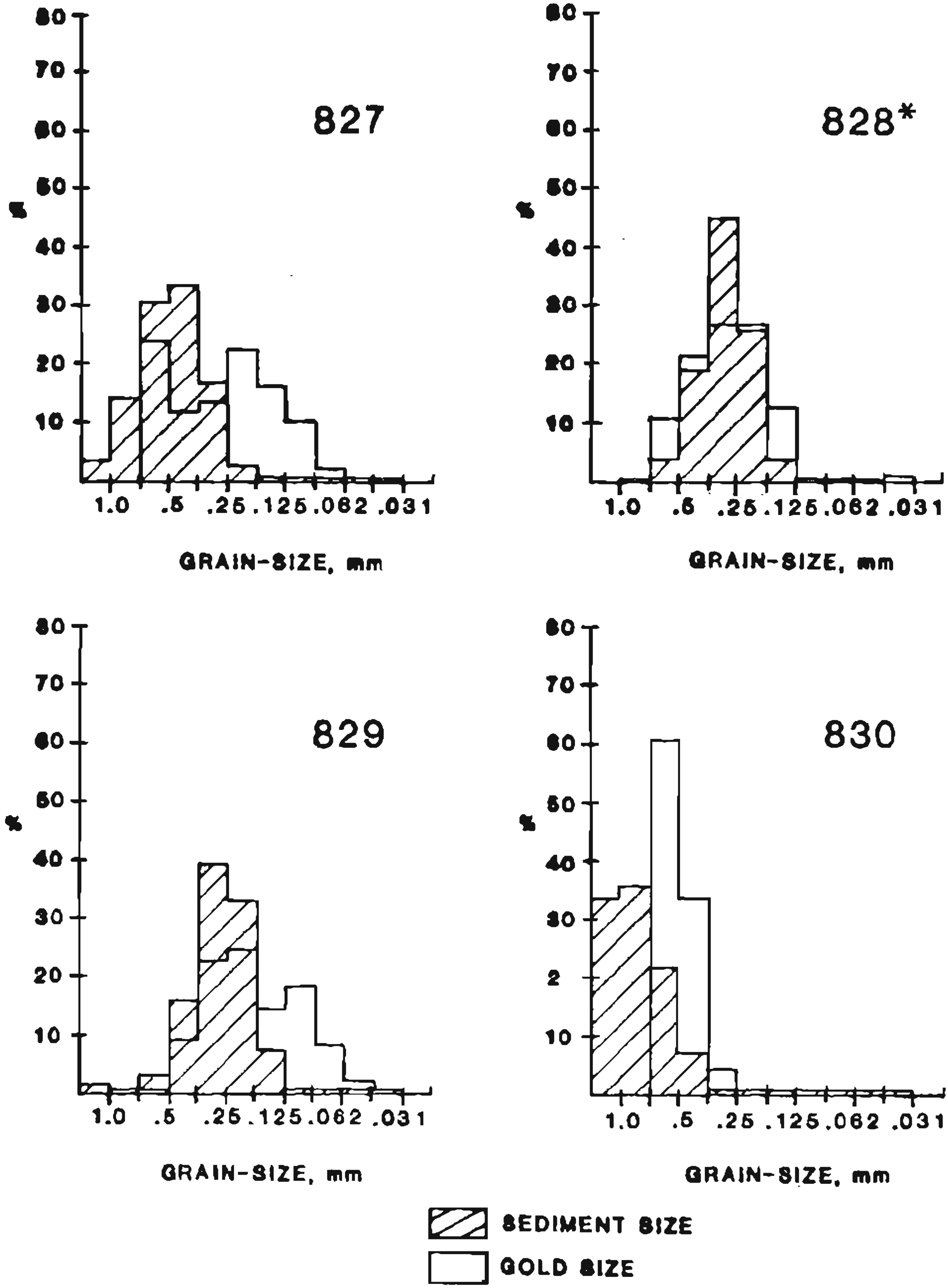

809-B
810
811*
812
%
80
70
60
50
40
30
20
10
1.0 .5 .25 .125 .062 .031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE

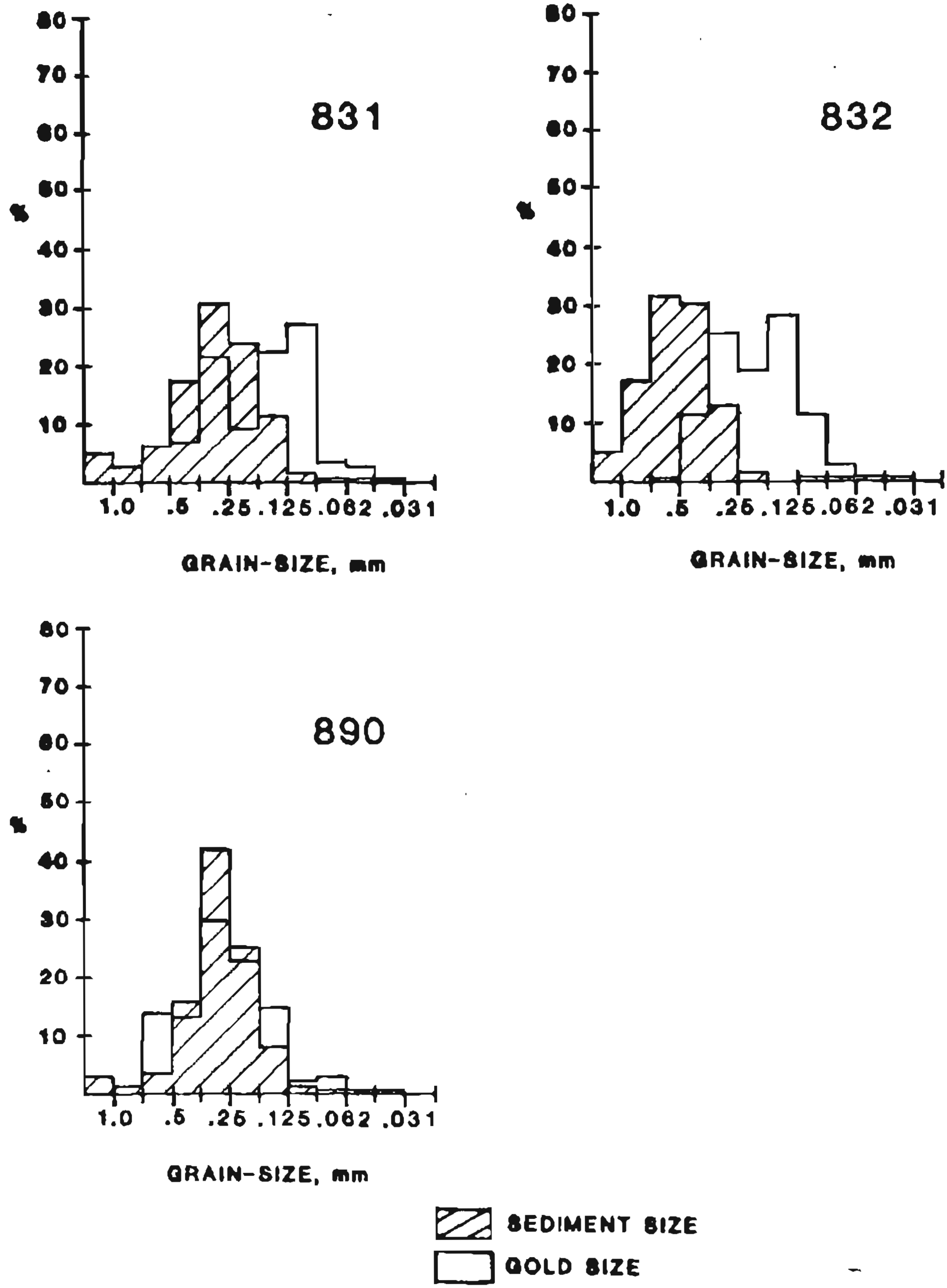

813
814
815
816
%
80
70
60
50
40
30
20
10
1.0 .5 .25 .125 .062 .031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE


817
818
819
820
80
70
60
50
40
30
20
10
%
1.0
.5
.25
.125
.062
.031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE


821
822-A
822-B
823-A
%
80
70
60
50
40
30
20
10
1.0
.5
.25
.125
.062
.031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE

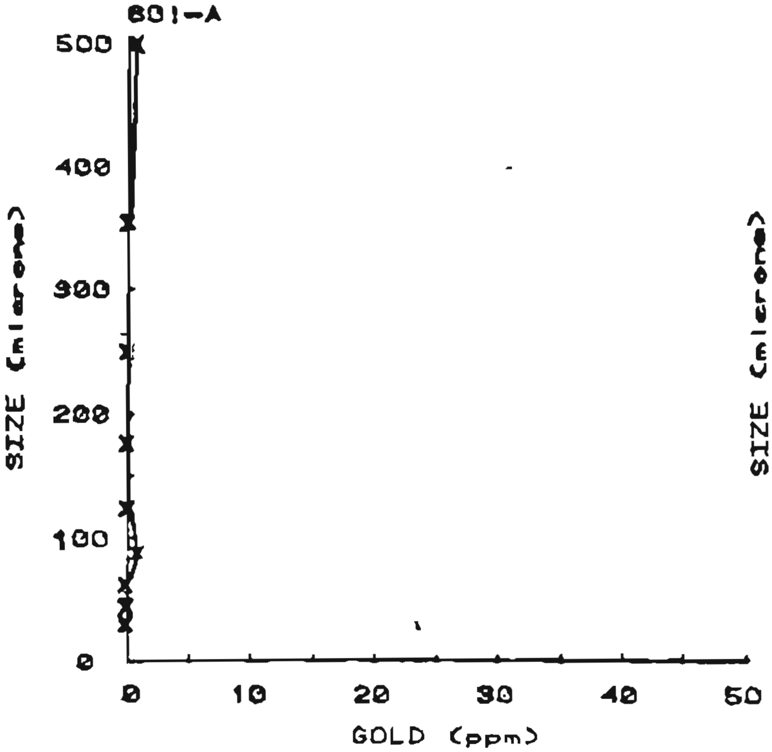

824-A
824-B
825
826*
%
80
70
60
50
40
30
20
10
1.0 .5 .25 .125 .062 .031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE

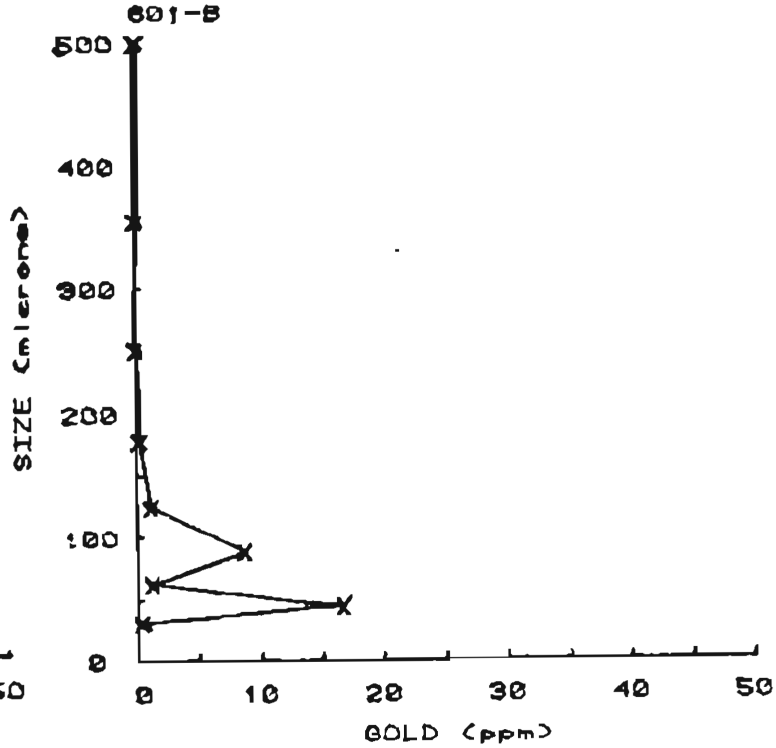

827
828*
829
830
80
70
60
50
%
40
30
20
10
1.0
.5
.25
.125
.062
.031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE

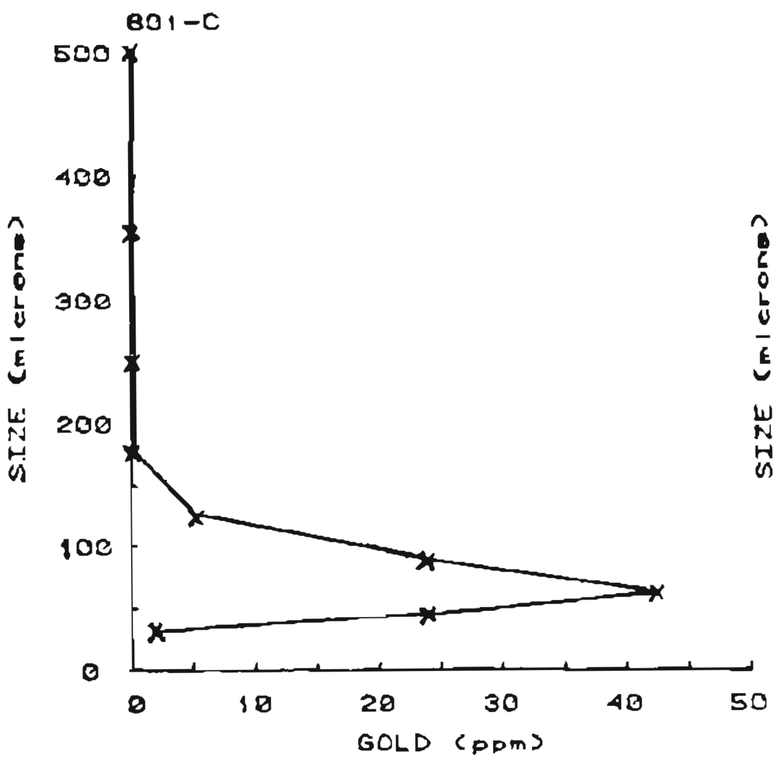

831
832
890
%
80
70
60
50
40
30
20
10
1.0
.5
.25
.125
.062
.031
GRAIN-SIZE, mm
SEDIMENT SIZE
GOLD SIZE

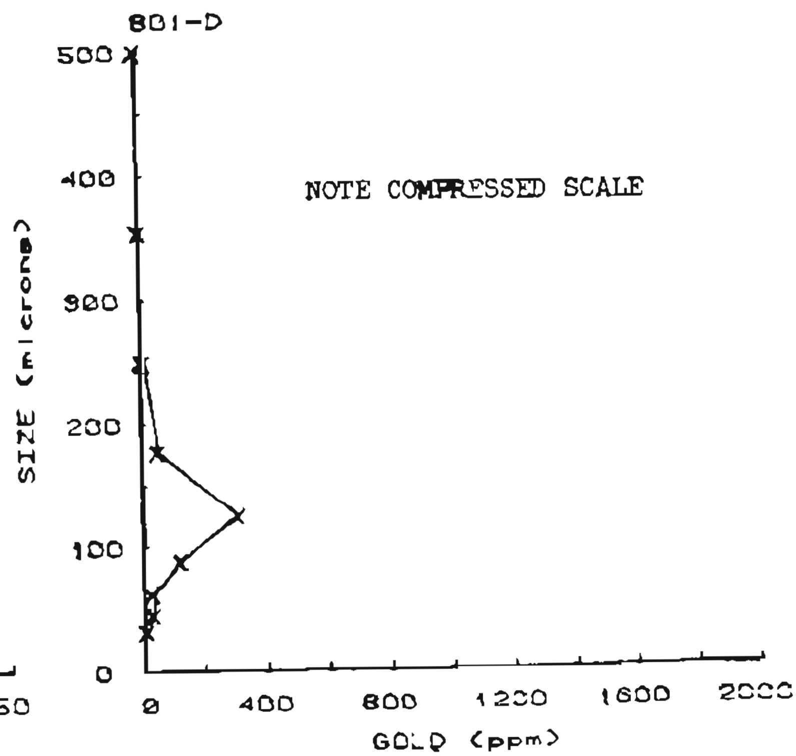
APPENDIX IV

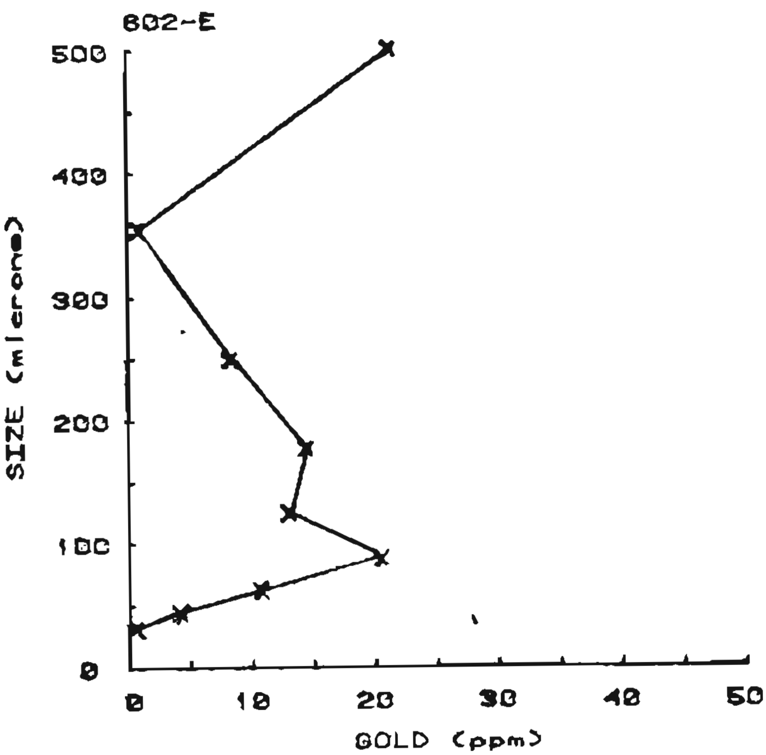
Individual sample plots of the concentration of gold in parts per million (ppm) versus the size of the gold in microns. Several samples are plotted on compressed scales; these are noted on the graphs.

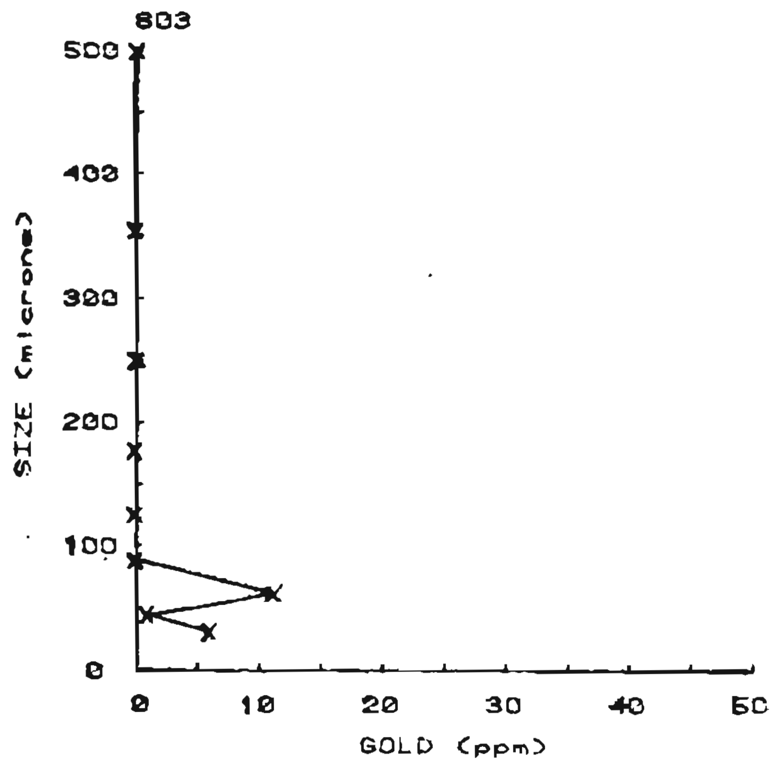

801-A
SIZE (microns)
GOLD (ppm)
0
10
20
30
40
50
100
200
300
400
500

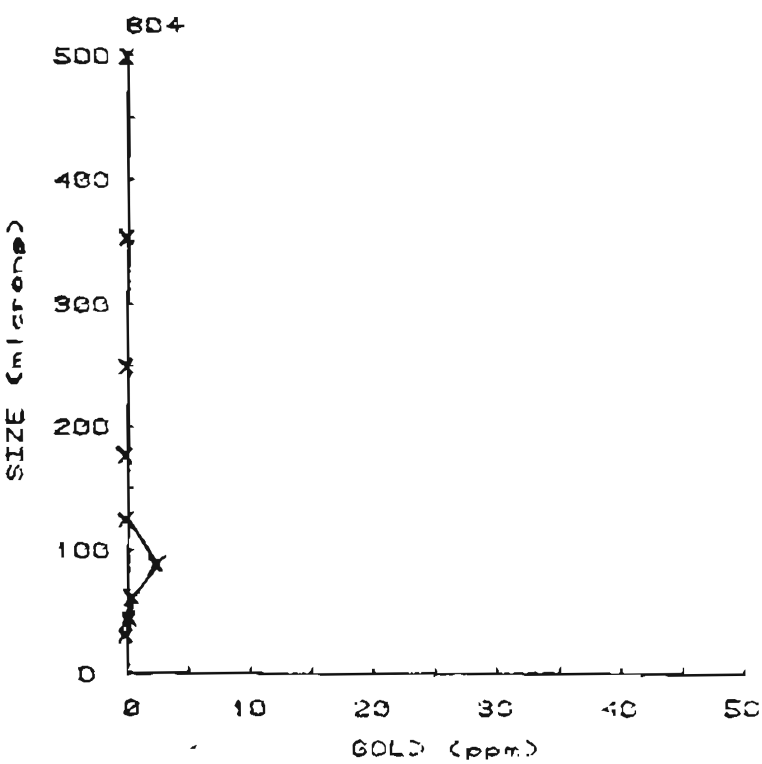

801-B
SIZE (microns)
GOLD (ppm)
0
10
20
30
40
50
100
200
300
400
500

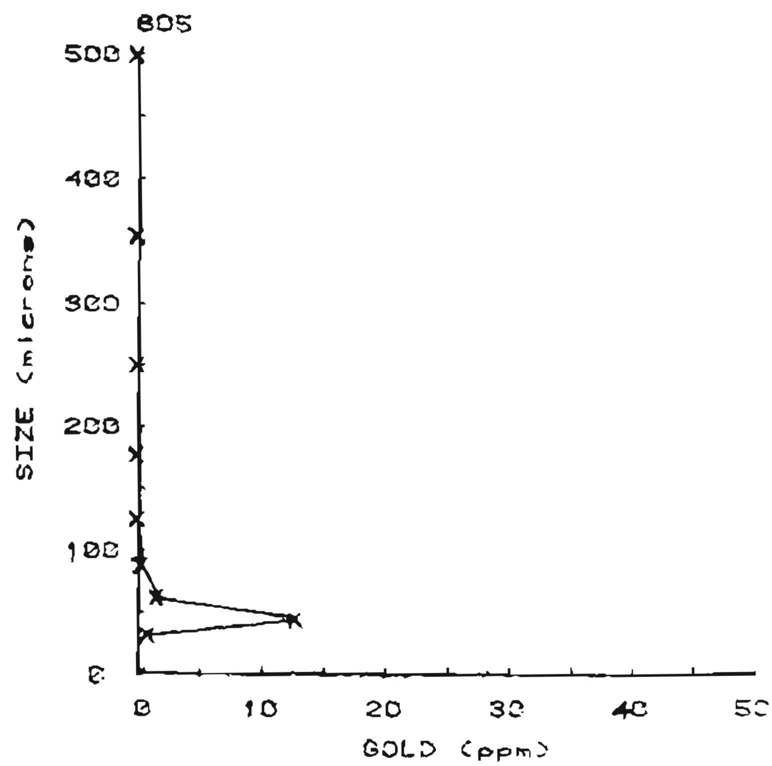

801-C
SIZE (microns)
GOLD (ppm)
0
10
20
30
40
50
100
200
300
400
500

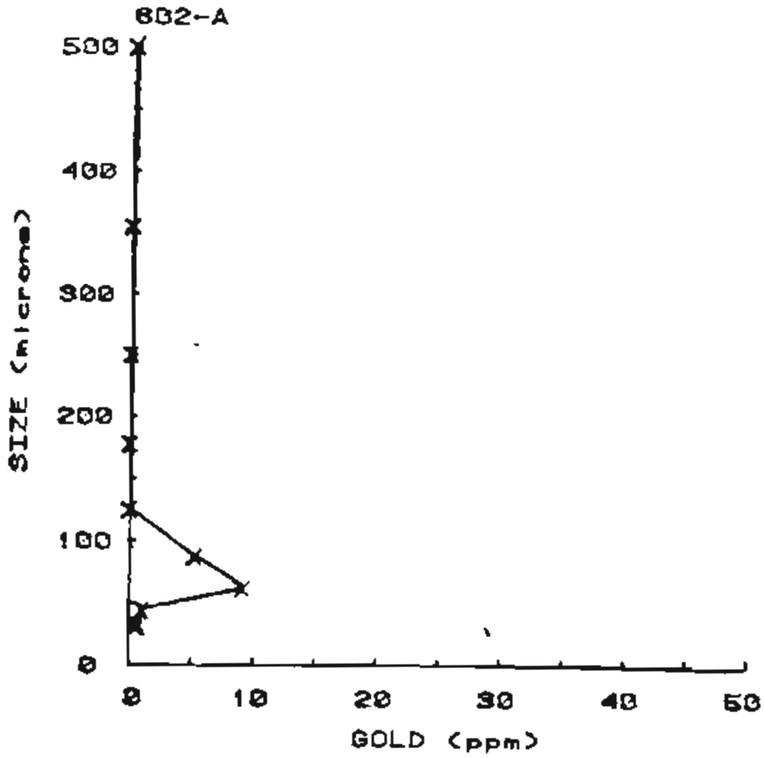

801-D
NOTE COMPRESSED SCALE
SIZE (microns)
GOLD (ppm)
0
400
800
1200
1600
2000
100
200
300
400
500

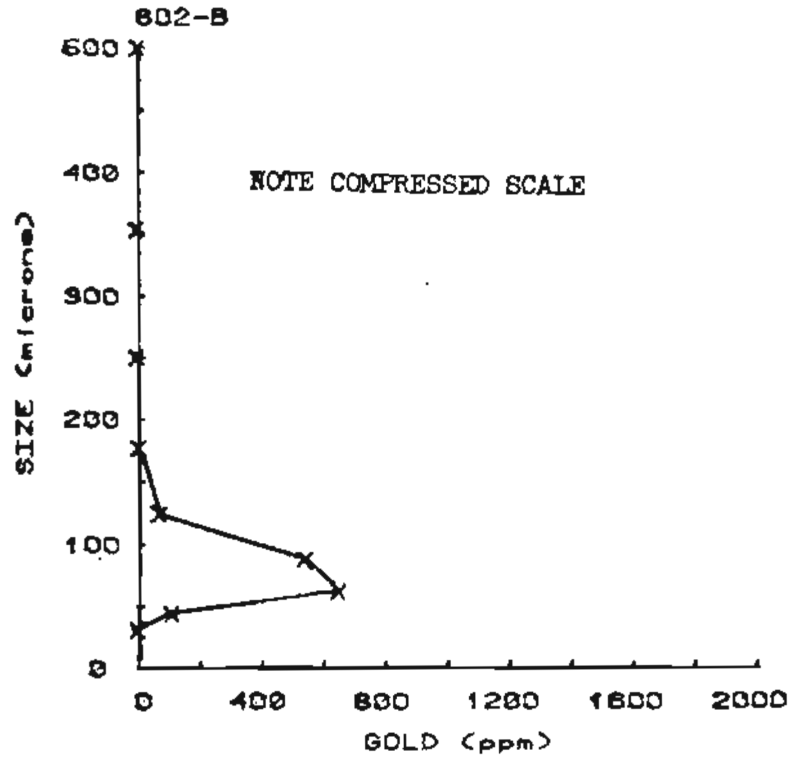

802-E
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
10
20
30
40
50

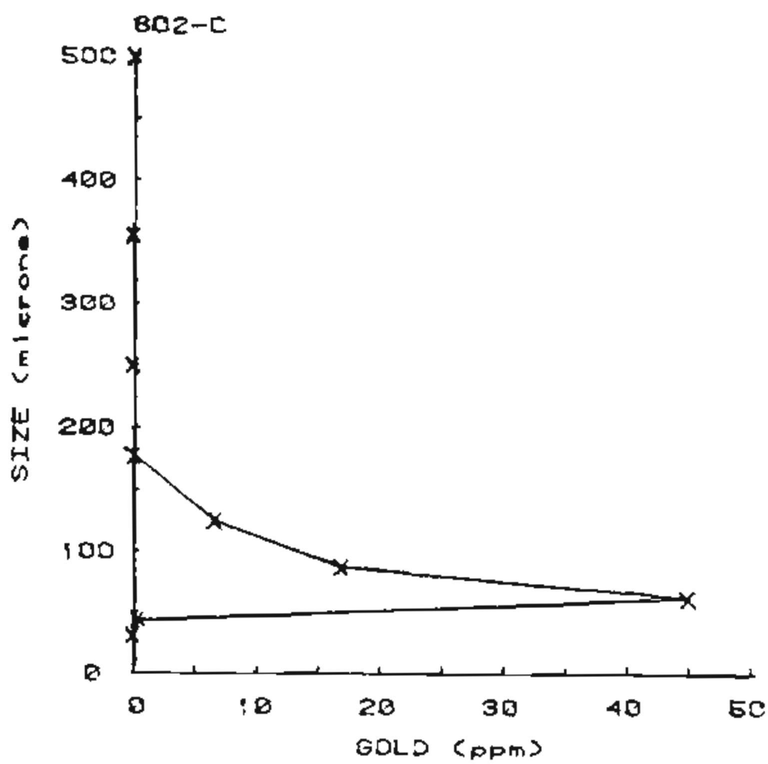

803
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
10
20
30
40
50

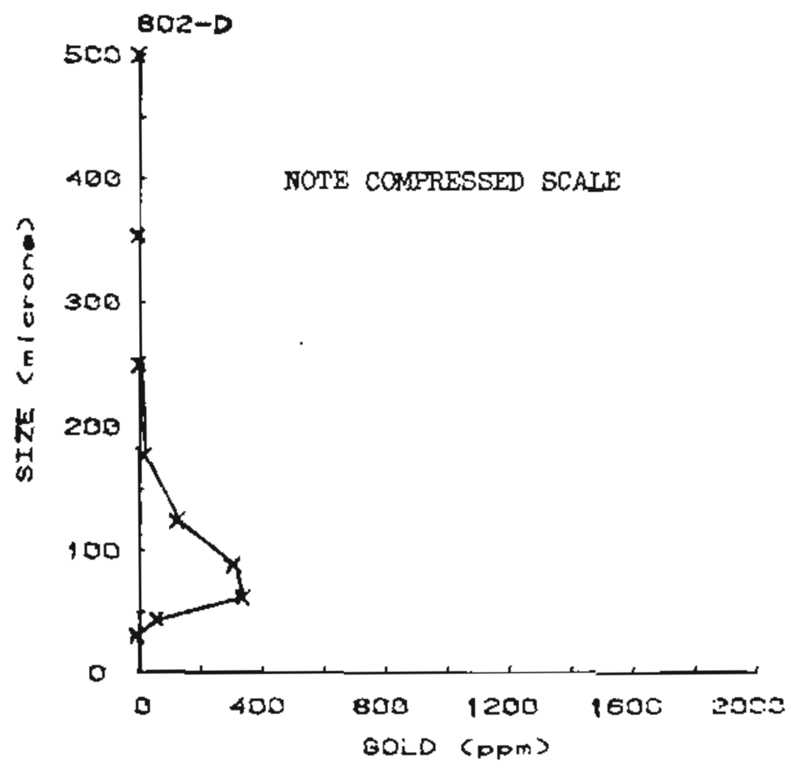

804
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
10
20
30
40
50

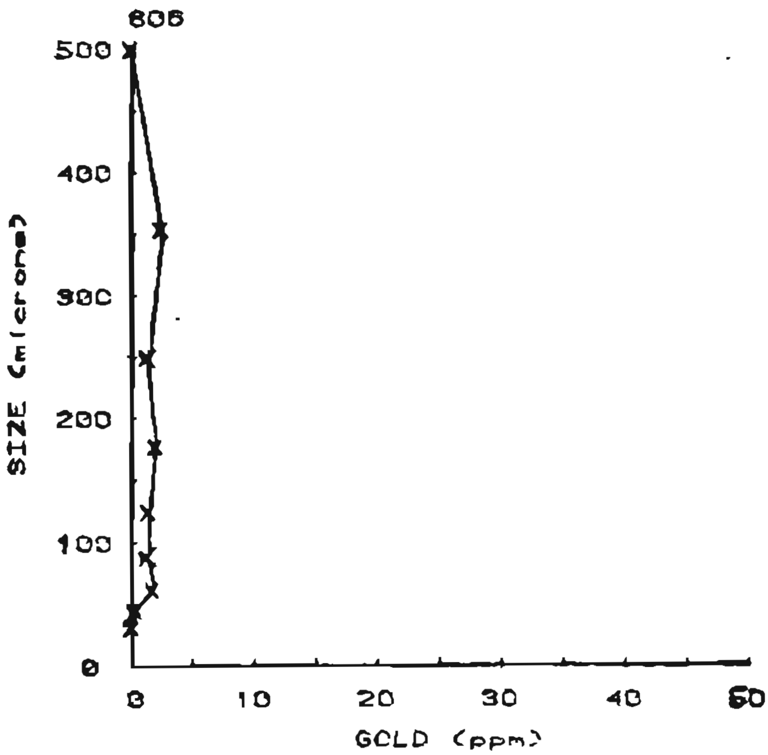

805
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
10
20
30
40
50

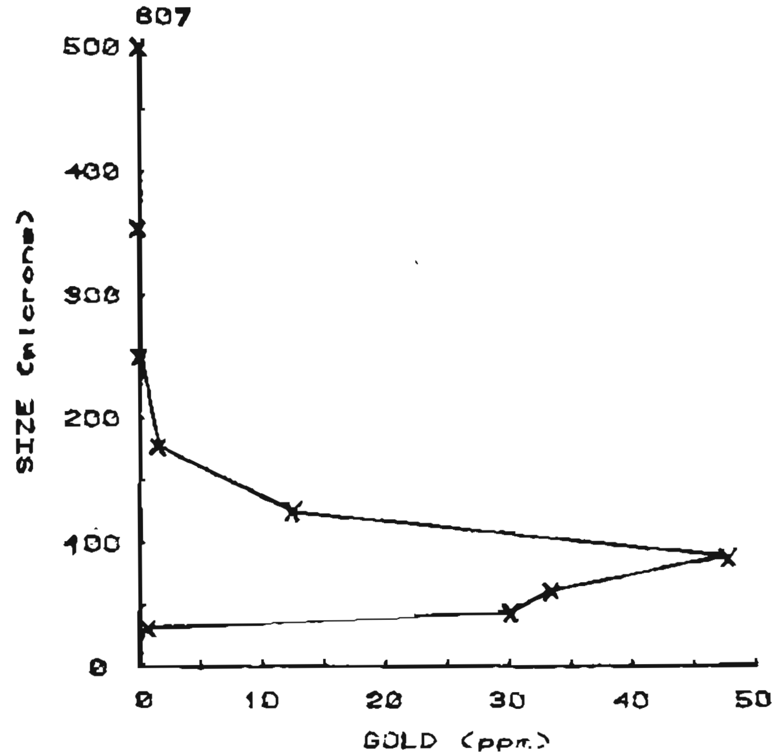

802-A
SIZE (microns)
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)

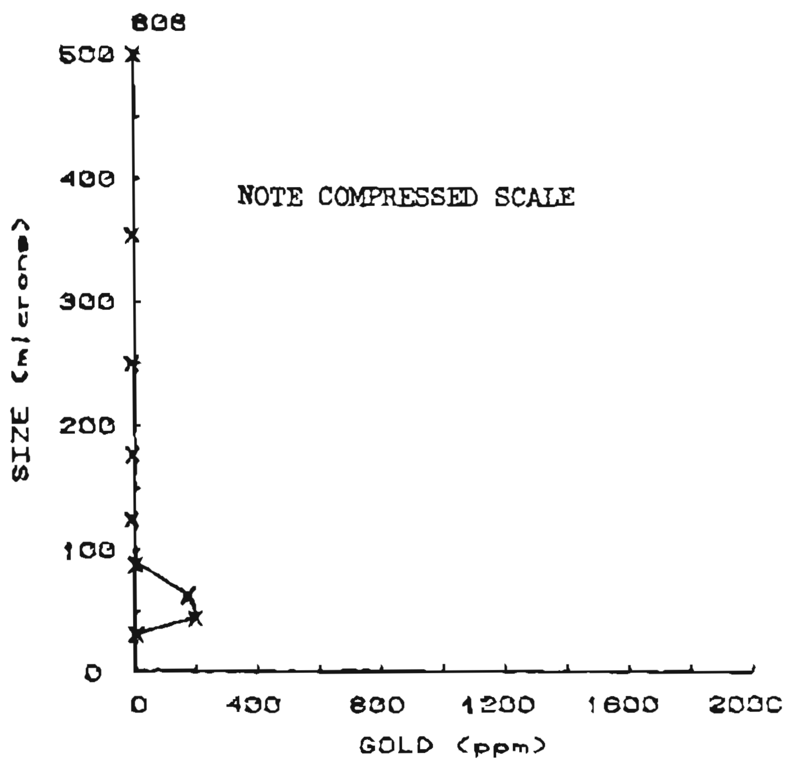

802-B
NOTE COMPRESSED SCALE
SIZE (microns)
600
400
300
200
100
0
0
400
800
1200
1600
2000
GOLD (ppm)

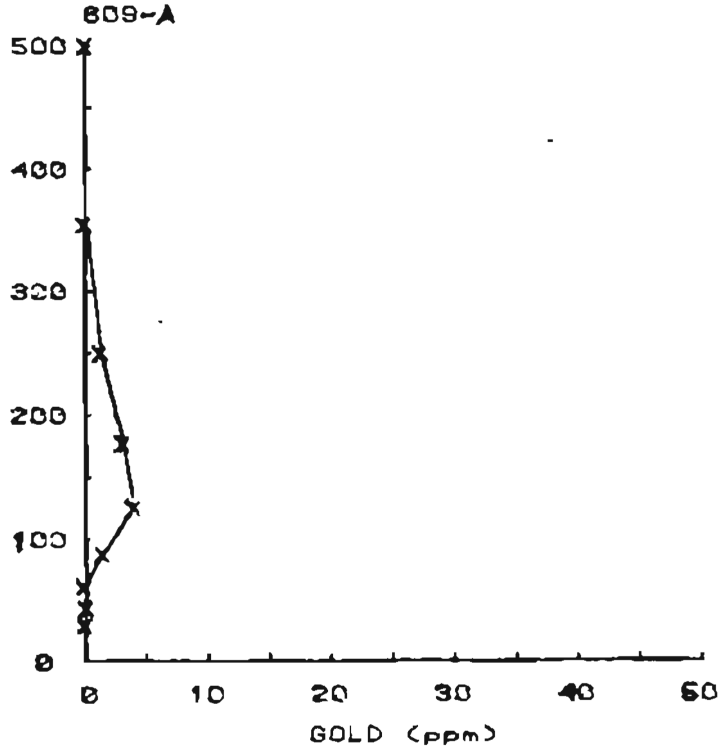

802-C
SIZE (microns)
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)

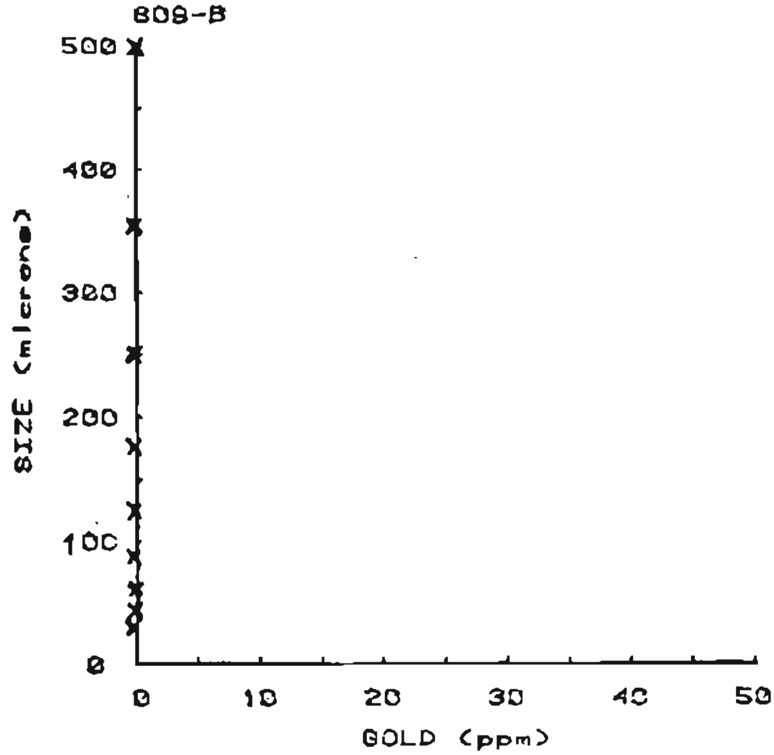

802-D
NOTE COMPRESSED SCALE
SIZE (microns)
500
400
300
200
100
0
0
400
800
1200
1600
2000
GOLD (ppm)

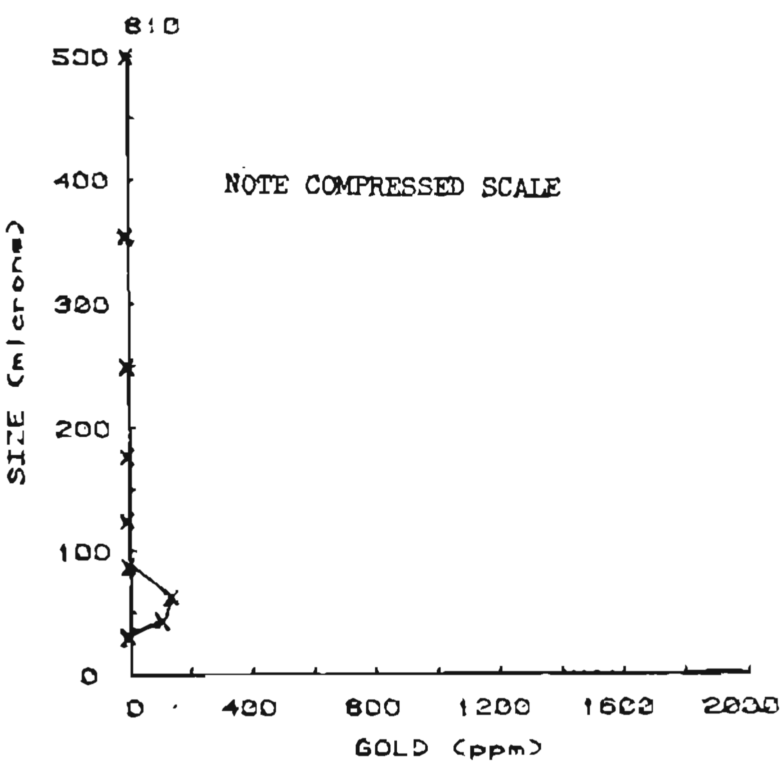

806
500
400
300
200
100
0
SIZE (microns)
0
10
20
30
40
50
GOLD (ppm)

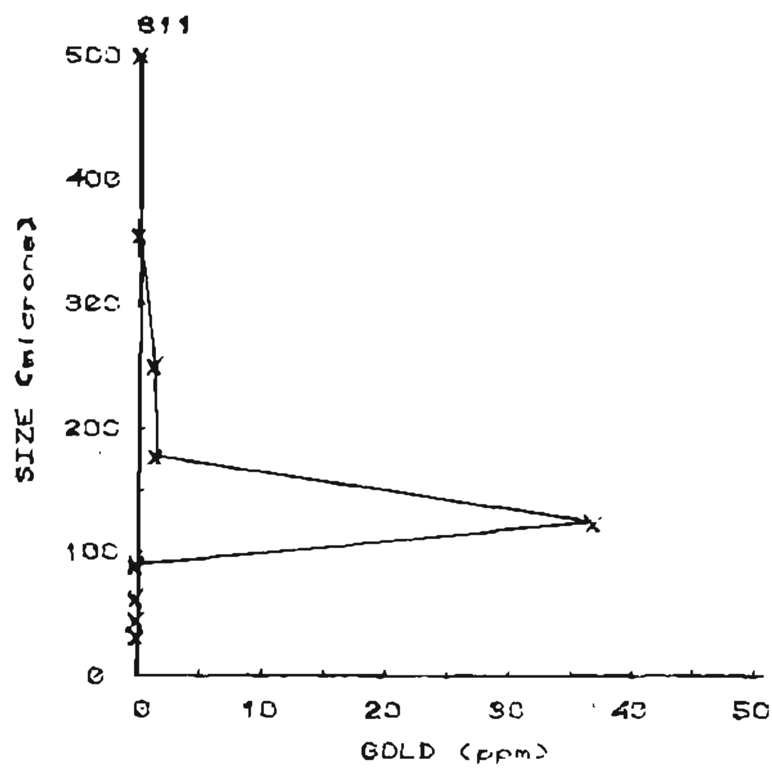

807
500
400
300
200
100
0
SIZE (microns)
0
10
20
30
40
50
GOLD (ppm)

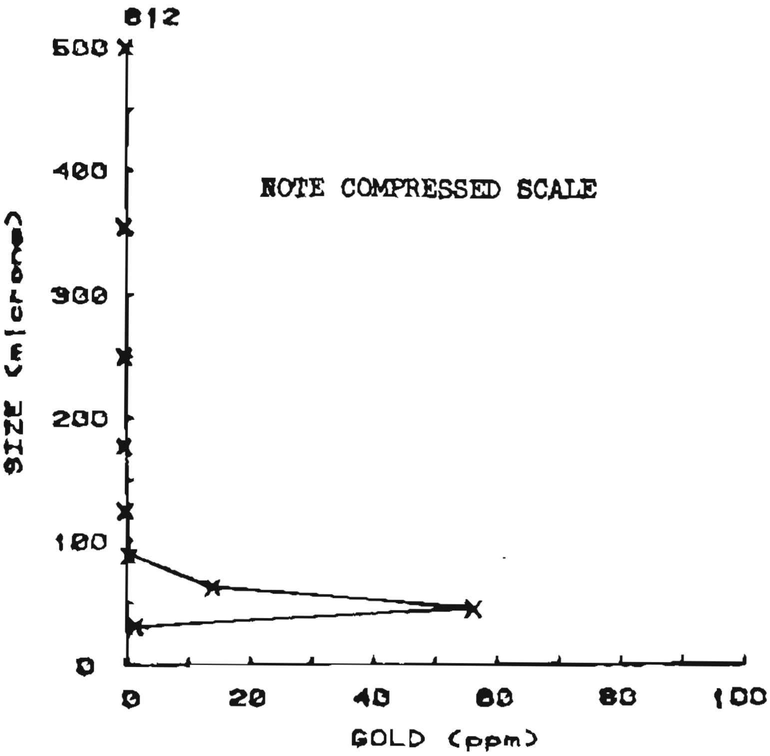

808
500
400
300
200
100
0
SIZE (microns)
NOTE COMPRESSED SCALE
0
400
800
1200
1600
2000
GOLD (ppm)

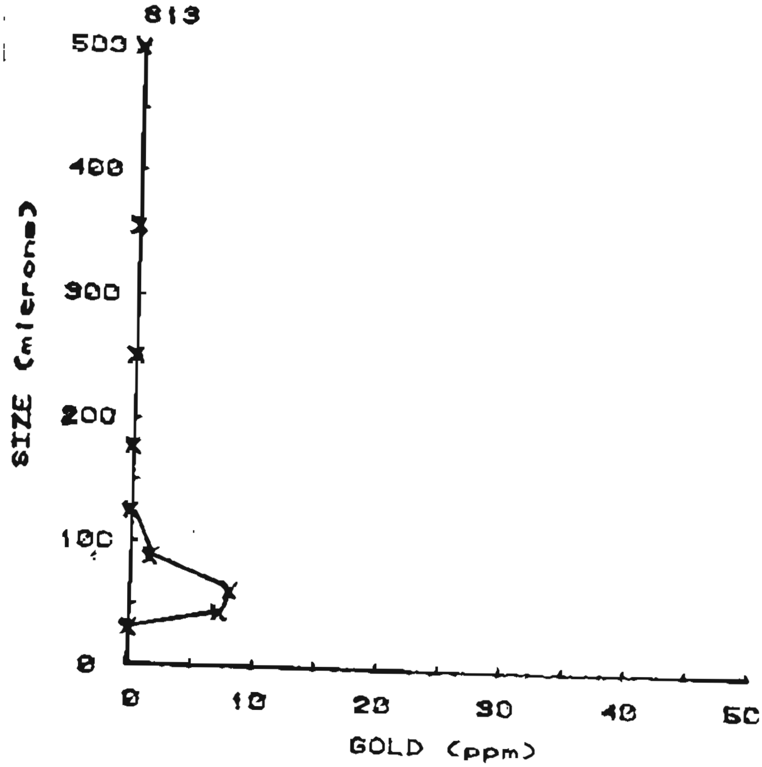

809-A
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)

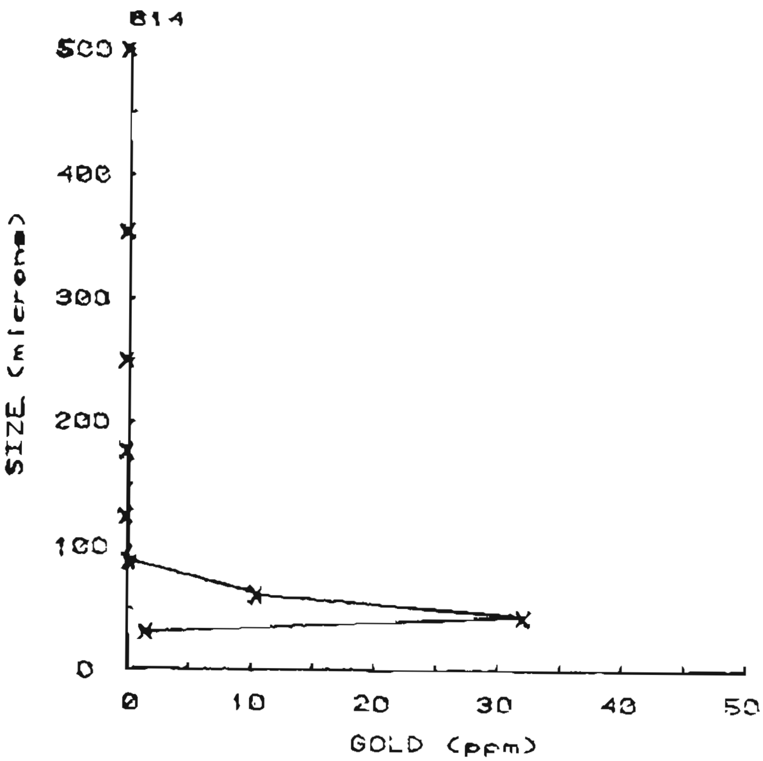

809-B
500
400
300
200
100
0
SIZE (microns)
0
10
20
30
40
50
GOLD (ppm)

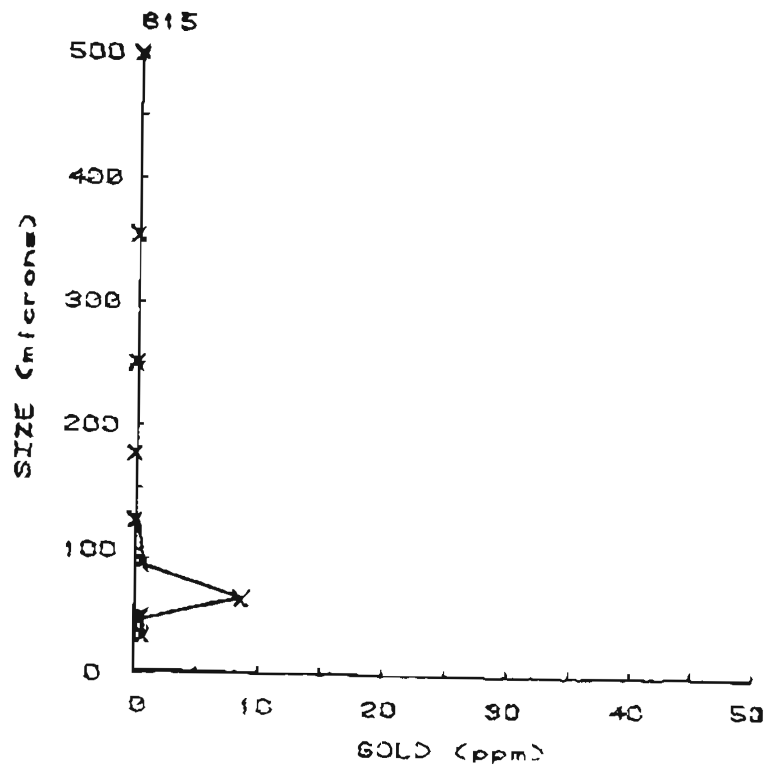

810
500
400
300
200
100
0
SIZE (microns)
NOTE COMPRESSED SCALE
0
400
800
1200
1600
2000
GOLD (ppm)

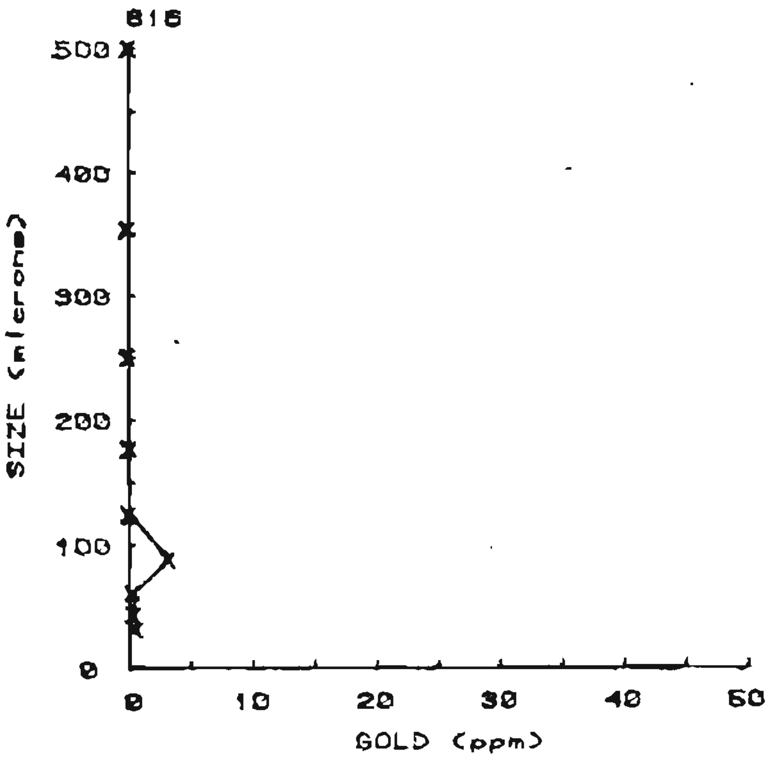

811
500
400
300
200
100
0
SIZE (microns)
0
10
20
30
40
50
GOLD (ppm)

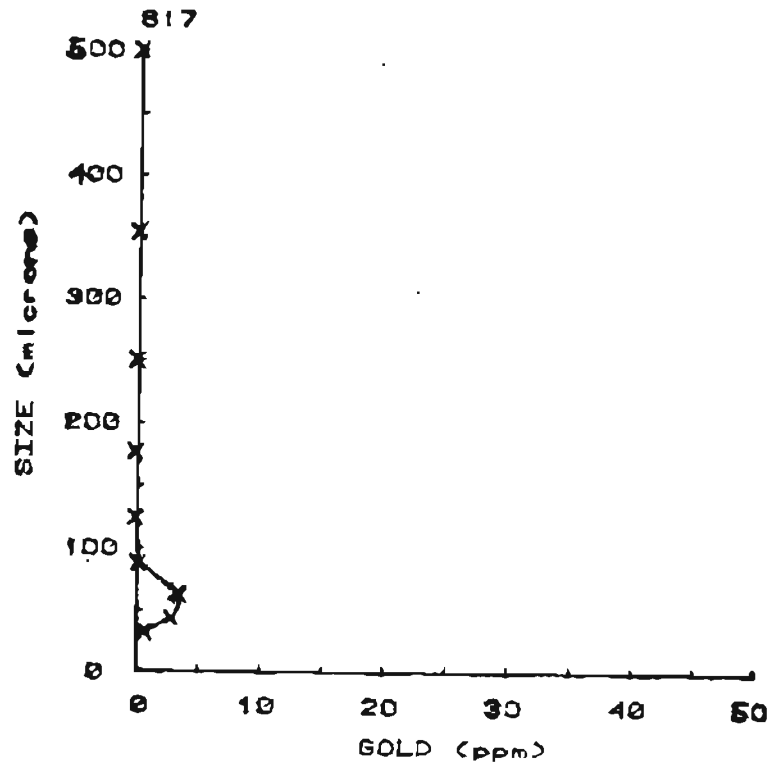

812
NOTE COMPRESSED SCALE
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
20
40
60
80
100

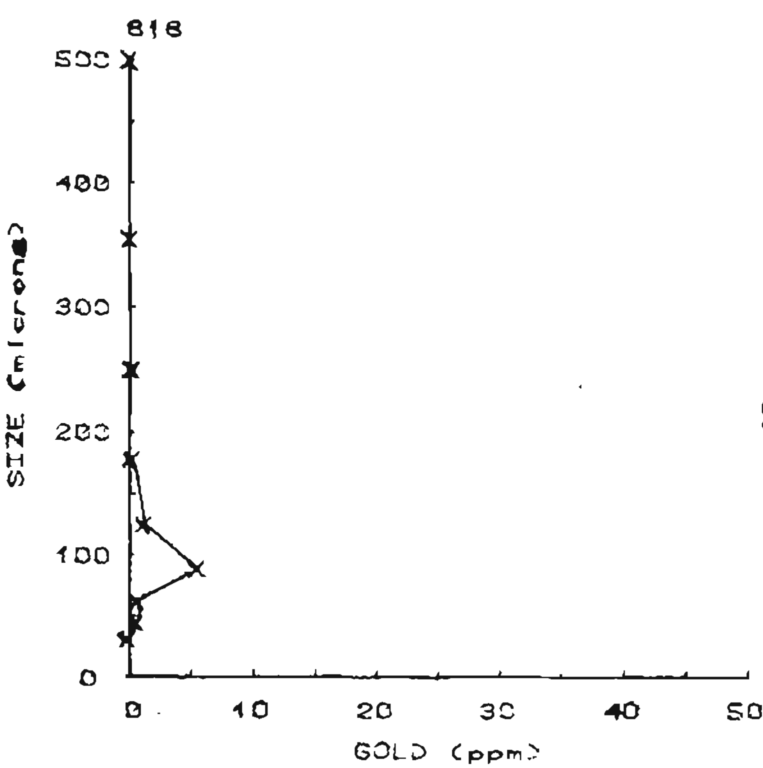

813
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
10
20
30
40
50

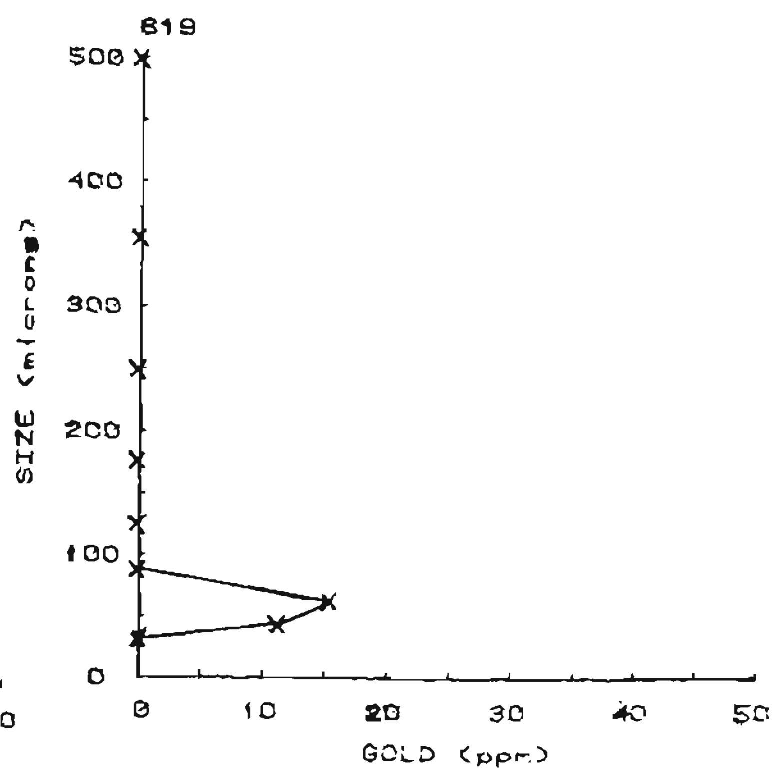

814
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
10
20
30
40
50

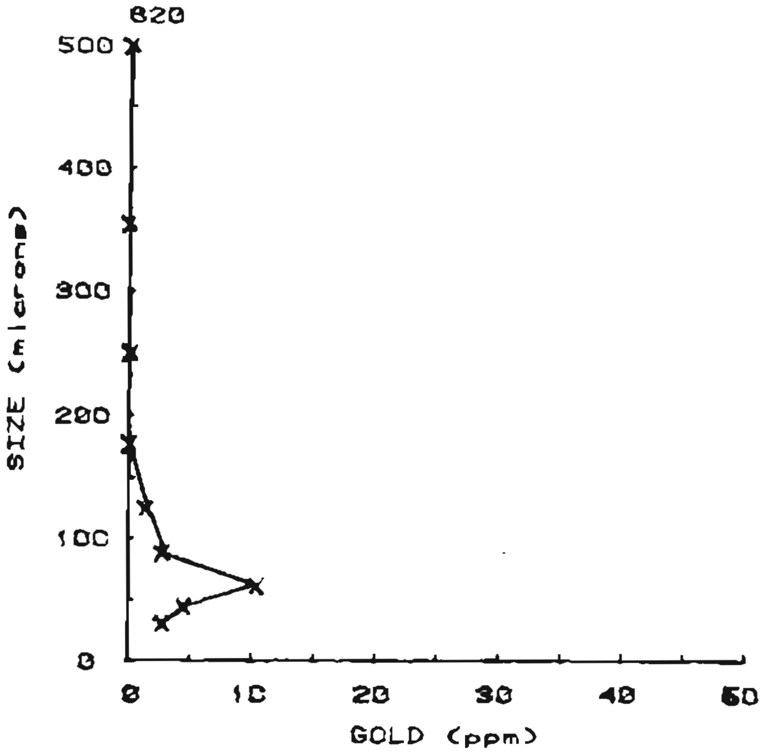

815
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
10
20
30
40
50

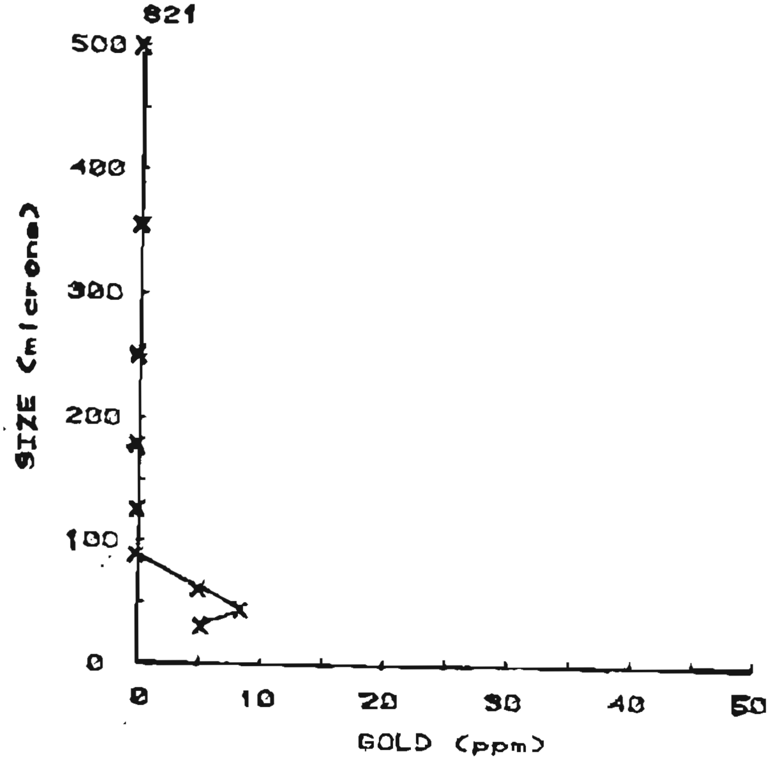

816
SIZE (microns)
GOLD (ppm)

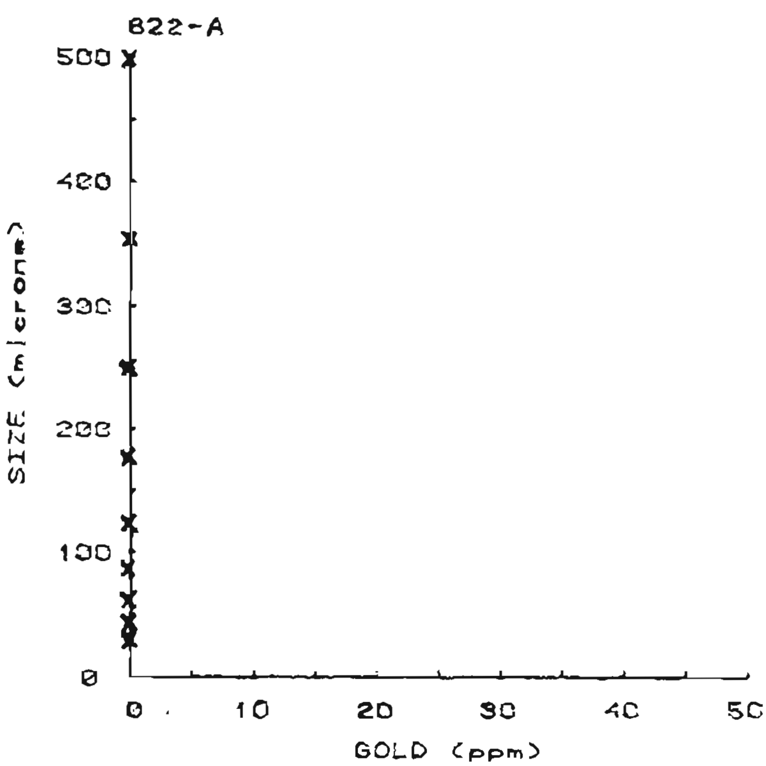

817
SIZE (microns)
GOLD (ppm)

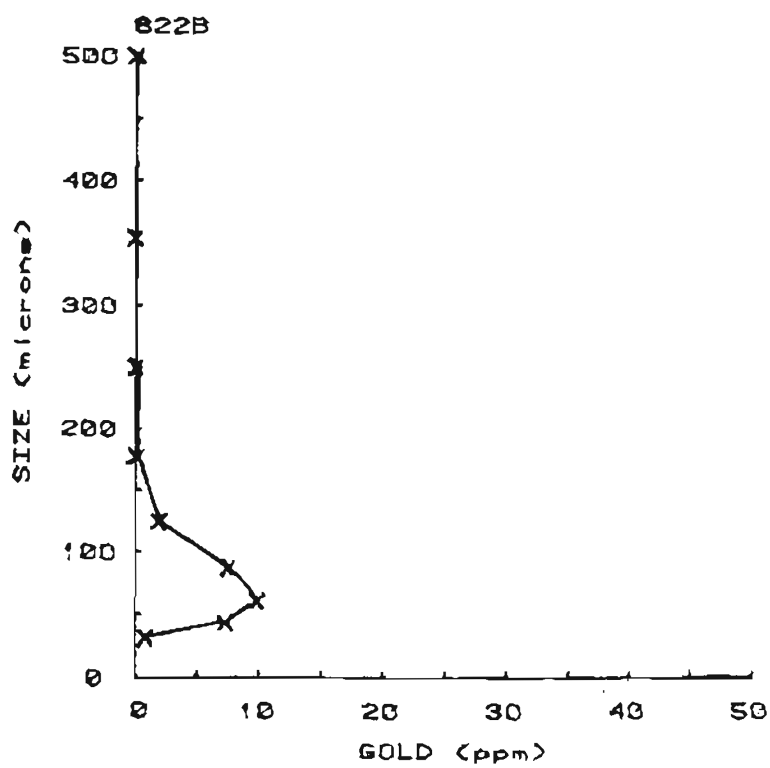

818
SIZE (microns)
GOLD (ppm)

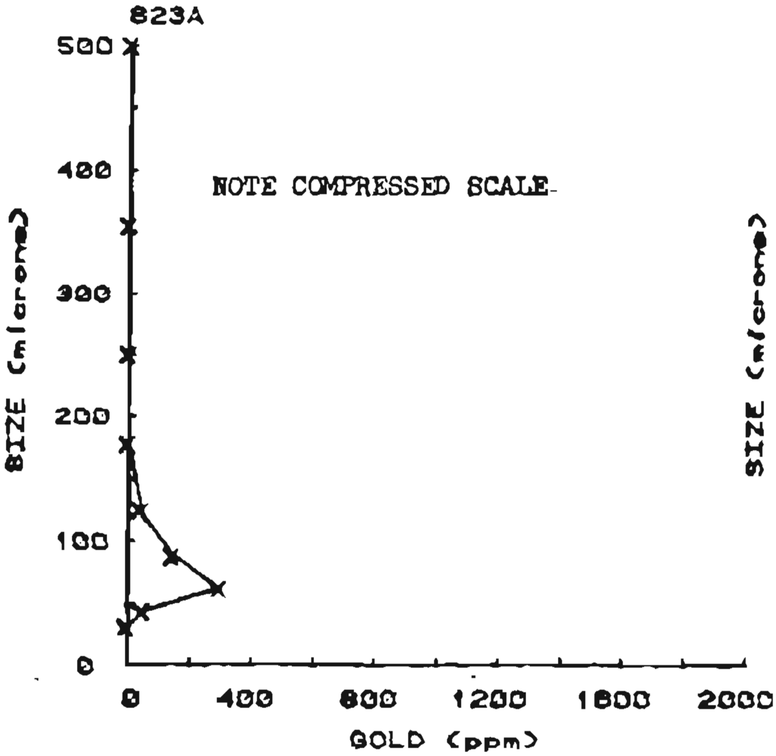

819
SIZE (microns)
GOLD (ppm)

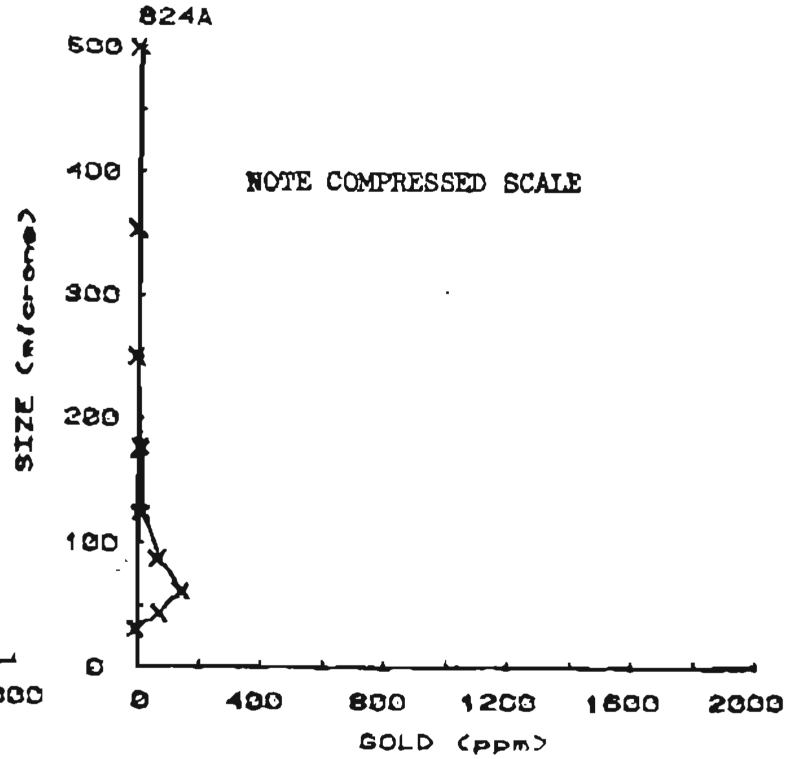

820
SIZE (microns)
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)

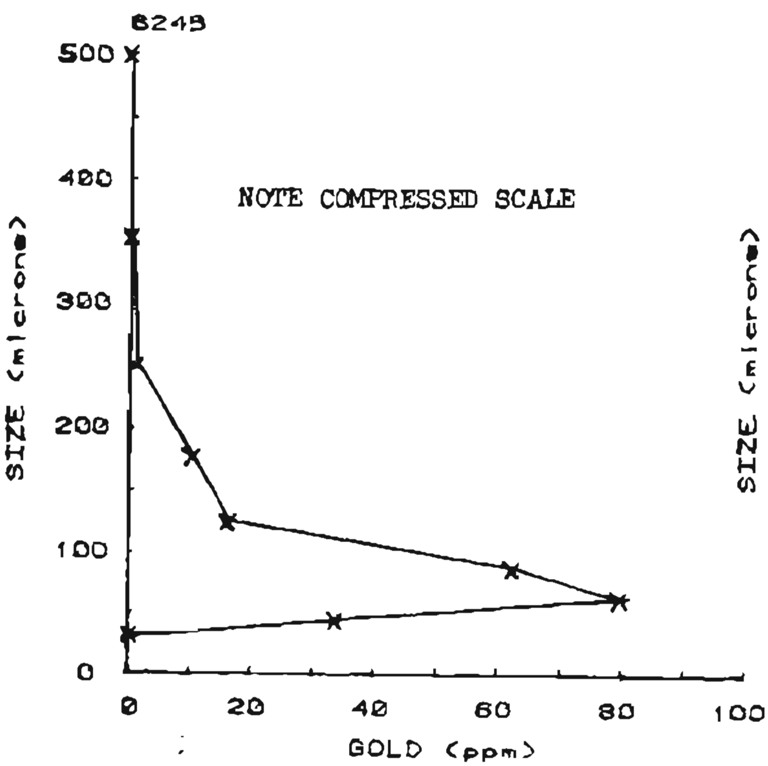

821
SIZE (microns)
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)

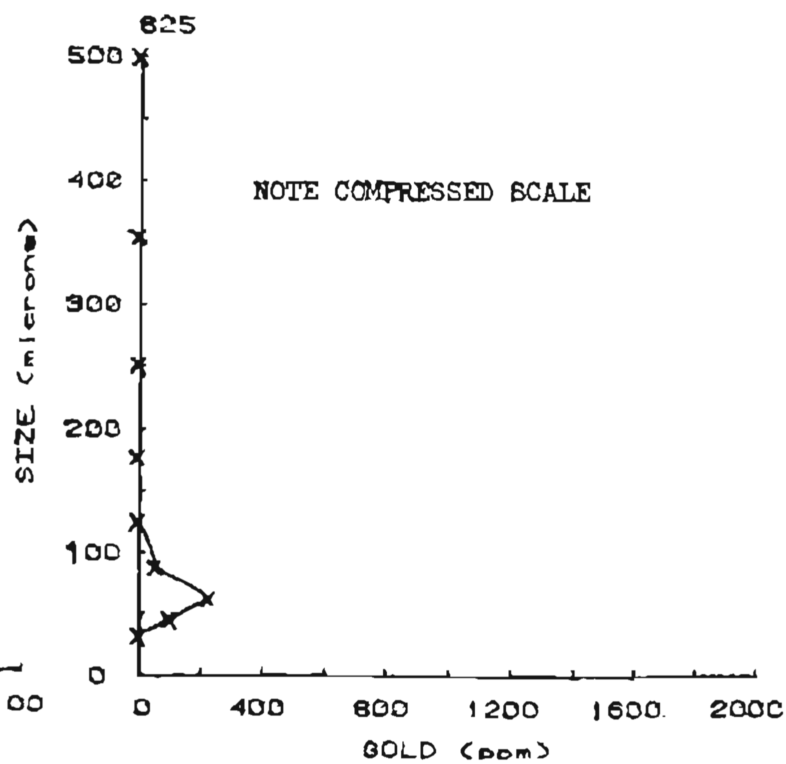

822-A
SIZE (microns)
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)

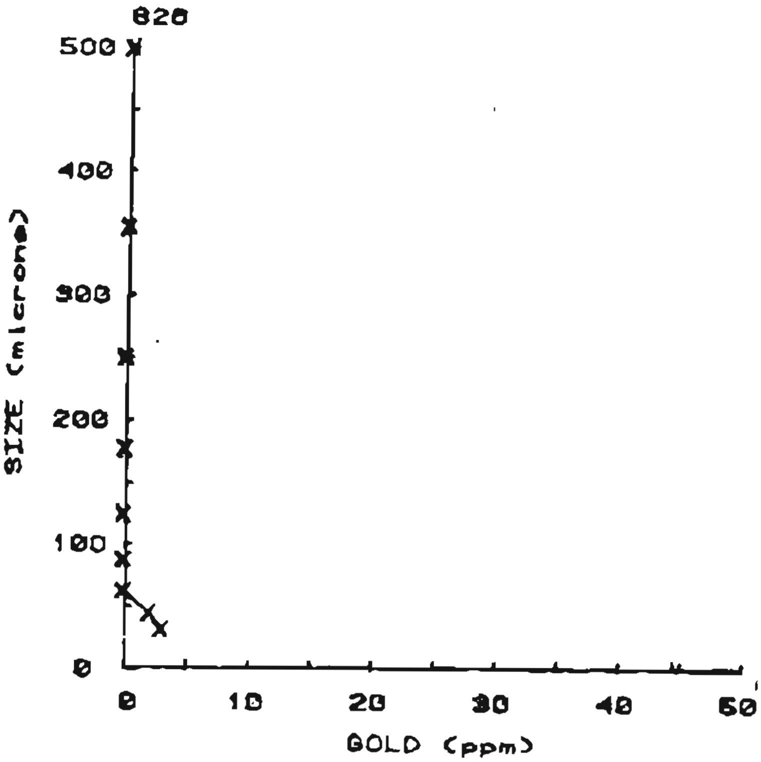

822B
SIZE (microns)
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)

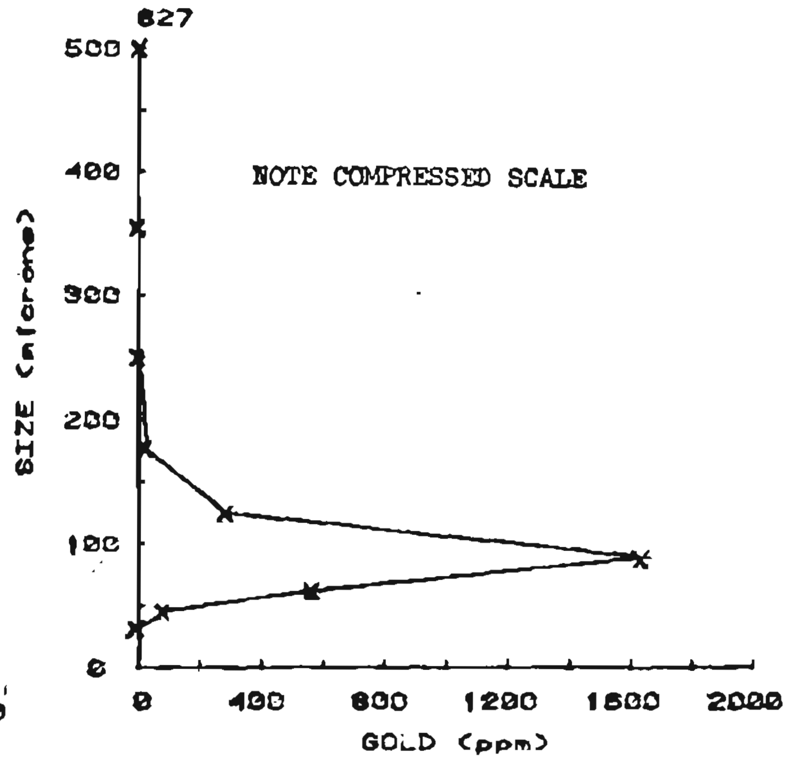

823A
NOTE COMPRESSED SCALE
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
400
800
1200
1600
2000

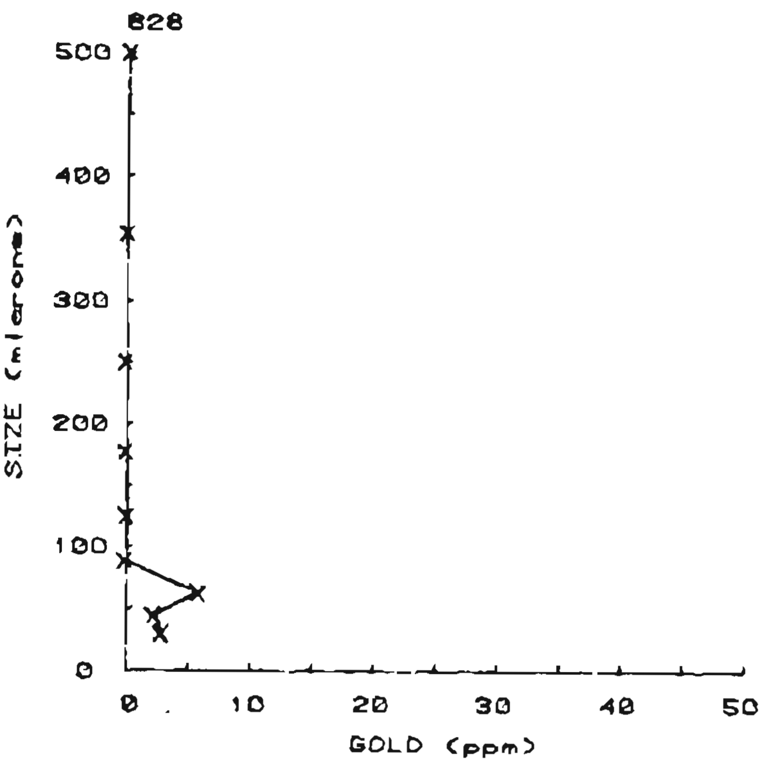

824A
NOTE COMPRESSED SCALE
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
400
800
1200
1600
2000

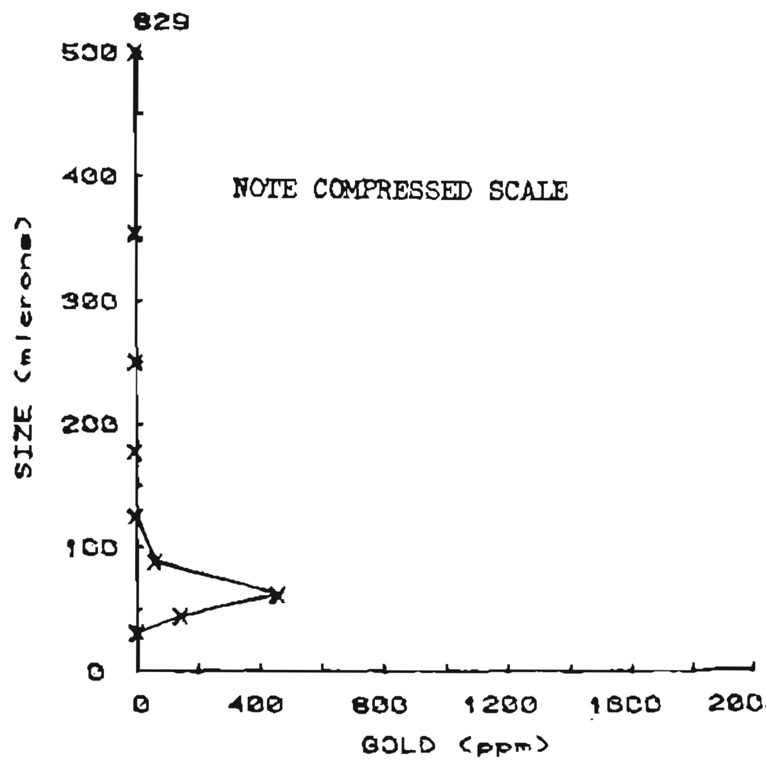

824B
NOTE COMPRESSED SCALE
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
20
40
60
80
100

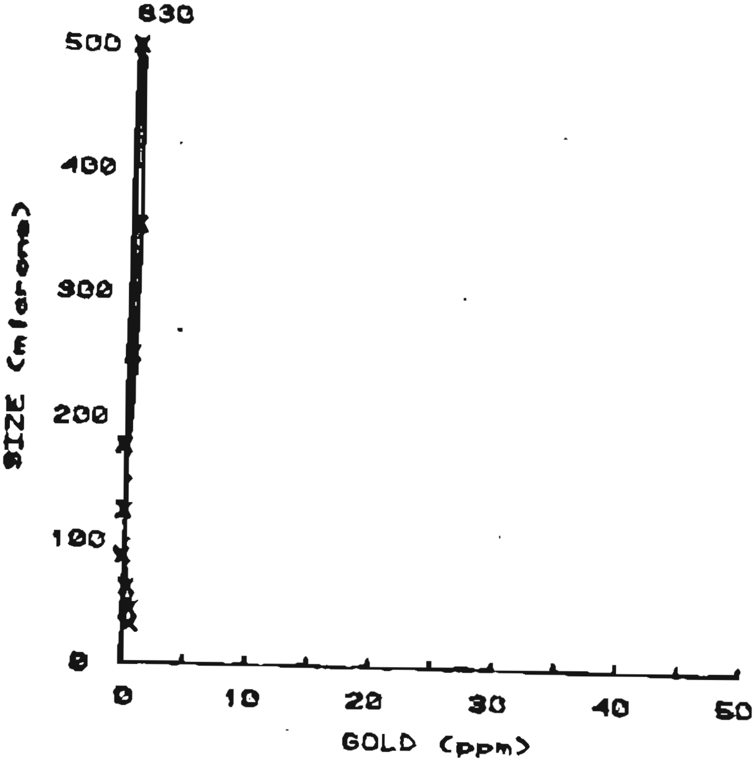

825
NOTE COMPRESSED SCALE
SIZE (microns)
GOLD (ppm)
0
100
200
300
400
500
0
400
800
1200
1600
2000

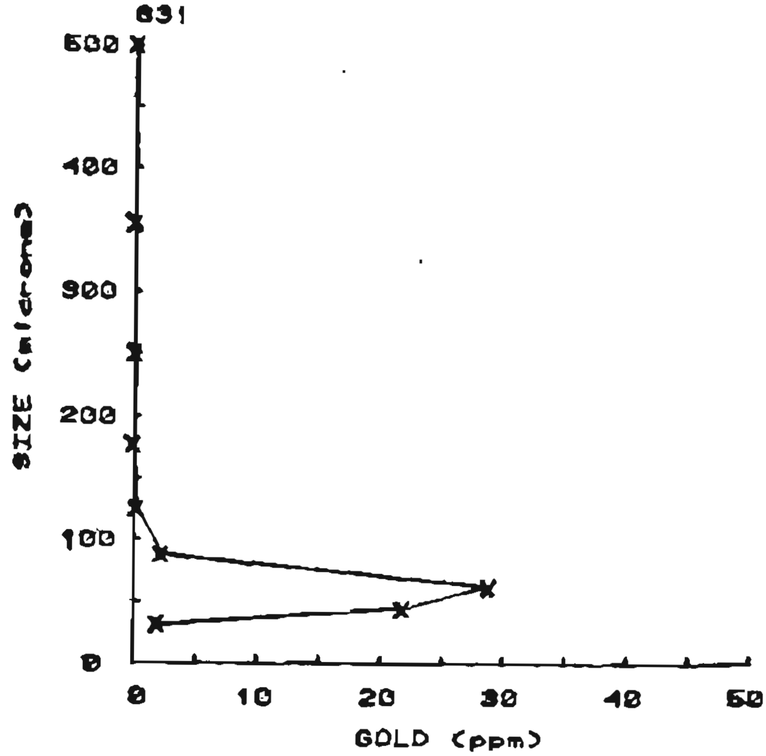

826
500
400
300
200
100
0
SIZE (microns)
0
10
20
30
40
50
GOLD (ppm)

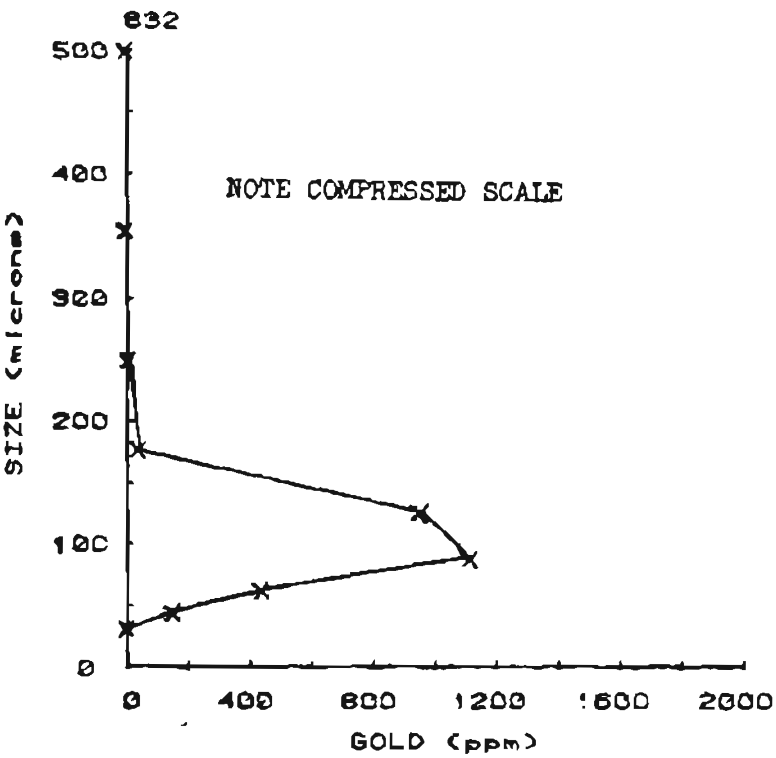

827
500
400
300
200
100
0
NOTE COMPRESSED SCALE
SIZE (microns)
0
400
800
1200
1600
2000
GOLD (ppm)

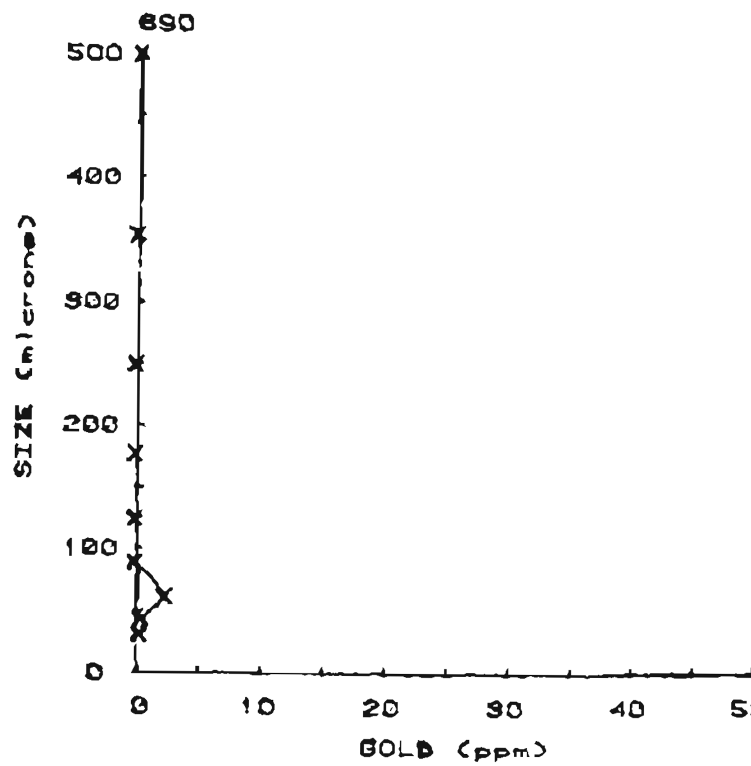

828
500
400
300
200
100
0
SIZE (microns)
0
10
20
30
40
50
GOLD (ppm)


829
500
400
300
200
100
0
NOTE COMPRESSED SCALE
SIZE (microns)
0
400
800
1200
1600
GOLD (ppm)


830
SIZE (microns)
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)


831
SIZE (microns)
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)


832
SIZE (microns)
500
400
300
200
100
0
NOTE COMPRESSED SCALE
0
400
800
1200
1600
2000
GOLD (ppm)


890
SIZE (microns)
500
400
300
200
100
0
0
10
20
30
40
50
GOLD (ppm)