W. Pentland.

MEMORANDUM:

TO: File V-168 Date: October 5th, 1982

From: Ian Thomson File: V-168

Re: REVIEW OF GOLD SOIL GEOCHEMISTRY DATA - QUEEN CHARLOTTE GOLD

INTRODUCTION:

During the spring of 1982 a field exploration program was conducted by Placer Development Limited over ground on Lyell Island in the Queen Charlotte group. The work included extensive soil sampling as a follow-up to reconnaissance work and grid sampling carried out in 1981. Concern developed when results from the 1982 surveys failed to reproduce gold soil values reported by the 1981 work. Questions were raised as to the reliability of the 1981 results and the suitability of the procedures employed in 1982. The situation was further complicated by the fact that the 1981 work was carried out by JMT Consultants with the samples analysed by Chemex while the 1982 work was conducted by Placer Development and the samples analysed in the Placer Lab.

As a consequence of these concerns a program of check analysis was implemented and a review undertaken of previous data, field and laboratory procedures. The pertinent results of this study are discussed below.

2. SAMPLE COLLECTION AND ANALYSIS

JMT and Placer employed essentually the same sampling technique in which "B" horizon soil material was collected using a grub hoe to make a small excavation. Field examination of JMT sample locations indicated that, on occasion, the material sampled might not be ideal "B" horizon. However these few examples could not account for the inconsistencies observed in the two sets of analytical data. Both groups noted that in some areas considerable difficulty was experienced in obtaining any suitable sample material. Further, both Chemex and the Placer Laboratory report that samples from this project were often very stoney with little fine inorganic material (silt and clay).

Sample preparation was the same for both groups. Samples were air dried and then sieved to minus 80 mesh (210 microns) to yield a fine fraction used for analysis. Some (approximately 3%) of the JMT samples were found to contain insufficient fine fraction for analysis. These samples were screened by Chemex to minus 35 mesh and the fine fraction then ground to minus 100 mesh for analysis. Careful scrutiny of the analytical data has shown that these few samples have no influence on the geochemical patterns observed in this area.

Analysis of the samples has been carried out using three procedures.

a) Fire Assay/Neutron Activation (FA/NA). This procedure was used by Chemex in the analysis of all the JMT samples. A 10 gram aliquot of sample material is attacked using the classic fire assay fusion with the determination of contained gold made by direct neutrom activation analysis of the cupel bead. A detection limit of 1 ppb is obtained.

b) HBr/Br-AAS (Br/AA). This is the routine method used in the Placer geochemical laboratory. A 3 gram aliquot of sample material is digested in Hydrobromic Acid with Bromine. Gold is liberated and back extracted using an organic solvent. The gold content of the sample is determined using an Atomic Absorbtion Spectrometer. A detection limit of 20 ppb is obtained and results are comparable to those obtained by fire assay.

c) Aqua Regis/AAS (AR/AA). This procedure, used by Chemex, was employed during the program of check analysis. A 5 gram aliquot of sample material is digested in Aqua Regia. The attack is further optimised by pre-roasting the sample to destroy organic matter and degrade sulphide minerals. The liberated gold is back extracted into an organic solvent and the final determination made using an atomic absorbtion spectrometer. A detection limit of 10 ppb is obtained and, as with the HBr/Br technique, results are comparable to those obtained by fire assay.

Both laboratories are experienced in gold analysis and apply similar procedures in which samples are agitated and rolled to homogenise them immediately prior to weighing out the few grams of material used in analysis.

3. THE GEOCHEMICAL DATA

The basic problem encountered in the course of the exploration program was that many gold values reported by the 1981 JMT survey did not repeat during the 1982 follow-up. More specifically grid sampling in areas where reconnaissance samples reportedly contained scattered locations with elevated concentrations of gold yielded uniformly non detectable levels. However, since the follow-up employed a different analytical procedure, with different detection limits etc., from the reconnaissance and since only rarely were exactly the same sample locations established there was some doubt as to where and how the inconsistencies between the two data sets might have occurred. A series of tests were then undertaken to help resolve this quandary. Unfortunately it was not possible to return to the field and collect more samples; testing was thus confined to the existing samples. This is unfortunate since the limited amounts of sample material available for study necessarily restricted the scope of the investigation.

In approaching the problem of the reliability of the geochemical data two features were questioned; accuracy and precision. Accuracy is the ability to measure a known, predetermined concentration of an element in a sample and is here used to assess confidence when comparing results from analyses carried out in 1981 and 1982 by the two laboratories. Accuracy and hence comparability between data sets was determined by the use of standard samples inserted into the analytical schedule by the laboratories. An exchange of standards between labs, multiple analysis by the different methods and careful scrutiny of results from 1981 and 1982 production runs indicate that, overall, results from the various analytical schedules may be compared with confidence. The most important difference between procedures is in the detection limit obtained and hence ability to "see" very low (less than 20 ppb) concentrations of gold.

Precision is a measure of the reproduceability of individual results and is here used to further assess confidence in the geochemical data. It was rapidly realized that this aspect of data quality defined the principal problem in the Queen Charlotte gold project. The test program highlighted this fact and has poduced some additional information of value in response to direct questions about reliability of the data.

A) Test 1. Reproduceability of Gold Values in the JMT Samples.

A total of 145 samples selected from the 1981 JMT program were resubmitted to Chemex. The samples were in batches of at least ten consecutive samples and included anomalous and background areas (as defined by the 1981 results) from both the reconnaissance work and grid sampling. In effect the pulps from the original samples were reanalysed using the same method (FA/NA) as that used in 1981. This provided data on 145 sample pairs suitable for statistical, graphical and empiracle evaluation (Table 1). It is noted that no duplicate analyses were run in the original JMT program. Hence, it was not possible to estimate precision and thus reliability until the 1982 series of tests.

Precision was calculated on the data set following the procedures of Garrett (1979). Analytical precision of +25 percent or less at the 95 percent confidence level is normally considered acceptable for exploration geochemical purposes with precision of +15 percent or less generally regarded as excellent.

Precision obtained on the test group was +145.77 percent at the 95 percent confidence level. This is well outside normal acceptance levels and represents a very low level of reproduceability. This can ba seen by inspection of the accompanying table and by examination of Figure 1 (note only samples with one of pair greater than 50 ppb Au are plotted). The low precision and very spiky character of the data, particularly at higher concentrations, cannot be attributed to the analytical method. Examination of the behaviour of laboratory standards show that a maximum of +12 percent at the 95 percent confidence level can be ascribed to analytical (weighing through determination) error. The problem therefore lies with the nature of the samples themselves. The low precision, erratic reporting of high values observed is characteristic of samples containing free particulate gold, and a profound "nugget effect" is evident. The problem is thus attributed to the inhomogenous distribution of small particles or free gold or gold included in other mineral grains. These data demonstrate that it is not possible to place great confidence in the gold results of single analyses and that caution must be advised when interpreting any gold soils data from this area.

The data has certain general characteristics:

i. High gold values reported in a sample are a reliable measure of the gold in the aliquot of sample material analysed. They are thus a reliable positive indicator of the presence of gold but are not necessarily representative of the absolute abundance of gold in the area.

ii. Low gold values reported in a sample reflect a low gold content in the aliquot of sample material analysed. However, because it cannot be confidently asserted that the sample is a truly homogenous representative, individual low gold values cannot be confidently interpreted as indicating low gold potential.

Further scrutiny of the test data reveals evidence of two characteristic patterns in samples from which high gold values are reported.

In the case of samples J895-904, high gold values occur sporadically with little consistency. No real pattern of consecutive or associated high values is developed. In contrast samples AM798-808 and J1133-1140 (Table 1) show low precision but a remarkable consistency of results in which the former have uniformly detectable gold while the latter are clearly background. The gold presumably occurs in greater abundance in part of the area. Furthermore it is somewhat more uniformly distributed in these samples and has spatial continuity. A more consistent geologial source is inferred.

Confidence in the data is thus greatly enhanced by recognition of patterns of contiguous high and low values. In this approach the erratic distribution of gold in individual samples is acknowledged. Individual sample results are given low significance, clusters of evaluated values are regarded as informative. Areas of consistently high background gold with erratic very high values are probably the most signifiant from the point of view of mineral potential. These interpretive criteria are further strengthened when reanalysis of the original samples gives confirmation of the patterns recognized in the original data.

Thus it is concluded:

i. The JMT sampling was carried out effectively.

i. The 1981 Analytical work was completed satisfactorly, but,

iii. Since no duplicate analysis or control samples were run in the JMT program it was not possible to establish relative confidence in the original data set.

iv. The analytical data are, in fact, very poor due to a profound nugget effect resulting from the erratic distribution of particulate gold at low absolute levels of abundence.

v. Individual analytical results cannot be interpreted with confidence.

vi. Consistent patterns of high and/or low gold values are meaningful and can be interpreted as having geological significance.

vii. Samples should be reanalysed before finalizing an interpretation and commencing follow-up work.

B. Test 2: Efficiency of the Placer Follow-up Program.

Two experiments were run to determine the reliability of the follow-up program and establish confidence levels in the results obtained. Since JMT and Placer employed the same methods of sampling and sample preparation concern focussed on the analytical method used by Placer.

The analytical method used in the Placer Laboratory is regarded as comparable to the fire assay procedure of Chemex but with a higher detection limit. A major difference from the Chemex FA/NA procedure is, however, the smaller (3 gms v. 10 gms) aliquot used in the Placer lab. This will serve to aggravate the nugget effect with consequent expectations of poor precision and hence low confidence in individual analytical values.

a) As a test of the character of the method, pulps from 25 samples from the 1981 JMT survey were reanalysed in the Placer laboratory (Br/AA method) and by Chemex using the Aqua Regia extraction (AR/AA). These results were then compared with the original fire assay/neutron activation determinations. The data are shown in Table 2.

In view of the low precision expected it is surprising and indeed encouraging that some samples, notably the Z series, show internal consistency in reported detectable concentrations of gold.

b) A second experiment was conducted using a block of seventeen samples collected by Placer in 1982 from a grid survey. The results are shown in Table 3 in which data obtained by the Placer (Br/AA) and Chemex fire assay (FA/NA) procedures are compared. Again, given the low expectations of reproduceability it is most encouraging to see patterns of elevated gold on line 3+00S confirmed by both analytical methods. This indicates the presence of elevated concentrations of gold well dispersed in the soil, presumably related to a geological source with similar characteristics.

From these results it is concluded that the analytical method employed by Placer is acceptable but could be improved if a larger weight of sample were analysed. As with the original JMT data, individual gold values have very low confidence; rather, patterns of high and/or low gold values are regarded as meaningful. Furthermore, the increased detection limit is not considered detrimental since relatively high (+100 ppb) concentrations must be consistently located in the follow-up program in order to demonstrate economic potential.

c) Test 3: Reproduceability of the Geochemical Patterns

Because of the inherent character of gold in soil samples from the Queen Charlotte Islands property it is unreasonable to expect to reproduce absolute values in samples collected at or near the same location. However, if the argument used earlier is correct, it should be possible to reproduce geochemical patterns of relative abundance displayed by groups of contiguous samples. This ability may be considered "proof" of the reality of such patterns and their potential geological significance.

Two suites of samples considered suitable for rigorous evaluation were available for study.

a. Sample material was collected at five locations from the original soil sample pits dug by JMT. These samples were analysd by the FA/NA method of Chemex and the Br/AA method of Placer. The results obtained may be compared with the original JMT results in Table 4. There is very poor reproduceability in this set; however, there are too few results to draw firm conclusions. Further it is suspected that these samples come from an area of very erratic gold values of the type described in Test 1 above.

b. A second suite comprise seventeen pairs of soil samples collected by JMT and Placer respectively along a grid traverse line. Both sets of samples were analysed by the fire assay/neutron activation procedure. Results are presented in Table 5. Precision on this suite of results is +67.13 percent at the 95 percent confidence level reflecting a measure of internal consistency. Indeed in this data set it can be seen that the geographical pattern of high and low values is reproduced quite well along the traverse.

From these limited data it is concluded that confidence in the analytical results is gained by an examination of gold distribution patterns rather than absolute values. Further, where such patterns are reproduceable they may be considered real and geologically meaningful.

4. General Conclusions:

i. The use of soil geochemistry in the Queen Charlotte project is hampered by the presence of fine particulate gold which gives rise to a profound nugget effect.

ii. Geochemicl data from this project must be treated with caution because of poor precision resulting from the mode of occurrence of gold. Thus: -

a) Low confidence should be given to individual analytical values but,

b) Patterns in which geographically consistent areas of high and/or low values of gold are developed may be regarded as significant.

iii. To reduce the detrimental effects of the presence of particulate gold and improve the reliability of analytical results from individual samples the following procedures are suggested.

a) Every effort be made to collect a large volume of optimum soil material in the field.

b) Insure that a large, hopefully representative portion is prepared for analysis. If the minus 80 mesh fraction is likely to yield only small amounts of material a coarser fraction may be taken and then ground.

c) Consideration be given to grinding the subsample to increase homogeneity.

d) Maintain procedures such as shaking and rolling that ensure homogenization of the sample prior to analysis.

e) Use the largest possible weight of sample for analysis.

f) Analyse samples in dupliate, record both values and use all available data for evaluation purposes.

g) Insure that there are quality control samples (standards, duplicates, replicates, etc.) in every batch of samples analysed and that the results are reported so that an estimate of confidence in the data may be mede prion to interpretation.

iv. Experience to date indicates that the method of analysis has no bearing on the quality of data produced. The weight of sample used for analysed will influence precission. Detection limits vary with the procedure employed but should be considered in terms of what the data is expected to show. Thus the higher detection limit given by the Placer procedure is acceptable in the follow-up stage of survey where the intent is to define the limits of ground with ore potential.

v. Follow-up and resampling projects cannot be expected to reproduce absolute values reported in soils. Rather, patterns of relative abundance of gold will be reproduced and the ability to perform this exercise is a reflection of the strength, consistency and hence reliability of any geochemical pattern.

vi. Since the available data indicates the presence of free gold in the soils, the occurrence of confirmed areas of elevated concentrations of gold within which erratic very high values are encountered is considered diagnostic of the presence of potentially significant mineralization.

Ian Thomson

Reference: Garrett, R.G. 1979
The Determination of sampling and analytical errors in exploration geochemistry. Econ. Geol., vol.64, p.568-574.

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SAMPLE NO.	FA/NA Au PPB	AR/AA Au PPB	Br/AA Au PPB
J778	19	10	20
779	1160	10	20
789	314	10	20
791	5	10	20
812	718	10	20
820	452	10	20
1099	10	10	20
1100	8	10	20
1101	6	10	20
AM466	345	60	250
740	490	30	50
741	10	10	20
760	44	10	20
762	124	10	10
781	13	10	20
782	114	10	20
800	33	20	20
801	42	10	20
802	79	10	20
807	309	60	30
908	172	10	90
Z 422	63	20	20
429	81	40	50
443	187	130	220
445	57	20	20

Table 2 JMT 1981 Samples analysed for gold by three different methods. For explanation see text.

SAMPLE NO.		Br/AA Au PPB	FA/NA Au PPB
2+00S	0+00	30	18
	0+25E	20	50
	0+50E	20	25
	0+75E	30	44
	1+00E	20	14
	1+25E	20	13
	1+50E	20	6
	1+75E	20	7
	2+00E	20	9
	2+25E	20	3
	2+50E	20	8
3+00S	0+00	100	119
	0+25E	380	20
	0+36E	40	100
	0+50E	20	14
	0+75	20	36
	0+95E	20	25

Table 3 PDL 1982 soil samples analysed for gold by two different methods. For explanation see text.

	1981	1982	
SAMPLE SITE	FA/NA AU PPB	FA/NA AU PPB	BR/AA AU PPB
762	192	24	20
778	19	27	20
779	1160	36	20
780	22	18	20
789	314	11	20

Table 4. Gold content of samples collected from the same pit. For explanation see text.

SAMPLE SITE	1981 Au PPB	1982 Au PPB
1	42	18
2	27	50
3	48	25
4	82	44
5	199	14
6	18	13
7	3	6
8	1	7
9	1	9
10	2	3
11	5	8
12	81	119
13	75	20
14	51	100
15	26	14
16	61	36
17	80	25

Table 5. Gold content of soil samples recollected along a traverse line in 1981 and 1982. Analysis by fire assay/neutron activation. For explanation see text.

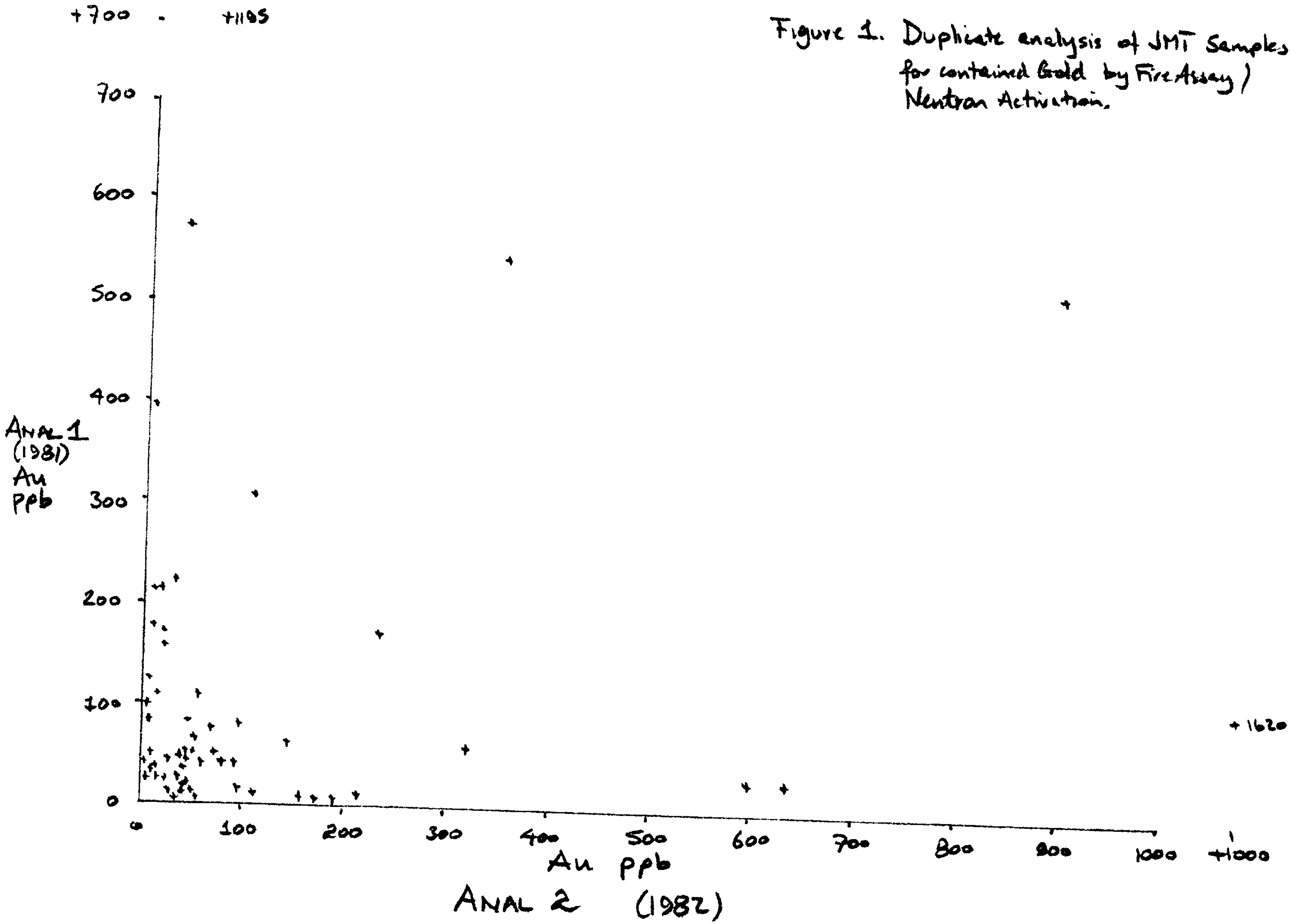

Figure 1. Duplicate analysis of JMT Samples for contained Gold by Fire Assay / Neutron Activation.

Table 1

Duplicate analysis of JMT soil samples
for contained gold by Fire Assay/Neutron Activation.
All values in ppb.

SAMPLE NO.	ANEL 1 (1981)	ANEL 2 (1982)
AM313	39	6
314	5	9
315	184	9
316	11	7
317	545	349
318	1	1
319	27	23
320	9	12
321	13	9
322	7	10
323	3	7
324	9	17
325	9	15
326	7	12
327	573	34
328	8	9
329	223	27
330	8	23
331	38	12
332	4	8
333	5	7
410	2	9
411	5	8
412	50	9

SAMPLE NO.	ANEL 1 (1981)	ANEL 2 (1982)
AM 413	7	8
414	49	32
415	18	20
416	81	92
418	51	72
419	26	36
420	61	142
421	81	8
423	5	8
424	9	16
425	8	156
426	8	1
462	13	25
463	45	80
464	63	319
465	17	95
467	172	230
468	22	11
469	11	14
470	30	8
471	1	4
472	1	1
474	2	5
475	2	28
J 806	41	90
807	13	5
808	7	12
809	1195	61
810	17	8
811	7	21
813	5	28
814	16	24

SAMPLE NO.	ANEL 1 (1981)	ANEL 2 (1982)
✓ J 815	212	11
816	2	5
817	5	8
818	9	174
819	1	18
✓ J 864	11	113
865	53	43
866	9	19
867	48	37
868	65	53
869	110	52
870	37	44
871	34	14
872	6	18
873	2	5
✓ J 895	4	5
896	3	10
897	20	11
898	13	213
899	46	25
900	107	14
901	20	13
902	7	51
903	8	15
904	22	43
AM 855	17	8
856	11	8
857	8	1
858	5	3
859	53	47
860	8	2

SAMPLE NO.	ANEL 1 (1981)	ANEL 2 (1982)
AM 861	22	4
862	8	4
863	1	26
864	213	7
865	10	13
J 1170	2	6
1171	15	4
1172	10	12
1173	7	9
1174	5	6
1175	5	10
1176	395	4
1178	157	20
1179	13	25
1180	18	15
J 1225	1	4
1226	1	5
1227	4	1
1228	2	5
AM 798	9	191
800	33	594
801	42	57
802	79	64
803	159	1620
804	517	894
805	81	45
806	11	40
807	309	104
808	12	50

SAMPLE NO.	ANEL 1 (1981)	ANEL 2 (1982)
J 1133	125	5
1134	1	1
1135	1	4
1136	1	4
1137	1	7
1138	2	2
1139	40	2
1140	1	1
AM 751	34	635
752	173	20
753	20	10
755	13	20
756	29	16
757	8	6
762	124	6
763	13	10
764	13	3
765	7	3