RESOURCE ASSESSMENT OF GOLD-QUARTZ VEINS, ZEBALLOS MINING CAMP VANCOUVER ISLAND - A PRELIMINARY REPORT (92L)

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INTRODUCTION

Production data and various geological measurements have been compiled and tabulated for gold-quartz veins of the Zeballos mining camp, Vancouver Island, British Columbia. A preliminary qualitative evaluation of some of these data indicate that: (1) mined tonnage is an acceptable relative value estimator, (2) on average, large deposits are lower grade than small deposits, (3) gold and silver are highly correlated, (4) gold grade is related systematically to bulk sulphide content as indicated by average combined lead plus copper, and (5) an important systematic relation exists between gold content of a deposit and distance from the contact of the Zeballos stock. A quantitative evaluation of these data is in progress.

Zeballos mining camp is on the west coast of Vancouver Island about 320 kilometres northwest of Victoria, British Columbia. Access is via an all-weather road between the settlements of Zeballos (5 kilometres south of the mining camp) and Nimpkish. The surrounding countryside is mountainous and rugged with elevations from near sea level to about 1 300 metres; it experiences mild winters and high rainfall.

The first gold-quartz vein staked in the area was the Tagore in 1924 although limited quantities of placer gold had been mined previously. Lode production began in 1934 and reached a peak in 1937 to 1943. By 1948 most production had ceased. Two deposits, Privateer and Spud Valley, have produced 473 082 of the 651 797 tonnes of ore mined in the camp.

Recorded metal production to date totals 9 465 244 grams of gold and 4 119 118 grams of silver, as well as minor amounts of copper and lead from a total of 651 797 metric tonnes of ore mined. This tonnage includes the substantial dilution resulting from mining veins commonly about 10 to 30 centimetres wide. Average mined grades for the camps are 15 grams gold per tonne and 6.5 grams silver per tonne although vein material contained as much as 30 to 150 grams gold per tonne.

Our evaluation of Zeballos camp is oriented toward a quantitative resource assessment following the approach of Sinclair (1979), Goldsmith, *et al.* (in preparation), and Orr and Sinclair (1971). The study is divided into two parts: (1) development of a quantitative data file, and

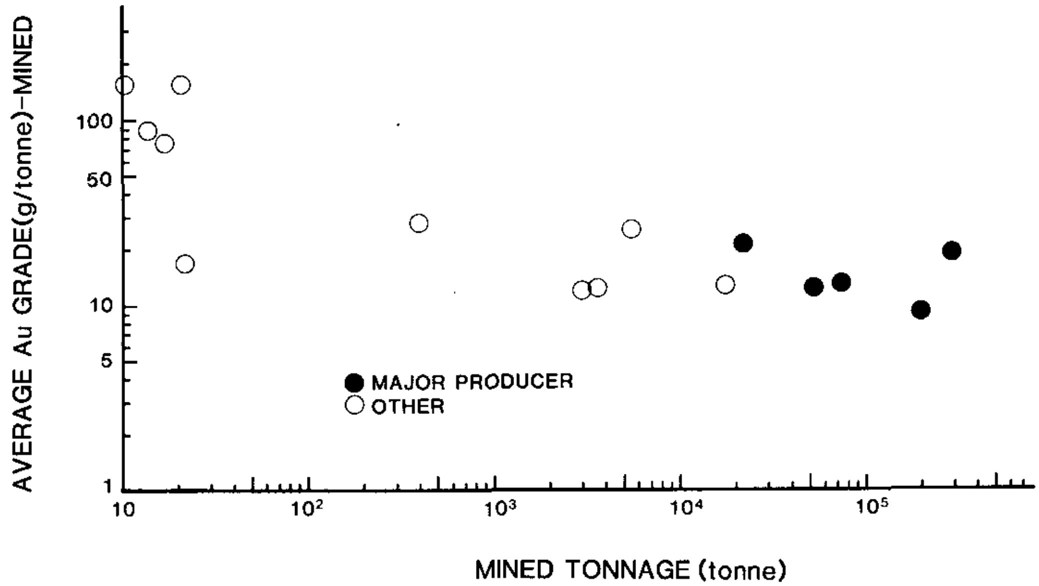

Figure 102. Average gold grade per tonne mined (grams per tonne) versus mined tonnes, Zeballos mining camp. Three deposits with tonnages of 2, 1, and 1 and corresponding gold grades of 70, 156, and 156 grams per tonne are not included in the plot.

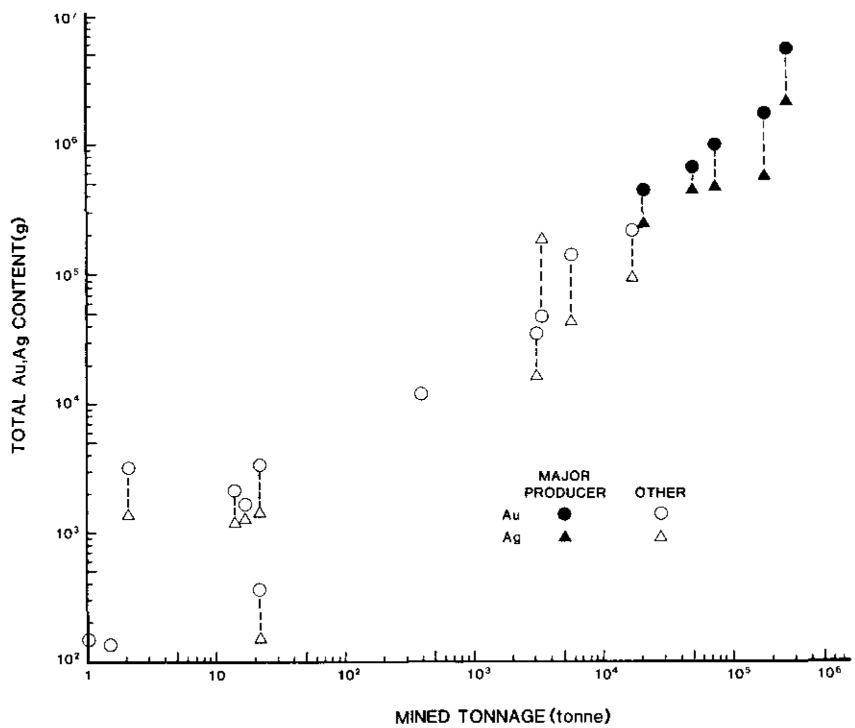

Figure 103. Plot of precious metal contents versus mined tonnes, Zeballos mining camp. Gold contents are shown with circles and silver contents by triangles.

(2) evaluation of quantitative data. This report describes the detailed data file and presents some of our initial results stemming from a preliminary evaluation of the file.

GEOLOGY OF ZEBALLOS CAMP

General geology of the area in and around Zeballos camp is shown on Figure 101. The area is underlain by an essentially monoclinal sequence of Mesozoic volcanic and sedimentary rocks cut by Jurassic and Tertiary intrusions. The Lower Jurassic Bonanza Group is a typical island arc sequence of largely basaltic to rhyolitic volcanic rocks. This unit is underlain conformably by limestones of the Quatsino Formation and tholeiitic basalts of the Upper Triassic Karmutsen Group. All these rocks are cut by Jurassic plutons of the Island intrusions, mainly dioritic and granodioritic in composition. The Zeballos stock, with its spatially related gold-quartz veins, is a quartz dioritic phase of the Catface intrusions of Eocene age.

A QUANTITATIVE DATA BASE

We have established a quantitative data base relating to mineral deposits and occurrences in Zeballos camp by reference to two sources of information: a report and map by Stevenson (1950), and the MINFILE computer file of mineral deposits in British Columbia. In addition to numerical data relating to grades and tonnage mined and/or milled, we have made a number of other measurements of a geological nature from Stevenson's (1950) map, as well as coding mineralogical information. These data are summarized in Tables 1 to 5, where deposits are listed in order of decreasing tonnage mined. The tables are self-explanatory but some comments on the nature and quality of data are warranted.

Mined tonnage refers to ore brought to surface and subject to hand sorting prior to milling. Quoted grade values refer to mined tonnage.

The two most productive vein orientations are shown for each deposit; each orientation may represent several veins. In general, an effort was made to record mean directions of undulatory surfaces.

Vein width recorded in Table 3 applies to the most productive segment of a vein; thus, is a subjective variable of uncertain value. The term 'sheeted zone' refers to '... joints spaced 2 to 8 inches apart and (which) contain either gouge or quartz-sulphide stringers an eighth of an inch to an inch wide' (Stevenson, 1950). Tensional features include gash veins and comb quartz. Associated replacement/alteration category refers to features observed in a vein or adjacent wallrock such as silicification or oxidation. In general, such data are sparse in available literature.

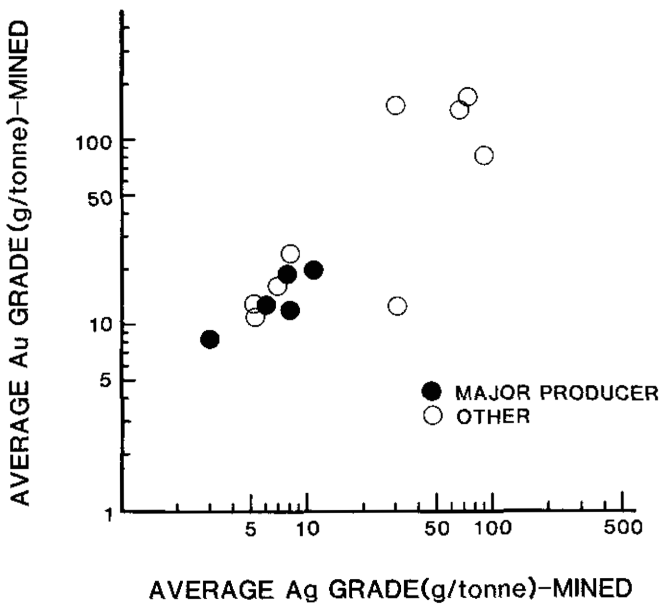

Figure 104. Average gold grade (grams per tonne) versus average silver grade (grams per tonne) for gold-quartz veins, Zeballos mining camp.

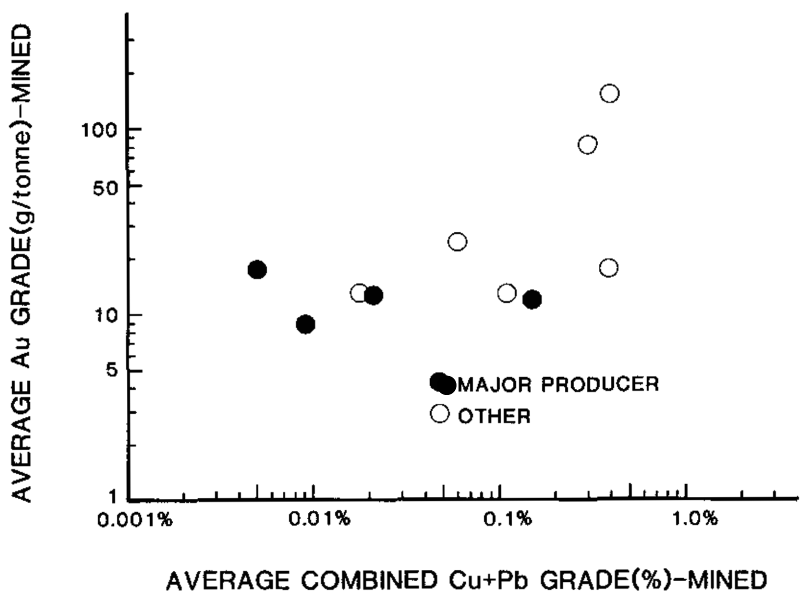

Figure 105. Average gold grade (grams per tonne) versus combined lead plus copper (per cent) for gold-quartz veins, Zeballos mining camp. Deposit 17 (Cordova) is included in this plot.

Distances of various deposits from the contact of the Zeballos stock were measured from Stevenson's (1950) geological map of the camp (*see* Fig. 101). In a few cases the contact had to be extended across drift-covered areas in order to obtain distance measurements.

PRELIMINARY EVALUATION OF ZEBALLOS DATA BASE

There are many blanks in Tables 1 to 5, particularly as regards to grade and tonnage information. Complete production statistics exist for only nine of 18 deposits with recorded production. Consequently, it will be difficult, if not impossible, to apply some of the techniques of evaluation recommended by Sinclair (1979) for vein camps.

Instead, we have chosen to examine various plots as a basis for a subjective preliminary evaluation of the data. Some of these graphs appear to establish important relations concerning deposit location or attributes. Figure 102 is a graph of average gold grades versus mined tonnages. A size of about 2 000 tonnes clearly divides the deposits into two size categories with different mean grade characteristics. The high tonnage category has a lower grand average grade and less dispersion of average grades than the low tonnage category. Some of this difference may be the result of selective mining and/or hand sorting.

Precious metal contents (gold and silver) are plotted versus production (mined tonnage) on Figure 103. This graph demonstrates that where production has been reported, both gold and silver metal contents increase systematically with an increase in size; consequently, production tonnage is an acceptable single measure of relative value of vein deposits in the Zeballos camp (*see* Sinclair, 1979).

Figure 104 is a plot of average gold grade versus average silver grade and demonstrates: (1) the consistently lower grade in silver compared with gold, and (2) the positive correlation between log gold and log silver. This correlation may be partly artificial; as indicated earlier, some of the high grades for small deposits may be the result of selective upgrading of ore. This possibility is suggested by the two clusters of points on Figure 104; such patterns represent dubious correlations. Even if this explanation is correct, it appears that a reasonable correlation exists between gold and silver as demonstrated by the five major producers in the camp.

Average gold grade of tonnes mined is plotted against copper plus lead on Figure 105 where there is a suggestion of a regular relation between the two. In general, precious metal grade is higher if copper plus lead is also high. The relation does not appear to be linear on the log-log plot suggesting that the effect is not due solely to hand sorting of ore.

Figure 106 is a plot of deposit relative value (total grams of gold per deposit) versus distance from the contact of the Zeballos stock. The graph shows a remarkably consistent pattern both in the Zeballos stock and in the country rock. The five principal producers are localized within 500 metres of the contact and smaller producers are more removed from the contact in a surprisingly regular pattern. These trends can be approximated by the following linear equation:

Within Stock: $\log(\text{Total gold}) = -0.0029D + 6.778$

Within Wallrock: $\log(\text{Total gold}) = 0.0025D + 6.778$

where gold is in grams, D is a positive distance into the stock or a negative distance into the wallrock measured in metres. These equations provide a means of contouring expected gold content of deposits remaining to be discovered. As such they outline a zone about the contact of the Zeballos stock that has high potential for relatively large new gold-quartz veins. The expected target in this zone can be estimated from Figure 102 to have a potential of 25 000 to 250 000 tonnes of ore grading about 10 to 20 grams gold per tonne. A median deposit would contain about 75 000 tonnes grading 12 grams gold per tonne. The gross value of gold in this median deposit, assuming a price of Canadian dollars 450 per ounce, is about $12 000 000.

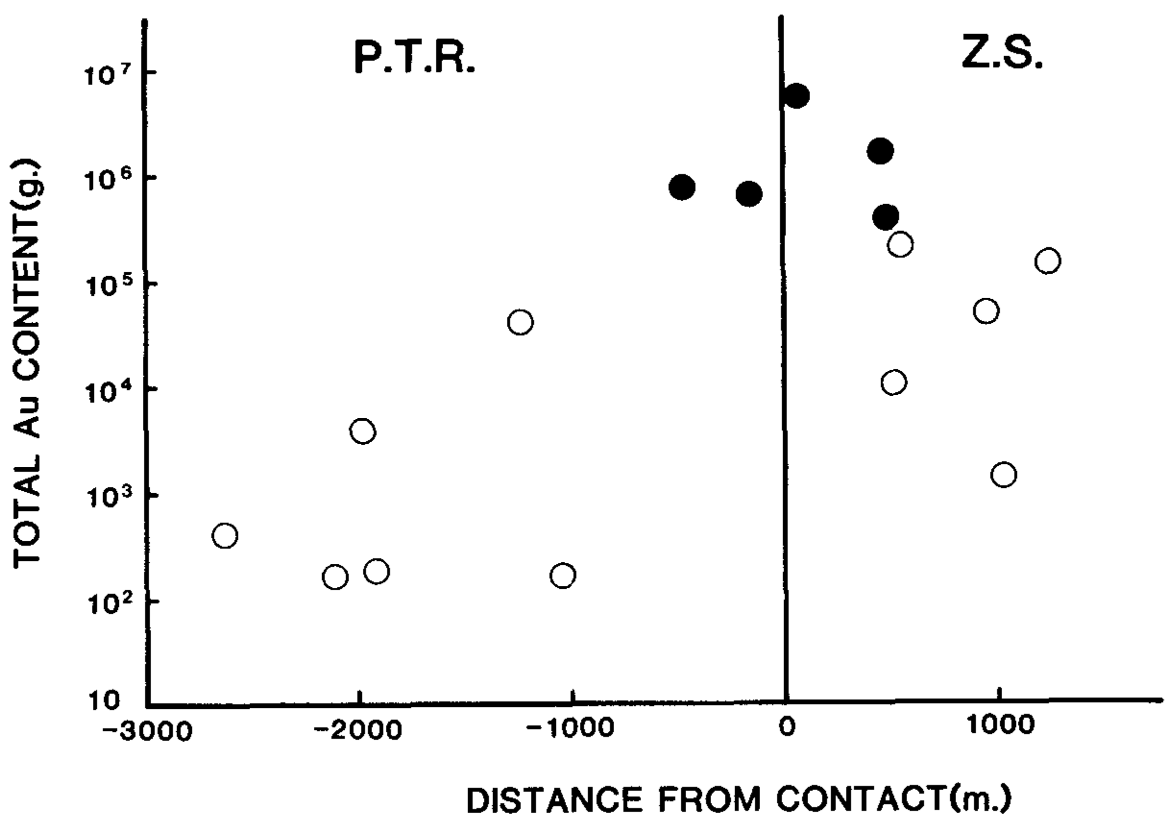

Figure 106. Total gold content (grams) versus distance of gold-quartz veins from contact of Zeballos stock (Z.S.) with pre-Tertiary rocks (P.T.R.). Positive distances are within the stock; negative distances are within country rock. Deposits greater than 2000 mined tonnes are closed circles, smaller deposits are are open circles.

TABLE 1

LISTING OF MINERAL DEPOSIT DATA FILE FOR
ZEBALLOS MINING CAMP - GENERAL INFORMATION

DEPOSIT NUMBER	DEPOSIT NAME	LOCATION UTMN	LOCATION UTME	MINFILE REF.	YEARS OF PRODUCTION (19__)	ELEVATION (FEET)	ELEVATION (METRES)
1	PRIVATEER	43400	56600	092L/008	34-53,75	750	229
2	SPUD VALLEY	42400	58000	092L/012	36,39-42,51	2000	610
3	MOUNT ZEBALLOS	42000	57000	092L/012	39-42,44	2000	610
4	CENTRAL ZEBALLOS	44800	58700	092L/018	38-42,46,47	1500	457
5	PRIDENT	43500	56900	092L/009	41-43,47,48	1500	457
6	C.D.	43300	58100	092L/015	38-41	1400	427
7	HOMEWARD	42700	60400	092L/019	41,42	2000	610
8	VAN ISLE	43100	55400	092L/038	40	600	183
9	WHITE STAR	43200	57100	092L/010	35-42,52,57	1500	457
10	ZEBALLOS PACIFIC	42900	57500	092L/011	34	1500	457
11	GOLDEN PORTAL	40900	55200	092L/005	40	750	229
12	BEANO	40600	56300	092E/002	48,49	2500	762
13	I.X.L.	43400	57300			2000	610
14	RIMY	43300	58700	092L/016	38	2500	762
15	TAGORE	41100	54300	092L/006	30,32,39	400	122
16	BARNACLE	46700	55300	092L/029		2400	732
17	CORDOVA	45800	55500	092L/027	39	2000	610
18	KING MIDAS	47700	58000	092L/020	40	500	152
19	ANSWER	40400	54600	092E/023		350	107
20	BRITANNIA	41900	58300	092L/013		1900	579
21	BIG STAR	42300	59300	092L/017		2500	762
22	MONITOR	42600	57300			1500	457
23	NORTH FORK EXPL.	48800	57800	092L/021		750	229
24	GOLD SPRING	47600	57300			1750	533
25	BODEN	44300	54400	092L/022		1200	366
26	MAQUINNA	44800	55300	092L/023		600	183
27	OMEGA	45500	54600	092L/024		1400	427
28	PANDORA	45300	55700	092L/026		850	259
29	LUCKY STRIKE	47300	54500	092L/030		3750	1143
30	FRIEND	39200	57800	092E/003		2500	762
31	PROSPERITY	41400	55500	092L/007		1000	305
32	PEERLESS	45300	54200	092L/025		1900	579
33	F.L./RIDGE	46200	55000	092L/028		2600	793
34	CHURCHILL	47400	55800	092L/031		2250	686
35	CAVALIER	47100	55800	092L/032		2500	762

NOTE: 1. DEPOSITS 1 TO 5 REFERRED TO AS MAJOR PRODUCERS.
DEPOSITS 6 TO 18 REFERRED TO AS MINOR PRODUCERS.
DEPOSITS 19 TO 35 REFERRED TO AS PROSPECTS.
2. BLANKS INDICATE NO AVAILABLE DATA, OR NON-APPLICABLE VARIABLE/ATTRIBUTE.
3. DEPOSITS 1 TO 30 & 34 ARE GOLD-QUARTZ VEIN PAST PRODUCERS OR PROSPECTS. THE CHURCHILL PROPERTY ALSO COVERS MAGNETITE REPLACEMENT MINERALIZATION. THE BEANO PROPERTY ALSO COVERS SKARN-TYPE MINERALIZATION. THE PROSPERITY PROPERTY SHOWS NO SIGN OF MINERALIZATION AT ALL, BUT IS INCLUDED FOR THE SAKE OF COMPLETENESS. DEPOSITS 33 & 34 ARE MAGNETITE REPLACEMENT DEPOSITS, AGAIN INCLUDED FOR SAKE OF COMPLETENESS.

TABLE 2

LISTING OF MINERAL DEPOSIT DATA FILE FOR
ZEBALLOS MINING CAMP - PRODUCTION DATA

DEP	PRODUCTION (TONNES)		TOTAL METAL CONTENT				GRADE (Gr,Kg/TONNE MINED)			
			(GRAMS)		(KILOGRAMS)					
NO	MINED	MILLED	Au	Ag	Cu	Pb	Au	Ag	Cu	Pb
1	282328	146798	5301289	2160196	4063	10093	18.7	7.7	.01	.04
2	190754	95876	1682859	575219	9195	8093	8.8	3.0	.05	.04
3	74268	51540	946589	444399	2408	12726	12.7	6.0	.03	.17
4	52596	37789	636773	432238	7370	71140	12.1	8.2	.14	1.35
5	21585		433440	239812			20.1	11.1		
6	5645	405	143074	44322	470	2982	25.3	7.9	.08	.53
7	3586	1375	46374	108705	318	347	12.9	30.3	.09	.10
8	3044		35929	16470			11.8	5.4		
9	1293		220987	92531	1563	17144	171.0	71.6	1.21	13.25
10	393		11174				28.0			
11	22		373	156	44	39	17.0	7.1	2.00	1.77
12	21		3297	1400	33		157.0	66.7	1.57	
13	20									
14	17		1369	1586			80.5	93.3		
15	14		1245	2022	23	20	89.0	144.4	1.64	1.43
16	2		140					70.0		
17	1		156	31	0	4	156.0	31.0		4.00
18	1		156	31	10		156.0	31.0	10.00	
19										
20										
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34										
35										

TABLE 3

LISTING OF MINERAL DEPOSITS DATA FILE FOR
ZEBALLOS MINING CAMP - GEOLOGICAL FEATURES OF HOST ROCK

DEP NO	HOST ROCK TYPE Tg	Jg	(I) lJB	(C) lJB	uTrQ	muTrK	HOST ROCK STRIKE	DIP	D/DRN	DYKES	DIST(M)/BRG FROM NOSE OF Z.STOCK DIST	BRG
1	3	0	3	2	0	0	010	60	270	5	1700	185
2	3	0	1	0	0	0				1	3400	160
3	0	0	3	2	0	0	160	90		2	3400	175
4	3	0	0	0	3	3				3	2270	110
5	3	0	2	0	0	0				2	1890	170
6	3	0	0	0	0	0				2	2650	150
7	3	0	0	0	0	0				2	4730	125
8	0	0	3	0	0	0	135	80	045	2	2650	210
9	3	0	0	0	0	0				2	2270	170
10	3	0	0	0	0	0				5	2650	165
11	0	0	3	0	0	0				3	4910	200
12	0	0	3	3	0	0	360	80	090	2	5100	185
13	3	0	0	0	0	0				5	2270	165
14	3	0	0	0	0	0				2	2840	135
15	0	0	3	2	0	0	080	80	000	3	4910	212
16	0	2	3	0	0	0				5	1890	315
17	0	3	0	0	0	0				2	1130	295
18	0	0	0	0	3	5				2	2650	035
19	0	0	3	0	0	0				2	5480	205
20	3	0	1	0	0	0				5	1130	160
21	3	0	0	0	0	0				1	4160	140
22	3	0	0	0	0	0				5	5670	120
23	0	0	0	0	0	3				5		
24	0	0	0	0	0	3	145	60	225	3	2270	020
25	0	0	3	0	0	0				5	2460	245
26	0	3	3	0	0	0	060	75	360	5	1520	250
27	0	2	3	0	0	0	050	80	135		1510	275
28	0	3	0	0	0	0					950	270
29	0	0	0	0	0	0				3	3030	310
30	0	0	3	3	0	0	135	50	225	2		
31	0	0	3	2	0	0	135	90		0	4350	196
32	0	0	3	0	0	0				2	2650	270
33	0	0	3	0	3	0				3		
34	0	3	0	0	3	0	150	45	045	3	2080	340
35	0	3	0	0	3	0				5		

HOST ROCK TYPE;Tg - TERTIARY CATFACE INTRUSIONS (ZEBALLOS STOCK);
Jg - ISLAND INTRUSIONS; lJB - BONANZA GROUP(I-IGNEOUS, C-CALC-SILICATE OR CARBONATE); uTrQ & muTrK - QUATSINO FORMATION & KARMUTSEN FORMATION OF THE VANCOUVER GROUP.
0 - ABSENT; 1 - PRESENT; 2 - MINOR; 3 - MAJOR; 5 - PRESENT TO AN UNKNOWN EXTENT

DYKES,PRESENCE OF DYKES OF VARYING COMPOSITION; 0 - ABSENT; 1 - PRESENT
2 - MINOR; 3 - MAJOR; 5 - PRESENT TO AN UNKNOWN EXTENT

DIST FROM NOSE;BEARING & DISTANCE FROM NOSE OF INTRUSION TO DEPOSIT

TABLE 4

LISTING OF MINERAL DEPOSITS DATA FILE FOR
ZEBALLOS MINING CAMP - GEOLOGICAL FEATURES OF VEINS

DEP	MAJOR VEIN/S			2NDARY VEIN/S			NO MINZ	AV VEIN WIDTH(CM)		ASSOC	AV SHEAR WIDTH(CM)	
NO	STRIKE	DIP	D/DRN	STRIKE	DIP	D/DRN	VEINS	MIN	MAX	ZONES	MIN	MAX
1	080	65	315	065	80	180	5	15	30	1	30	90
2	055	80	315	070	85	315	3	15	20	1	10	60
3	045	70	135	045	90		2	5	8	1	5	60
4	090	75	180				1	20	25	1	8	45
5	040	80	135	180	80	225	3	2	12	1	30	90
6	045	80	135	060	60	315	7	8	12	1	10	45
7	090	85	360	090	90		5	0	30	1	25	75
8	045	75	315	032	80	315	2	3	30	1	3	30
9	040	75	135	040	80	135	2	1	15	1	3	90
10	035	90		057	80	315	7	1	20	1	5	75
11	160	70	045				1	0	15	1	4	20
12	000	90								4		
13	040	75	135				1	1	10	1	3	90
14	095	80	180	080	90		2	3	8	1	3	25
15	045	90					1	0	35	2		
16	000	90		000	65	135	4	5	10	1	5	60
17	063	80	135				1	0	25	1	5	45
18	176	90		000	90		5	0	8	1	10	20
19	057	75	315	090	90		3	2	5	1	3	5
20	050	90		060	80	315	4	1	3	1	10	60
21	090	90		090	90		10	0	5	1	150	1500
22												
23	010	75	045				1	3	12	1	15	25
24	175	60	135	030	70	135	2	3	20	1	15	20
25	090	72	360				1	5	15	1	15	60
26	090	80	360				1	5	15	1	45	75
27	052	80	135				1	5	10	1	10	30
28	058	90					1	0	10	1	15	180
29	047	90		050	90		2	4	8	1	5	15
30	160	70	135	050	90		3	5	10	1	15	60
31												
32	065	90					1	5	5	3		
33										4		
34	155	60	225				1	0	30	1	50	75
35										4		

ASSOCIATED ZONES; 1 - VEINS INTIMATELY ASSOCIATED WITH SHEAR ZONES; 2 - VEINS ASSOCIATED WITH DILATANT ZONES; 3 - MINERALIZATION ASSOCIATED WITH CONTACT ZONE; 4 - ASSOCIATED REPLACEMENT (SKARN) ZONE

TABLE 5

LISTING OF MINERAL DEPOSITS DATA FILE FOR
ZEBALLOS MINING CAMP - VEIN MINERALOGY AND CHARACTER

DEP NO	ASSOCIATED VEIN MINERALS Pyr	Sp	Aspy	Py	Cpy	Gn	Qtz	Cc	Ank	SH'TD ZONES	VEIN FORM	TENL FEAT	REPL	DIST(M) TO CONTACT
1	1	2	1	3	1	2	3	2	3	3	2	3	2	+ 57
2	0	2	0	2	0	2	3	0	0	2	2	3	0	+ 473
3	0	0	3	3	0	0	3	2	2	0	2	3	3	- 473
4	5	0	0	5	3	3	3	0	0	2	2	2	3	- 151
5	0	3	0	3	0	2	3	0	0	0	1	3	0	+ 473
6	0	2	2	3	2	2	3	0	0	0	2	2	0	+1229
7	0	2	3	3	0	2	3	0	0	0	1	2	0	+ 964
8	2	3	2	3	0	3	3	2	0	2	4	5	0	-1229
9	0	2	2	2	2	3	3	0	0	0	1	3	0	+ 529
10	0	2	2	2	0	2	3	0	0	2	2	2	0	+ 491
11	3	3	0	2	1	2	3	2	0	0	2		0	-2646
12	3	0	0	0	0	0	3	3	0	0		0	3	-1985
13	2	0	2	0	0	0	3	0	0	0	1	5	0	+ 548
14	0	1	2	2	0	1	3	0	0	0	2	2	0	+1040
15	3	3	0	2	1	2	3	2	0	0	2	5	5	-3175
16	2	0	0	0	2	0	0	3	0	0	3		0	-1890
17	0	0	2	2	0	0	3	0	0	0	1	5	0	-1115
18	0	2	2	2	2	1	3	0	0	0	2		3	-2174
19	0	0	0	2	0	0	3	3	0	0	1	2	0	-3400
20	0	0	0	2	0	0	3	2	0	0	1	2	0	+ 113
21	0	1	2	3	0	1	3	2	0	0	2	3	0	+1130
22	0	0	0	3	0	0	3	0	0	0	1	0	0	+ 435
23	2	3	3	0	2	0	3	0	0	0	1		0	
24	0	1	0	3	2	1	3	0	0	0	2	5	0	-1985
25	5	1	1	1	0	0	2	2	0	0	2		0	-1814
26	1	1	2	1	1	1	3	0	0	0	1	5	0	- 983
27	0	1	1	2	1	1	3	2	0	0	1	5	0	-1852
28	0	0	0	1	0	0	3	0	0	0	2		0	- 718
29	1			2			2				1		0	-2948
30	1	1	1	1	1	0	3	2	0	0	1	5	0	
31	0	0	0	0	0	0	0	0	0	0		0	0	-2022
32	0	1	0	0	1	0	3	3	0	0	1		0	-2211
33													3	
34	0	2	3	2	0	2	3	0	0	0	2	3	0	
35													3	

ASSOCIATED VEIN MINERALS ; MINERALS WHICH ARE PRESENT ALONG WITH Au AND Ag; 0 - ABSENT; 1 - MINOR; 2 - MODERATE; 3 - MAJOR; 5 - PRESENT TO UNKNOWN EXTENT.

SH'TD ZONES ; OCCURENCE OF SHEETED ZONES ON THE VEIN: 0 - ABSENT; 2 - MINOR; 3 - MAJOR

VEIN FORM;LOCAL FEATURES OF THE VEINS; 1 - PLANAR & APPROX PARALLEL-SIDED; 2 - VARIABLE IN WIDTH & ATTITUDE; 3 - LENTICULAR; 4 - COMBINATION OF 2 & 3.

TENL FEAT,TENSIONAL FEATURES,E.G.DIAGONAL GASH VEINS; 0 - ABSENT 2 - MINOR; 3 - MAJOR; 5 - PRESENT TO UNKNOWN EXTENT

REPL,ASSOCIATED REPLACEMENT/ALTERATION; 0 - ABSENT; 2 - MINOR ; 3 - MAJOR; 5 - PRESENT TO UNKNOWN EXTENT

DIST TO CONTACT;DISTANCE FROM DEPOSIT TO NEAREST CONTACT BETWEEN THE ZEBALLOS STOCK AND COUNTRY ROCK(+,WITHIN THE STOCK; -,WITHIN THE COUNTRY ROCK).

FUTURE WORK

We are in the process of examining the application of a variety of multivariate statistical methods of evaluation to the Zeballos data file. Among these methods are multiple regression, discriminant function analysis, cluster analysis, and characteristic analysis. These are complex methods of data evaluation that are hampered in the case of Zeballos data by the limited number of deposits for which data are relatively complete.

In addition to statistical evaluation of our quantitative data file, a detailed structural analysis appears to warrant attention to assist in defining a resource model for Zeballos camp.

CONCLUSIONS

An extensive quantitative data file has been established for gold-quartz veins in Zeballos mining camp. A preliminary evaluation of these data leads to the following conclusions:

(1) For past producers, total production in metric tonnes is an indicator of relative gross value of a deposit.

(2) Large vein deposits are lower grade on average than are small vein deposits.

(3) Gold and silver average grades appear highly correlated on a log-log plot although this relationship appears to be accentuated by extreme hand sorting of small deposits.

(4) A systematic relation exists between gold grades and combined copper plus lead content.

(5) A pronounced systematic relationship exists between relative deposit worth (approximated by total gold content) and distance from the nearest contact of the Zeballos stock. This relationship leads to a procedure for defining areas of greatest potential for gold-quartz veins in the camp.

(6) A 1 000-metre-wide zone centred on the contact of the Zeballos stock is an area of high potential for location of a deposit equivalent to the five largest producers known in the camp.

(7) A median target defined from the five producers contains 900 000 grams of gold in 75 000 tonnes of ore.

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REFERENCES

Goldsmith, L. B., Sinclair, A. J., and Read, P. B. (in preparation): An Evaluation of Average Grades and Production Tonnages, Trout Lake Mining Area, Southern British Columbia.

Orr, J.F.W. and Sinclair, A. J. (1971): A Computer-Processable File for Mineral Deposits in the Slocan and Slocan City Areas of British Columbia, *Western Miner*, Vol. 44, No. 4, pp. 22-34.

Sinclair, A. J. (1979): Preliminary Evaluation of Summary Production Statistics and Location Data for Vein Deposits, Slocan, Ainsworth and Slocan City Camps, Southern British Columbia, *in* Current Research, Pt. B, *Geol. Surv., Canada*, Paper 79-1B, pp. 173-178.

Stevenson, J. S. (1950): Geology and Mineral Deposits of the Zeballos Mining Camp, *B.C. Ministry of Energy, Mines & Pet. Res.*, Bull. 27, 145 pp.

TABLE 1: GALENA-LEAD ISOTOPE ANALYSES FROM MINERAL DEPOSITS
Cariboo Area (Omineca Belt and Adjacent Intermontane Belt), South-Central British Columbia

Sample Number	Analysis	Deposit Name	Map Name	Lat. North	Long. West	Lead Isotope Ratios (Relative 1S Error as %) 206/204	207/204	208/204
NTERMONTANE BELT								
G79CD-001*	1	Cedar Creek	CD	52.55	121.47	18.757 (.09)	15.584 (.17)	38.310 (.21)
G79MR-001*	1	Mariner	MR	52.59	121.27	18.953 (.03)	15.654 (.11)	38.845 (.13)
Number of deposits (n)= 2				Arithmetic average ($\overline{x}$) =		[18.855 (.06)]	[15.619 (.14)]	[38.577 (.17)]
Number of analyses (a)= 2				Standard deviation (S) =		[0.139]	[0.050]	[0.378]
				Std. error of mean ($S \cdot n^{-1/2}$) =		[0.098]	[0.035]	[0.267]
MINECA BELT (CARIBOO DISTRICT)								
G79AU-001*	1	Aurum (Island Mountain)	AU	53.10	121.58	19.237 (.07)	15.759 (.14)	39.280 (.13)
G79CC-001*	1	Cunningham Creek (A-Zone)	CC	52.93	121.38	19.209 (.09)	15.759 (.19)	39.233 (.19)
G79CG-001	1	Cariboo Gold Quartz	CG	53.08	121.55	19.202 (.06)	15.703 (.16)	39.198 (.08)
30431-001	2	Cariboo Gold Quartz	CG	53.08	121.55	19.163 (.07)	15.692 (.08)	39.064 (.08)
30132-AVG*		Cariboo Gold Quartz (n=2)	CG	53.08	121.55	19.183 (.04)	15.698 (.09)	39.131 (.05)
G79CH-001*	1	Cariboo Hudson	CH	52.88	121.37	19.201 (.04)	15.752 (.12)	39.258 (.12)
30426-001	2	Pin Money	426	53.03	121.49	19.184 (.23)	15.720 (.24)	39.225 (.25)
30426-001@	2	Pin Money	426	53.03	121.49	19.195 (.15)	15.729 (.17)	39.213 (.18)
30426-002	2	Pin Money	426	53.03	121.49	19.245 (.22)	15.783 (.32)	39.417 (.28)
30426-AVG*	2	Pin Money	426	53.03	121.49	19.208 (.20)	15.744 (.24)	39.285 (.24)
30427-001	2	Mosquito Creek	427	53.10	121.57	19.046 (.20)	15.745 (.22)	39.133 (.24)
30427-002	2	Mosquito Creek	427	53.10	121.57	19.169 (.06)	15.759 (.07)	39.267 (.07)
30427-AVG*	2	Mosquito Creek	427	53.10	121.57	19.107 (.1[illegible])	15.752 (.15)	39.200 (.16)
Number of deposits (n)= 6				Arithmetic average ($\overline{x}$) =		[19.194 (.10)]	[15.744 (.16)]	[39.231 (.15)]
Number of analyses (a)= 10				Standard deviation (S) =		[0.045]	[0.023]	[0.058]
				Std. error of mean ($S \cdot n^{-1/2}$) =		[0.018]	[0.009]	[0.024]

1. Analyses by B.D. Ryan, Geology-Geophysics Laboratory, The University of British Columbia.
2. Analyses by A. Andrew, Geology Laboratory, The University of British Columbia.
3. The * symbol denotes those analyses used in the calculation of averages, standard deviations and standard errors.
4. The @ symbol denotes a duplicate analysis.
5. Two samples of galena, one coarse grained and one fine grained, were taken from the same hand specimen.

Table 2

Sample Data for K and Ar analyses on Whole Rock and Muscovite

Sample Number	Lat.	Long.	K%	Ar^{40*} (mol/gm)	rad. Ar%	Age (Ma)
Whole Rock						
A81 SN1	53 5'	121 33'	2.49 .07	8.114×10^{-10}	95.2	179 8
Muscovite						
A81 VN1	53 5'	121 33'	8.61 .06	21.986×10^{-10}	96.9	141 5

K was determined by Krista Scott by atomic absorption using a Techtron AA4 spectrophotometer. Ar was determined by J.E. Harakal, by isotope dilution, using an AEI MS-10 mass spectrometer and high purity ^{38}Ar spike (White et al., 1967). Errors are for two standard deviations. The constants used are:

$$\lambda^{40}K_{\varepsilon} = 0.581 \times 10^{-10} a^{-1}, \lambda^{40}K_{\beta} = 4.962 \times 10^{-10} a^{-1},$$

$$^{40}K = 0.01167 \text{ atom per cent.}$$