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Report for

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PRELIMINARY REPORT ON THE LITHOGEOCHEMISTRY OF THE SURF INLET SHEAR ZONE

by

J.F. HARRIS Ph. D.

JF Harris

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Excellent!

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PRELIMINARY REPORT ON THE LITHOGEOCHEMISTRY OF THE SURF INLET SHEAR ZONE

J.F. HARRIS

Introduction

Past production from the Surf Inlet gold camp has come from two ore bodies, the Surf and the Pugsley, within a major shear zone. This structure, ranging from a few metres up to some 60 m. in width, is known to continue over several miles of strike. It is distinguished by varying degrees of alteration and shearing of the gneiss or diorite country rocks, accompanied by intermittent development of quartz veins. Au mineralization tends to show a close correlation with abundance of pyrite but is typically erratic in its distribution.

Numerous vein quartz showings occur along the shear, some of them yielding encouraging Au values over narrow widths.

Although the shear is well exposed and accessible (within the limitations of the terrain) to surface examination and sampling, the highly variable nature of vein widths and grades in both horizontal and vertical senses, makes conventional methods of evaluation (assaying of channel samples or core from scattered diamond drill holes) less than reliable.

Objectives

The purpose of the study currently in progress is to investigate the possible existence within the shear zone of broader, more consistently measurable compositional variations which could be used as indicators of proximity to additional centres of significant Au mineralization comparable with the Surf and Pugsley.

Several cases of lithogeochemical studies of gold deposits exist in the literature (see References, p.6), but these are mostly more regional in scale - investigating broad halos in the (more or less unaltered) hosting lithologies, rather than variations within a confined structural zone.

Some elements which have been reported as useful in the halo-forming context are Te, Hg, As, Sb, Ag, Mo, Pb, Rb and CO_2. Naturally the elements exhibiting the best responses differ from camp to camp.

The objectives of the present study are to find out:

a) which mineralization or alteration-related elements show interesting levels of variation within the Surf Inlet shear zone

b) whether any elements showing enrichment in the actual mineralized veins also show a more dispersed enrichment in the adjacent altered/shear zone material.

c) what scale of variation is exhibited by the elements of interest, and how the shear must be sampled in order to detect the patterns sought.

Work done

As a first step (directed towards objective (a) above) a small suite of 16 samples was analyzed for 35 elements. These samples are part of a fairly extensive suite collected from surface showings, underground workings, diamond drill holes and ore dumps by Cominco Ltd. during their 1981 programme of exploration on the property, and kindly made available for use in this study.

Analytical results are tabulated in Appendix A.

Trace elements found to show substantial variation are Au, Ag, Cu, Hg and Te. Somewhat lesser variation is shown by Ba, Mn, Sr, C and, possibly, Mo.

Trace elements showing notably flat responses (in some cases below analytical detection limit) are As, Be, Bi, Cd, Ga, La, Pb, Sb, Tl U, W, Zn, Rb and Se.

Major elements are considered to be generally inapplicable to this study in that their distribution is likely to be more strongly influenced by lithological variations in the rocks traversed by the shear than by mineralization-related processes. Likewise such trace elements as Co, Ni and Cr are downgraded because of their likely dependence on variations in the proportions of primary mafic minerals.

Of the five elements showing the most initial promise (Au, Ag, Cu, Hg and Te), data for the first three already exist for all samples by virtue of the Cominco work. Analyses for Hg and Te have been done on an additional suite of 53 more samples. These include Au-bearing veins, barren veins, and altered wall rocks. Together with the corresponding data from the initial 16 samples, these results form the basis for the preliminary findings discussed in the following section.

Discussion

The frequency distribution of concentrations of all the five elements under consideration is strongly logarithmic in character, showing ranges of several orders of magnitude.

As a means of looking at inter-relationships in a semi-quantitative sense, a three-fold classification of concentrations was made for each element. The cut-offs adopted are as follows:

	Low	Medium	High
Au (ppb)	<10 - 290	300 - 3,000	>3,000
Ag (ppm)	<0.4 - 1.9	2.0 - 20	>20
Cu (ppm)	2 - 99	100 - 1,000	>1,000
Hg (ppb)	10 - 90	100 - 500	>500
Te (ppm)	0.05 - 0.45	0.5 - 5	>5

The above provides a reasonably even division of the 69 samples, which are distributed as follows:

Number of Samples

	Low	Medium	High
Au	37	11	21
Ag	45	16	8
Cu	42	15	12
Hg	39	18	12
Te	26	19	24

The following diagrams show the degree of correlation of the various elements with Au, in terms of the numbers of samples in which, for example, high, medium and low Te values are respectively associated with high, medium and low Au.

Te \ Au	Low	Med	High
High	2	1	21
Med.	9	10	-
Low	26	-	-

Hg \ Au	Low	Med	High
High	4	1	8
Med.	5	2	10
Low	27	9	3

Ag \ Au	Low	Med	High
High	-	1	7
Med.	1	3	12
Low	36	7	2

Cu \ Au	Low	Med	High
High	1	3	8
Med.	5	3	7
Low	31	5	6

General conclusions to be drawn from the above are that all four elements show strong to moderate positive correlations with Au content. Details of the pattern differ somewhat. Low Au values can be seen to have associated high Hg and medium to high Te and Cu in a significant percentage of cases; this is essentially never the case with Ag.

On the other hand, high Au values never show associated low or even medium Te values, but frequently coincide with low and medium Cu values. Ag and Hg show intermediate features in this respect.

In this study we are looking not for an element which correlates perfectly with Au (and hence presents the same high variance and difficulties of sampling), but one which, whilst being genetically associated with the mineralizing process, shows a significant degree of dispersion into the shear zone rocks around and above the immediate Au-bearing veins, or sections of veins. Those elements in which the association diagrams show an overlap of high values from the high Au into the low Au samples are believed to show promise in this respect.

Hg shows the most favourable distribution, followed by Te and, in turn, Cu. Ag appears to completely lack dispersive characteristics.

It is possible that Au itself also offers some possibilities as a pathfinder. Although it shows a highly erratic (segregated) distribution on the basis of conventional assays, there are grounds for expecting some dispersion in the very low trace range. This may well be obscured in the existing Cominco data (rock geochemical determinations by acid digestion/solvent extraction/atomic absorption to a nominal detection limit of 10 ppb) in which discrimination in the range 0 - 30 ppb is likely to be poor. Currently available geochemical techniques (fire assay/ neutron activation or fire assay/AA) yield a detection limit of 1 ppb and should be better capable of displaying low-level halos of Au distribution. These may be manifested by significantly higher abundances of 10 - 30 ppb concentrations compared with 0 - 10 ppb concentrations in certain sections of the shear.

Although the sample suite so far studied is by no means a balanced representation of the various showings, shear intersections, etc. and the mineralized veins and associated shear zone material which jointly compose them, it may nevertheless prove intructive to see how the present data stand up in use as a lithogeochemical guide.

For this purpose it is necessary to rate the various groups of samples in terms of how close each comes to representing the situation we hope to be able to characterize i.e. a portion of the shear zone which contains, or is closely proximal to, a major concentration of mineralization.

The samples from the underground workings in the Pugsley Mine must presumably be rated as most closely representing the target 'productive' situation. The samples from the Homestake adit, being spatially related to auriferous veins in the East Shear system in the vicinity of the Pugsley, perhaps rate close to them in favourability. The diamond drill hole, 81-4, intersects the shear only a few hundred feet along strike from the southern limits of the Pugsley zone, so it may exemplify an 'adjacent to productive' situation.

Of other locations represented in the suite, the Sadie's showings are relatively close to the northern end of the Pugsley, and the Bluff showing is in the general vicinity of the Surf ore body: however, neither may be sufficiently close to reflect the influence of the respective ore zones.

The remaining locations (Cassie, Bonanza, Diabase, Summit, DDH-2 and DDH-7) are not close to any known ore concentrations and, provisionally, can be considered as less favourable situations.

Parameters used in comparing the various locations are relative enrichment of Hg, Te, Ag and Cu in mineralized material (arbitrarily defined, for this purpose, as samples containing >1,000 ppb Au) and the relative enrichment of the same elements in unmineralized vein and shear zone material (samples containing <1,000 ppb Au). The relative enrichment factors are simply the ratios of average element contents (in ppb) vs average Au contents (in ppb) for the 'mineralized' and 'unmineralized' samples from each location. Because of the preliminary status of the study, and the rather sketchy sample coverage, these are, in some cases, averages of one!

The calculated factors are compiled in Table 1.

The enrichment factors which best distinguish the two ore-related locations (Pugsley and Homestake) from the others appear to be Hg/Au and Cu/Au, in both

TABLE 1. COMPARISON OF ENRICHMENT FACTORS

Location	Category	Enrichment factors: Mineralized samples				Enrichment factors: Unmineralized samples			
		Hg/Au	Te/Au	Ag/Au	Cu/Au	Hg/Au	Te/Au	Ag/Au	Cu/Au
u/g Pugsley	Ore related	0.5	1.4	2.6	2,052	11.1	3.1	3.4	8,983
u/g Homestake	"	0.3	2.8	0.6	411	8.6	10.5	1.5	446
DDH-81-4	Near to ore?	0.02	1.7	1.0	381	1.2	4.4	12.5	2,937
Sadies	"	0.01	0.7	0.4	166	0.4	6.3	1.9	2,298
Bluff	"	0.02	1.0	3.2	8	0.3	6.8	2.9	321
Cassie	Unknown	0.03	0.7	1.5	1	0.2	3.6	3.4	365
Bonanza	"	0.3	2.7	7.3	1,663	0.3	75.8	6.8	720
Diabase	"	0.02	3.4	5.5	6	0.5	5.8	17.3	1,059
Summit	"	0.04	2.2	2.2	23	0.2	3.6	2.2	145
DDH-81-2	"	0.05	2.7	7.4	1	0.3	4.8	15.4	20
DDH-81-7	"	0.01	0.7	0.2	2	0.2	1.8	1.0	137
Dumps	"	0.01	1.0	0.4	268	0.2	3.4	1.5	229

mineralized and unmineralized material. Te/Au in unmineralized samples is also perceptibly higher in these areas.

The mean values of these factors for the two ore-related locations are:

Hg/Au (min)	0.4
Hg/Au (unmin)	9.8
Cu/Au (min)	1,231
Cu/Au (unmin)	4,714
Te/Au (unmin)	6.8

The locations classed as possibly 'near to ore' show no tendency for elevated values in Hg/Au (min), though DDH-81-4 is somewhat elevated in Hg/Au (unmin). It also shows values of Cu/Au (min and unmin) resembling those of the ore-related areas.

Sadie's shows a high score in Cu (unmin) and a marginal one in Cu/Au (min), but is not distinctive in terms of Hg/Au. Sadie's and Bluff both show relatively high Te/Au (unmin).

Among the locations of unknown potential, the Bonanza stands out as having values of Hg/Au (min), Cu/Au (min) and Cu/Au (unmin) similar to those of the ore-related examples. It also shows a uniquely high score in Te/Au (unmin).

The Diabase showing has high Cu/Au (unmin) and somewhat high Te/Au (unmin).

In summary, based on scores in the five factors which best distinguish the known ore-related areas, the three possible near-ore situations all show partial ore-related characteristics.

Among the unknowns, the Bonanza and, to a lesser degree, the Diabase show partially favourable lithogeochemical features.

The failure of the Dump samples to show any resemblance to the ore-related group is somewhat puzzling. One assumes that these represent material which came from old workings and should hence exhibit strongly the chemical characteristics tentatively ascribed as 'favourable'. It is possible that weathering and oxidation affecting the broken rock over a period of several years has resulted in depletion of the mobile elements Hg and Te.

Recommendations

Results of the study to date are promising. In order to confirm (or modify) the tentative findings, further work is required.

1. The second group (of 53 samples) should be run for multi-element ICP analysis to ascertain whether any other elements (notably Ba, Mn, Mo and Sr) show potential for discriminating ore-related environments within the shear. Au analysis to 1 ppb detection limit should also be considered, to check out the low-level dispersion hypothesis.

2. Following this, all remaining shear-zone samples from the Cominco programme (estimated at about 100) should be analyzed for Hg, Te and any other element(s) found to exhibit discriminatory potential.

The resultant data, combined with that already acquired, will permit a more reliable and refined derivation of lithogeochemical discriminants.

3. Given success in stage 2 (above), plans for the collection of new samples and a systematic evaluation of the Surf Inlet Shear Zone can be made.

APPENDIX

LIST OF SAMPLES AND ANALYTICAL RESULTS

SELECTED BIBLIOGRAPHY ON TRACE ELEMENT DISPERSIONS AROUND GOLD DEPOSITS

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LIST OF SAMPLES

Sample No.	Lab. No.	Location	Description
SR 81-152	R81-12486	Pugsley 907 drive, S.	2.5m. channel, vein and shear
153	12487	" "	2.0m. " " "
158	12492	" " C.	3.0m. " , shear with quartz
163	12497	" "	3.0m. " , vein and shear
165	12499	" " N.	2.0m. " , vein and shear
168	12502	" "	3.0m. " , quartz vein
SR 81-103	R81-10203	Homestake adit, N.	1m. channel, HW to quartz
105	10205	" "	" , FW to quartz
108	10208	" " C.	" , vein and shear
109	10209	" "	" , shear
110	10210	" " S.	" , shear with quartz
111	10211	" "	" , shear with sulfides
SR 81- 79	R81- 9976	Sadie's Ck. 195m.	Shear, HW to vein
80	9977	" "	Quartz vein
81	9978	" "	Shear, FW to vein
15	9982	" 145m.	Shear, HW to vein
86	9983	" "	Quartz vein
87	9984	" "	Shear, FW to vein
89	9986	" 125m.	Shear, HW to vein
91	9988	" "	Shear, FW to vein
SR 81- 71	R81- 9882	Bluff, 200L Adit	Shear, HW to quartz vein
72	9883	" "	Quartz vein
SR 81- 17	R81- 8523	Cassie Showing	Grabs from ore dump
18	8524	"	Shear, HW to upper quartz vein
19	8525	"	Upper quartz vein
20	8526	"	Shear between veins
21	8527	"	Lower quartz vein
22	8528	"	Shear, FW to lower quartz vein
SR 81- 28	R81- 9431	Summit Showing	Shear, HW to quartz vein
29A	9432	"	Quartz vein
30	9434	"	Shear, FW to quartz vein
SR 81- 23	R81- 8617	Bonanza Showing	Shear, HW to quartz vein
24	8618	"	Upper quartz vein
25	8619	"	Shear between veins
26	8620	"	Lower quartz vein
27	8621	"	Shear, FW to lower quartz vein
SR 81- 31	R81- 9435	Diabase Showing	Shear, HW to quartz vein
32	9436	"	Quartz vein
33	9437	"	Shear FW to quartz vein
34	9438	"	Diabase dyke cutting shear

List of Samples cont.

SR 81-125	R81-10605	Surf Dumps, W. Dump		Composite grab
129	10609	"	"	"
130	10610	"	"	"
142	10622	"	"	"
145	10625	"	E. Dump	"
148	10628	"	"	"
118	10218	"	Paradise Ck	"
119	10219	"	"	"
121	10221	"	"	"
	R81- 8555	DDH 81-2	116.0 - 116.6	Shear zone
	8556	"	116.6 - 117.6	"
	8557	"	117.6 - 118.6	"
	8558	"	118.6 - 119.6	"
	8559	"	119.6 - 120.6	"
	8560	"	120.6 - 121.6	"
	8561	"	121.6 - 122.6	"
	8562	"	122.6 - 123.2	"
	8563	"	123.2 - 124.0	"
	R81- 9852	DDH 81-4	117.9 - 118.9	Shear zone
	9853		116.9 - 117.9	"
	9854		116.3 - 116.9	"
	9855		115.3 - 116.3	"
	R81-12507	DDH 81-7	58.6 - 60.8	Shear zone
	12508	"	60.1 - 60.8	"
	12510	"	61.4 - 61.5	"
	12511	"	61.5 - 62.6	"
	12512	"	62.6 - 63.8	"
	12514	"	64.8 - 65.8	"
	12515	"	65.8 - 66.8	"

ANALYTICAL RESULTS

Location	Lab. No	Chemex, 1986		Cominco, 1981		
		Hg (ppb)	Te (ppm)	Au (ppb)	Ag (ppm)	Cu (ppm)
Pugsley u/g						
	12486	3,400	18.00	14,000	29.9	2,340
	12499	5,600	3.80	2,030	1.3	1,586
	12502	320	1.55	1,140	14.0	31,300
	Means (hi Au)	3,106	7.80	5,723	15.1	11,742
	12487	4,000	0.75	124	0.4	168
	12492	1,420	0.55	124	1.8	6,100
	12497	2,400	0.85	456	0.4	65
	Means (lo Au)	2,607	0.72	235	0.87	2,111
Homestake u/g						
	10208	3,000	30.00	10,500	3.6	1,890
	10210	1,640	13.00	4,630	5.8	5,150
	10211	820	9.50	3,860	2.3	763
	Means (hi Au)	1,820	17.50	6,330	3.9	2,601
	10203	240	1.25	160	<0.4	81
	10205	100	0.55	140	<0.4	38
	10209	3,000	2.30	90	<0.4	56
	Means (lo Au)	1,113	1.37	130	<0.4	58
Cassie	8523	1,760	22.00	63,000	93.2	26
	8525	120	13.00	4,300	7.4	11
	8527	100	13.50	6,000	11.1	11
	Means (hi Au)	660	16.20	24,330	37.2	16
	8524	20	0.40	110	<0.4	138
	8526	40	1.10	300	0.8	2
	8528	20	0.05	24	0.4	19
	Means (lo Au)	27	0.52	145	0.5	53
Bonanza	8618	240	13.50	4,020	36.9	10,780
	8620	4,600	32.50	12,800	86.0	17,200
	Means (hi Au)	2,450	23.00	8,410	61.5	13,990
	8617	20	26.00	238	1.0	25
	8619	90	9.00	90	1.2	70
	8621	60	1.50	156	1.2	252
	Means (lo Au)	57	12.20	161	1.1	116

Sadie's Ck.	9977	200	13.50	19,000	10.0	403
	9983	240	33.00	45,000	15.1	10,200
	Means (hi Au)	220	23.20	32,000	12.5	5,301
	9976	100	0.05	<10	<0.4	14
	9978	40	0.25	100	<0.4	47
	9982	20	3.10	400	<0.4	782
	9984	40	0.40	80	<0.4	549
	9986	20	0.15	20	0.4	21
	9988	10	0.05	20	0.4	22
	Means (lo Au)	38	0.66	104	<0.4	239
Summit						
	9432	260	15.00	6,670	14.5	152
	9431	60	0.60	170	<0.4	18
	9434	40	1.35	380	1.0	63
	Means (lo Au)	50	1.00	275	0.6	40
Diabase						
	9436	100	15.00	4,400	24.4	28
	9435	20	0.10	22	<0.4	48
	9435	20	0.30	60	2.0	47
	9438	40	0.50	74	0.6	71
	Means (lo Au)	27	0.30	52	0.9	55
Bluff						
	9983	660	29.00	30,000	97.7	224
	9982	40	0.95	140	0.4	45
Dumps						
	10219	60	13.50	3,250	1.0	750
	10221	120	11.50	18,000	8.0	8,330
	10605	20	8.00	7,170	0.8	117
	10609	20	2.25	1,820	2.2	2,510
	10610	40	10.00	14,800	5.3	1,626
	10622	100	12.50	10,200	5.9	3,490
	Means (hi Au)	68	9.50	9,207	3.9	2,804
	10218	60	2.50	230	<0.4	60
	10625	60	0.40	272	<0.4	13
	10628	100	1.20	690	1.2	200
	Means (lo Au)	73	1.37	397	0.6	91

DDH 81-2						
	8555	430	19.80	10,400	69.7	18
	8563	170	14.60	2,190	23.9	6
	Means (hi Au)	300	17.20	6,295	46.8	12
	8556	50	0.70	14	1.3	3
	8557	100	0.60	128	5.0	6
	8558	40	0.05	22	1.3	2
	8559	60	2.50	704	4.8	4
	8560	30	0.75	140	1.9	2
	8561	20	0.25	22	0.9	2
	8562	20	0.10	12	0.6	1
	Means (lo Au)	46	0.71	149	2.3	3
DDH 81-4						
	9853	20	2.50	1,600	1.4	510
	9854	20	2.25	1,100	1.3	518
	Means (hi Au)	20	2.35	1,350	1.3	514
	9852	20	0.10	<10	<0.4	61
	9855	20	0.05	28	<0.4	34
	Means (lo Au)	20	0.07	16	<0.4	47
DDH 81-7						
	12510	260	19.00	26,000	5.1	41
	12507	80	0.05	<10	<0.4	12
	12508	60	0.65	284	0.8	87
	12511	40	0.10	64	<0.4	13
	12512	20	1.10	702	<0.4	6
	12514	20	0.10	60	<0.4	18
	12515	20	0.05	22	<0.4	23
	Means (lo Au)	40	0.35	190	<0.4	26

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Job #85-75

January 21st, 1986

Report for: Murray McLaren,
Fleet Developments Ltd.,
701-744 West Hastings St.,
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Samples:

5 samples of products from metallurgical test work on material from Surf Inlet, B.C., as follows:

Sample	Slide No.	Au assay (oz/ton)
Plant tailings	85-231X	0.061
E. Surf Dump, compo	85-232X	0.067
W. Surf Dump, compo	85-233X	0.151
E. Surf flotation conc.	85-234X (A & B)	1.03
W. Surf flotation conc.	85-235X (A & B)	3.33

Samples were prepared as polished thin sections. Two sections of each of the flotation concentrates were prepared so as to maximize the chances of observing particulate Au.

Descriptions:

1. Plant Tailings

This material consists of angular particles, mainly in the size-range 0.05 - 0.25mm (50 - 250 microns).

The particles consist chiefly of quartz, with minor plagioclase, sericite and carbonate, and occasional hornblende.

Opaques are sparse. They consist dominantly of pyrite, at an estimated concentration of 0.1 - 0.3%. Rare specks of chalcopyrite and iron oxides were also seen.

The sulfides are as liberated grains.

2. E. Surf Dump: composite heads

The material mounted is a -10+20 mesh fraction sieved from the crushed, homogenized head sample. It consists of rock and mineral fragments, mainly in the size range 0.2 - 2.0mm.

The dominant particle type is a more or less altered, fine-grained, intrusivetextured rock of quartz diorite to granodiorite composition. This is composed of quartz, plagioclase (variably replaced by sericite and carbonate), minor K-feldspar and hornblende, and a little biotite. The mafics are partially altered to chlorite and epidote.

A considerable proportion of grains (30 - 40%) consist totally, or largely, of quartz. This is probably indicative of a phase of veining or silicification affecting the intrusive.

The sulfide content is estimated at approximately 0.5% and consists almost entirely of pyrite. The majority of this is in the form of a few relatively coarse, free grains, up to 2.0mm in size. A very minor proportion is as individual smaller grains (0.01 - 0.05mm) or small clumps within silicate rock fragments.

The great majority of fragments (both intrusive and quartz) are devoid of sulfides.

3. W. Surf Dump: composite heads

This material was prepared as for the E. Surf compo and presents a generally similar appearance under the microscope.

The intrusive material appears to be dominantly quartz dioritic in composition (K-feldspar is not seen) and may be slightly more altered (fresh hornblende or biotite are rare, and sericite and carbonate are possibly more abundant than in the E. Surf sample, sometimes making up descrete particles). A high proportion of the grains (perhaps as much as 50%) consist of essentially monomineralic quartz,

The sulfide content, though still low (estimated at about 1%), is noticeably higher than in the E. Surf compo. Again it consists essentially of pyrite, though very minor accessory chalcopyrite and pyrrhotite were also noted.

The pyrite is dominantly in the form of free grains, 0.5 - 2.0mm in size. A small proportion occurs as grains 0.01 - 0.1mm in particles of quartz diorite or quartz. There is no observable tendency for the sulfides to occur preferentially in the free quartz. Most of the quartz particles are quite devoid of sulfides.

4. E. Surf Flotation Concentrate

This material consists of angular grains showing a size range of about 2 - 150 microns.

The estimated mode is as follows:

Quartz) Feldspars)	50
Sericite	8
Carbonate	10
Mafic silicates	10
Pyrite	20
Chalcopyrite	1
Iron oxides) Metallic iron)	1

The sulfide particles show a remarkable degree of liberation, approaching 100%. Pyrite and chalcopyrite also show essentially complete liberation one from the other. The pyrite appears homogenous and free of inclusions of other minerals.

The majority of the sulfide particles (estimated >80%) fall in the upper part of the size range (>40 microns).

The majority of the silicate particles appear free of included or attached sulfides and it appears that considerable upgrading of the concentrate would be possible by reflotation.

5. W. Surf Flotation Concentrate

This material shows a similar size range to the E. Surf concentrate.

Estimated mode

Quartz) Feldspars)	28
Sericite	7
Carbonate	10
Mafic silicates	5
Pyrite	45
Chalcopyrite	4
Iron oxides) Metallic iron)	1

Significant differences from the E. Surf concentrate are notably higher overall sulfide content and a somewhat higher ratio of chalcopyrite to pyrite.

As in the other product, liberation of sulfides from silcates and of chalcopyrite from pyrite appears essentially complete. It therefore appears that differential flotation to produce a separate copper concentrate would be quite feasible if economically justified.

Mode of Occurrence of Gold

Intensive microscopic examination of both the East and West Surf concentrates has failed to provide an explanation for the relatively high assay values (1.0 and 3.3 oz/ton respectively).

The extreme homogeneity of the pyrite in both concentrates and the rarity of any inclusions is a striking feature.

Only one example of native Au was seen (in the W. Surf concentrate). This was in the form of a small cluster of minute grains (1 - 2 microns in size) intergrown with chalcopyrite and an unidentified phase (probably petzite).

Prompted by the apparent lack of Au in the metallic form, and by reports of the occurrence of gold tellurides in a sample from the property (J.A. McLeod, Cominco Ltd, 1981), the two concentrates were submitted for analysis for Te.

Results were as follows:

E. Surf concentrate	Te	14 ppm
W. Surf concentrate	Te	68 ppm.

The presence of Te is thus confirmed. Moreover, the Te contents show a general correlation with the S and Au levels in the respective products.

In light of the above, the products were re-examined under the microscope to make sure that gold in the form of tellurides had not been overlooked. Nothing was found that would account for these Te values in terms of gold tellurides.

A number of examples of optically unidentifiable phases in the slides of the W. Surf concentrate were marked and checked for composition by scanning electron microanalysis. Of 8 such grains examined, 2 proved to be metallic iron (a contaminant from grinding); 3 were too small to be locatable under the SEM (they were inclusions, 1 - 2 microns in size, in pyrite); and 3 proved to be tellurides.

Of the latter, one grain (a 6 micron inclusion in pyrite) is a composite of Pb telluride and Ag telluride and the other two (free grains, 25 and 30 microns in size) are a Ag-Au telluride, probably petzite $(AgAu)_2Te$.

Although the existence of telluride minerals in the Surf Inlet mineralization is thus confirmed, the extreme rarity of the phases fails to account for the analysed Te levels, or for the Au values in terms of previous metals tellurides.

It appears, therefore, that the Au in these samples must be held in sub-microscopic form within another mineral - most likely the pyrite. Numerous examples of this mode of occurrence exist in the literature. The fact that exploitation of the Surf Inlet deposit in the past has always been via production and sale of an auriferous sulfide concentrate rather than by gravity and/or cyanidation, adds weight to this possibility, as does the strong correlation of Au values with S contents in the present products:

	S (%)	Au (oz/ton)
E. Surf concentrate	8.3	1.03
W. Surf concentrate	22.5	3.33

As an additional check on this probability, 5 separate analyses for Au on very small portions (0.1g) of the W. Surf concentrate were done. Results are as follows:

	Au (ppb)	Equiv. oz/ton
Portion 1	116,000	3.31
" 2	121,000	3.46
" 3	110,000	3.14
" 4	117,000	3.34
" 5	108,000	3.10

The extremely low variance of these replicate micro-analyses is a striking confirmation of the hypothesis that the Au is present in a homogenously distributed (possibly molecular or solid solution) form in the pyrite.

Agreement of this order between analyses is hard to obtain on most Au-bearing materials even by conventional assays using weights in the order of 20g. To obtain it on replicate portions 1/200th of this size would be essentially inconceivable if any significant proportion of the Au existed in discrete particulate form. It is also significant that every one of the 0.1g portions analysed very close to the official assay of 3.33 oz/ton for this material.

A comparable experiment was then carried out with regard to the Te. Four replicate analyses on 0.2g portions of the W. Surf concentrate gave the following results:

	Te (ppm)
Portion 1	100.0
" 2	97.5
" 3	97.5
" 4	122.5

These data (coupled with the rarity of microscopically visible tellurides) suggest that most of the Te in these materials is also held in solid solution in the sulfides.

The discrepancy between these figures and the original analysis of 68 ppm is considered by the analyst to be a function of superior digestion achieved in the later work.

Conclusions:

1. The sulfide mineralogy at Surf Inlet (insofar as it is represented by the dump material) is very simple, consisting of major pyrite and minor chalcopyrite.

2. Liberation of the sulfides is essentially complete at the grind used for the present tests. The bulk of the sulfides occur in the upper part of the size range, suggesting that adequate liberation may still be achieved at coarser grinds.

3. Only a very minor proportion of the Au occurs in particulate form. The bulk of it is indicated as being in a homogenously dispersed, sub-microscopic form in pyrite.

4. The poor results obtained in cyanidation tests (around 20% recovery) fit the above conclusion. Total decomposition of the sulfides (by chemical, biohydrometallurgical or pyrometallurgical means) would appear necessary to liberate the Au.

5. Te contents of the Surf concentrates are substantial. Only traces of tellurides can be seen, so this element too may exist dominantly in dispersed form in the sulfides. It is therefore unlikely to be a factor in Au recovery.

6. Exploration at Surf Inlet should be geared to locating bodies of rock enriched in pyrite.

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