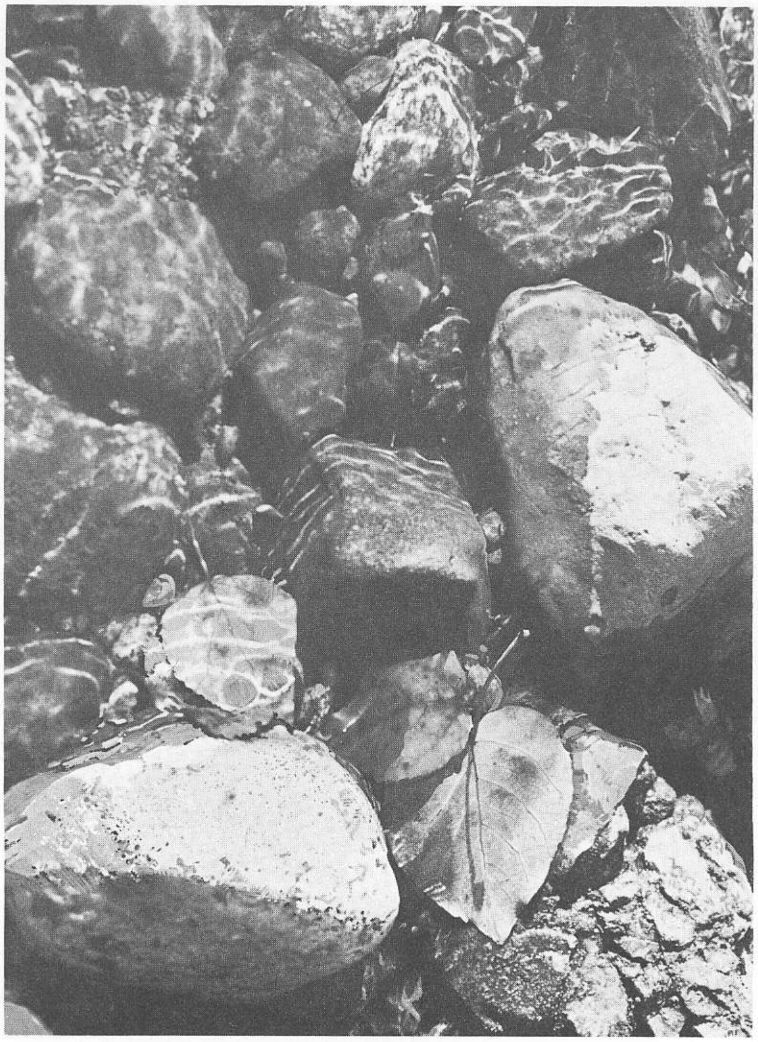
800189

PRELIMINARY METALLURGICAL STUDY

METEOR MINE STOCKPILE



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SUMMARY

Bulk sulphide concentrates can be produced from ore represented by this sample by using a medium fine primary grind and xanthate type collectors. The concentrates produced, which are composed principally of pyrites, galena and marmatitc contain in excess of ninety percent of the silver present in the feed and contain significant concentrations of gold. Minor concentrations of arsenic and mercury were detected but at a level which would not influence smelter acceptance of the concentrates.

Despite the high silver recoveries, recorded losses to the flotation tailings were considered excessive, averaging even under best conditions 2 oz/SDT. More testwork is recommended to attempt to improve silver recovery by using special function collectors for metallic silver.

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KM049

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INTRODUCTION

In early January, we were contacted by representatives from Native Seeker Resources Ltd. of Vancouver and requested to perform a metallurgical response study on a sample of ore from the Meteor Mine Dump. The ore sample, which was collected by representatives of Native Seeker Resources, comprised large angular rocks and was delivered to the laboratory by Mr. R. G. Blundell.

After a preliminary examination of the ore had been completed, a metallurgical test program and program cost estimate were forwarded to the office of Native Seekers in Vancouver on January 8th, 1981.

Upon receipt of approval for the project, work commenced immediately and was essentially complete before month end.

THE TEST PROGRAM

1. Test Program Objectives

The objectives of the testwork were carefully selected to permit a maximum of useful data to be generated with a limited amount of laboratory work. The objectives were as follows:

(a) To develop a reagent scheme which would be simple to employ, effective in terms of bulk sulphide recovery, and one which would be environmentally acceptable.

(b) To determine the optimum primary grind level required for acceptable mineral liberation.

(c) To examine the concentrates produced for deleterious elements which could affect saleability and to also estimate the extent of the payable components.

2. Test Procedures

The Ore Sample

The sample consisted of about 15 kg. of large angular lumps of rock showing minor sulphides. Microscopic analysis of a heavy density fraction of the feed showed that the sulphide minerals present in order of prevalence were pyrite, galena, a medium iron marmatite and some small quantities of chalcopyrite. A dark blue-grey opaque mineral which could have been one of the tetrahedrite-tennantite group was also noted, although argentite appeared predominant. Some of the mineral grains showed distinctive signs of oxidation. Non-sulphide minerals present were quartzite, calcite and minor barite.

The sample was crushed down to pass ten mesh and divided into 2 kg. lots in preparation for laboratory work and a head sample was withdrawn for assay. The chemical composition is shown in Table 1.

TABLE 1

Chemical Composition of Sample

SAMPLE	ASSAYS %						
	Ag*	Pb	Zn	Cu	Fe	Sb	As
Meteor Dump	31.2	0.40	0.18	0.03	1.64	0.01	L0.01

* oz/SDT

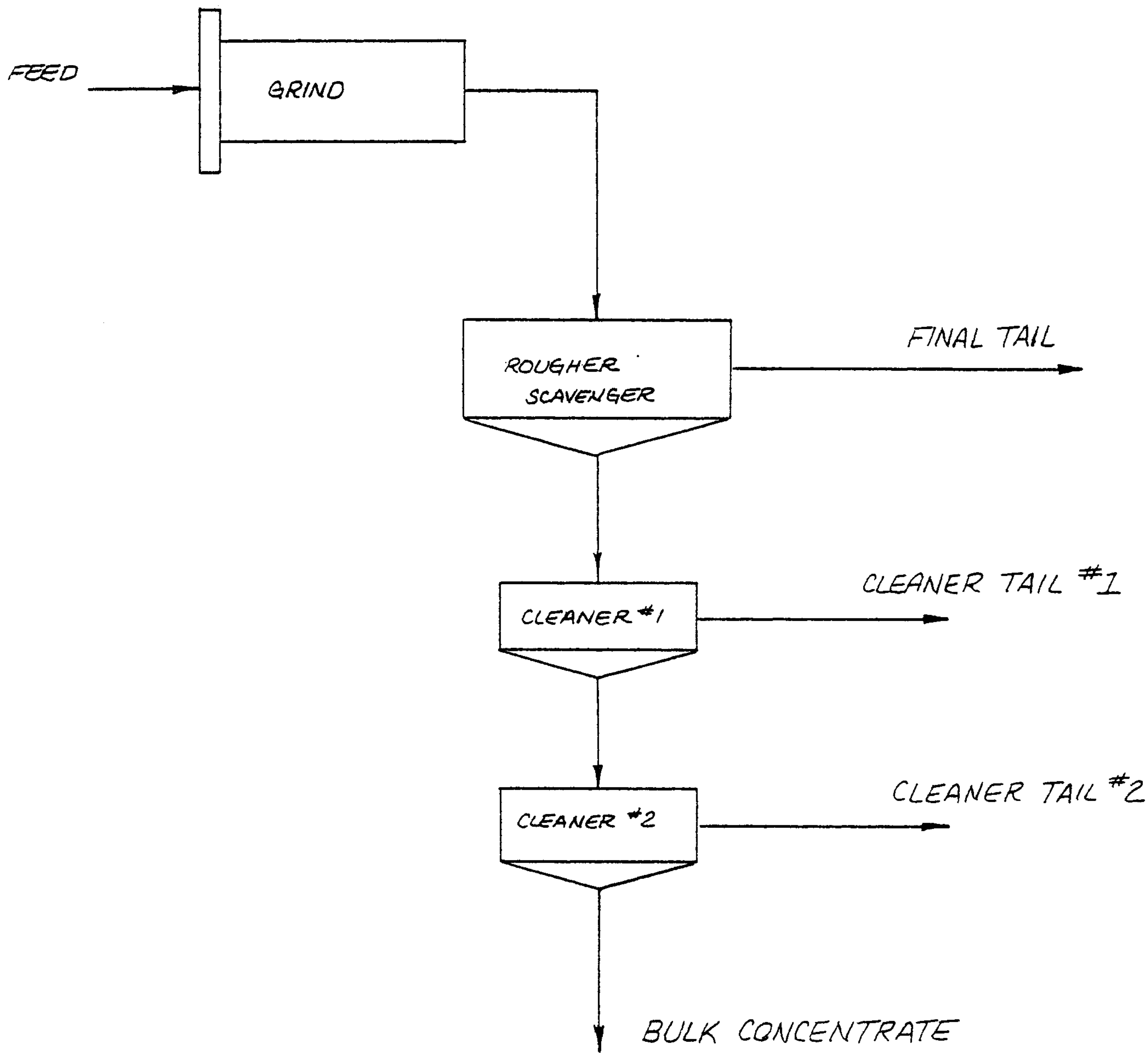
L means less than

Test Procedures

The flotation test procedures used were based on the modified open circuit cleaner tests. Following grinding of the sample at natural pH or with lime or soda ash for various periods of time in the laboratory rod mill, a rougher scavenger concentrate was floated off using isopropyl xanthate. The concentrates produced were cleaned twice in open circuit at natural pH.

Samples generated during testing were filtered and air dried at $105^{o}C$. The samples were then prepared for assay and the elements of interest determined with a Techtron Model 475 spectrophotometer. Data was then processed via computer to produce metallurgical balance information and grade recovery curves. The tailings samples in some tests were subjected to screen analysis procedures to permit the sample size distribution to be determined.

FIGURE 1 PROCESS FLOW DIAGRAM



ANALYSIS AND DISCUSSION OF RESULTS

The metallurgical response of ore represented by the sample tested is expected to be very favorable. Most of the silver and gold can be recovered into a bulk sulphide concentrate by utilizing a simple milling scheme and a non-toxic reagent combination. The concentrates produced are essentially pyrite concentrates with minor components of lead and zinc and small quantities of arsenic and copper. Silver and gold concentrations in the concentrates are exceptional for this type of ore.

Some of the most important metallurgical characteristics of this ore are discussed in detail below:

1. Mineralogical Aspects

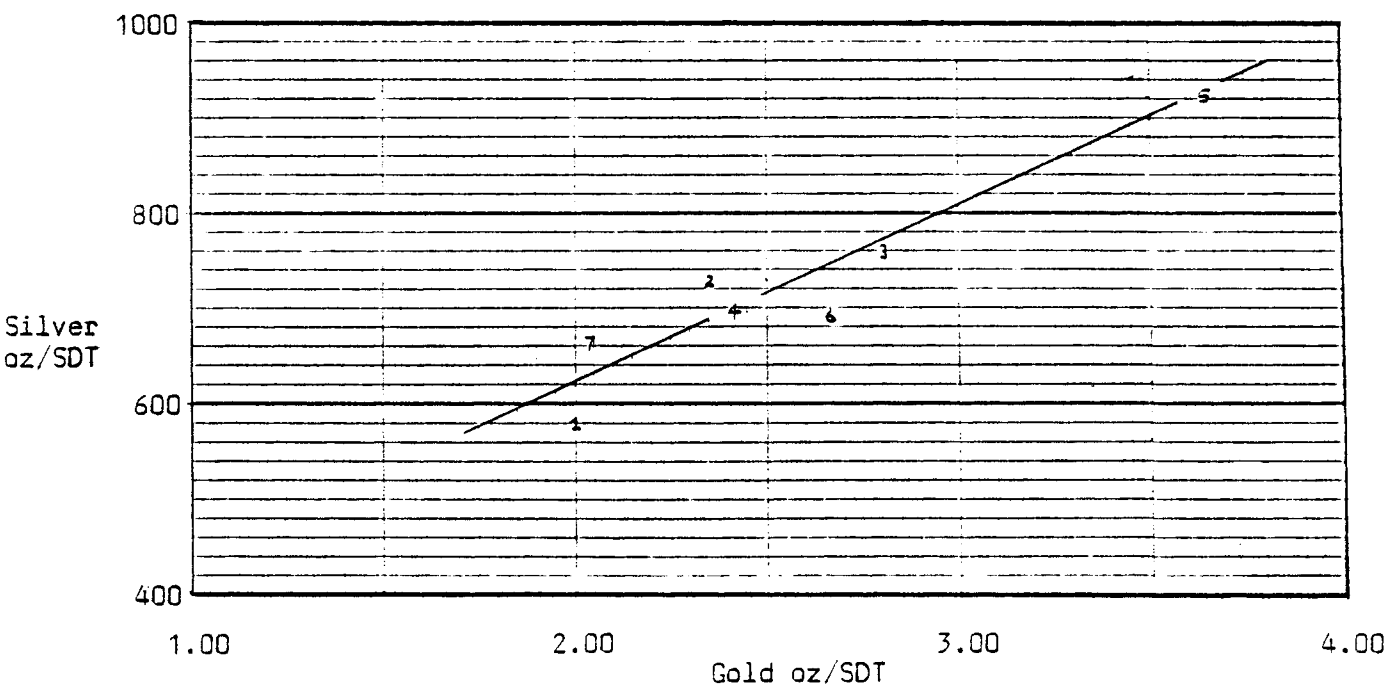
The sulphide minerals in the ore are dispersed in a quartz matrix as small crystals averaging less than 200 microns in size; pyrite, galena and marmatite occur as well formed crystals, with a small amount of interlocking.

Silver appears to be present as argentite, tennantite and possibly as native silver. The gold in the ore appears closely related to the silver and may in fact be dissolved in the silver sulphide lattice or exist as the gold-silver alloy electrum. In the microscopic work performed on this sample no free gold or silver were observed.

The relationship between gold and silver is shown in the graph below. The linear relation confirms that gold and silver occur in a fixed ratio and hence supports the dissolved specie concept.

GRAPH 1

Relationship between gold and silver in the concentrates



NOTE: Numbers refer to the test in which the concentrate was produced

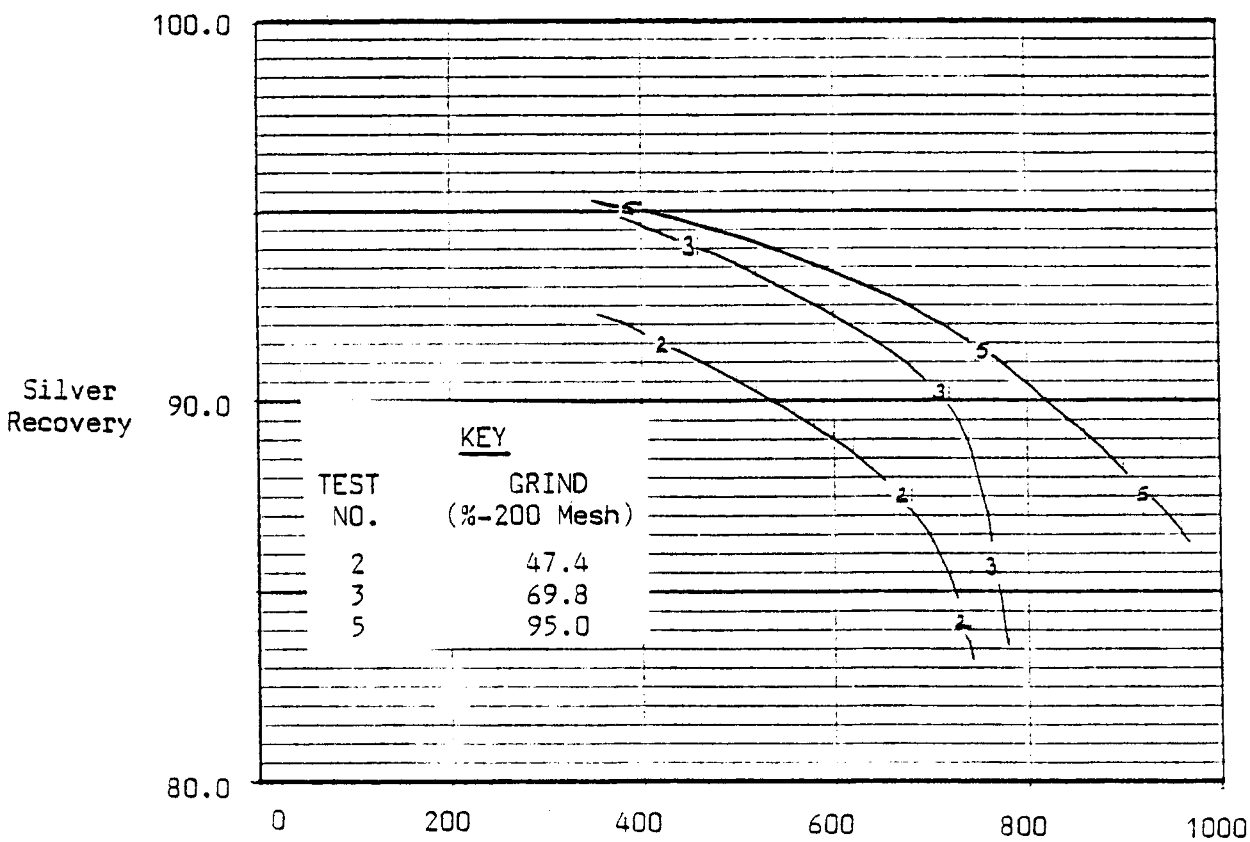
2. Effect of Primary Grind on Metallurgy

Three tests were performed to determine the effect of primary grind on silver metallurgy. The results which are shown below in Graph 2 clearly show that overall metallurgy improves as fineness of grind increases. In studying the data however it should be noted that the advantage of fine grinding diminishes as the concentrate grade (eg. silver grade) decreases.

GRAPH 2

Effect of Primary Grind on Metallurgy

Silver Grade - Recovery Curves



From a practical standpoint then it might be advantageous to process the ore at a medium fine grind of about 70% passing 200 mesh and accept a concentrate grade of about 400 oz/SDT.

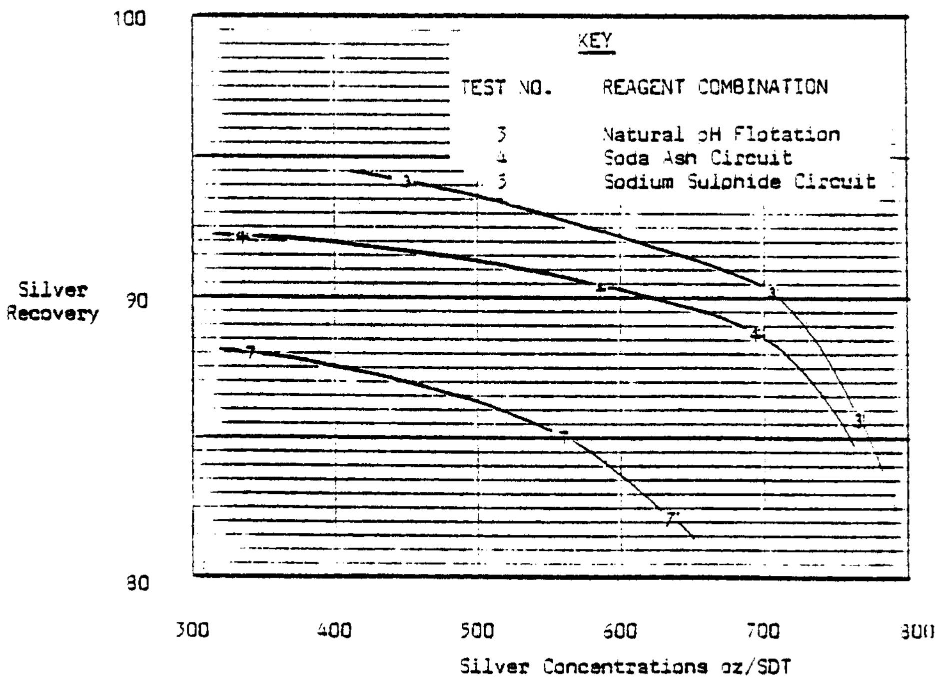
3. Reagent Effects

The simplicity of this flotation process at natural pH is such that reagent effect tests might be considered unnecessary. However, the silver losses to tailings were considered to be excessive and three tests were designed to attempt to improve silver recovery. The tests were carried out with a medium fine primary grind of about 70% passing 200 mesh and identical flotation times. Test variations were achieved by changing the reagent additions to the grinding circuit.

GRAPH 3

Reagent Combination Effects

Silver Grade - Recovery Curves



Using test 3 as a standard, eg. grinding at natural ore pH, it is apparent that neither soda ash nor sulphurdization with sodium sulphide improves silver metallurgy. From these results it can be seen that best results were attained by grinding the ore at natural pH. In plant operation, however, with the locally available water, or even recycled water, it may be found prudent to use some soda ash as a dispersant and as a buffering agent to the grinding circuit.

The problem of high silver losses (eg. 2-3 oz/SDT) to the tailings is worthy of some discussion. Possibly the silver in the tails is totally encapsulated or locked in such a way as to slow the rate of flotation. Oxidation of silver minerals is another possibility, but most probably the silver losses are due to the presence of pieces of metallic silver in the ore which does not respond to xanthate type collectors.

When more sample becomes available it might be worthwhile to perform another test series involving the use of various collectors in an attempt to reduce the silver losses to the tails.

4. Chemical Composition of Concentrates

The final concentrates produced in some of the tests were composited and assayed for elements of interest. The results of these analyses are shown below in Table 2.

TABLE 2

Chemical Composition of Bulk Concentrate

	ASSAYS %										
	Au	Ag	Pb	Zn	Cu	Fe	As	Sb	Hg	INSOL	Mn
METEOR BULK CONCENTRATE	2.74	761	8.9	4.1	.50	33.4	0.38	L0.01	L0.001	8.15	.04

NOTE: (a) Silver and gold in oz/SDT

(b) Assays for silver, gold, lead and zinc were calculated from test averages. Test 2 - 6 inclusive

(c) Insoluble content refers to non-sulphide, acid insoluble components

Of special note are the very low levels of mercury, arsenic and antimony; these deleterious elements are well below the level at which a smelter would levy any penalty.

5. Process Design Considerations

Assuming that the sample is truly representative of the ore to be treated, it is possible to construct a metallurgical balance from the data generated in this program. The balance shown in Table 3 assumes that a grind of 70% passing 200 mesh is utilized with two stages of cleaning.

TABLE 3

Probable Metallurgical Balance

	ASSAYS %			DISTRIBUTION		
	Ag*	Pb	Zn	Ag	Pb	Zn
Feed	35	0.4	0.2	100	100	100
Sulphide Conc.	750	8.0	4.0	92	90	90

* oz/SDT

To produce this metallurgy the mill design should be based on the following:

(a) Grinding circuit power requirements can be expected to be high. Any attempt to process this material at a coarse grind will result in very high silver losses. The recommended target of 70% passing 200 mesh should be regarded as a design minimum.

(b) Conditioning of the ore with xanthates prior to flotation appears to be important. Conditioning stages should be incorporated into the circuit.

(c) Flotation times in the testwork should be noted with care. Design should be based on at least twice the laboratory flotation times at about 15 - 20% solids by weight.

(d) The reagent consumptions used in testwork are considerably greater than one would expect in a small plant operation.

CONCLUSIONS

1. Bulk sulphide concentrates containing most of the silver and gold in the ore can be readily produced from ore represented by the sample tested. A medium fine grind of about 70% passing 200 mesh is recommended with a small amount of soda ash to ensure a pH of about 8.0 - 8.5 in the flotation circuit. Final concentrate grade can be improved by dilution cleaning in closed circuit, although with some loss in silver recovery.

2. The proposed reagent scheme, involving xanthate type collectors and methyl isobutyl carbinol as a frother is environmentally acceptable. The nature of the ore matrix is such that it is considered unlikely that the tailings pond effluents will be toxic.

3. Concentrate quality is excellent. Silver concentrates in excess of 700 - 750 oz/ton can be anticipated with gold contents of about 2.5 oz/ton. The concentrates do not contain significant concentrations of deleterious elements.

APPENDIX I

DETAILS OF EQUIPMENT USED IN TESTWORK

APPENDIX I

Details of Equipment Used in Testwork

A. Grinding

Rod Mill	-Steel container 21.5 cm ø x 40.5 cm. Charge 25 kg steel rods approx. 2.0 cm ø.
Ball Mill	-Steel container 21.5 cm ø x 18 cm. Charge 5 kg steel balls - graded charge 0.5 - 3.0 cm ø.
Drive for Mill	-Twin rolls, one drive, one idle. Both 12.5 ø x 122 cm.
	-Motor 0.37 KWH at 1725 RPM full load.
	-Mill speed approximately 80 RPM.

B. Flotation

Denver D2 Flotation Machine	-Used for roughing and scavenger at 1500 RPM with a 5.5 L stainless steel tank.
	-For first cleaner work with a 2.5 L stainless steel tank.
Denver D1 Flotation Machine	-Used for all cleaning stages at 1500 RPM with a 2.5 L stainless steel tank.
Galigher Agitair LA500	-Used for general purpose work with various sizes of perspex flotation tanks.

C. Instrumentation

Orion Specific Ion Meter 401	- Used for pH control on the rougher and scavenger circuits.
Fisher Digital pH Meter 609	- Used for pH control on the cleaning circuit.
Kalnew 12701 Microscope	- Used for microscopic examination of various minerals.
Swift 80 Microscope	- Used for microscopic examination of various minerals.

APPENDIX II

TECHNICAL DETAILS OF TESTS 1 - 7 INCLUSIVE

For each test are shown details of reagents used, essential test parameters, assays and a metallurgical balance.

KM049

TEST NO. 1

PURPOSE: Preliminary Flotation Test - Grind Effect

PROCEDURE: Grind and float a bulk concentrate - clean twice

FEED: Meteor Mine Dump

GRIND: 5 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne				TIME, MINUTES			pH	
	LIME	Z-11	$CuSO_4$		GRIND	COND	FROTH	START	FINISH
PRIMARY GRIND	500				5				10.0
BULK CONDITIONING			200			2		9.6	9.5
BULK RO/SC		50				2	5	9.5	9.0
BULK 1ST CLEANER		20				2	3	10.0	9.8
BULK 2ND CLEANER		10				2	2	10.2	10.4

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Ag	Pb	Zn		Ag	Pb	Zn	
BULK CONCENTRATE	3.75	582.98	8.80	4.04		61.42	78.00	69.87	
BULK CLEANER TAILS 2	0.71	301.70	4.20	1.32		6.04	7.08	4.34	
BULK CLEANER TAILS 1	2.33	72.90	1.11	0.40		4.77	6.10	4.29	
TAILS	93.21	10.68	0.04	0.05		27.77	8.81	21.58	
CALCULATED HEAD	100.00	35.58	0.42	0.22		100.00	100.00	100.00	

KM049

TEST NO. 2

PURPOSE: Grind Effects - Preliminary

PROCEDURE: Grind and float a bulk concentrate - clean twice

FEED: Meteor Mine Dump

GRIND: 10 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne				TIME, MINUTES			pH	
	LIME	Z-11	$CuSO_4$		GRIND	COND	FROTH	START	FINISH
PRIMARY GRIND	-				10				9.4
BULK CONDITIONING			200			2		8.7	8.7
BULK RO/SC		60				2	6	8.7	8.6
BULK 1ST CLEANER		20				2	4	8.7	8.6
BULK 2ND CLEANER		20				2	3	8.7	8.6

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Ag	Pb	Zn		Ag	Pb	Zn	
BULK CONCENTRATE	4.14	732.90	8.40	4.04		84.30	85.74	83.28	
BULK CLEANER TAILS 2	0.58	194.50	3.30	1.01		3.13	4.71	2.91	
BULK CLEANER TAILS 1	3.21	46.30	0.92	0.29		4.13	7.28	4.63	
TAILS	92.07	3.30	0.01	0.02		8.44	2.27	9.17	
CALCULATED HEAD	100.00	35.99	0.41	0.20		100.00	100.00	100.00	

KM049

TEST NO. 3

PURPOSE: Grind Effects

PROCEDURE: Per test No. 2

FEED: Meteor Mine Dump

GRIND: 15 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne				TIME, MINUTES			pH	
	LIME	Z-11	$CuSO_4$		GRIND	COND	FROTH	START	FINISH
PRIMARY GRIND					15				8.8
BULK CONDITIONING			200			2		8.6	8.5
BULK RO/SC		70				2	5	8.5	8.5
BULK 1ST CLEANER		20				2	4	8.8	8.7
BULK 2ND CLEANER		10				2	3	8.7	8.7

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Ag	Pb	Zn		Ag	Pb	Zn	
BULK CONCENTRATE	4.06	762.10	9.35	3.99		88.01	85.71	88.30	
BULK CLEANER TAILS 2	0.43	169.90	3.40	1.00		2.06	3.28	2.33	
BULK CLEANER TAILS 1	2.94	49.50	1.03	0.27		4.14	6.84	4.33	
TAILS	92.57	2.20	0.02	0.01		5.79	4.18	5.04	
CALCULATED HEAD	100.00	35.19	0.44	0.18		100.00	100.00	100.00	

KM049

TEST NO. 4

PURPOSE: Reagent Effects

PROCEDURE: Use soda ash in grinding mill to improve silver recovery

FEED: Meteor Mine Dump

GRIND: 15 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne				TIME, MINUTES			pH	
	LIME	Z-11	$CuSO_4$	Na_2CO_3	GRIND	COND	FROTH	START	FINISH
PRIMARY GRIND				1000	15				10.1
BULK CONDITIONING			200			2		9.9	9.9
BULK RO/SC		70				2	10	9.8	9.8
BULK 1ST CLEANER		20				2	5	9.0	9.4
BULK 2ND CLEANER		10				2	4	9.2	9.3

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Ag	Pb	Zn		Ag	Pb	Zn	
BULK CONCENTRATE	4.40	690.70	9.03	4.33		88.77	76.36	84.48	
BULK CLEANER TAILS 2	0.86	61.80	3.08	1.00		1.55	5.09	3.31	
BULK CLEANER TAILS 1	4.13	14.30	0.80	0.20		1.73	6.36	3.67	
TAILS	90.61	3.00	0.07	0.02		7.95	12.20	8.04	
CALCULATED HEAD-	100.00	34.21	0.52	0.23		100.00	100.00	100.00	

KM049

TEST NO. 5

PURPOSE: Grind Effects

PROCEDURE: Per test No. 3

FEED: Meteor Mine Dump

GRIND: 25 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne				TIME, MINUTES			pH	
	LIME	Z-11	$CuSO_4$		GRIND	COND	FROTH	START	FINISH
PRIMARY GRIND	-				25				9.1
BULK CONDITIONING			200			2		8.3	8.4
BULK RO/SC		90				2	7	8.6	8.9
BULK 1ST CLEANER		30				2	5	9.0	8.4
BULK 2ND CLEANER		20				2	3	8.9	8.4

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Ag	Pb	Zn		Ag	Pb	Zn	
BULK CONCENTRATE	3.58	920.50	9.03	4.33		87.62	71.07	80.57	
BULK CLEANER TAILS 2	0.97	141.90	3.08	1.00		3.64	6.53	5.02	
BULK CLEANER TAILS 1	4.81	28.80	0.80	0.20		3.68	8.46	5.00	
TAILS	90.64	2.10	0.07	0.02		5.06	13.94	9.42	
CALCULATED HEAD	100.00	37.64	0.46	0.19		100.00	100.00	100.00	

KM049

TEST NO. 6

PURPOSE: Reagent Effects

PROCEDURE: Determine the effect of a soda ash circuit - increase float time

FEED: Meteor Mine Dump

GRIND: 15 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne				TIME, MINUTES			pH	
	LIME	Z-11	$CuSO_4$	Na_2CO_3	GRIND	COND	FROTH	START	FINISH
PRIMARY GRIND				1000	15				9.9
BULK CONDITIONING			200			2		9.7	9.7
BULK RO/SC		90	200			2	9	9.7	9.5
BULK 1ST CLEANER		30				2	5	9.1	8.9
BULK 2ND CLEANER		20				2	4	9.0	8.8

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Ag	Pb	Zn		Ag	Pb	Zn	
BULK CONCENTRATE	4.40	697.00	8.37	3.92		84.72	78.79	90.93	
BULK CLEANER TAILS 2	0.84	109.40	1.98	0.52		2.53	3.35	2.30	
BULK CLEANER TAILS 1	3.75	23.60	0.42	0.10		2.44	3.18	1.98	
TAILS	91.00	4.10	0.08	0.01		10.30	14.68	4.79	
CALCULATED HEAD	100.00	36.23	0.50	0.19		100.00	100.00	100.00	

KM049

TEST NO. 7

PURPOSE: Reagent Effects

PROCEDURE: Grind with sodium sulphide and then float bulk concentrate

FEED: Meteor Mine Dump

GRIND: 15 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne				TIME, MINUTES			pH	
	LIME	Z-11	$CuSO_4$	Na_2S	GRIND	COND	FROTH	START	FINISH
PRIMARY GRIND				2000	15				10.5
BULK CONDITIONING			400			2			
BULK RO/SC		100				2	10	9.8	9.7
BULK 1ST CLEANER		30				2	5	9.5	7.2
BULK 2ND CLEANER		20				2	3	9.0	8.8

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Ag	Pb	Zn		Ag	Pb	Zn	
BULK CONCENTRATE	4.45	635.70	8.61	3.82		82.09	87.51	87.61	
BULK CLEANER TAILS 2	0.76	131.70	1.40	0.43		2.90	2.42	1.68	
BULK CLEANER TAILS 1	3.61	29.50	0.21	0.07		3.10	1.73	1.30	
TAILS	91.18	4.50	0.04	0.02		11.91	8.33	9.40	
CALCULATED HEAD	100.00	34.44	0.44	0.19		100.00	100.00	100.00	

SCREEN ANALYSIS

TEST NO. 1

MESH SIZE TYLER	APERTURE MICRONS	% RETAINED INDIVIDUAL	% RETAINED CUMULATIVE	% PASSING CUMULATIVE
65	210	31.35	31.35	68.65
100	150	16.71	48.06	51.94
150	105	12.91	60.97	39.03
200	74	8.50	69.47	30.53
325	44	6.45	75.92	24.08
-325	-	24.08	100.00	

TEST NO. 2

MESH SIZE TYLER	APERTURE MICRONS	% RETAINED INDIVIDUAL	% RETAINED CUMULATIVE	% PASSING CUMULATIVE
65	210	0.94	0.94	99.06
100	150	8.71	9.65	90.35
150	105	29.71	39.36	60.64
200	74	13.25	52.61	47.39
325	44	12.20	64.81	35.19
-325	-	35.19	100.00	

TEST NO. 3

MESH SIZE TYLER	APERTURE MICRONS	% RETAINED INDIVIDUAL	% RETAINED CUMULATIVE	% PASSING CUMULATIVE
65	210	0.15	0.15	99.85
100	150	0.81	0.96	99.04
150	105	11.04	12.00	88.00
200	74	18.25	30.25	69.75
325	44	18.12	48.37	51.63
-325	-	51.63	100.00	

SCREEN ANALYSIS

TEST NO. 5

MESH SIZE	APERTURE	% RETAINED		% PASSING
TYLER	MICRONS	INDIVIDUAL	CUMULATIVE	CUMULATIVE
65	210	0.06	0.06	99.94
100	150	0.22	0.28	99.72
150	105	0.48	0.76	99.24
200	74	4.24	5.00	95.00
325	44	16.31	21.31	78.69
-325	-	78.69	100.00	

TEST NO. 6

MESH SIZE	APERTURE	% RETAINED		% PASSING
TYLER	MICRONS	INDIVIDUAL	CUMULATIVE	CUMULATIVE
65	210	0.16	0.16	99.84
100	150	0.50	0.66	99.34
150	105	9.14	9.80	90.20
200	74	16.55	26.35	73.65
325	44	21.16	47.51	52.49
-325	-	52.49	100.00	

APPENDIX III

COMPARISON BETWEEN ASSAYED AND CALCULATED HEADS AND SPECIAL ASSAYS

A comparison between the silver, lead, zinc assayed heads and the average calculated heads, for the ore sample used is shown. Special gold assays are also shown in this appendix.

TABLE III - 1

Statistical Analysis of Head Assay Data

	ASSAYS %		
	Ag*	Pb	Zn
Assay Head	31.2	0.41	0.19
Calculated Head	35.61	0.46	0.20
Standard Deviation	1.17	0.04	0.02

* oz/SDT

NOTE: The difference between the calculated and assayed values for silver is most probably due to the difficuity in sampling metallic bearing ores.

TABLE III - 2

Special Gold Assays

TEST NO. 1

STAGE	Au
Concentrate	2.00
Cleaner Tails 2	.70
Cleaner Tails 1	.12
Tails	.04

TEST NO. 2

STAGE	Au
Concentrate	2.36
Cleaner Tails 2	.26
Cleaner Tails 1	.06
Tails	.01

TEST NO. 3

STAGE	Au
Concentrate	2.76
Cleaner Tails 2	.26
Cleaner Tails 1	.06
Tails	.01

TEST NO. 4

STAGE	Au
Concentrate	2.42
Cleaner Tails 2	.12
Cleaner Tails 1	.06
Tails	.01

TEST NO. 5

STAGE	Au
Concentrate	3.66
Cleaner Tails 2	.31
Cleaner Tails 1	.06
Tails	.01

TEST NO. 6

STAGE	Au
Concentrate	2.64
Cleaner Tails 2	.24
Cleaner Tails 1	.04
Tails	.04

NOTE: values reported in troy oz/S.D.T.

TEST NO. 7

STAGE	Au
Concentrate	2.02
Cleaner Tails 2	.49
Cleaner Tails 1	.10
Tails	.02