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R.684. Gold recovery tests on core samples from Beaconsfield.

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At the request of Allstate Exploration N.L. gold recovery tests were carried out on five samples of diamond drill core taken from intersections of the Beaconsfield ore body. Three of the samples were from holes put down by the Department of Mines and two samples were from Allstate drilling.

SAMPLE PREPARATION

All the available individual core samples were used to make the intersection composites for the recovery tests, and therefore were not weighted proportionately. The following table shows the assays for each intersection and the calculated heads of the samples used in the recovery tests.

DDH No.	B4		B4A		B4B		A601-11		H6WL	
	Sample	Test	Sample	Test	Sample	Test	Sample	Test	Sample	Test
Au (g/t)	90	167	60	56.5	40	61	11	14.6	38	35.3
Ag (g/t)	7	18.1	9	3.8	16	-	-	2.9	11	6.2
As (%)	1.5	0.95	0.4	0.51	0.05	-	1	0.74	0.7	0.72
Cu (%)	1.1	1.43	0.9	0.98	1.1	1.3	0.8	0.89	0.5	0.50
S (%)	7.5	8.4	4.9	4.4	3.6	-	5	5.0	-	13.2

Each sample was roll crushed in closed circuit with a one millimetre screen until all the material passed through the screen.

TEST WORK AND RESULTS

Test N1. Sample Reg. No. 671015, DDH B4B

Core from diamond drill hole B4B was selected for a preliminary test, because of its low arsenic content, and was in this aspect different from the remaining samples.

The whole sample was passed over a Denver laboratory mineral jig (No. 1M). The jig tailing was ground in the 203 mm diameter x 203 mm Warman laboratory ball mill, and was then floated in the Denver D1 laboratory flotation cell, using 3 kg/t of sodium carbonate, 0.2 kg/t of sodium ethyl xanthate, and pine oil as frother to produce a bulk sulphide concentrate. This concentrate was re-floated in a cleaning operation. The cleaned concentrate was re-floated using sodium cyanide at the rate of 0.1 kg/t of rougher feed as a pyrite depressant to form a copper concentrate. The tail thus formed was a pyrite concentrate.

The initial flotation test to produce the bulk sulphide concentrate was very active and at the time was thought to be due to the choice of frother.

At this stage of the investigation, copies of Amdel reports MP 3634/74 and MP 3929/74 were received and it was noted that no gold was found by visual examination. The jig concentrate was then examined under the microscope and free gold, gold/pyrite composites and gold/quartz composites were found and were removed by handpicking.

The remainder of the jig concentrate was ground with a pestle and mortar to pass through a 250 μ m screen. The ground product was then floated using Aerofloat 238 as collector and Teric 401 as frother to produce a copper concentrate. A pyrite concentrate was then floated off using sulphuric acid and potassium amyl xanthate. In the flotation of the jig concentrate there

was no sign of over-activity in flotation as had been noticed in the bulk sulphide flotation of the ground jig tail.

The results of the bulk sulphide flotation test were as follows:

Product	% Mass	Assays			% Distribution	
		Au (g/t)	Cu (%)	As (%)	Au	Cu
F7C	1.82	339	24.9	0.28	10.1	34.5
F7T	<u>6.35</u>	178	7.9		<u>18.5</u>	<u>38.1</u>
F6C	8.17	214	11.7		28.6	72.6
F6T	<u>4.51</u>	26	0.87		<u>2.0</u>	<u>3.0</u>
F5C	12.68	147	7.8		30.6	75.6
F5T	<u>84.48</u>	9.5	0.07		<u>12.9</u>	4.5
J1T	97.16	27	1.08		43.5	80.1
J1C	<u>2.84</u>	1210	9.2		<u>56.5</u>	<u>19.9</u>
H	<u>100.0</u>	61	1.3		<u>100.0</u>	<u>100.0</u>

Flotation of the jig concentrate after hand-picking gold from it, gave the following results.

Product	% Mass	Assays		% Distribution	
		Au (g/t)	Cu (%)	Au	Cu
H/P2C	0.0	**		27.1	-
F3C	0.71	250	22.5	2.8	12.5
F4C	2.08	800	4.5	26.6	7.4
F4T	<u>0.05</u>	-	-	-	-
J1C	<u>2.84</u>	1240	8.9	56.5	19.9

**Clean metallic gold, not assayed for silver. Assumed 100% Au for calculation purposes.

Tests N2 and N3. Sample Reg. No. 660984, DDH B4

Before treatment of this sample, the depth of ragging in the jig was altered so that less sulphide material would be pulled into the concentrate and a higher grade of concentrate would be produced.

The sample from diamond drill hole B4 was passed over the jig and the mass of concentrate was greatly reduced. The free and composited gold was hand-picked out of the jig concentrate and the jig bed in the jig at the end of the test, and the remaining concentrate and jig bed material was put with the jig tail.

The jig tail was then halved by riffing; one half was ground for five minutes in the ball mill, and the other ground for fifteen minutes in the ball mill.

After 15 minutes conditioning with 1 kg/t of sodium sulphite, flotation, with 0.05 kg/t of Aerofloat 238 using Teric 401 as a frother, produced a copper concentrate, and 0.1 kg/t of potassium amyl xanthate was used to produce the pyrite concentrate.

However, the over-active condition was again present in the copper flotation as in the bulk sulphide flotation in Test N1. This over-activity resulted in the copper concentrates being low grade.

Table 1. RESULTS OF TESTS N2 AND N3

Test	% Mass	Assays					% Distribution					
		Cu (%)	Au (g/t)	Ag (g/t)	S (%)	As (%)	Cu	Au	Ag	S	As	
N2 Coarse grind	Free gold		*	*				65.1				
	F1C	16.4	5.7	192	22	34.7	3.32	77.7	19.6	23.2	68.5	56.7
	F2C	12.2	2.0	75	34	16.6	2.47	17.3	5.7	26.5	24.4	31.4
	F2T	71.4	0.10	22	11	0.82	0.16	5.0	9.6	50.3	7.1	11.9
	Calculated head	100.0	1.41	160	15.6	8.30	0.96	100.0	100.0	100.0	100.0	100.0
N3 Fine grind	Free gold		*	*				60.4				
	F1C	15.2	7.9	203	29	28.8	2.15	82.8	17.8	21.5	51.4	35.2
	F2C	19.1	1.2	153	29	20.4	2.98	15.8	17.0	27.2	45.8	61.3
	F2T	65.7	0.03	13	16	0.36	0.05	1.4	4.8	51.3	2.8	3.5
	Calculated head	100.0	1.45	173	20.5	8.51	0.93	100.0	100.0	100.0	100.0	100.0

*Clean metallic gold, not assayed for silver, assumed to be 100% Au for calculation purposes.

Table 2. RESULTS OF TESTS N4-N9

Test	% Mass	Assays					% Distribution					
		Cu (%)	Au (g/t)	Ag (g/t)	S (%)	As (%)	Cu	Au	Ag	S	As	
N4	Free gold		*	*				57.7				
	F1C	2.79	10.5	8	13	12.8	0.34	30.2	0.4	8.7	8.9	1.8
	F2C	2.51	15.6	520	61	22.8	3.3	40.4	22.6	36.9	14.2	16.1
	F3C	10.47	2.0	100	11.5	26.0	3.4	21.6	18.2	29.0	67.5	69.0
	F3T	84.23	0.09	0.75	1.25	0.45	0.08	7.8	1.1	25.4	9.4	13.1
	Calc. head	100.0	0.97	57.7	4.2	4.0	0.52	100.0	100.0	100.0	100.0	100.0
N5	Free gold		*	*				60.2				
	F1C	2.15	9.1	18	2	12.1	0.38	19.8	0.7	1.3	5.5	1.7
	F2C	2.76	18.0	372	53	20.2	2.9	50.1	18.6	42.5	11.8	16.1
	F3C	10.05	2.2	102	8.7	35.0	3.3	22.4	18.6	25.3	74.3	66.8
	F3T	85.04	0.09	1.25	1.25	0.47	0.09	7.7	1.9	30.9	8.4	15.4
	Calc. head	100.0	0.99	55.2	3.4	4.7	0.50	100.0	100.0	100.0	100.0	100.0
N6	Free gold		*	*				15.1				
	F1C	2.70	7.6	5	4	7.3	0.48	22.5	0.9	4.0	4.0	1.8
	F2C	3.34	14.8	85	24	23.6	1.2	54.0	19.0	29.5	16.2	5.4
	F3C	11.01	1.5	65.3	1.3	28.3	3.3	18.1	48.3	5.4	64.1	49.7
	F3T	82.95	0.06	3	2	0.92	0.38	5.4	16.7	61.1	15.7	43.1
	Calc. head	100.0	0.91	14.9	2.7	4.9	0.73	100.0	100.0	100.0	100.0	100.0
N7	Free gold		*	*				15.7				
	F1C	3.55	5.7	6.7	2.7	7.4	0.50	23.4	1.6	3.1	5.1	2.4
	F2C	2.30	19.2	88	50	24.8	1.3	51.0	14.2	37.0	11.1	4.0
	F3C	14.63	1.3	52	10	26.3	3.3	21.9	53.2	47.1	74.8	64.8
	F3T	79.52	0.04	2.75	0.5	0.58	0.27	3.7	15.3	12.8	9.0	28.8
	Calc. head	100.0	0.87	14.3	3.1	5.1	0.75	100.0	100.0	100.0	100.0	100.0
N8	Free gold		*	*				17.8				
	F1C	1.41	2.3	9.7	17.5	9.9	0.37	6.5	0.5	4.0	1.1	0.7
	F2C	2.56	13.7	428	102	37.3	0.74	71.0	37.7	42.4	7.8	2.6
	F3C	29.71	0.33	36.5	10	36.9	2.2	19.8	37.2	48.2	87.8	89.4
	F3T	66.32	0.02	3	0.5	0.60	0.08	2.7	6.8	5.4	3.3	7.3
	Calc. head	100.0	0.49	29.1	6.2	12.4	0.73	100.0	100.0	100.0	100.0	100.0

Table 2. (continued)

Test	% Mass	Assays					% Distribution					
		Cu (%)	Au (g/t)	Ag (g/t)	S (%)	As (%)	Cu	Au	Ag	S	As	
N9	Free gold		*	*				12.5				
	F1C	1.36	2.4	4.8	18.3	9.8	0.35	6.5	0.1	4.0	1.0	0.7
	F2C	2.80	12.4	412	79	43.6	0.85	69.6	27.9	35.9	8.7	3.4
	F3C	26.62	0.37	70.5	10	44.9	1.9	19.7	45.3	43.2	85.4	71.5
	F3T	69.22	0.03	8.5	1.5	1.0	0.25	4.2	14.2	16.9	4.9	24.4
	Calc. head	100.0	0.50	41.4	6.2	14.1	0.71	100.0	100.0	100.0	100.0	100.0

*Clean metallic gold not assayed for silver; assumed to be 100% Au for calculation purposes.

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TABLE 2. (continued)
 % MASS, % DISTRIBUTION, ASSAYS

The results of the two tests with coarse and fine grinding are shown in Table 1.

A sizing analysis on the flotation tail from test N3 on 662821 (B4A) is as follows:

Screen aperture (μm)	% Mass	Cum. % mass
+212	0.2	0.2
+150	1.5	1.7
+106	8.9	10.6
+75	13.1	23.7
+53	13.8	37.5
+38	13.5	51.0
-38	49.0	100.0

The results of tests N2 and N3 confirm that the over-active condition during copper flotation produced a low grade of concentrate. The results also indicate that the fine grind has produced better recoveries of sulphur and all the metals except silver.

Tests N4 and N5. Sample Reg. No. 662821, DDH B4A

Tests N6 and N7. Sample Reg. No. 740911, A601-11

Tests N8 and N9. Sample Reg. No. 740852, H6WL 1-14

Each of the above samples was treated similarly, in the following manner. The samples were passed over the jig, and the free and composited gold was hand-picked out of the concentrate and the jig bed, and the remaining material from these products was put with the jig tail. The jig tail was then riffled in half, and each half was ground in the laboratory ball mill for 15 minutes.

Because of the over-active condition of the flotation tests on the first two samples, it was decided to try pre-flotation. The ground sample was conditioned for fifteen minutes with 1 kg/t of sodium sulphite, and then floated without any collector type flotation reagent and with only sufficient frother (Teric 401) to maintain a froth.

During 5 minutes flotation, a flotation concentrate was made which was dirty in appearance. This concentrate may contain a low density free-floating non-metallic mineral such as talc, sericite, or similar material.

A copper concentrate was then produced with the addition of 0.05 kg/t of Aerofloat 238 and 5 minutes flotation, and a pyrite concentrate was produced with the addition of 0.1 kg/t of potassium amy xanthate and 10 minutes flotation.

The results of these tests are given in Table 2.

Subsequently the free gold taken by treatment of the sample H6WL 1-14 was assayed to find the silver content, and was found to be 99.7% Au and 0.3% Ag. Because of this assay no adjustments were made to the metal balances where the free gold had been assumed to be 100% gold.

The results show that the pre-flotation concentrate contains between 20% and 30% of the copper for the diamond drill holes B4B and A601-11 and 6.5% of the copper for diamond drill hole H6WL 1-14. Less than 1% of the gold present in the drill holes tested, reports in the pre-flotation concentrate.

After having taken off the pre-flotation concentrate, there was no trouble in producing a copper concentrate of reasonable grade, ranging from 12.4-19.2% in all the tests. The concentrate produced was a rougher concentrate, and there should be no problem in upgrading this to a concentrate of saleable grade by cleaning and recleaning flotation. Over 70% of the copper has been recovered in the pre-flotation concentrate plus the copper concentrate. A further 20% of the copper is recovered in the pyrite concentrate.

Gold recovery is a little irregular, ranging from 83-99% in the jig and flotation concentrates, depending largely on the head grade. It may be more useful to examine the tailing assays. In all tests the gold assay of the tailing was 3 g/t or less except Test N9 in which the assay was 8.5 g/t. The calculated gold head assays of Tests N8 and N9 do not duplicate very well, and re-assaying of the products in the tests did not make any appreciable difference. The calculated sulphur head assays in these tests did not duplicate very well either.

Silver recoveries were also erratic, ranging from 69-94% in the flotation concentrate except in Test N6 where the recovery was 39%.

The major proportion of the arsenic reported in the pyrite concentrate.

Cyanidation tests

Cyanidation tests on roasted pyrite concentrates were then undertaken to determine the recovery of gold from these concentrates.

Composite pyrite concentrates for each diamond drill hole were made by taking 50 g each of pyrite concentrates from the duplicate tests and mixing, viz. from N4 and N5, N6 and N7, and N8 and N9.

The concentrates were then roasted at about 900°C until sulphur dioxide could no longer be detected.

The calcines were then agitated for 16 hours in beakers by means of magnetic stirrers, in 600 ml of solution containing 0.2% potassium cyanide and 0.1% lime.

The results of the cyanidation tests on calcine are as follows:

Pyrite concentrate	Calcine mass as % of pyrite concentrate	Calcine Assay % As	% Distribution		% Recovery in	
			in calcine	in exhaust	in solution	in solution
					Au	Ag
B4A (N4 and N5)	72.8	1.7	36.9	63.1	82.8	nil
A601-11 (N6 and N7)	81.9	3.2	79.4	20.6	48.4	nil
H6WL 1-14 (N8 and N9)	69.1	0.82	27.6	72.4	79.6	10.0

Cyanidation tests were also done on the flotation tailings.

Composite flotation tailings for each diamond drill hole were made by taking 500 g each of flotation tailings from the duplicate tests and mixing, viz. from N4 and N5, N6 and N7, and N8 and N9.

The tailings were agitated for 24 hours in one litre of solution containing 0.5% sodium cyanide, and lime to give a pH of 11-12.

The results of the cyanidation tests on flotation tailings are as follows:

Flotation tailing	Cyanide consumption of tailing (kg/t)	Gold recovery in solution g/t	%
B4A (N4 and N5)	1.6	0.55	54.5
A601-11 (N6 and N7)	0.2	0.66	22.9
H6WL 1-14 (N8 and N9)	0.2	1.80	31.3

CONCLUSIONS

Free gold can be recovered by jigging. The amount recovered in this manner is largely dependent on the head value of the ore.

There is a free-floating gangue mineral present in the ore. It should be advantageous to remove this material by pre-flotation. Some copper tends to float with this material, but gold does not. When ore becomes available, more extensive flotation test work should be carried out in order to determine the best method of coping with this free-floating material and endeavouring to place more copper into the copper concentrate.

Copper flotation yielded concentrates assaying about 400 g/t Au and about 15% copper. Cleaning and recleaning of the copper concentrate should appreciably raise these assays. About 20% of the gold present is recovered in the copper concentrate and this figure is somewhat dependent on the head grade of the ore.

The pyrite concentrate carried appreciable quantities of gold. After calcining the pyrite concentrates and cyanidation, about 80% of the gold in the pyrite concentrates can be recovered.

There is little point in cyanidation of the flotation tailings as there is not much gold present, and recovery of this gold is low.

Diamond drill hole A601-11 was the lowest in grade, and it was also the most difficult to treat. About 16% of the gold present in this ore found its way into the flotation tailing. Cyanidation of the tailing gave the lowest recovery (22.9%) and cyanidation of the calcine of the pyrite concentrate also gave the lowest recovery (48.4%).

Cyanidation tests of the pyrite concentrate without roasting to compare recoveries were subsequently carried out and are reported below.

[17 October 1974]

CYANIDATION TESTS

A cyanidation test was carried out on pyrite concentrate made in Tests N8 and N9 from diamond drill core from sample 740852. A composite of 50 g from each of these tests was agitated for 16 hours in a beaker by means of a magnetic stirrer in 600 ml of solution containing 0.2% potassium cyanide and 0.1% lime. The results are as follows together with the results of the cyanidation of the calcine for comparison.

740852 (H6WL 1-14)	% Recovery in solution	
	Au	Ag
Calcine	79.6	10.0
Pyrite concentrate	86.0	14.0

There was insufficient pyrite concentrate from the other bore holes to compare direct cyanidation of the pyrite concentrate with cyanidation of the calcine.

The result obtained on sample 740852 indicates that on this ore there is no benefit gained in calcining the pyrite concentrate prior to cyanidation.

[10 November 1974]

0.22	0.22
0.86	0.86
1.98	1.98

COMPARISON

Free gold can be recovered by leaching. The amount recovered in this manner is largely dependent on the head value of the ore.

There is a free-floating gangue mineral present in the ore. It should be advantageous to remove this gangue by pre-leaching. Some copper leach to float with this material, but gold does not. When ore becomes available, more extensive floatation work should be carried out in order to determine the best method of coping with this free-floating material and endeavouring to place more copper into the copper concentrate.

Copper leaching yielded concentrates assaying about 400 g/t Au and about 12% copper. Flotation and leaching of the copper concentrate should approximately raise these assays. About 10% of the gold present is recovered in the copper concentrate and this figure is somewhat dependent on the head grade of the ore.

The pyrite concentrate carries appreciable quantities of gold. After calcining the pyrite concentrates and cyanidation, about 50% of the gold in the pyrite concentrate can be recovered.

There is little point in cyanidation of the flotation tailings as there is not much gold present, and recovery of this gold is low.

Diamond drill hole M67-11 was the lowest in grade, and it was also the most difficult to assay. About 1% of the gold present in this ore found its way into the flotation tailings. Cyanidation of the tailing gave the lowest recovery (21.7%) and cyanidation of the calcine of the pyrite concentrate also gave the lowest recovery (48.4%).

Cyanidation tests of the pyrite concentrate without roasting to compare recoveries were simultaneously carried out and are reported below.

[10 November 1974]

CYANIDATION TESTS

A cyanidation test was carried out on pyrite concentrates from Test 18 and 19 from diamond drill core from sample 740852. A composite of 50 g from each of these tests was selected for its assay in a basket by means of a magnetic sizer in 600 ml of solution containing 0.2% potassium cyanide and 0.1% lime. The results are as follows together with the results of the cyanidation of the calcine for comparison.

Recovery in solution	Sample	Recovery (M67-11)
14.0	Pyrite concentrate	28.0
10.0	Calcine	19.3
5.0	Free gold	10.0

There was insufficient pyrite concentrate from the other two holes to compare direct cyanidation of the pyrite concentrate with cyanidation of the calcine.