EFFECT OF GRIND ON METALLURGY

VANGORDA TYPES 1B4G, 2B4E

VANGORDA PLATEAU

YUKON TERRITORY

Ex 35.

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CONTENTS

SUMMARY

Very significant metallurgical losses will occur if any attempt is made to process Vangorda ore types 284E and 184G at grind levels coarser than 45 microns P_{80}. Based on data generated in this program and in previous studies, the estimated recovery losses, compared to a fine grind operation, approximates 15 percent recovery at a P_{80} of 95 microns and about 25 percent recovery at a P_{80} of 135 microns. These figures apply to both lead and zinc recoveries at a constant concentrate grade of 50 percent contained metal.

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KM043

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INTRODUCTION

In late November of this year, we were contacted by Mr. L. P. Taggart, Manager Feasibility and Development of Cyprus Anvil Mines Ltd., and requested to perform a limited flotation test program on samples of predominant Vangorda ores.

The work, which was to be performed with the utmost attention to detail, was required for an economic study of the Vangorda deposit under various conditions. Project completion was required as soon as possible and the results were delivered by courier to Mr. Taggart on December 8, 1980.

THE TEST PROGRAM

1. Test Program Objectives

The objectives of the test program as outlined by Mr. L. P. Taggart were as follows:

(a) To determine the difference in metallurgy exhibited by samples of Vangorda ore at two levels of primary grind. The grind levels utilized should be equivalent to those existing in the present Anvil concentrator (130 microns P_{80}) and those which would exist in the modified concentrator (50 microns P_{80}).

(b) To perform the work on samples of Vangarda ores currently in storage at the laboratory. These samples were designated 184G and 284E and represented a major component of the minable reserves.

2. Ore Samples Used in the Program

The samples used in the program had been prepared into 1.0 kg. charges in 1979 during the course of work on type testing of the Vangorda ores. The charges had been stored under nitrogen in sealed plastic bags to preclude oxidation.

The average sample composition as determined from calculated head assays were as shown in Table 1.

TABLE 1

CHEMICAL COMPOSITION OF SAMPLES

ORE TYPE	DESIGNATION	ASSAYS %	
		Pb	Zn
Barytic	1B4G	3.23	5.07
Pyritic	2B4E	4.49	4.25

3. Test Procedures

The objectives of the program were achieved by utilizing standard laboratory flotation procedures; notably the open circuit, three stage cleaner test.

Open Circuit Cleaner Tests

The laboratory flotation test procedure consisted of grinding the pre-prepared 1.0 kg ore sample for various times in a laboratory rod mill with 25 kg of steel rods. (See Appendix I). The grinding stage was conducted in the presence of soda ash and cyanide.

Following additions of Z-11 and MIBC, and allowing for a short conditioning period, the lead rougher-scavenger concentrates were floated. When the lead flotation was complete the rougher concentrates were ground in a small ball mill for 20 minutes with 10 kg of steel balls with soda ash and cyanide. The lead cleaning then proceeded for three stages. The lead first cleaner tail was filtered, weighed wet and added to the lead scavenger tailings prior to conditioning in preparation for zinc flotation.

The zinc conditioning was carried out in a lime modulated circuit for eight minutes and $CuSO_4$ added to activate the minerals; conditioning time with $CuSO_4$ was two minutes. The zinc then floated with Z-11 in the presence of DOW 1012 as a frother. The zinc rougher-scavenger concentrates were then reground in the laboratory ball mill for ten minutes with lime and a small amount of $CuSO_4$. Cleaning at various pH levels was then pursued through three stages.

The samples were filtered, dried at $105^{o}C$ and prepared for assay. Assays were performed using a Techtron 5 Atomic Absorption Spectrophotometer.

ANALYSIS AND DISCUSSION OF RESULTS

1. Test Precision

A detailed examination of the distribution of metals throughout the products, and also the very close correlations of the calculated head assays for each test pair, confirmed that the tests were comparable.

TABLE 2

COMPARISON OF HEAD ASSAYS

TEST	ORE TYPE	CALCULATED HEAD ASSAY %	
		Pb	Zn
1	2B4E	4.53	4.22
2	2B4E	4.45	4.28
3	1B4G	3.21	5.10
4	1B4G	3.24	5.05

From the final tailings sample a representative portion was withdrawn for screen analysis procedures. The P_{80} values for each test pair were determined by plotting the screen analysis data on log-probability paper.

2. Effect of Primary Grind on Metallurgy

The grade recovery curves for lead and zinc for each test pair were plotted and are shown below in graph No. 1 - 4. Analysis of the data proved difficult since the coarsely ground results required some extrapolation to reach acceptable concentrate grade levels. Shown in Table 3 are the projected recovery differences at constant grade for each test pair.

TABLE 3

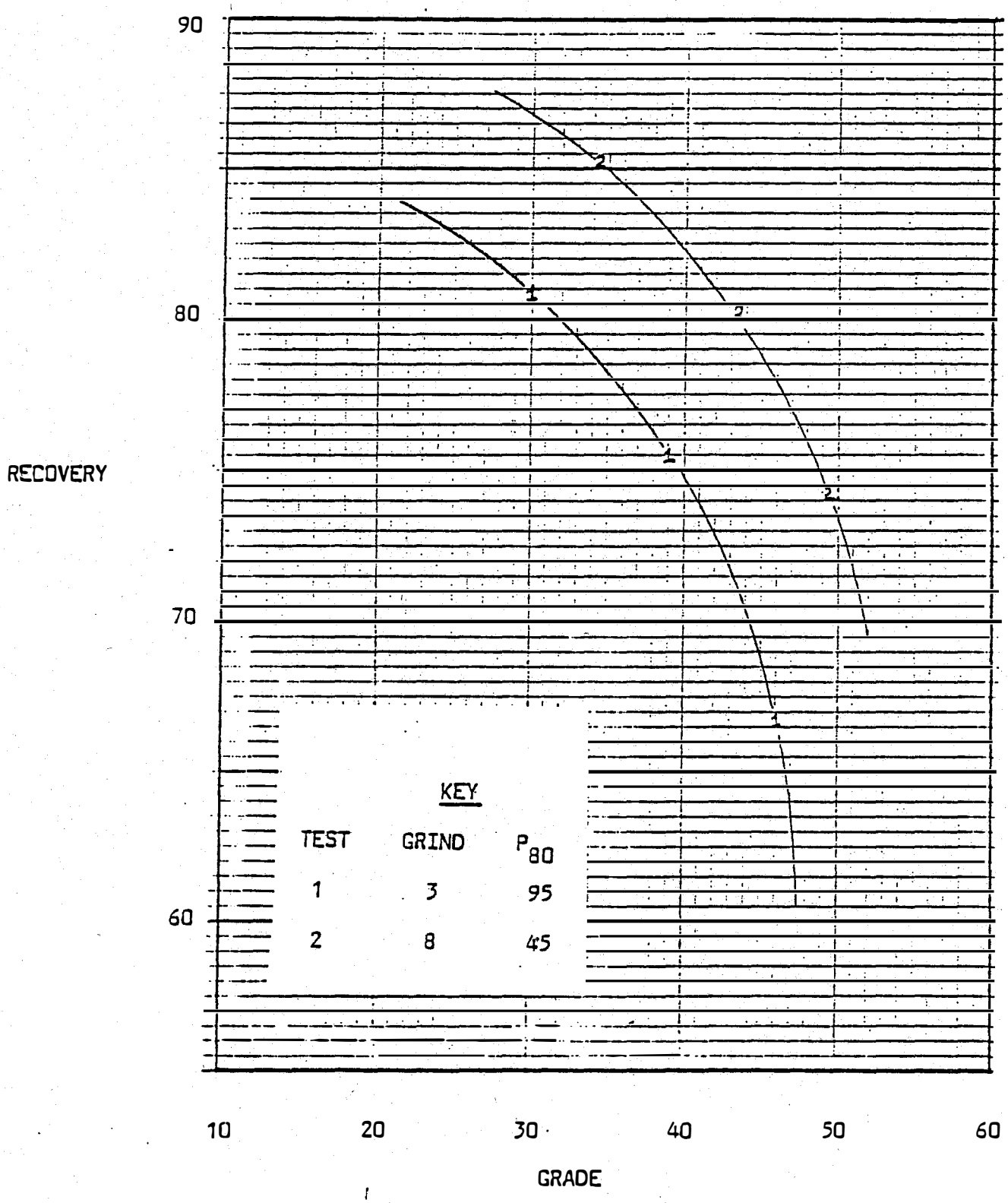
RECOVERY AT 50% CONTAINED METAL

% passing 90 microns

ORE TYPE	CONCENTRATE	TEST	GRIND LEVEL P_{80}	RECOVERY AT GRADE	DIFFERENCE
284E	Lead	1	95	60	15
		2	45	75	
	Zinc	1	95	57	10
		2	45	67	
184G	Lead	3	95	60	17
		4	45	77	
	Zinc	3	95	57	17
		4	45	74	

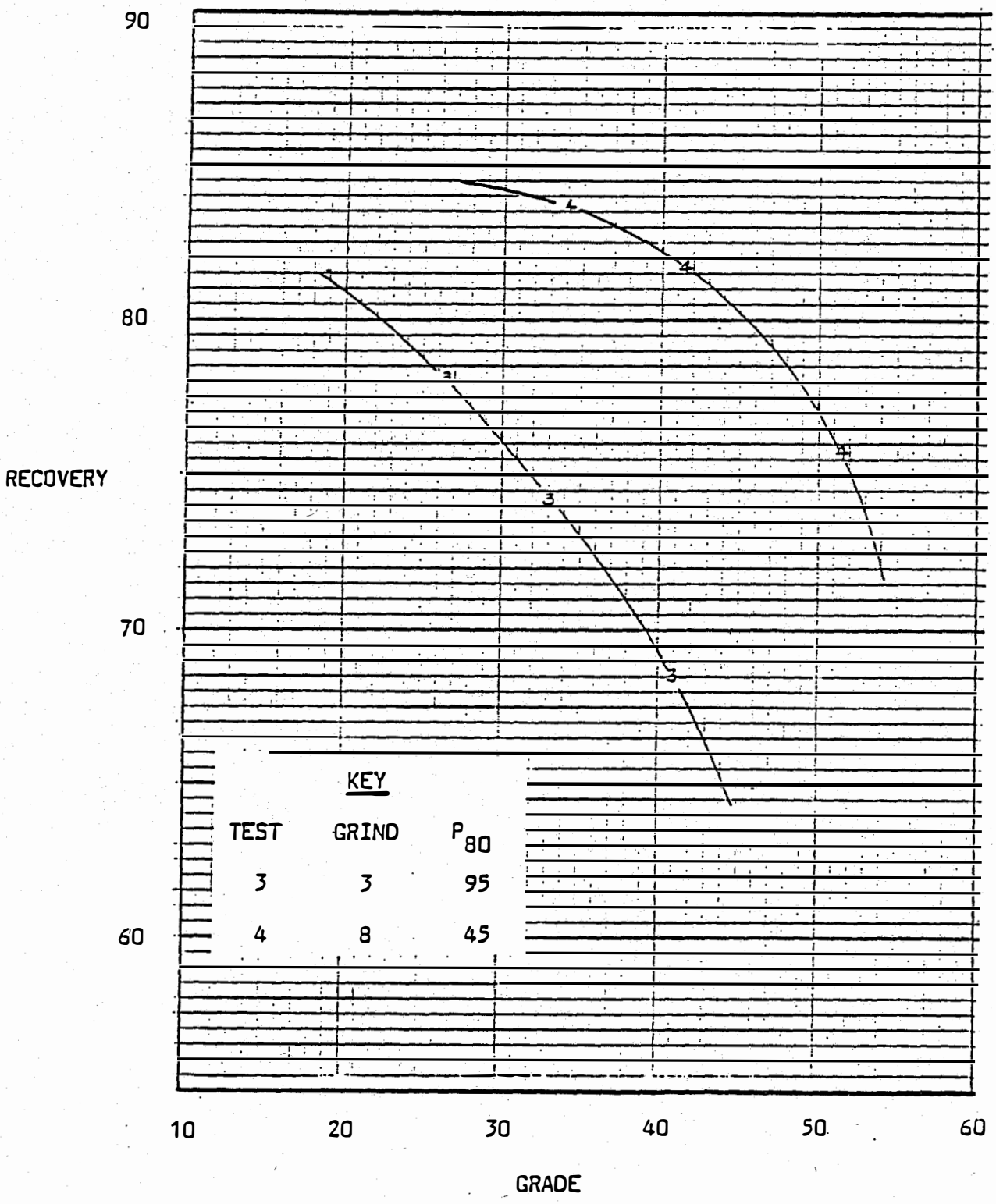
GRAPH NO. 1

LEAD METALLURGY TYPE 2B4E



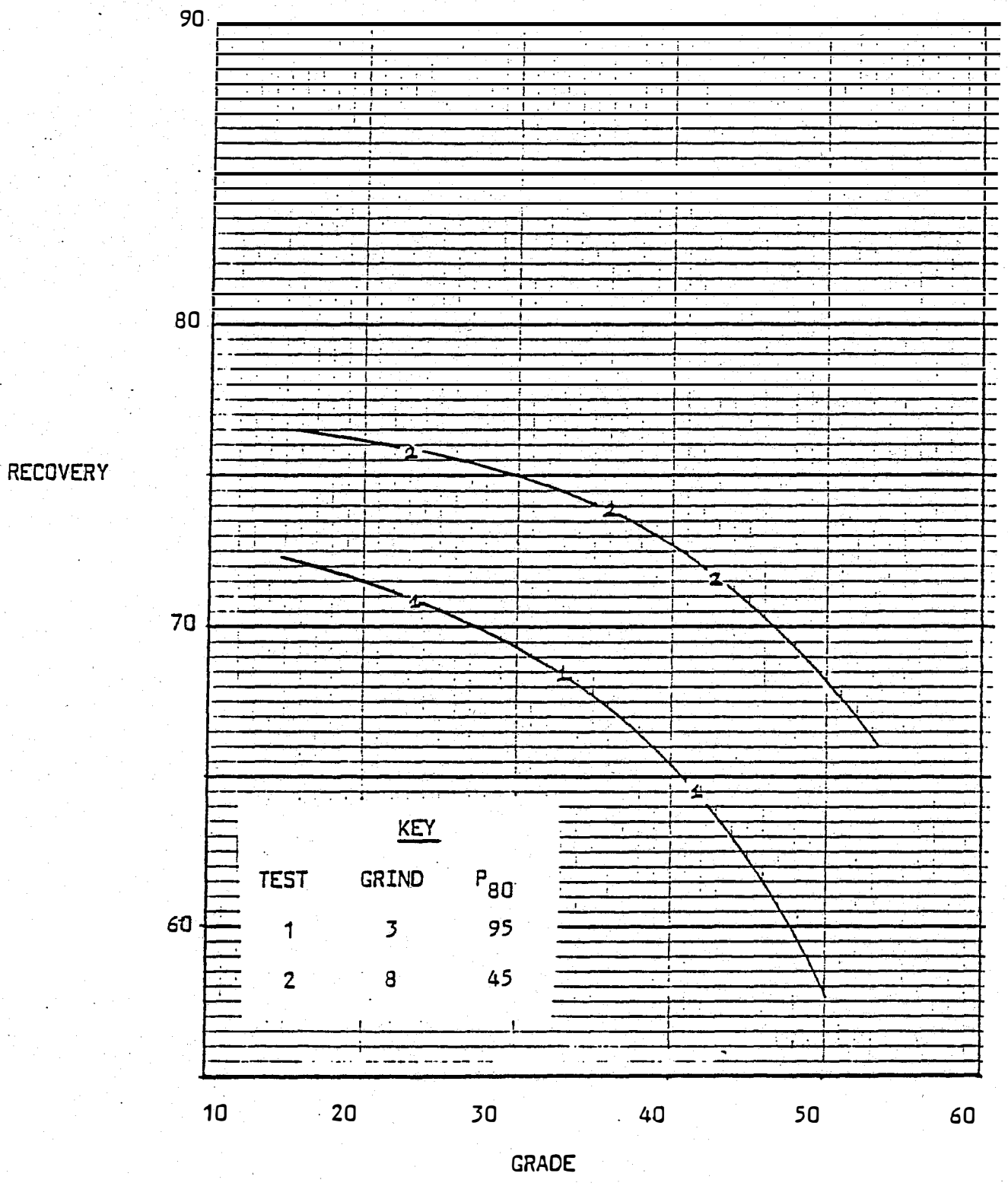
GRAPH NO. 2

LEAD METALLURGY TYPE 1B4G



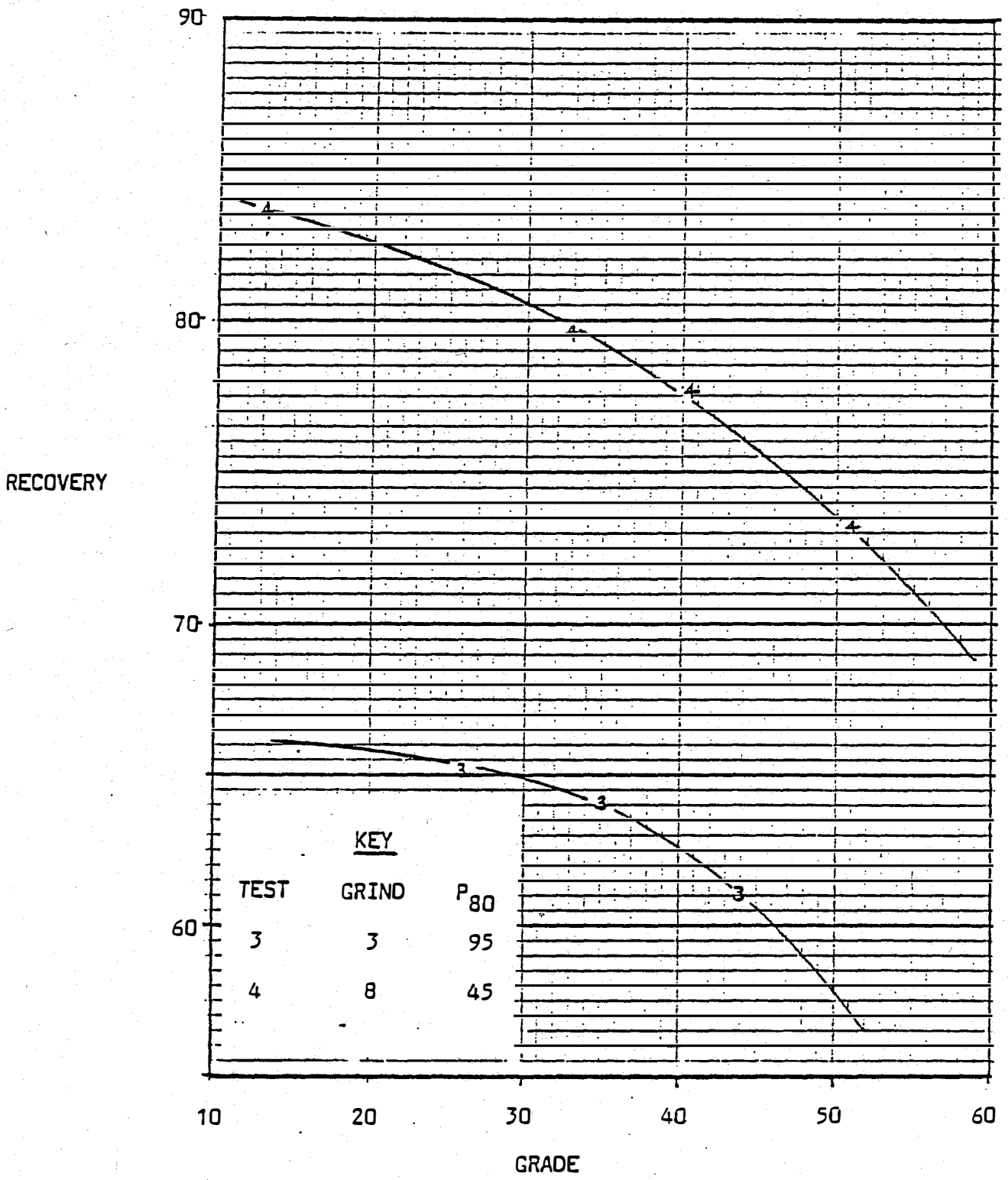
GRAPH NO. 3

ZINC METALLURGY TYPE 2B4E



GRAPH NO. 4

ZINC METALLURGY TYPE 184G



CONCLUSIONS

1. Attempts to process the Vangorda ore types at coarse grind levels in the range 100 microns P_{80} will result in very substantial metallurgical ineffeciencies. Metal recoveries at a constant grade of 50% contained metal, which probably represents the economic cutoff level for Vangorda ores, can be expected to fall an average of 15% from recovery levels predicted at P_{80} of 45 microns.

2. Further significant deteriorations in metallurgy will undoubtedly occur if the primary grind P_{80} is increased to 135 - 150 microns. Based on experience with this ore it is estimated that metal losses would increase almost linearly with the degree of coarse grinding.

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.

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.

APPENDIX II

TECHNICAL DETAILS OF TESTS 1 - 4 INCLUSIVE

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

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TEST NO. 1

PURPOSE: Effect of coarse grind on metallurgy

PROCEDURE: Vary primary grind

FEED: Vangorda 284E Composite

GRIND: 3 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne						TIME, MINUTES			pH	
	Na_2CO_3	NaCN	Z-11	$CuSO_4$	Lime		GRIND	COND	FROTH	START	FINIS
PRIMARY GRIND	1500	300					3				9.8
LEAD RO/SC			100					2	10	9.8	9.5
LEAD REGRIND	500	200					10				10.0
LEAD 1ST CLEANER	500		40					2	8	10.3	9.8
LEAD 2ND CLEANER	500		20					2	5	10.1	9.8
LEAD 3RD CLEANER	500		10					2	3	10.1	9.8
ZINC CONDITIONING				1000				10		11.0	11.0
ZINC RO/SC			50					2	10	11.0	11.0
ZINC REGRIND				150	500		10				
ZINC 1ST CLEANER			20					2	7	11.5	11.5
ZINC 2ND CLEANER			10					2	5	12.0	12.0
ZINC 3RD CLEANER			10					4	3	12.5	12.5

TEST NO. 1

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Pb	Zn			Pb	Zn		
PB CLEANER CONC. 3	6.56	46.20	7.38			66.88	11.48		
PB CLEANER TAILS 3	2.19	17.90	9.10			8.65	4.72		
PB CLEANER TAILS 2	3.42	7.21	7.94			5.44	6.44		
ZN CLEANER CONC. 3	6.60	2.68	41.30			3.90	64.61		
ZN CLEANER TAILS 3	2.10	3.64	8.00			1.69	3.98		
ZN CLEANER TAILS 2	3.98	2.29	2.52			2.01	2.38		
ZN CLEANER TAILS 1	41.11	0.78	0.44			7.07	4.29		
TAILS	34.03	0.58	0.26			4.35	2.10		
CALCULATED HEAD	100.00	4.53	4.22			100.00	100.00		

KM043

TEST NO. 2

PURPOSE: Effect of Fine Grind on Metallurgy

PROCEDURE: Increase primary grind

FEED: Vangorda 2B4E Composite

GRIND: 8 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne						TIME, MINUTES			pH	
	Na_2CO_3	NaCN	Z-11	$CuSO_4$	Lime		GRIND	COND	FROTH	START	FINISH
PRIMARY GRIND	1500	300					8				9.8
LEAD RO/SC			100					2	10	9.8	
LEAD REGRIND	500	200					10				10.3
LEAD 1ST CLEANER	500		40					2	8	10.3	10.0
LEAD 2ND CLEANER	500		20					2	5	10.3	10.1
LEAD 3RD CLEANER	500		10					2	3	10.3	10.1
ZINC CONDITIONING				1000				10		11.0	11.0
ZINC RO/SC			50					2	10	11.0	11.0
ZINC REGRIND				150	500		10				9.8
ZINC 1ST CLEANER			20					2	7	11.5	11.5
ZINC 2ND CLEANER			10					2	5	12.0	12.0
ZINC 3RD CLEANER			10					2	3	12.5	12.5

TEST NO. 2

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Pb	Zn			Pb	Zn		
PB CLEANER CONC. 3	6.75	49.20	6.70			74.67	10.56		
PB CLEANER TAILS 3	1.43	16.90	8.27			5.44	2.77		
PB CLEANER TAILS 2	2.85	7.90	7.93			5.06	5.27		
ZN CLEANER CONC. 3	7.16	1.55	42.90			2.49	71.68		
ZN CLEANER TAILS 3	1.67	2.26	5.96			0.85	2.32		
ZN CLEANER TAILS 2	5.11	1.33	1.50			1.53	1.79		
ZN CLEANER TAILS 1	32.48	0.67	0.44			4.89	3.34		
TAILS	42.56	0.53	0.23			5.07	2.28		
CALCULATED HEAD	100.00	4.45	4.28			100.00	100.00		

KM043

TEST NO. 3

PURPOSE: Effect of coarse grind on Metallurgy

PROCEDURE: Vary primary grind

FEED: Vangorda 184G Composite

GRIND: 3 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne						TIME, MINUTES			pH	
	Na_2CO_3	NaCN	Z-11	$CuSO_4$	Lime		GRIND	COND	FROTH	START	FINI
PRIMARY GRIND	1500	300					3				10.
LEAD RO/SC			80					2	8	10.0	10.
LEAD REGRIND	500	200					10				11.
LEAD 1ST CLEANER			40					2	7	10.2	10.
LEAD 2ND CLEANER	200		20					2	5	10.3	10.
LEAD 3RD CLEANER	200		10					2	3	10.3	10.
ZINC CONDITIONING				500				10		11.0	11.0
ZINC RO/SC			50					2	8	11.0	11.0
ZINC REGRIND				150	500						
ZINC 1ST CLEANER			20					2	7	11.5	11.5
ZINC 2ND CLEANER			10					2	5	12.0	12.0
ZINC 3RD CLEANER			10					2	3	12.5	12.5

TEST NO. 3

PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Pb	Zn			Pb	Zn		
PB CLEANER CONC. 3	5.41	40.80	13.60			68.72	14.45		
PB CLEANER TAILS 3	1.73	10.40	20.00			5.60	6.79		
PB CLEANER TAILS 2	2.27	5.25	17.30			3.70	7.69		
ZN CLEANER CONC. 3	7.17	2.60	43.40			5.80	61.04		
ZN CLEANER TAILS 3	2.21	2.54	6.98			1.75	3.03		
ZN CLEANER TAILS 2	3.47	1.47	1.61			1.59	1.10		
ZN CLEANER TAILS 1	28.64	0.67	0.57			5.97	3.20		
TAILS	49.09	0.45	0.28			6.87	2.70		
CALCULATED HEAD	100.00	3.21	5.10			100.00	100.00		

KM043

TEST NO. 4

PURPOSE: Effect of Fine grind on Metallurgy

PROCEDURE: Vary primary grind

FEED: Vangorda 184G Composite

GRIND: 8 minutes in laboratory rod mill at 65% solids

STAGE	REAGENTS ADDED g/tonne						TIME, MINUTES			pH	
	Na_2CO_3	NaCN	Z-11	$CuSO_4$	Lime		GRIND	COND	FROTH	START	FINIS
PRIMARY GRIND	1500	300					8				10.0
LEAD RO/SC			80					2	8	10.0	9.9
LEAD REGRIND	500	200					10				10.1
LEAD 1ST CLEANER			40					2	7	10.1	9.7
LEAD 2ND CLEANER	200		20					2	5	10.2	9.8
LEAD 3RD CLEANER	200		10					2	3	10.2	9.8
ZINC CONDITIONING				500				10		11.0	11.0
ZINC RO/SC			50					2	8	11.0	11.0
ZINC REGRIND				150	500		10				
ZINC 1ST CLEANER			20					2	7	11.5	11.5
ZINC 2ND CLEANER			10					2	5	12.0	12.0
ZINC 3RD CLEANER			10					2	3	12.5	12.5

TEST NO. 4

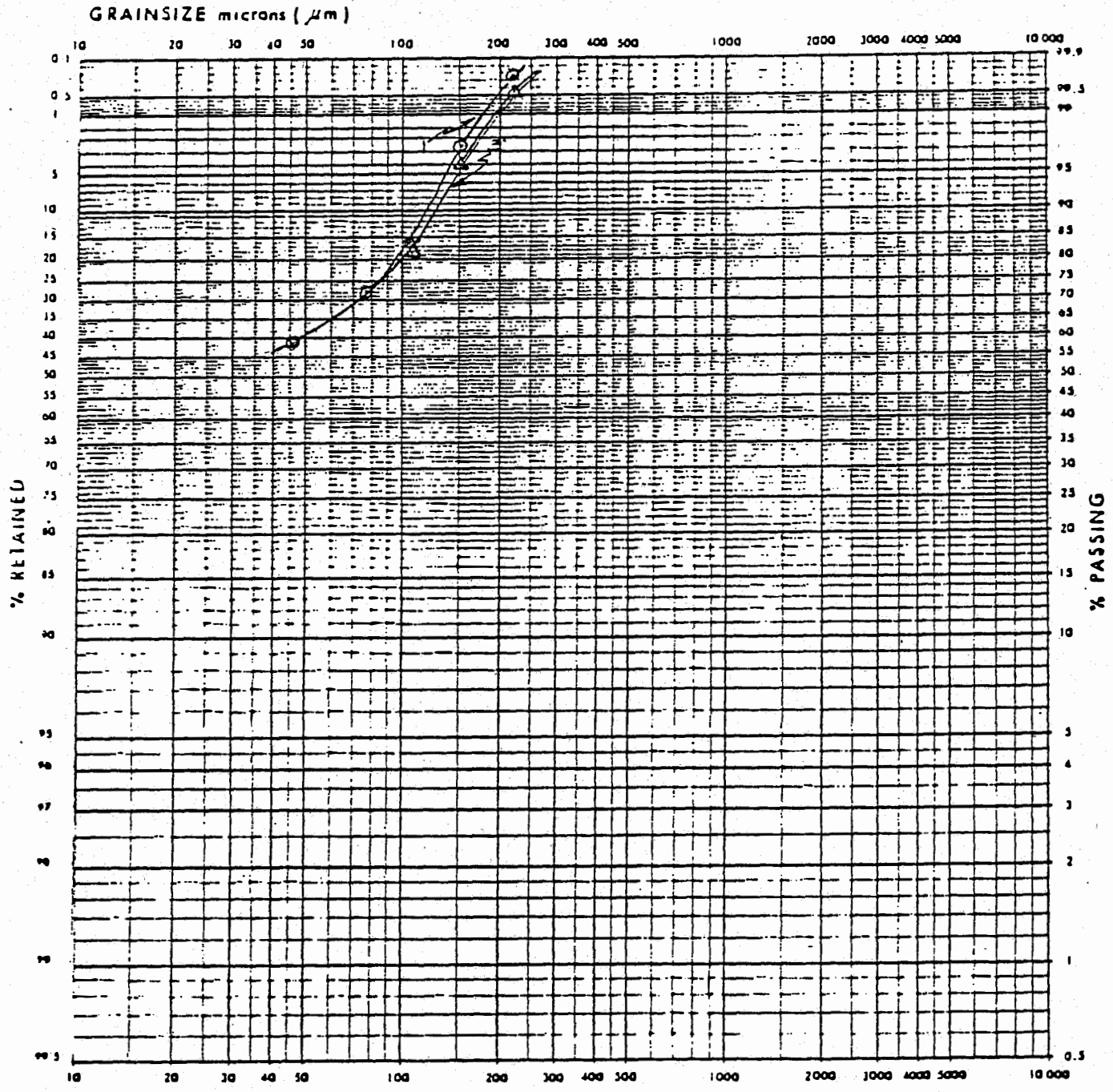
PRODUCT	WEIGHT	ASSAYS %				DISTRIBUTION			
	%	Pb	Zn			Pb	Zn		
PB CLEANER CONC. 3	4.76	51.60	8.91			75.95	8.41		
PB CLEANER TAILS 3	1.60	11.90	12.10			5.88	3.84		
PB CLEANER TAILS 2	1.54	3.74	5.20			1.77	1.58		
ZN CLEANER CONC. 3	7.28	1.19	50.90			2.68	73.41		
ZN CLEANER TAILS 3	2.44	1.66	9.01			1.25	4.35		
ZN CLEANER TAILS 2	2.57	1.83	3.82			1.45	1.95		
ZN CLEANER TAILS 1	20.31	0.73	1.02			4.58	4.10		
TAILS	59.50	0.35	0.20			6.43	2.36		
CALCULATED HEAD	100.00	3.24	5.05			100.00	100.00		

. PROJECT

SIZE DISTRIBUTION CURVE

FOR SIZE FRACTION :

REMARKS :



. PROJECT

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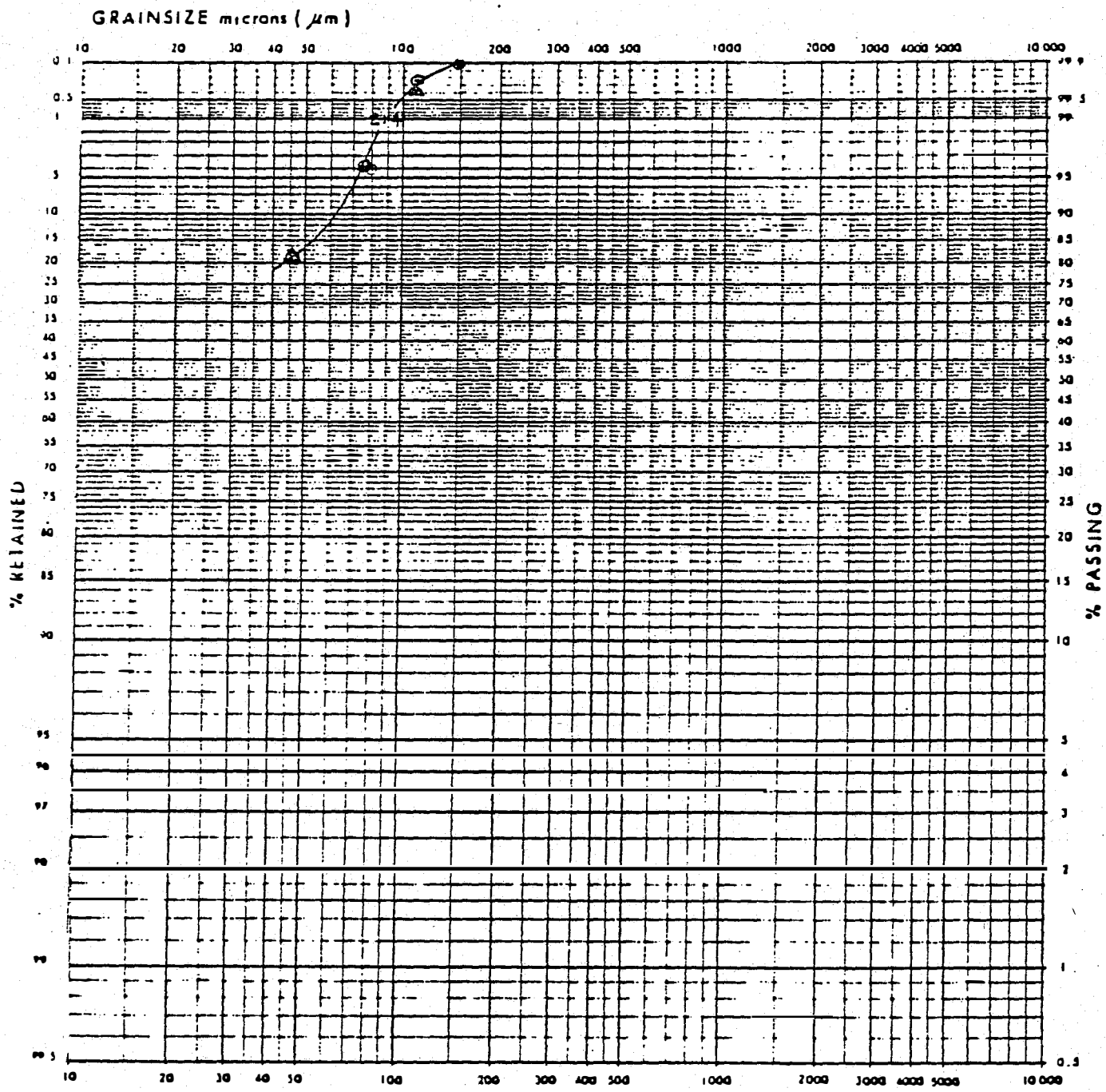

SCREEN ANALYSIS

TEST NO. 1

MESH SIZE TYLER	APERTURE MICRONS	% RETAINED		% PASSING
		INDIVIDUAL	CUMULATIVE	CUMULATIVE
65	210	0.23	0.23	99.77
100	149	2.51	2.74	97.26
150	105	13.49	16.29	83.77
200	77	10.41	26.64	73.36
325	44	13.44	40.08	59.92
-325		59.92	100.00	

TEST NO. 2

MESH SIZE TYLER	APERTURE MICRONS	% RETAINED		% PASSING
		INDIVIDUAL	CUMULATIVE	CUMULATIVE
65	210	-	-	-
100	149	0.02	0.02	99.98
150	105	0.19	0.21	99.79
200	77	3.55	3.76	96.24
325	44	13.81	17.57	82.43
-325		82.43	100.00	

TEST NO. 3

MESH SIZE TYLER	APERTURE MICRONS	% RETAINED		% PASSING
		INDIVIDUAL	CUMULATIVE	CUMULATIVE
65	210	0.48	0.48	99.52
100	149	3.13	3.61	96.39
150	105	13.59	17.20	32.80
200	77	9.70	26.90	73.10
325	44	12.16	39.06	60.94
-325		60.94	100.00	

SCREEN ANALYSIS

TEST NO. 4

MESH SIZE TYLER	APERTURE MICRONS	% RETAINED		% PASSING
		INDIVIDUAL	CUMULATIVE	CUMULATIVE
65	210	-	-	-
100	149	0.05	0.05	99.95
150	105	0.31	0.36	99.64
200	77	3.44	3.80	96.20
325	44	13.62	17.42	82.58
-325		82.58	100.00	

