REPORT ON MINING DEVELOPMENT PLAN OF ISCAYCRUZ(OYON) AREA REPUBLIC OF PERU

REPORT OF METALLURGICAL INVESTIGATION

MARCH 1986

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

REPORT ON MINING DEVELOPMENT PLAN

OF

ISCAYCRUZ(OYON) AREA

REPUBLIC OF PERU

REPORT OF METALLURGICAL

INVESTIGATION

MARCH 1986

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

CONTENTS

1. Introduction 1

2. Outline of the mill test 2
  2-1 Title of the mill test 2
  2-2 Purpose of the mill test 2
  2-3 Period 2
  2-4 Engineers 2
  2-5 Place 2
  2-6 Apparatus for test 3

3. Sample for the test 4
  3-1 Sampling 4
  3-2 Sample preparation 4
  3-3 Complete analysis of the samples 7

4. Mineralogical study of the sample 8

5. Charactor of the ore 11
  5-1 Real specific gravity 11
  5-2 Work index 12

6. Fundamental mill test 14
  6-1 Grinding test 15
  6-2 Flotation velocity test 16

7. Preliminary mill test 24
  7-1 Bulk differential flotation 24
  7-2 Straight differential flotation 32
  7-3 Comparison of both flotation methods 40

8. Additional tests of the straight differential flotation 42
  8-1 Reagent test 42
  8-2 Number of cleaning stages 48
  8-3 Confirmation test 51
  8-4 Studies for silver minerals 60

9. Test for tailing and wasted water treatment 63
9-1 Settling velocity of tailing slime 63
9-2 Analytical results of the wasted water 66

10. Conclusion 67
10-1 The results of mineralogical study, EPMA and
X-ray diffraction analysis 67
10-2 The results of the characteristics of the ore 67
10-3 The results of the mill tests 67
10-4 The results of the tests for tailing treatment 69

11. Closing 70

Table of the results of flotation tests 71

Annexed sheets
Ⅰ Apparatus for the test .... Ⅰ－1
Ⅱ Microscopic photographs .... Ⅱ－1
Ⅲ Result of X-ray diffraction test .... Ⅲ－1
Ⅳ Result of EPMA test .... Ⅳ－1

Table & Figure

TAB. 1	Preparation of Ore-M, Ore-A, Ore-B and Ore-C	6
TAB. 2	Complete Analysis of the samples	7
TAB. 3	Existence of ore mineral and gangue mineral	10
TAB. 4	Work indes	12
TAB. 5	Grinding tests of Ore-M	71
TAB. 6	Grinding tests of Ore-A	72
TAB. 7	Grinding tests of Ore-B	73
TAB. 8	Grinding tests of Ore-C	74
TAB. 9	Flotation velocity tests (Ore-M)	75
TAB. 10	Flotation velocity tests (Ore-A)	76
TAB. 11	Flotation velocity tests (Ore-B)	77
TAB. 12	Flotation velocity tests (Ore-C)	78
TAB. 13	Influence of quantity of lime on flotation velocity (Ore-M)	79
TAB. 14	Reagent of bulk roughing flotation	26
TAB. 15	Bulk differential flotation tests (1) ∿ (4)	80
TAB. 16	Comparison of the results of bulk differential flotation tests (1∿3).............................	27
TAB. 17	Reagent conditions of straight differential flotation	33
TAB. 18	Straight differential flotation tests (1) ∿ (4) ...	84
TAB. 19	Comparison of the results of straight differential tests (1∿3).......................................	35
TAB. 20	Comparison between the bulk differential flotation system and the straight differential floation system	41
TAB. 21	Reagent conditions of additional test of straight differential flotation	43
TAB. 22	Straight differential flotation tests (1) ∿ (4) ...	88
TAB. 23	Comparison of the results of additional tests of straight differential flotation (1∿3)	44
TAB. 24	Tests for the number of cleaning stages (Case A, Case B).................................	92
TAB. 25	Confirmation tests (Ore-M, Ore-A, Ore-B, Ore-C)	96
TAB. 26	The results of confirmation tests (Ore-M)	52

TAB. 27	The results of confirmation tests (Ore-A)	53
TAB. 28	The results of confirmation tests (Ore-B)	54
TAB. 29	The results of confirmation tests (Ore-C)	55
TAB. 30	The estimated performances of the flotation for Ore-M	57
TAB. 31	The estimated performances of mill operation with expected grade	58
TAB. 32	The results of complete analysis of crude ore, lead/zinc concentrates and tailing	59
TAB. 33	Settling tests of tailing slime	64
TAB. 34	Analytical results of the wasted water.............	66
Fig. 1	Sampling point map	5
Fig. 2	Relationship between grinding time and weight percent of 200 mesh oversize	15
Fig. 3	Distribution of weight of each mineral	16
Fig. 4	Flowsheet of flotation velocity test	17
Fig. 5	Flotation velocity tests (Ore-M)	18
Fig. 6	Flotation velocity tests (Ore-A)	19
Fig. 7	Flotation velocity tests (Ore-B)	20
Fig. 8	Flotation velocity tests (Ore-C)	21
Fig. 9	Influence of quantity of lime on Flotation velocity (Ore-M)	23
Fig. 10	Flowsheet of bulk differential flotation tests	25
Fig. 11	Relationship between quantity of lime and Lead recovery	30
Fig. 12	Relationship between quantity of lime and Zinc recovery	31
Fig. 13	Flowsheet of straight differential flotation test ..	34
Fig. 14	Influence of the number of cleaning stages on the zinc recovery and the zinc grade of concentrate and tailing from cleaning	49
Fig. 15	Flowsheet of confirmation tests	51
Fig. 16	Settling test of tailing slime	65

1. INTRODUCTION

1. Introduction

Regarding the "Mine Development Survey Works at the Area of ISCAYCRUZ of the Republic of Peru" promoted by the Metal Mining Agency of Japan as one of its projects for the fiscal year of 1985, a series of various mill tests in laboratorial scale for the samples from the ore deposits of ISCAYCRUZ have been carried out. The results of the tests are summarized and reported herewith.

2. OUTLINE OF THE MILL TEST

2. Outline of the mill test

2-1 Title of the mill test

"REPORT ON MINING DEVELOPMENT PLAN OF ISCAYCRUZ (OYON) AREA, REPUBLIC OF PERU: REPORT OF METALLURGICAL INVESTIGATION"

2-2 Purpose of the mill test

To obtain the basic data for the designing of a future mill plant and to estimate the results of the mill operation under the best conditions to recover the useful minerals from the ore including zinc, lead, silver and copper which have been found by means of "the Bilateral Technical Cooperation for the Exploration of Mineral Resources" carried out in the area of ISCAYCRUZ and OYON during 1979 to 1984.

2-3 Period

The tests have been carried out from 30th November, 1985 to 31st January, 1986.

2-4 Engineers

The name list of engineers who carried out the tests are shown below;

General	Yoshio	MURAKAMI
Chief of mill test	Masatoshi	MURATA
Mill test	Isao	SHINTANI
	Yoshihiro	TSUCHIYA
Mineralogical study	Kenji	KONAGAI
	Mitsuo	YAMAGUCHI

2-5 Place

The tests have been carried out at the Central Laboratory of Mitsui Mining & Smelting Co., Ltd.

2-6 Apparatus for the test

Apparatus and equipment for the mill test and other tests installed at the Central Laboratory of Mitsui Mining & Smelting Co., Ltd. were used for the tests.

(refer to Annex I , Photo. No.1-6)

3. SAMPLE FOR THE TEST

3. Sample for the test

3-1 Sampling

Samples for the tests had been taken from the ore deposits which were found in the tunnels developed during 1984 to 1985

(refer to Fig.1)

Samples consisted of the following three ;

Ore-A (Foot wall side, highly graded lead ore)
Ore-B (Foot wall side, highly graded zinc ore)
Ore-C (Hanging wall side ore)

3-2 Sample preparation

The grades of crude ore had been expected as 0.10% of copper, 1.61% of lead, 15.9% zinc and 35 g/t of silver. These grades are calculated based on the average grades of the ore reserve above the South tunnel, which has been reported in the Report on Mineral Exploration in ISCAYCRUZ (OYON) Area of Republic of Peru (Phase III), with a safety factor of 95% and a waste dilution ratio of 85%.

The grades of the samples taken are as shown in the following table;

	Weight	Cu	Pb	Zn	Ag	Fe
	kg	%	%	%	g/t	%
Ore-A	about 30	0.005	2.8	20.4	165	15.4
Ore-B	about 60	0.061	2.8	32.2	129	18.5
Ore-C	about 60	0.025	0.2	17.8	16	25.3
Total	about 150	0.036	1.7	24.2	91	20.6

All grades of lead, zinc and silver are higher than the above mentioned expected grades of the crude ore.

Therefore, another sample with a lower grade has been taken additionally from hanging/foot wall and mother rock. Then, both

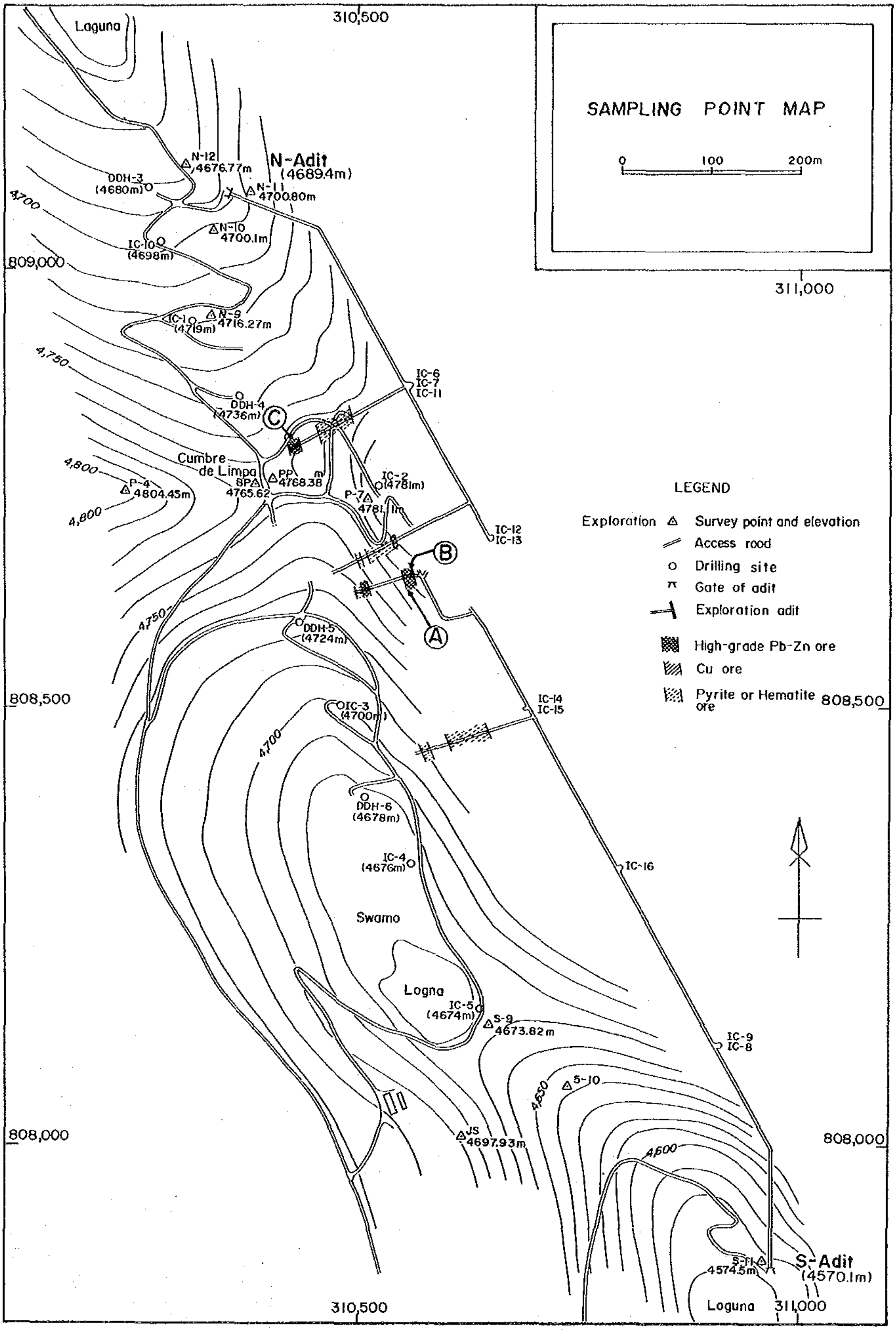

Fig. 1 SAMPLING POINT MAP

samples were mixed up in order to adjust the grade similar to the expected grade.

A part of the sample is used for surveying the work index. Beside, remaining samples are crushed to minus 28 mesh by means of a sample breaker and a sample grinder in order to prepare the blended ore sample which is the mixture of Ore-A, Ore-B, Ore-C (here-after called by Ore-M).

Similarly, each of Ore-A, Ore-B and Ore-C are blended by low graded ore for the grade adjustment.

The results of the adjustment are as shown in Table 1.

TAB.1 Prepareation of Ore-M, Ore-A, Ore-B and Ore-C

Ore	Item	Mixed Ratio	Grade				
			Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%
Ore-M	Ore-A	16.8	0.006	2.79	20.61	166	15.36
	Ore-B	36.4	0.060	2.78	31.40	126	18.11
	Ore-C	21.2	0.022	0.12	15.76	16	26.09
	Low graded ore	25.6					
	Prepared ore	100	0.092	1.37	18.13	85	18.87
Ore-A	Ore-A	68.8	0.010	2.17	26.43	199	15.55
	Low graded ore	31.2					
	Prepared ore	100	0.044	1.48	19.80	155	16.80
Ore-B	Ore-B	63.3	0.054	2.64	28.46	116	18.49
	Low graded ore	36.7					
	Prepared ore	100	0.116	1.66	19.01	91	18.30
Ore-C	Ore-C	85.6	0.030	0.11	21.03	16	23.87
	Low graded ore	14.4					
	Prepared ore	100	0.071	0.11	19.06	17	21.47

3-3 Complete Analysis of the samples

The results of the complete analysis of the samples (Ore-M, Ore-A, Ore-B and Ore-C) are as shown in Table 2.

TAB.2 Complete Analysis of the samples

Components		Ore-M	Ore-A	Ore-B	Ore-C
Ag	(g/t)	80	180	83	16
Cu	(%)	0.08	0.04	0.11	0.06
Pb	(〃)	1.3	1.3	1.5	0.1
Zn	(〃)	20.5	20.8	19.9	20.1
Cd	(〃)	0.03	0.03	0.04	0.03
Sn	(〃)	<0.005	<0.005	<0.005	<0.005
Fe	(〃)	20.2	19.4	19.8	23.3
Sb	(〃)	<0.001	<0.001	<0.001	<0.001
As	(〃)	0.04	0.12	0.06	0.02
Bi	(〃)	<0.001	<0.001	<0.001	<0.001
Hg	(g/t)	<0.5	<0.5	<0.5	<0.5
Ga	(%)	0.004	0.001	0.008	0.001
Mn	(〃)	0.12	0.10	0.12	0.13
T-S	(〃)	30.8	31.2	30.6	35.4
SiO_2	(〃)	13.6	14.9	12.0	9.1
Al_2O_3	(〃)	2.0	1.5	1.9	1.5
CaO	(〃)	4.2	3.9	5.6	2.9
MgO	(〃)	2.1	1.8	2.5	1.5
LOI	(〃)	5.8	5.1	6.0	7.7

N.B. "LOI" means "Loss of ignition".

4. MINERALOGICAL STUDY OF THE SAMPLE

4. Mineralogical study of the sample
(refer to the annex sheet)

For the massive samples (Ore-A, Ore-B and Ore-C), microscopic observation and electron probe microanalysis (EPMA), and for the grain samples (Ore-M, Ore-A, Ore-B and Ore-C), X-ray diffraction analyses have been carried out.

The results of those analyses are as mentioned below;

(1) Ore-M

Ore minerals consisted of a lot of sphalerite(ZnS) and pyrite(FeS_2) with a smaller amount of galena(PbS) and lesser amount of chalcopyrite($CuFeS_2$), hematite(Fe_2O_3), arsenopyrite ($FeAsS_2$), pyrrhotite($Fe_{1-x}S$) and colusite($Cu_3(As,Sn,V,Fe,Sb)S_2$).

Chalcopyrite exists in sphalerite in the shape of many dots. Arsenopyrite and colusite are in pyrite as fine grains. There are many cases found that the sphalerite and galena are coexisting in pyrite and gangue minerals.

(refer to Annex II, Photo. 1, 2)

Gangue minerals mainly consisted of quartz and calcite with a smaller amount of dolomite, sericite, chlorite and talc.

(refer to Annex III, Fig. 1)

(2) Ore-A

Main portion of Ore-A is sphalerite mass including pyrite and gangue minerals just like in the case of Ore-B. Partially, there is some ore with the bedding structure of sphalerite, pyrite and galena. Galena is usually with sphalerite, but sometimes with pyrite in the shape of very fine vein (with a width of 10 m).

(refer to Annex II, Photo. 3, 4)

Gangue minerals mainly consisted of quartz, calcite and dolomite with a small amount of chlorite and talc.

(refer to Annex III, Fig. 2)

(3) Ore-B

Ore-B is mainly sphalerite and pyrite with small amount of galena. Mostly sphalerite mass with small grains of pyrite and gangue minerals, grain size of sphalerite is comparatively coarse (over 0.1mm)

(refer to Annex II, Photo. 5, 6)

Gangue minerals are simillar to Ore-A.

(refer to Annex III, Fig. 3)

(4) Ore-C

Ore-C consisted of a lot of sphalerite and pyrite with a very limited amount of galena and chalcopyrite. Diameter of galena is 60-100 μm and is in sphalerite and/or pyrite. Chalcopyrite is in sphalerite in the shape of dots.

(refer to Annex II, Photo. 7, 8)

Gangue minerals mainly consisted of quartz and calcite with a small amount of dolomite, siderite, sericite and talc.

(refer to Annex III, Fig. 4)

(5) Summary

The electron probe microanalysis (EPMA) has been carried out for Ore-A, Ore-B and Ore-C, but there is no indication of existing silver mineral.

(refer to Annex IV, Photo.(1),(2),(3))

The summary of the mineralogical study is as shown in Table 3.

TAB. 3 Existence of ore mineral and gangue mineral

Mineral	Ore-M	Ore-A	Ore-B	Ore-C
Galena	△	△	△	–
Sphalerite	◎	◎	◎	◎
Pyrite	○	○	○	○
Quartz	○	○	○	○
Calcite	○	○	○	○
Dolomite	△	○	○	△
Siderite	–	–	–	△
Sericite	△	–	–	△
Chlorite	△	△	△	–
Talc	△	△	△	△

N.B.

◎ Large quantity ○ Medium quantity

△ small quantity – not recognized

5. CHARACTOR OF THE ORE

5. Charactors of the ore

5-1 Real specific gravity

Each real specific gravity of Ore-M, Ore-A, Ore-B and Ore-C has been surveyed by means of a specific gravity bottle (Picnometer Method). The results are as follows;

Ore-M	4.01
Ore-A	3.90
Ore-B	3.93
Ore-C	4.02

These samples are with a zinc grade of about 18 to 20% which is higher than the expected grade of the crude ore. Therefore, since abovementioned specific gravities will be a little heavier, the specific gravity of expected crude ore should be estimated lighter.

For example, in the case of Ore-M, which has a zinc grade of 18.1%, in order to convert to the expected ore grade, 15.9% Zn, Ore-M should be diluted by wasted rock. So, the weight of Ore-M will increase 14%. As for the wasted rock, there is limestone, dolomite and shale with a specific gravity of 2.65, 2.74, 2.63 respectively. It will be considered that the average specific gravity of wasted rock is 2.67.

Thus, the estimated real specific gravity of Ore-M with the expected grade can be calculated as follows;

$$(1 \times 4.01 + 0.14 \times 2.67) / (1 + 0.14) = 3.84$$

Similarly, the real specific gravities of other kinds of ores are calculated;

Ore-A $(1 \times 3.90 + 0.25 \times 2.67) / (1 + 0.25) = 3.65$

Ore-B $(1 \times 3.93 + 0.20 \times 2.67) / (1 + 0.20) = 3.84$

Ore-C $(1 \times 4.02 + 0.20 \times 2.67) / (1 + 0.20) = 3.84$

As the real specific gravity of Ore-M at the expected grade is estimated as 3.84, it may be 3.8 in the operation stage.

5-2 Work index

The estimation of the work index has been done by the Hardgrove method which is shown in Photo.6 of Annexed sheet I.

The Hardgrove grindability index is calculated by the equation of

$$Hd = 13 + 6.93 \times (50 - W)$$

Hd: Hardgrove grindability index

W : Weight of oversize in gramme after 200 mesh screening with constant grinding

Then, the work index is calculated by equation of

$$Wi = 435 / (Hd)^{0.91}$$

Wi: Work index (kWh/st)

The results of the estimation of work index are as shown in Table 4;

TAB. 4 Work index

Ore		Ore-M	Ore-A	Ore-B	Ore-C
Weight of oversize 200 mesh (W)	(g)	42.24	43.29	42.46	42.12
Hardgrove grindability Index (Hd)		66.7768	59.5003	65.2522	67.6084
Work index (Wi)	(kWh/st)	9.51	10.56	9.71	9.40

Since the above mentioned values are for the flotation tests, it will be necessary to estimate the work index for the ores at the expected grade.

For example, diluting Ore-M by the wasted rock and adjusting the grade just the same as in the case of 6-1, as the work index of the wasted rocks are

Limestone	12.54	kWh/st
Dolomite	11.44	
Shale	15.87	

respectively by Bond's Report.

Ore-M	(1 x 9.51 + 0.14 x 13.28) / 1.14 = 9.97 (kWh/st)
Ore-A	(1 x 10.56 + 0.25 x 13.28) / 1.25 = 11.10 (kWh/st)
Ore-B	(1 x 9.71 + 0.20 x 13.28) / 1.20 = 10.31 (kWh/st)
Ore-C	(1 x 9.40 + 0.20 x 13.28) / 1.20 = 10.05 (kWh/st)

As 9.97 kWh/st in equivalent to 10.97 kWh/t, the work index of Ore-M at the expected grade is estimated as 11 kWh/t in the operation stage.

6. FUNDAMENTAL MILL TEST

6. Fundamental mill test

6-1 Grinding test

To get the relationship between grinding time and size of product, the following grinding tests have been carried out for each kind of ore.

Equipment	:	a cylindrical ball mill ($153mm^{\phi}$ x $174mm^{L}$)
Amount of ore sample for 1 test	:	500 gramme
Volume of water for 1 test	:	330ml in order to make the pulp density of 60% at minus 28 mesh
Grinding time	:	10, 15 and 20 minutes, respectively

The results of the grinding tests are shown in Tables 5, 6, 7 and 8. Based on the test results, the meshes of which make the amount of under size more than 90% for each grinding time are estimated as in the following table.

Grinding time min.	Ore-M mesh	Ore-A mesh	Ore-B mesh	Ore-C mesh
10	150	150	150	170
15	200	170	170	200
20	250	200	250	250

And the relation between the grinding time by ball mill and weight percent of plus 200 mesh of the product is as shown in Fig.2.

Among Ore-A, Ore-B and Ore-C, Ore-A seems to be a little harder to grind.

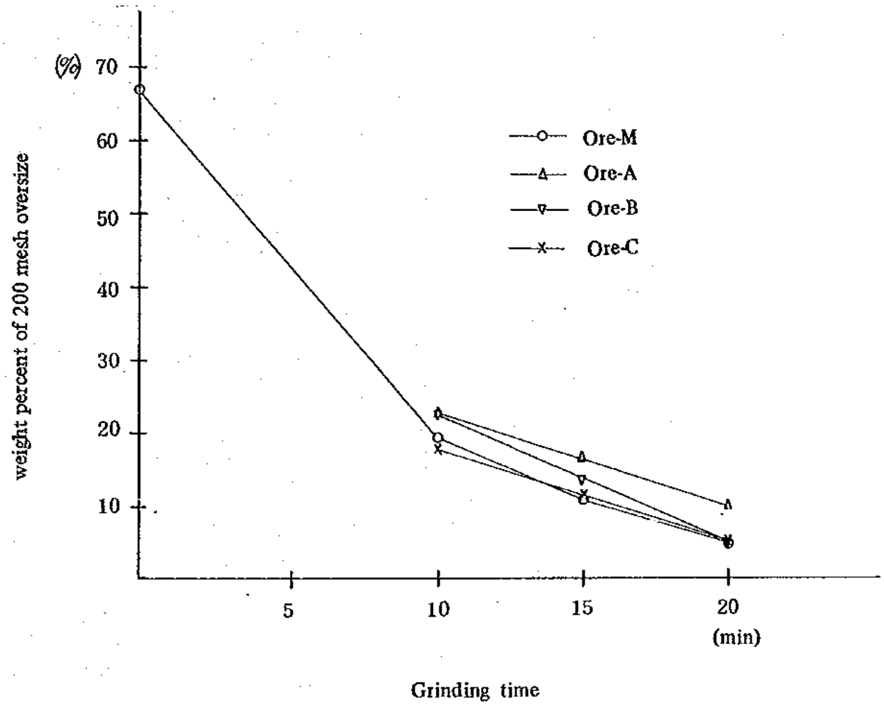

Fig. 2 Relationship between grinding time and weight percent of 200 mesh oversize

And also, it will be pointed out that the lead mineral tends to be selectively and easily ground compared with the other minerals.
(as shown in Fig. 3.)

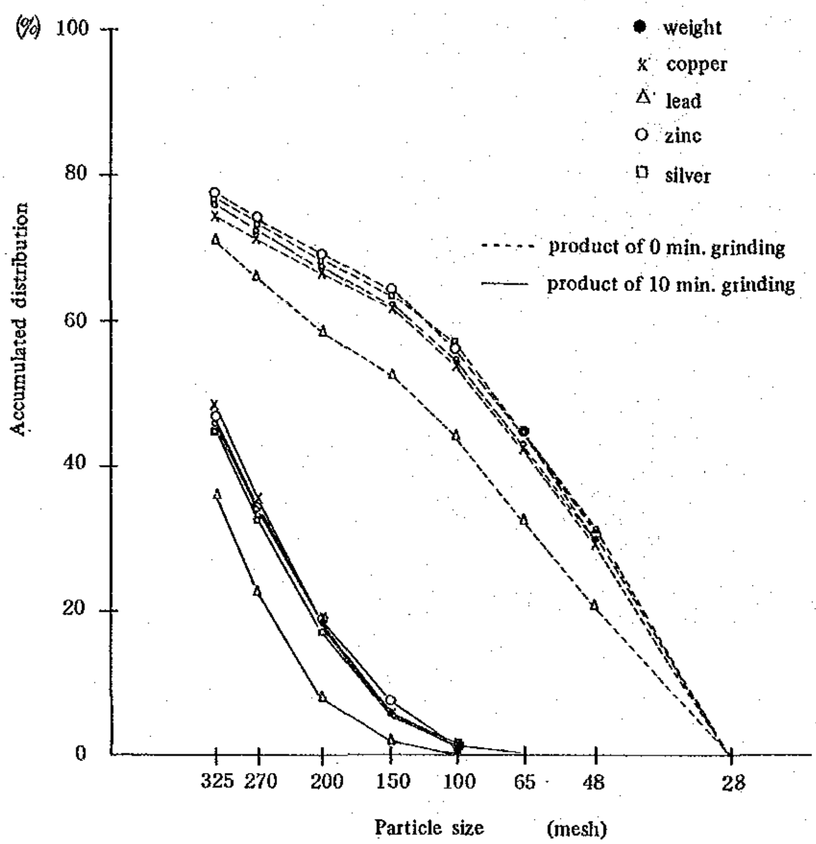

Fig. 3 Distribution of weight of each mineral

6-2 Flotation velocity tests

In order to survey the relation between the size of feed and the flotation time, the rougher flotation tests have been carried out using the products of various grinding tests mentioned 6-1 as for the feeds and under the same conditions of flotation.

The flowsheet of the flotation tests is as shown in Fig.4 and the results of the flotation tests are as shown in Tables 9, 10, 11 and 12. Additionally, the relation between the size of feed and the accumulative recovery of each component minerals is as shown in Fig.5, 6, 7 and 8.

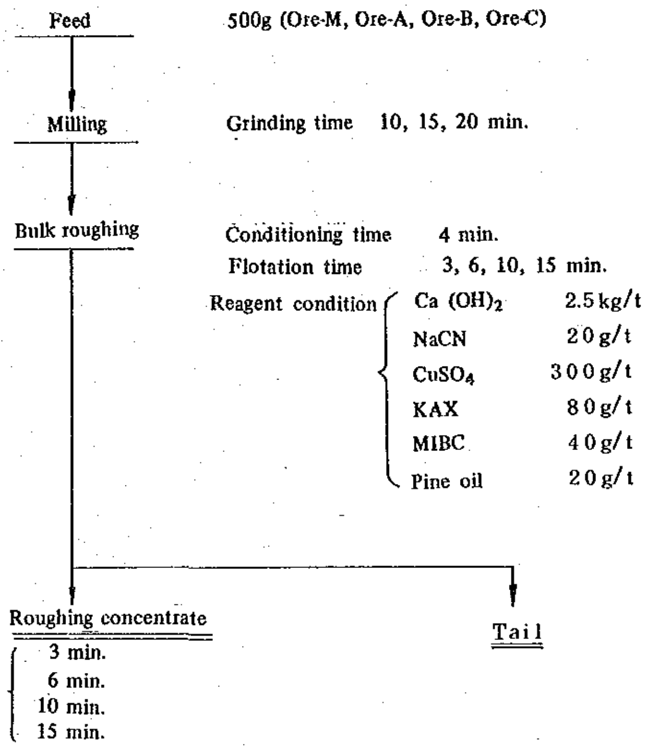

Fig. 4 Flowsheet of flotation velocity test

6-2-1 Size of the feed for flotation

Comparing each recovery of each mineral component with a flotation time of 15 minutes as shown in Fig. 5, 6, 7 and 8, generally, the feed of which is ground 10/15 minutes is apparently better than 20 minutes.

For zinc, the recovery is more or less the same with each ore, however, for the other mineral components including lead, the recoveries are different depending on the ore samples.

In any case, the recovery from the feed of which is ground 20 minutes is not good. It may be caused by overgrinding.

According to the mineralogical study, galena tends to easily become middling with sphalerite, pyrite and others. In order to liberate the middling, it is necessary to grind 250 to 325 meshes and it takes more than 20 minutes of grinding. However, the results of the tests show that

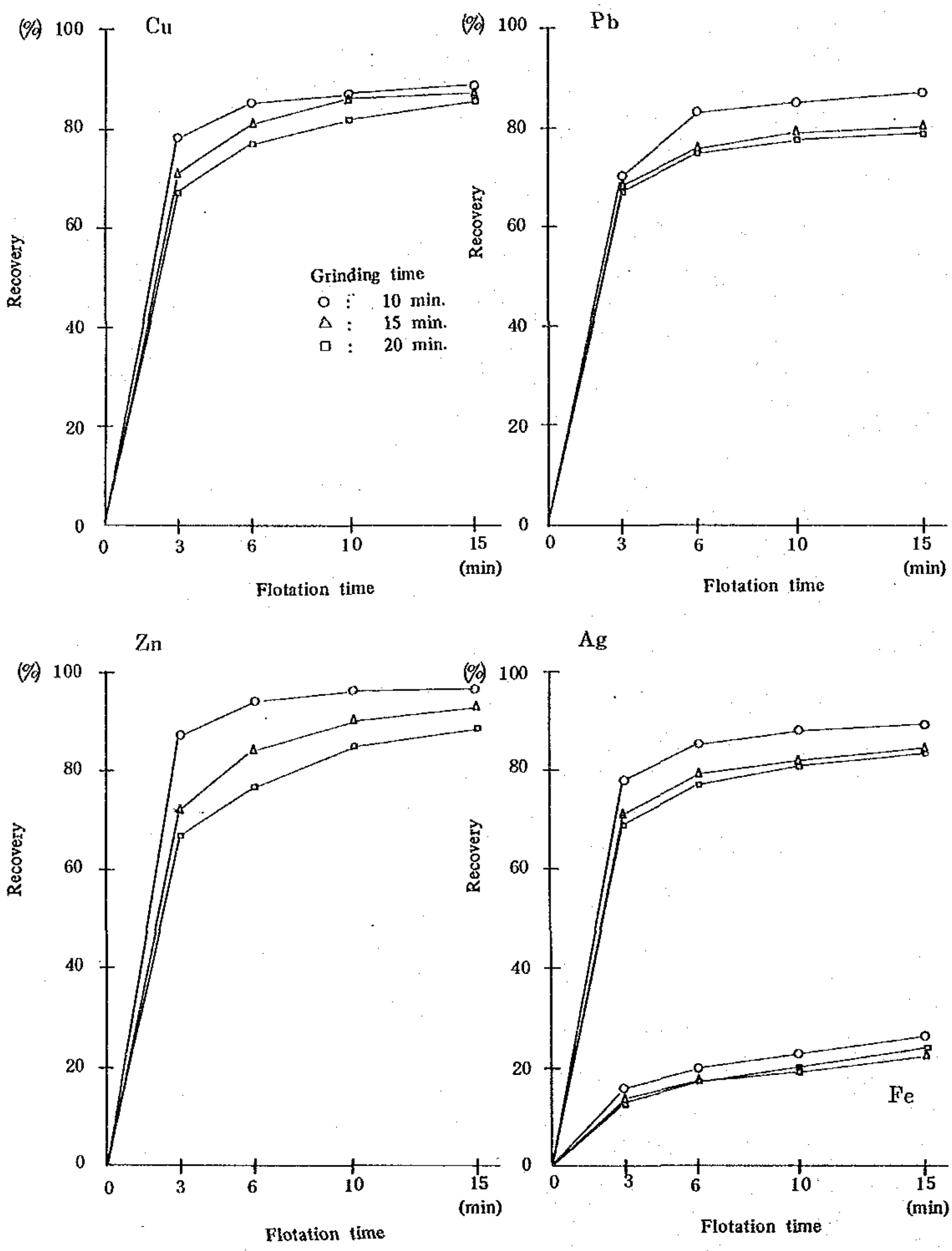

Fig. 5 Flotation velocity tests (Ore-M)

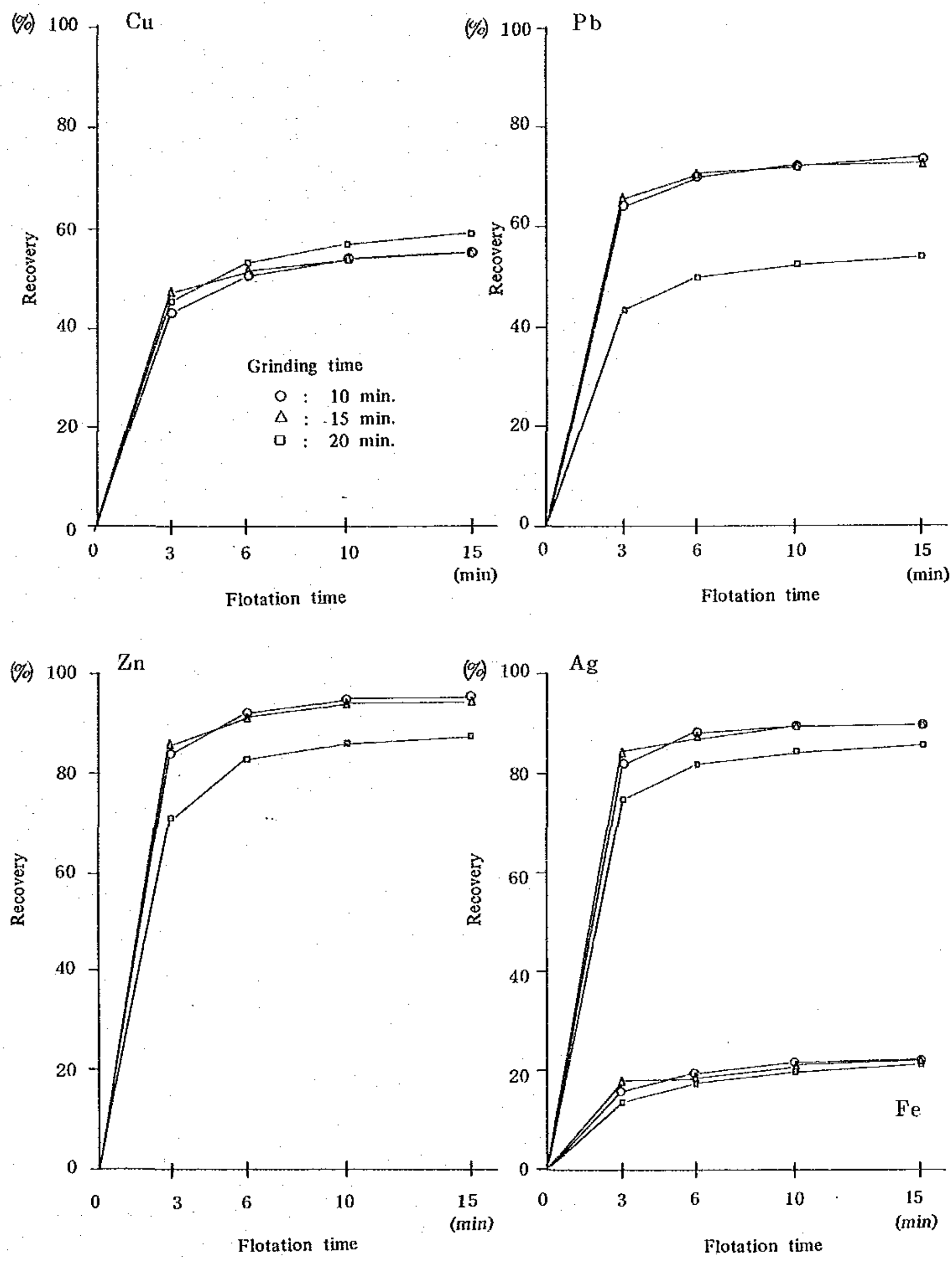

Fig. 6 Flotation velocity tests (Ore-A)

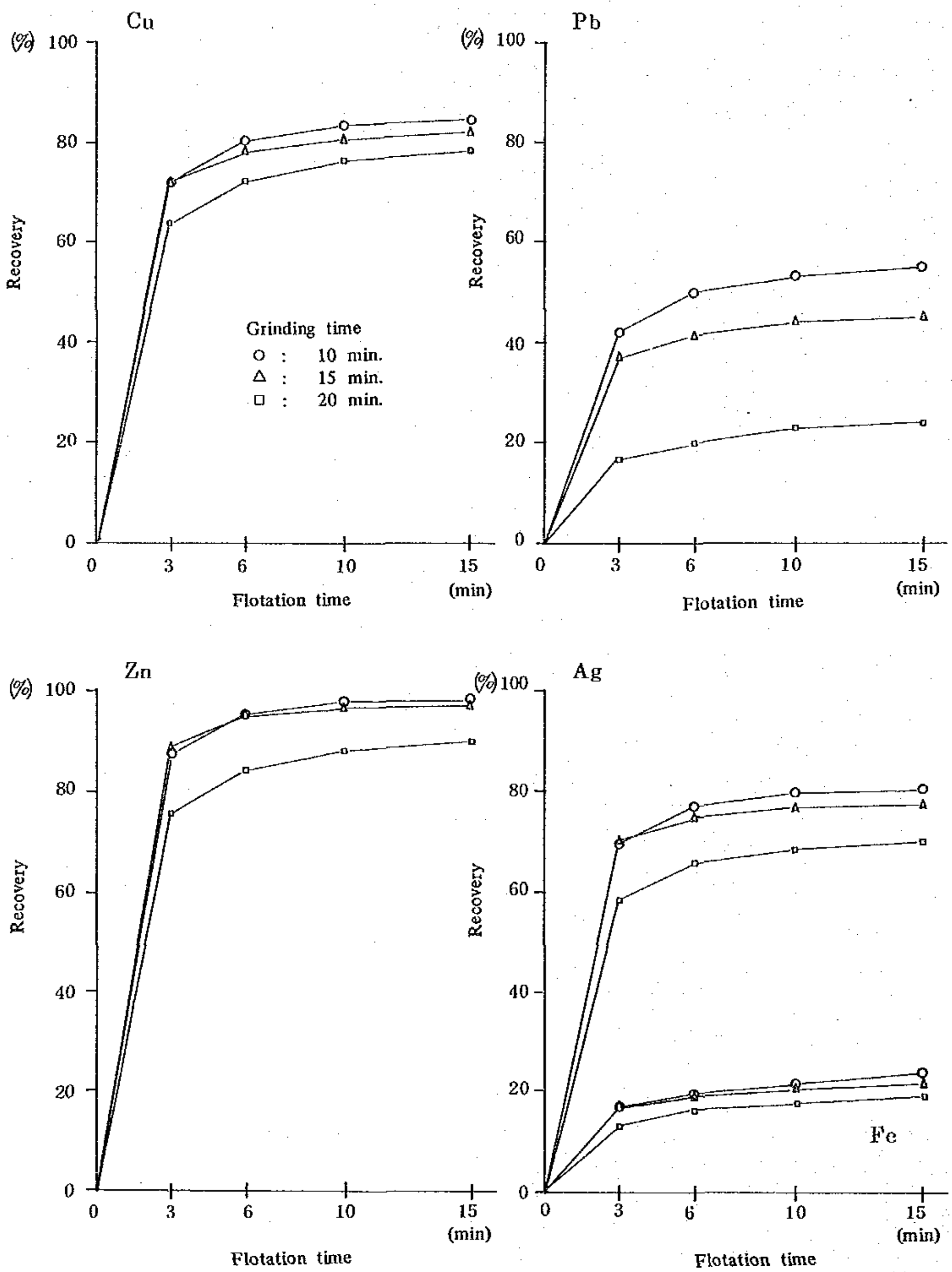

Fig. 7 Flotation velocity tests (Ore-B)

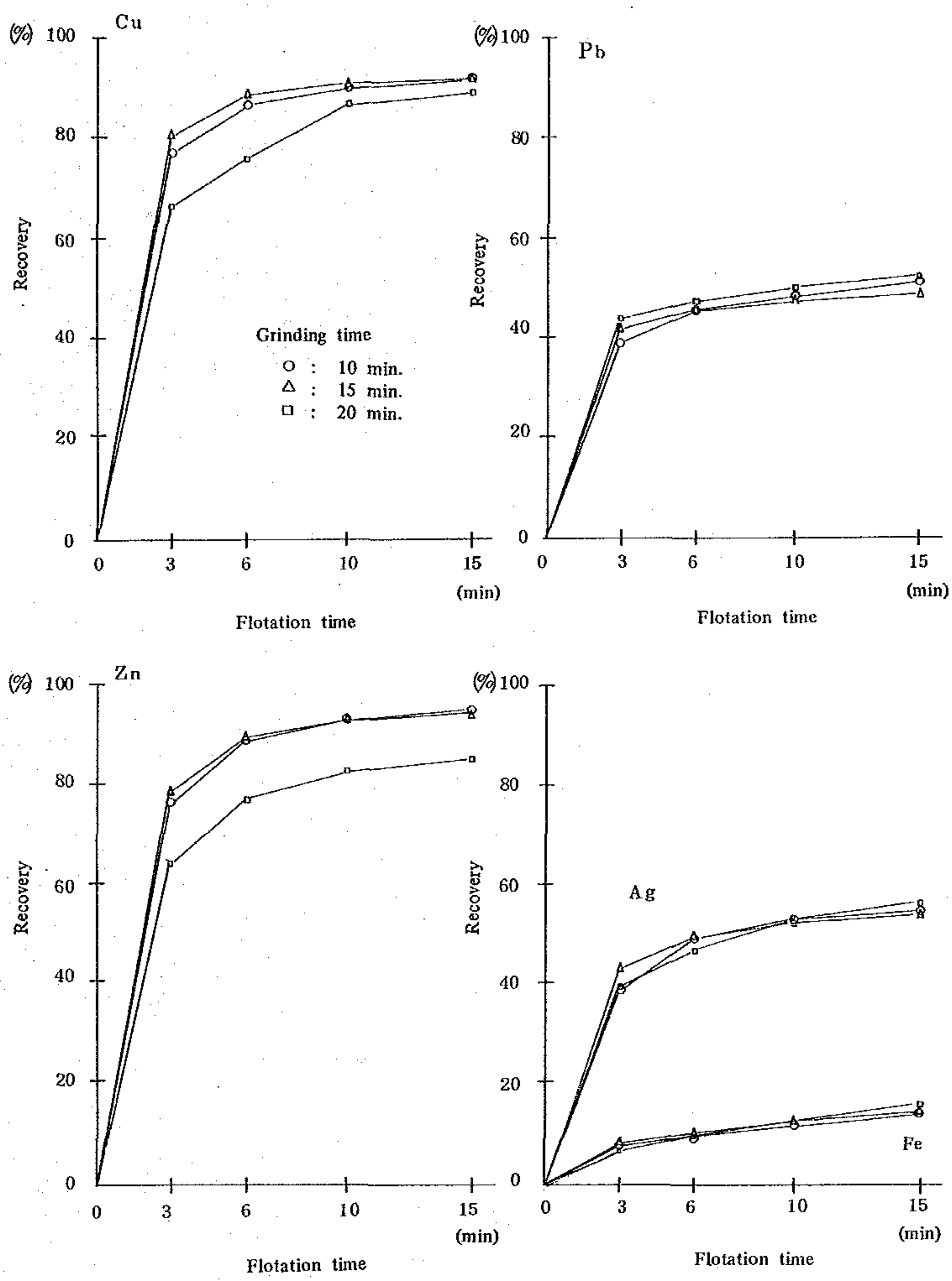

Fig. 8 Flotation velocity tests (Ore-C)

such a long grinding time will perform the overgrinding which will be no good from the point of view of the recovery.

And also, if the grinding size becomes finer, the grinding equipment becomes bigger and the investment and operation costs naturally become more expensive.

There is not such a big difference in the recovery between 10 and 15 minutes of the grinding time according to the test results, it has been decided to carry on the further tests using the 10 minute grinding products with 19% of over 200 meshes.

6-2-2 Flotation time

In the case of bulk flotation, in every kind of ore, the zinc recovery reaches a similar value with a flotation time of 10 minutes.

The lead recovery is generally lower caused by the effect of the slaked lime, also it reaches a stable level after 10 minutes flotation.

Thus, it may be considered that the adequate bulk flotation time is 10 minutes.

In the case of the zinc flotation by means of the straight differential flotation, the flotation time seems to be good enough to make it 10 minutes since it is the same condition as the bulk flotation.

Besides, in order to check the necessary flotation time of lead flotation by means of zinc-lead differential flotation and straight differential flotation and also to test the influence of quantity of lime, similar tests have been carried out reducing the quantity of lime from 2.5 to 1.5kg/t. The results of these tests are shown in Fig.9.

When the quantity of lime to charge in is reduced, the lead recovery is considerably improved. As the lead recovery reaches a certain stable value after 5 minutes flotation, it is considered that the adequate flotation time for lead is about 5 minutes under the suitable flotation conditions of both bulk and straight differential flotation.

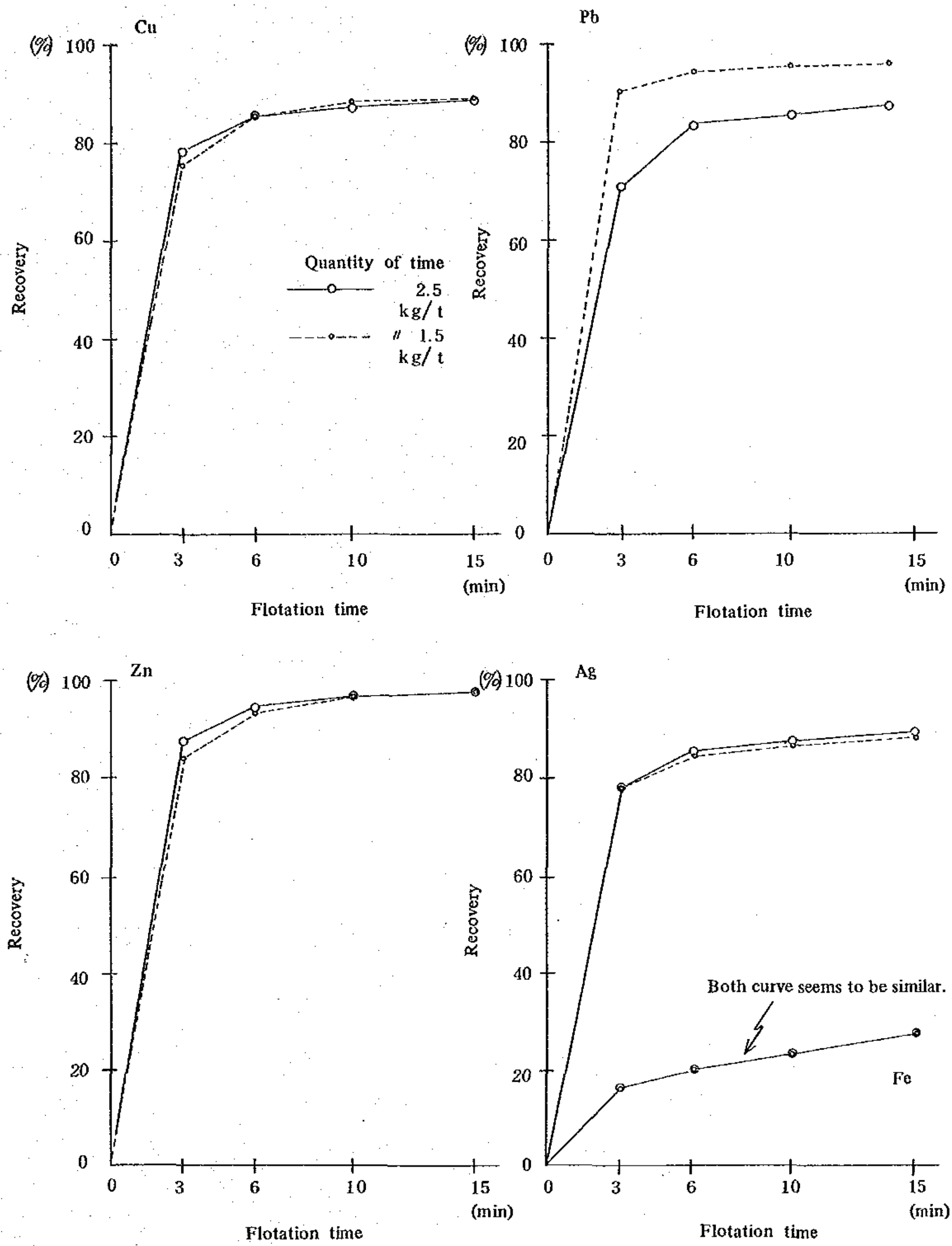

Fig. 9 Influence of quantity of lime on flotation velocity (Ore-M)

7. PRELIMINARY MILL TEST

7. Preliminary mill test

7-1 Bulk differential flotation

In order to get the ideas of flotation conditions, bulk differential flotation tests have been carried out.

The following reagents have been adopted for the tests.

Depressor and pH adjuster	Lime
Collector	KAX (Potassium Amyle Xanthate)
Activator	Copper sulphate
Frother	MIBC, Pine oil

The flowsheet and the conditions for the tests are settled as shown in following table, Fig.10 and Table 14 based on the results of the flotation velocity test and the other tests.

Reagents	Level	Charged quantity
Lime	3	1,000, 1,500, 2,000g/t
KAX	2	60, 80g/t
Copper sulphate	2	200, 300g/t
Frother	1	MIBC 40g/t + Pine oil 20g/t

For copper, as the grade is quite low and the copper minerals, mainly chalcopyrite, scatter in sphalerite as in shape of fine dots, it is neglected to consider as for the object of further studies.

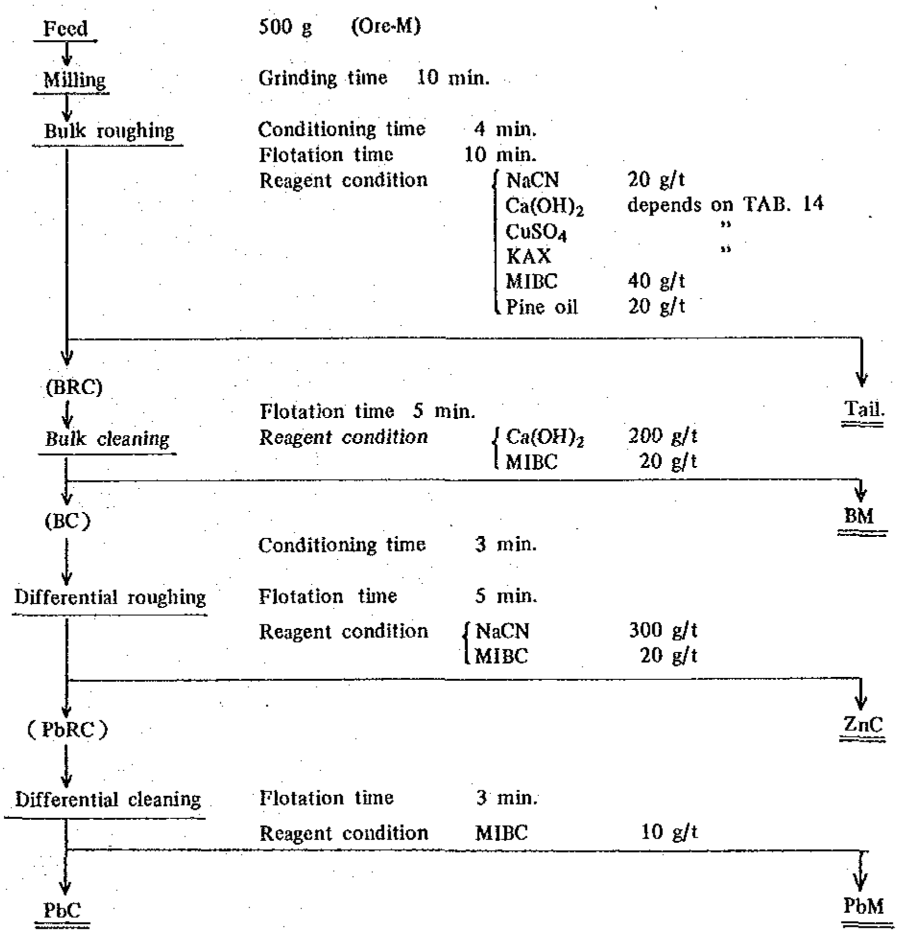

Fig. 10 Flowsheet of bulk differential flotation tests

The results of the tests are shown as in the Table 15 and the comparison of the results of each condition is in Table 16.

TAB. 14. Reagents of bulk roughing flotation

Test No.	Reagent			
	$Ca(OH)_2$	$CuSO_4$	KAX	MIBC+Pine oil
	g/t	g/t	g/t	g/t
No.8 −1	1000	300	80	40 + 20
No.8 −2	1500	300	80	40 + 20
No.8 −3	2500	300	80	40 + 20
No.8 −4	1000	200	80	40 + 20
No.8 −5	1500	200	80	40 + 20
No.8 −6	2500	200	80	40 + 20
No.8 −7	1000	300	60	40 + 20
No.8 −8	1500	300	60	40 + 20
No.8 −9	2500	300	60	40 + 20
No.8 −10	1000	200	60	40 + 20
No.8 −11	1500	200	60	40 + 20
No.8 −12	2500	200	60	40 + 20

N.B. Other flotation conditions are shown in the flowsheet Fig. 10

TAB. 16 Comparison of the results of bulk differential flotation tests
(1. Influence of collector)

Quantity of KAX	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
KAX 60g/t	Feed	100	0.082	1.36	18.5	84	19.0	100	100	100	100	100
	BRC	30.53	0.169	3.00	41.3	184	8.4	62.9	67.3	68.3	66.7	13.4
	Tail	69.47	0.044	0.64	8.4	40	23.7	37.1	32.7	31.7	33.3	86.6
	BC	23.30	0.196	2.74	48.6	209	7.4	55.6	46.8	61.3	57.9	9.0
	BM	7.23	0.083	3.86	17.8	102	11.5	7.3	20.5	7.0	8.8	4.4
	PbRC	1.68	0.076	34.61	14.3	486	6.2	1.5	42.5	1.3	9.7	0.5
	ZnC	21.62	0.205	0.27	51.2	187	7.5	54.1	4.3	60.0	48.2	8.5
	PbC	0.69	0.050	53.48	5.7	630	4.0	0.4	26.9	0.2	5.1	0.1
	PbM	0.99	0.093	21.53	20.3	387	7.6	1.1	15.6	1.1	4.6	0.4
KAX 80g/t	Feed	100	0.082	1.37	18.0	80	18.2	100	100	100	100	100
	BRC	37.00	0.168	3.16	42.5	167	9.2	75.7	85.6	87.3	77.7	18.7
	Tail	63.00	0.032	0.31	3.6	28	23.5	24.3	14.4	12.7	22.3	81.3
	BC	29.71	0.193	2.77	49.8	185	8.2	69.8	60.3	82.1	68.9	13.4
	BM	7.29	0.067	4.75	12.9	96	13.3	5.9	25.3	5.2	8.8	5.3
	PbRC	2.25	0.137	34.12	14.9	462	6.7	3.7	56.2	1.9	13.0	0.8
	ZnC	27.46	0.198	0.21	52.6	162	8.4	66.1	4.1	80.2	55.9	12.6
	PbC	0.99	0.117	60.22	4.6	678	3.6	1.4	43.5	0.3	8.4	0.2
	PbM	1.26	0.153	13.74	22.9	293	9.2	2.3	12.7	1.6	4.6	0.6

TAB. 16 Comparison of the results of bulk differential flotation tests
(2. Influence of activator)

Quantity of $CuSO_4$	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
$CuSO_4$ 200g/t	Feed	100	0.081	1.35	18.4	83	18.7	100	100	100	100	100
	BRC	30.86	0.156	2.89	41.7	170	9.0	59.6	66.4	70.1	63.3	15.0
	Tail	69.14	0.047	0.65	7.9	44	23.0	40.4	33.6	29.9	36.7	85.0
	BC	23.40	0.181	2.85	49.5	194	7.9	52.4	49.5	63.1	54.8	10.0
	BM	7.46	0.078	3.04	17.3	94	12.5	7.2	16.9	7.0	8.5	5.0
	PbRC	1.83	0.083	33.54	14.3	427	6.5	1.9	45.7	1.4	9.4	0.7
	ZnC	21.57	0.190	0.23	52.5	174	8.0	50.5	3.8	61.7	45.4	9.3
	PbC	0.88	0.063	53.55	5.6	585	3.8	0.7	35.1	0.3	6.2	0.2
	PbM	0.95	0.101	14.97	22.3	281	9.1	1.2	10.6	1.2	3.2	0.5
$CuSO_4$ 300g/t	Feed	100	0.083	1.38	18.1	81	18.6	100	100	100	100	100
	BRC	36.67	0.176	3.26	42.1	179	8.7	78.8	86.4	85.2	81.0	17.3
	Tail	63.33	0.028	0.30	4.2	24	24.3	21.2	13.6	14.8	19.0	82.7
	BC	29.60	0.205	2.69	49.0	196	7.9	72.8	57.6	80.0	71.9	12.6
	BM	7.07	0.071	5.64	13.3	104	12.4	6.0	28.8	5.2	9.1	4.7
	PbRC	2.09	0.136	35.02	15.0	511	6.4	3.4	53.0	1.7	13.2	0.8
	ZnC	27.51	0.210	0.23	51.6	172	8.0	69.4	4.6	78.3	58.7	11.8
	PbC	0.79	0.120	61.84	4.5	739	3.8	1.1	35.4	0.2	7.2	0.2
	PbM	1.30	0.145	18.76	21.4	373	8.0	2.3	17.6	1.5	6.0	0.6

TAB. 16 Comparison of the results of bulk differential flotation tests
(3. Influence of lime)

Quantity of lime	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
lime 1000g/t	Feed	100	0.082	1.37	17.8	81	18.6	100	100	100	100	100
	BRC	34.23	0.170	3.57	42.0	177	8.7	70.6	88.9	80.6	74.3	15.9
	Tail	65.77	0.037	0.23	5.3	32	23.7	29.4	11.1	19.4	25.7	84.1
	BC	27.08	0.195	3.48	48.9	198	7.9	64.2	68.6	74.3	65.8	11.4
	BM	7.15	0.073	3.89	15.7	96	11.8	6.4	20.3	6.3	8.5	4.5
	PbRC	2.20	0.095	40.05	13.7	491	6.2	2.5	63.9	1.6	13.2	0.7
	ZnC	24.88	0.204	0.26	52.0	172	8.0	61.7	4.7	72.7	52.6	10.7
	PbC	1.05	0.071	63.86	4.3	662	3.6	0.9	48.6	0.2	8.5	0.2
	PbM	1.15	0.118	18.36	22.2	335	8.6	1.6	15.3	1.4	4.7	0.5
lime 1500g/t	Feed	100	0.082	1.39	18.2	82	18.9	100	100	100	100	100
	BRC	33.88	0.165	3.12	41.3	174	8.8	68.1	75.9	76.8	71.7	15.8
	Tail	66.12	0.040	0.15	6.4	35	24.1	31.9	24.1	23.2	28.3	84.2
	BC	26.65	0.190	2.65	48.4	194	7.8	62.0	50.7	70.7	62.7	11.1
	BM	7.23	0.070	4.87	15.3	103	12.4	6.1	25.2	6.1	9.0	4.7
	PbRC	1.91	0.111	33.96	14.6	474	6.8	2.5	46.6	1.5	11.0	0.7
	ZnC	24.74	0.197	0.23	51.0	172	7.9	59.5	4.1	69.2	51.7	10.4
	PbC	0.77	0.090	56.64	4.9	684	3.9	0.8	31.3	0.2	6.4	0.2
	PbM	1.14	0.125	18.67	21.1	332	8.7	1.7	15.3	1.3	4.6	0.5
lime 2500g/t	Feed	100	0.082	1.33	18.7	82	18.4	100	100	100	100	100
	BRC	33.19	0.172	2.57	42.6	173	9.1	69.2	64.2	75.6	70.2	16.4
	Tail	66.81	0.038	0.71	6.8	36	23.0	30.8	35.8	24.4	29.8	83.6
	BC	25.78	0.198	2.11	50.5	194	7.9	61.9	40.9	69.6	61.2	11.2
	BM	7.41	0.081	4.16	15.1	99	13.0	7.3	23.3	6.0	9.0	5.2
	PbRC	1.78	0.130	27.16	16.0	448	6.5	2.8	37.1	1.5	9.8	0.7
	ZnC	24.00	0.203	0.21	53.0	175	8.0	59.1	3.8	68.1	51.4	10.5
	PbC	0.69	0.119	48.71	6.6	623	4.0	1.0	25.4	0.2	5.3	0.2
	PbM	1.09	0.137	14.30	22.0	336	8.1	1.8	11.7	1.3	4.5	0.5

The results of preliminary mill tests are summarized as follows;

Recovery of lead:

(1) Charging 80 g/t of collector performed 18.3% higher recovery than in the case of 60 g/t. As for the charging quantity of collector, 60 g/t is not enough.

(2) Charging 300 g/t of copper sulphate as for the activator performed 20.0% higher recovery than in the case of 200 g/t. It is considered that since the test is bulk flotation treating with a lot of floating zinc, co-existing lead with zinc which are floating together with.

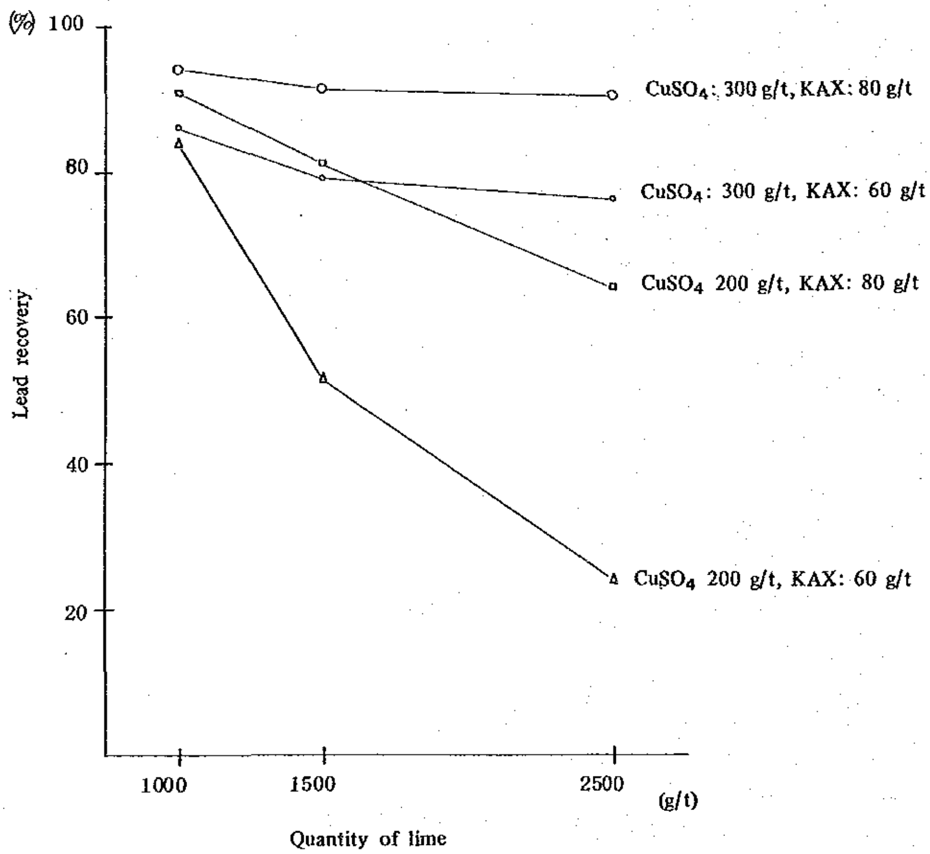

Fig. 11 Relationship between quantity of lime and Lead recovery

(3) Regarding to the charging quantity of lime, when the quantity of lime is increased, the recovery tends to be inversely reduced.
The relationship of charging quantity of lime and lead recovery is shown in Fig. 11 which indicates the above-mentioned tendency clearly.

Recovery of zinc:

(1) Quantity of collector should be 80 g/t or more. 60 g/t is not enough.

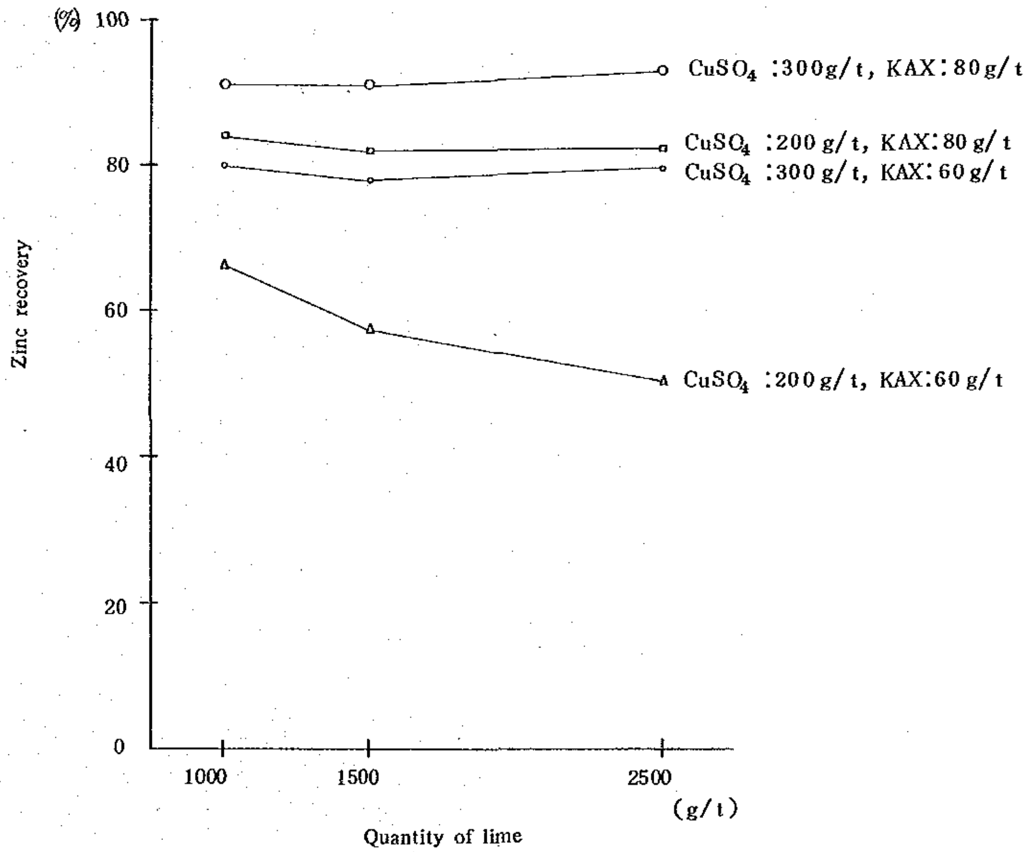

Fig. 12 Relationship between quantity of lime and zinc recovery

(2) Quantity of copper sulphate as for the activator should be more than 300 g/t. 200 g/t is not enough to make good activation.

(3) The relationship between the charging quantity of lime and the zinc recovery is shown in Fig. 12. Compared with the case of lead, fluctuation is very small.

Recovery of silver:

Similar to the cases of lead and zinc, a bigger charging quantity of KAX and copper sulphate performs better recovery. On the contrary, a bigger quantity of lime, the recovery becomes lower.

In conclusion, as for the suitable charging quantity of the reagents, it has been settled as the following combination:

Lime	1,000 g/t
Copper sulphate	300 g/t
KAX	80 g/t
Frother	MIBC 40 g/t + Pine oil 20 g/t

The results of the tests under the abovementioned reagents are as shown in Table 20 or Table 15, Test No.8-1.

7-2 Straight differential flotation

By studying the test results as shown in Table 15, it becomes clear that, in the case of bulk differential flotation, the lead recovery becomes considerably lower at the stage of bulk cleaning flotation which creates a big problem, since this matter makes it difficult to adopt the bulk differential flotation. In regard to the next trial, the tests of straight differential flotation have been carried out.

Based on the results of the bulk differential flotation tests and some of the preliminary tests, the flotation conditions and the flowsheet of the tests are settled as shown in Fig.13.

The results of the tests and the comparison of each test under the different conditions are shown in Table 17, 18 and 19, respectively.

TAB. 17 Reagent conditions of straight differential flotation

Test No.	Reagent condition		
	Lead flotation		Zinc flotation
	$Ca(OH)_2$	NaCN	$Ca(OH)_2$
	g/t	g/t	g/t
8－21	150	50	1000
8－22	150	50	1800
8－23	150	70	1000
8－24	150	70	1800
8－25	250	50	1000
8－26	250	50	1800
8－27	250	70	1000
8－28	250	70	1800

N.B. Other flotation conditions are shown in the flowsheet Fig. 13

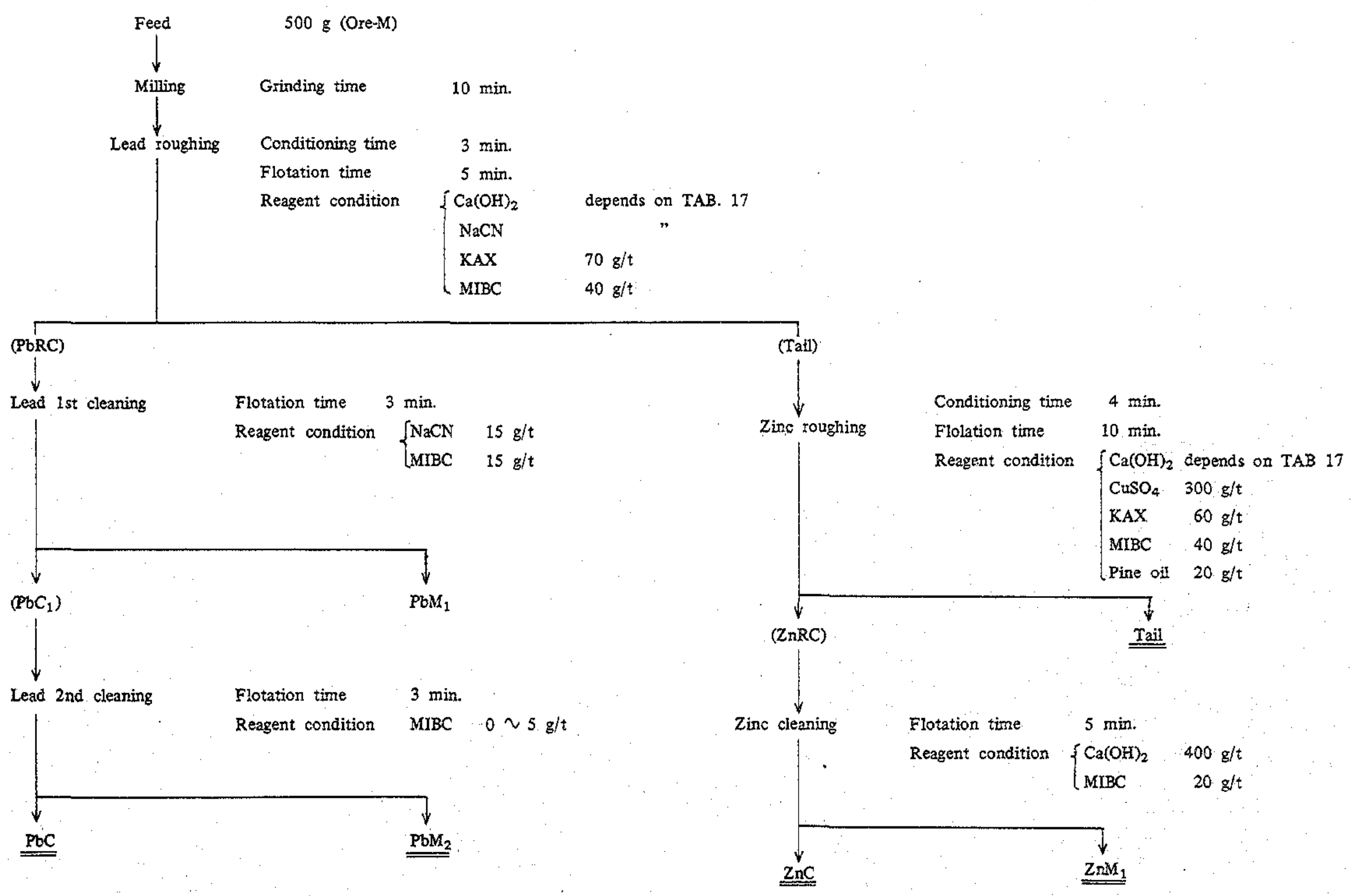

Fig. 13 Flowsheet of straight differential flotation test

TAB. 19 Comparison of the results of straight differential flotation tests

(1. Influence of line on the lead roughing)

Quantity of lime	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
lime 150 g/t	Feed	100	0.092	1.4	19.0	85	18.7	100	100	100	100	100
	PbRC	7.87	0.112	15.3	9.3	307	9.0	9.7	89.2	3.9	28.3	3.8
	tail	92.13	0.090	0.2	19.9	67	19.5	90.3	10.8	96.1	71.7	96.2
	ZnRC	35.53	0.184	0.2	48.9	142	8.4	70.8	5.9	91.3	59.1	16.1
	Tail	56.60	0.032	0.1	1.6	19	26.5	19.5	4.9	4.8	12.6	80.1
	ZnC	29.65	0.208	0.2	54.3	158	7.2	66.9	4.2	84.6	54.8	11.5
	ZnM$_1$	5.88	0.061	0.4	21.6	62	14.6	3.9	1.7	6.7	4.3	4.6
	PbC$_1$	2.47	0.147	44.0	5.4	676	6.7	4.0	80.3	0.7	19.6	0.9
	PbM$_1$	5.40	0.097	2.2	11.1	138	10.1	5.7	8.9	3.2	8.7	2.9
	PbC	1.59	0.149	61.2	3.8	860	4.8	2.6	71.9	0.3	16.0	0.4
	PbM$_2$	0.88	0.143	12.9	8.3	346	10.2	1.4	8.4	0.4	3.6	0.5
lime 250 g/t	Feed	100	0.092	1.4	19.5	86	19.6	100	100	100	100	100
	PbRC	7.57	0.106	16.0	10.2	315	9.9	8.8	89.4	3.9	27.8	3.8
	tail	92.43	0.091	0.2	20.2	67	20.4	91.2	10.6	96.1	72.2	96.2
	ZnRC	36.57	0.186	0.2	48.6	142	9.5	74.2	6.0	91.4	60.8	17.7
	Tail	55.86	0.028	0.1	1.6	18	27.5	17.1	4.6	4.7	11.4	78.5
	ZnC	30.30	0.210	0.2	54.8	160	8.3	69.2	4.3	85.4	56.7	12.8
	ZnM$_1$	6.27	0.072	0.4	18.6	57	15.3	4.9	1.7	6.0	4.1	4.9
	PbC$_1$	2.39	0.132	46.6	5.7	707	7.2	3.5	82.2	0.6	19.7	0.9
	PbM$_1$	5.18	0.094	1.9	12.3	135	11.1	5.3	7.2	3.3	8.1	2.9
	PbC	1.63	0.127	61.8	4.1	851	5.4	2.3	74.3	0.3	16.2	0.5
	PbM$_2$	0.76	0.142	14.0	8.9	399	11.1	1.2	7.9	0.3	3.5	0.4

TAB. 19 Comparison of the results of straight differential flotation tests
(2. Influence of NaCN on the lead flotation)

Quantity of NaCN	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
NaCN 50 g/t	Feed	100	0.092	1.4	18.8	85	18.8	100	100	100	100	100
	PbRC	6.90	0.113	17.6	9.5	339	9.3	8.5	88.7	3.4	27.4	3.4
	tail	93.10	0.090	0.2	19.5	66	20.0	91.5	11.3	96.6	72.6	96.6
	ZnRC	35.41	0.195	0.2	48.8	144	8.8	75.1	6.1	91.8	59.7	16.6
	Tail	57.69	0.026	0.1	1.6	19	26.1	16.4	5.2	4.8	12.9	80.0
	ZnC	29.46	0.217	0.2	54.3	159	7.6	69.6	4.3	85.0	55.0	11.9
	ZnM_1	5.95	0.085	0.4	21.4	67	14.8	5.5	1.8	6.8	4.7	4.7
	PbC_1	2.49	0.138	45.5	5.6	698	6.9	3.7	82.6	0.7	20.3	0.9
	PbM_1	4.41	0.099	1.9	11.7	137	10.6	4.8	6.1	2.7	7.1	2.5
	PbC	1.66	0.136	61.5	3.9	852	4.9	2.4	74.3	0.3	16.5	0.4
	PbM_2	0.83	0.142	13.7	9.0	391	10.9	1.3	8.3	0.4	3.8	0.5
NaCN 70 g/t	Feed	100	0.092	1.3	19.7	86	19.5	100	100	100	100	100
	PbRC	8.55	0.106	14.1	10.0	288	9.6	9.9	89.9	4.3	28.6	4.1
	tail	91.45	0.091	0.2	20.6	67	20.4	90.1	10.1	95.7	71.4	95.9
	ZnRC	36.69	0.176	0.2	48.8	141	9.1	70.0	5.7	91.1	60.2	17.2
	Tail	54.76	0.034	0.1	1.7	18	27.9	20.1	4.4	4.6	11.2	78.7
	ZnC	30.49	0.202	0.2	54.9	159	7.9	66.7	4.1	85.2	56.4	12.4
	ZnM_1	6.20	0.049	0.3	18.8	52	15.1	3.3	1.6	5.9	3.8	4.8
	PbC_1	2.37	0.141	45.0	5.4	685	7.0	3.7	79.8	0.6	18.9	0.8
	PbM_1	6.18	0.093	2.2	11.7	136	10.6	6.2	10.1	3.7	9.7	3.3
	PbC	1.56	0.140	61.6	4.0	859	5.3	2.4	71.8	0.3	15.6	0.4
	PbM_2	0.81	0.143	13.1	8.2	349	10.3	1.3	8.0	0.3	3.3	0.4

TAB. 19 Comparison of the results of straight differential flotation tests
(3. Influence of lime on the zinc flotation)

Quantity of lime	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
lime 1000g/t	Feed	100	0.095	1.4	19.3	85	19.2	100	100	100	100	100
	PbRC	7.98	0.109	15.3	9.4	304	9.0	9.2	89.8	3.9	28.4	3.7
	tail	92.02	0.093	0.2	20.1	66	20.1	90.8	10.2	96.1	71.6	96.3
	ZnRC	35.97	0.185	0.2	48.9	143	8.9	70.2	5.6	91.2	60.1	16.6
	Tail	56.05	0.035	0.1	1.7	18	27.3	20.6	4.6	4.9	11.5	79.7
	ZnC	29.79	0.209	0.2	54.9	160	7.7	65.8	4.1	84.9	56.0	11.9
	ZnM$_1$	6.18	0.067	0.3	19.8	57	14.8	4.4	1.5	6.3	4.1	4.7
	PbC$_1$	2.59	0.139	43.6	5.4	670	6.6	3.8	82.7	0.7	20.3	0.9
	PbM$_1$	5.39	0.094	1.8	11.4	129	10.1	5.4	7.1	3.2	8.1	2.8
	PbC	1.63	0.138	61.7	3.7	850	4.4	2.4	73.8	0.3	16.2	0.4
	PbM$_2$	0.96	0.142	12.7	8.2	362	10.3	1.4	8.9	0.4	4.1	0.5
lime 1800g/t	Feed	100	0.089	1.3	19.2	86	19.1	100	100	100	100	100
	PbRC	7.48	0.110	16.0	10.1	318	9.9	9.2	89.0	3.9	27.7	3.9
	tail	92.52	0.088	0.2	19.9	67	19.8	90.8	11.0	96.1	72.3	96.1
	ZnRC	36.13	0.186	0.2	48.7	142	9.1	75.0	6.1	91.6	59.8	17.1
	Tail	56.39	0.025	0.1	1.5	19	26.8	15.8	4.9	4.5	12.5	79.0
	ZnC	30.16	0.209	0.2	54.2	158	7.9	70.5	4.3	85.3	55.5	12.4
	ZnM$_1$	5.97	0.067	0.4	20.4	62	15.1	4.5	1.9	6.3	4.3	4.7
	PbC$_1$	2.28	0.140	47.2	5.7	716	7.4	3.6	80.0	0.6	19.0	0.9
	PbM$_1$	5.20	0.097	2.3	12.0	144	11.0	5.6	9.0	3.3	8.7	3.0
	PbC	1.59	0.138	61.3	4.2	861	5.8	2.5	72.6	0.3	15.9	0.5
	PbM$_2$	0.69	0.144	14.4	9.2	382	11.0	1.1	7.4	0.3	3.1	0.4

The results of the straight differential flotation tests are summarized as follows;

(1) Lime quantity for the lead flotation

There are no big difference in the lead and zinc recovery at the stage of rougher flotation.

Quantity of lime	150 g/t	250 g/t
Lead recovery	89.2 %	89.4 %
Zinc recovery	91.3 %	91.4 %

However, it seems to be better to make the charging quantity of lime 250 g/t taking into consideration that the pH at the lead rougher flotation is easy to fluctuate caused by the existing amount of pyrite in the ore.

(2) NaCN quantity for the lead flotation

Compared with the case of 50 g/t, 70 g/t performs a little better recovery of lead and silver at the stage of rougher flotation.

Quantity of NaCN	50 g/t	70 g/t
Lead recovery	88.7 %	89.9 %
Zinc recovery	27.4 %	28.6 %

Therefore, 70 g/t is adopted for the charging quantity of NaCN.

(3) Lime quantity for the zinc flotation

There are no big differences in the zinc and silver recovery at the stage of rougher flotation.

Quantity of lime	1,000 g/t	1,800 g/t
Lead recovery	91.2 %	91.6 %
Zinc recovery	60.1 %	59.8 %

It seems to be good enough to charge 1,000 g/t of lime since the pH becomes more than 11 and the including amount of pyrite is quite stable.

In conclusion, as for the suitable charging quantity of the reagents, it has been settled as the following combination.

For lead flotation	$Ca(OH)_2$	250 g/t
	NaCN	70
	KAX	70
	MIBC	40
For zinc flotation	$Ca(OH)_2$	1,000 g/t
	$CuSO_4$	300
	KAX	60
	MIBC	40
	Pine oil	20

The results of the tests under the abovementioned reagents are shown as in Table 20 or Table 18, Test No.8-27.

7-3 Comparison of both flotation methods

Table 20 shown compares the test results resulting from bulk differential flotation with the results by straight differential flotation, under each settled condition.

Main items of Table 20 are digested as follows;

Item	Straight differential flotation (A)	Bulk differential flotation (B)	difference (A-B)
Rougher flotation,			
Recovery of lead	90.8 %	94.0 %	-3.2 %
Recovery of zinc	91.6 %	90.8 %	+0.8 %
Recovery of lead at lead conc.	71.6 %	44.9 %	+26.7 %
Recovery of zinc at zinc conc.	86.8 %	83.4 %	+3.4 %
Lead content at lead conc.	63.0 %	59.9 %	+3.1 %
Zinc content at zinc conc.	55.2 %	54.4 %	+0.8 %

At the rougher flotation stage, there is not such a big difference in the recoveries in each method.

At the separation stage, for zinc, the recoveries are more or less the same, but for lead, the recovery of straight differential flotation is much better (26.7 %) than bulk differential flotation.

Concerning the total flotation time and the quantity of charging reagents, there is no big difference between both methods.

And also, it will be pointed out as a merit that if the suitable conditions for the straight differential flotation could be known, it will be also applicable for the bulk differential flotation.

As the conclusion, for the ISCAYCRUZ ore, the straight differential flotation method should be adopted.

Additionally, 60 % of the silver is recovered in zinc concentrate in both methods. This matter seems to be very peculiar.

TAB. 20 **Comparison between the bulk differential flotation system and the straight differential flotation system**

Flotation system	Product	Weight	grade					recovery					remark
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe	
		%	%	%	%	g/t	%	%	%	%	%	%	
bulk differential flotation	Feed	100	0.082	1.41	18.2	79	17.9	100	100	100	100	100	refer to Fig. 10
	BRC	38.90	0.174	3.42	42.3	174	9.3	82.2	94.0	90.8	85.4	20.2	bulk flotation NaCN 20g/t
	Tail	61.10	0.024	0.14	2.7	19	23.4	17.8	6.0	9.2	14.6	79.8	$Ca(OH)_2$ 1000g/t
	BC	30.28	0.209	2.89	51.3	198	8.3	77.1	61.9	85.6	75.4	14.1	$CuSO_4$ 300g/t
	BM	8.62	0.049	5.26	10.9	92	12.7	5.1	32.1	5.2	10.0	6.1	KAX 80g/t
	PbRC	2.47	0.145	33.44	16.3	476	5.8	4.3	58.4	2.2	14.9	0.8	MIBC 40g/t
	ZnC	27.81	0.215	0.18	54.4	173	8.6	72.8	3.5	83.4	60.5	13.3	Pine oil 20g/t
	PbC	1.06	0.120	59.85	4.8	701	3.4	1.5	44.9	0.3	9.4	0.2	differential flotation NaCN 300g/t
	PbM	1.41	0.163	13.58	25.0	307	7.6	2.8	13.5	1.9	5.5	0.6	MIBC 20g/t
straight differential flotation	Feed	100	0.088	1.31	20.1	80	19.9	100	100	100	100	100	refer to Fig. 13
	PbRC	8.86	0.103	13.45	10.5	273	10.3	10.3	90.8	4.7	30.1	4.6	lead flotation $Ca(OH)_2$ 250g/t
	tail	91.14	0.087	0.13	21.0	62	20.8	89.7	9.2	95.3	69.9	95.4	NaCN 70g/t
	ZnRC	37.35	0.184	0.18	49.3	130	9.8	78.1	5.1	91.6	60.5	18.3	KAX 70g/t
	Tail	53.79	0.019	0.10	1.4	14	28.5	11.6	4.1	3.7	9.4	77.1	MIBC 40g/t
	ZnC	31.42	0.205	0.16	55.2	146	8.6	74.1	3.8	86.8	57.2	13.6	zinc flotation $Ca(OH)_2$ 1000g/t
	ZnM_1	5.93	0.059	0.29	16.1	45	15.8	4.0	1.3	4.8	3.3	4.7	$CuSO_4$ 300g/t
	PbC_1	2.22	0.141	47.17	5.4	706	7.3	3.5	79.8	0.6	19.5	0.8	KAX 60g/t
	PbM_1	6.64	0.090	2.17	12.3	128	11.3	6.8	11.0	4.1	10.6	3.8	MIBC 40g/t
	PbC_2	1.49	0.133	63.04	3.7	858	5.1	2.2	71.6	0.3	15.9	0.4	Pine oil 20g/t
	PbM_2	0.73	0.157	14.78	8.8	397	11.9	1.3	8.2	0.3	3.6	0.4	

8. ADDITIONAL TESTS OF THE STRAIGHT DIFFERENTIAL FLOTATION

8. Additional tests of the straight differential flotation

8-1 Reagents test

As mentioned above, it becomes clear that the lead content of the lead concentrate and the recovery of the lead are considerably improved by the adoption of the straight differential flotation method.

Generally, silver used to be recovered in lead concentrate, however, in the case of the ISCAYCRUZ ore, the major part of silver goes into zinc concentrate and only about 15 % of silver is recovered in lead concentrate.

The reasons of this peculiar matter seem to be caused by the negative effects of sodium cyanide and lime. And it will be expected to improve by means of some collector, such as ACC #208, which will be good for the recovery of silver at the lead concentrate.

Therefore, in order to improve the recovery of silver in the lead concentrate, additional tests have been carried out according to the flowsheet as shown in Fig. 13.

Reagents	Level
ACC #208	3
Soda ash	2
Zinc sulphate	2

The conditions of flotation of the tests are as shown in Table 21, and the results of the tests are shown in Table 22 and 23.

TAB. 21 Reagent conditions of additional test of straight differential flotation

Test No.	reagent condition									
	lead flotation						zinc flotation			
	$Ca(OH)_2$	Na_2CO_3	KAX	#208	NaCN	$ZnSO_4$	$Ca(OH)_2$	Na_2CO_3	KAX	#208
	g/t	g/t	g/t	g/t	g/t	g/t	g/t	g/t	g/t	g/t
No.9－1	150	200	70	−	70	−	500	1000	60	−
No.9－2	250	−	70	−	70	−	1000	−	60	−
No.9－3	150	200	50	20	70	−	500	1000	40	20
No.9－4	250	−	50	20	70	−	1000	−	40	20
No.9－5	150	200	40	30	70	−	500	1000	30	30
No.9－6	250	−	40	30	70	−	1000	−	30	30
No.9－7	250	−	70	−	50	30	1000	−	60	−

TAB. 23 Comparison of the results of additional tests of straight differential flotation (1. Influence of ACC#208)

Quantity of collector	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
KAX only lead flotation 70g/t zinc flotation 60g/t	Feed	100	0.088	1.29	19.0	83	18.4	100	100	100	100	100
	PbRC	8.62	0.106	13.54	9.6	291	9.5	10.3	90.1	4.4	30.1	4.5
	tail	91.38	0.087	0.14	19.9	64	19.2	89.7	9.9	95.6	69.9	95.5
	ZnRC	31.93	0.190	0.18	48.5	138	8.6	68.5	4.4	81.4	52.9	15.0
	Tail	59.45	0.032	0.12	4.6	24	24.9	21.2	5.5	14.2	17.0	80.5
	ZnC	24.31	0.212	0.15	54.4	155	7.7	58.3	2.8	69.5	45.4	10.2
	ZnM_1	7.62	0.118	0.27	29.7	81	11.5	10.2	1.6	11.9	7.5	4.8
	PbC_1	2.93	0.136	37.24	5.5	636	7.4	4.5	84.3	0.9	22.4	1.2
	PbM_1	5.69	0.090	1.33	11.7	113	10.6	5.8	5.8	3.5	7.7	3.3
	PbC	1.67	0.141	56.77	3.3	867	5.2	2.7	73.2	0.3	17.4	0.5
	PbM_2	1.26	0.129	11.36	8.5	330	10.3	1.8	11.1	0.6	5.0	0.7
KAX/#208 lead flotation 50g/t/20g/t zinc flotation 40/20	Feed	100	0.078	1.31	18.5	86	18.9	100	100	100	100	100
	PbRC	9.98	0.100	11.88	9.3	264	10.4	12.7	90.3	5.1	30.6	5.5
	tail	90.02	0.076	0.14	19.5	66	19.8	87.3	9.7	94.9	69.4	94.5
	ZnRC	33.31	0.161	0.17	46.2	138	8.5	68.4	4.3	83.4	53.5	15.0
	Tail	56.71	0.026	0.12	3.8	24	26.4	18.9	5.4	11.5	15.9	79.5
	ZnC	25.02	0.180	0.14	52.4	160	7.6	57.5	2.7	71.0	46.4	10.1
	ZnM_1	8.29	0.103	0.25	27.5	73	11.2	10.9	1.6	12.4	7.1	4.9
	PbC_1	3.28	0.107	33.87	5.6	583	8.3	4.5	84.6	1.0	22.2	1.4
	PbM_1	6.70	0.096	1.12	11.2	108	11.5	8.2	5.7	4.1	8.4	4.1
	PbC	1.77	0.086	55.12	4.2	845	6.9	1.9	74.3	0.4	17.4	0.6
	PbM_2	1.51	0.133	8.96	7.3	276	9.9	2.6	10.3	0.6	4.8	0.8
KAX/#208 lead flotation 40g/t/30g/t zinc flotation 30/30	Feed	100	0.075	1.31	18.4	86	19.2	100	100	100	100	100
	PbRC	10.40	0.104	11.51	10.1	273	10.1	14.3	91.3	5.8	32.9	5.4
	tail	89.60	0.072	0.13	19.4	64	20.3	85.7	8.7	94.2	67.1	94.6
	ZnRC	34.70	0.149	0.13	44.3	132	9.1	68.9	3.4	83.3	53.4	16.4
	Tail	54.90	0.023	0.13	3.7	21	27.4	16.8	5.3	10.9	13.7	78.2
	ZnC	24.83	0.181	0.10	53.7	160	7.9	59.8	1.9	72.2	46.2	10.2
	ZnM_1	9.87	0.070	0.19	20.8	63	12.0	9.1	1.5	11.1	7.2	6.2
	PbC_1	2.89	0.124	37.81	6.0	672	6.9	4.7	83.3	1.0	22.5	1.0
	PbM_1	7.51	0.096	1.40	11.7	120	11.3	9.6	8.0	4.8	10.4	4.4
	PbC	1.92	0.124	54.32	4.7	895	6.1	3.1	79.4	0.5	19.9	0.6
	PbM_2	0.97	0.126	5.22	8.7	231	8.4	1.6	3.9	0.5	2.6	0.4

TAB. 23 Comparison of the results of the additional tests of straight differential flotation (2. Influence of soda ash)

Test condition	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
lime only	Feed	100	0.078	1.35	19.0	85	18.5	100	100	100	100	100
	PbRC	9.55	0.102	12.82	9.7	273	9.7	12.4	90.5	4.9	30.4	5.0
	tail	90.45	0.076	0.14	20.0	66	19.4	87.6	9.5	95.1	69.6	95.0
	ZnRC	35.37	0.163	0.17	46.8	135	9.0	73.8	4.6	87.2	56.1	17.2
	Tail	55.08	0.020	0.12	2.7	21	26.1	13.8	4.9	7.9	13.5	77.8
	ZnC	26.40	0.189	0.14	53.9	159	7.8	63.8	2.8	75.0	49.3	11.1
	ZnM1	8.97	0.088	0.26	25.8	65	12.6	10.0	1.8	12.2	6.8	6.1
	PbC1	3.09	0.115	37.09	5.7	610	7.1	4.5	84.5	0.9	22.0	1.2
	PbM1	6.46	0.095	1.24	11.6	112	10.9	7.9	6.0	4.0	8.4	3.8
	PbC	1.91	0.106	56.01	4.3	838	5.9	2.6	78.9	0.4	18.7	0.6
	PbM8	1.18	0.128	6.43	8.1	242	9.1	1.9	5.6	0.5	3.3	0.6
with soda ash	Feed	100	0.083	1.26	18.3	85	19.2	100	100	100	100	100
	PbRC	9.78	0.104	11.68	9.7	278	10.3	12.3	90.7	5.2	32.1	5.2
	tail	90.22	0.081	0.13	19.2	64	20.1	87.7	9.3	94.8	67.9	94.8
	ZnRC	31.22	0.169	0.14	45.7	137	8.5	63.6	3.4	78.0	50.4	13.8
	Tail	59.00	0.034	0.13	5.2	25	26.3	24.1	5.9	16.8	17.5	81.0
	ZnC	23.01	0.193	0.12	53.0	158	7.8	53.5	2.1	66.6	42.7	9.3
	ZnM1	8.21	0.103	0.20	25.4	79	10.5	10.1	1.3	11.4	7.7	4.5
	PbC1	2.98	0.130	35.29	5.7	648	8.0	4.7	83.6	1.0	22.8	1.2
	PbM1	6.80	0.093	1.32	11.4	115	11.3	7.6	7.1	4.2	9.3	4.0
	PbC	1.66	0.128	54.59	3.9	907	6.2	2.6	72.2	0.4	17.8	0.5
	PbM8	1.32	0.132	10.92	8.1	319	10.2	2.1	11.4	0.6	5.0	0.7

TAB. 23 Comparison of the results of additional tests of straight differential flotation
(3. Influence of $ZnSO_4$)

Quantity of reagent	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
NaCN only	Feed	100	0.087	1.21	18.7	83	19.0	100	100	100	100	100
NaCN 70 g/t	PbRC	9.27	0.104	11.74	10.4	281	10.0	11.1	90.0	5.2	31.6	4.8
	tail	90.73	0.085	0.13	19.6	62	19.9	88.9	10.0	94.8	68.4	95.2
	ZnRC	27.81	0.188	0.14	50.4	140	8.2	59.9	3.2	74.7	47.0	11.9
	Tail	62.86	0.040	0.13	6.0	28	25.2	29.0	6.8	20.1	21.4	83.3
	ZnC	20.86	0.200	0.12	55.2	152	7.6	47.9	2.1	61.4	38.4	8.3
	ZnM_1	6.95	0.150	0.20	35.8	102	9.9	12.0	1.1	13.3	8.6	3.6
	PbC_1	3.08	0.131	32.88	6.1	627	8.3	4.7	83.7	1.0	23.4	1.3
	PbM_1	6.19	0.090	1.23	12.6	109	10.8	6.4	6.3	4.2	8.2	3.5
	PbC	1.43	0.120	54.46	3.5	922	5.7	2.0	64.4	0.3	16.0	0.4
	PbM_3	1.65	0.140	14.17	8.4	371	10.6	2.7	19.3	0.7	7.4	0.9
with $ZnSO_4$	Feed	100	0.053	1.30	17.64	86	18.48	100	100	100	100	100
NaCN 50 g/t	PbRC	8.64	0.103	13.46	9.92	298	9.08	16.8	89.7	4.9	30.0	4.2
$ZnSO_4$ 30 g/t	tail	91.36	0.048	0.15	18.36	65	19.37	83.2	10.3	95.1	70.0	95.8
	ZnRC	35.75	0.090	0.20	43.52	138	9.12	61.2	5.6	88.2	57.7	17.6
	Tail	55.61	0.021	0.11	2.19	19	25.96	22.0	4.7	6.9	12.3	78.2
	ZnC	28.66	0.100	0.18	49.65	155	7.80	54.1	4.0	80.7	51.7	12.1
	ZnM_1	7.09	0.053	0.30	18.77	73	14.47	7.1	1.6	7.5	6.0	5.5
	PbC_1	2.43	0.130	42.90	5.32	731	6.49	6.0	80.4	0.7	20.7	0.9
	PbM_1	6.21	0.092	1.94	11.72	129	10.10	10.8	9.3	4.2	9.3	3.3
	PbC	1.70	0.136	57.76	4.01	918	5.14	4.4	75.7	0.4	18.2	0.5
	PbM_3	0.73	0.117	8.30	8.39	297	9.62	1.6	4.7	0.3	2.5	0.4

8-1-1 Effect of ACC #208

There is no big difference in the lead and silver recovery even if the quantity of ACC #208 is increased at the lead flotation.

Quantity of ACC #208 KAX / ACC #208 g/t	Lead recovery %	Silver recovery %
70 / 0	90.1	30.1
50 / 20	90.3	30.6
40 / 30	91.4	32.9

At the zinc flotation, the effect of ACC #208 is more or less same as above for silver and zinc recovery.

Quantity of ACC #208 KAX / ACC #208 g/t	Zinc recovery %	Silver recovery %
70 / 0	81.4	52.9
50 / 20	83.4	53.5
40 / 30	83.3	53.4

Therefore, the effect of ACC #208 does not contribute much for the improvement of the silver recovery in lead concentrate and it may not make sense to charge ACC #208 additionally.

8-1-2 Effect of soda ash

Since lime also sometimes depresses the silver minerals, test using soda ash in place of a part of lime have been carried out.

As for the results, in the case of lead flotation, the recovery of silver improved a little (1.7 %), but the recovery of copper, lead and zinc were not improved by means of soda ash. In the case of zinc flotation, the recovery of zinc became considerably lower from 87.2 % to 78.0 %, and the recoveries of silver and copper also went down to 5.7 % and 10.2 % respectively.

So, it is quite obvious that lime only is very much better than soda ash as the depressor and pH ajuster.

8-1-3 Effect of zinc sulphate

In order to prevent too much depression of silver by sodium cyanide, tests using zinc sulphate in place of a part of sodium cyanide have been carried out.

However, the results do not show any improvement of the recovery of the silver.

8-1-4 Summary

In order to improve the recovery of silver to lead concentrate, various tests with several kinds of reagents have been done. However, the results were not effective. The reason why will be stated below in 8-4.

8-2 Number of cleaning stages

As the suitable conditions have been settled abovementioned various tests, the tests in order to get the most adequate number of stages of the cleaning for lead/zinc flotation have been carried out under suitable conditions in the following 2(two) cases:

	Case A	Case B
Lead flotation	3 stages	4 stages
Zinc flotation	2 stages	3 stages

Each case was repeated twice respectively. The test results are as shown in Table 24 and Fig. 14.

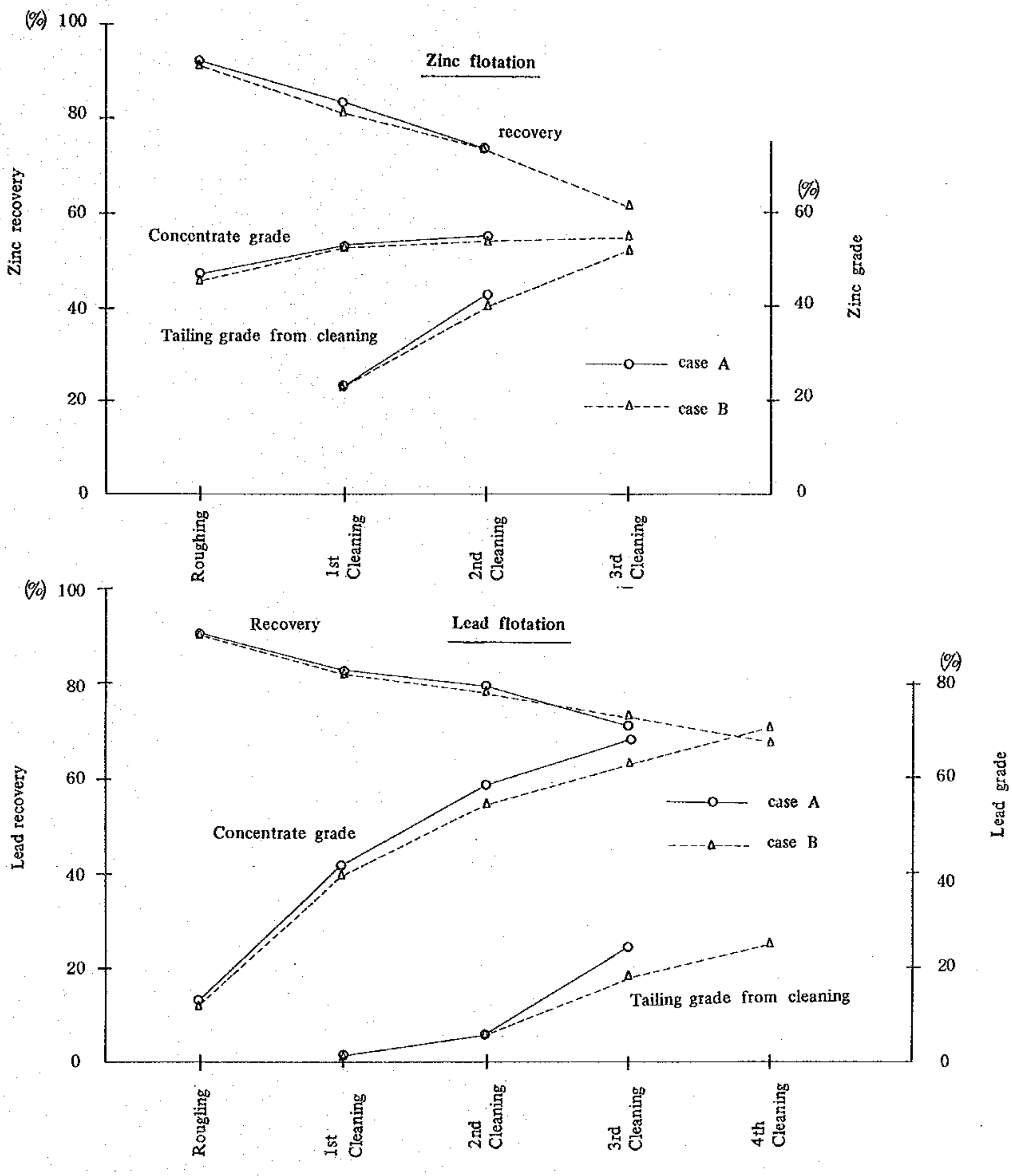

Fig. 14 Influence of the number of cleaning stages on the zinc recovery and the zinc grade of concentrate and tailing from cleaning

From the test results, the following matters are pointed out:

(1) At the lead flotation, the lead content in lead concentrate in every stage reached 58 % at the 2nd stage cleaning, 65 % at the 3rd stage cleaning and 70 % at the 4th stage cleaning. However, lead recovery becomes less than 70 % at the 4th stage cleaning.

Also, in the case of lead cleaning, there is a lesser amount of froth than in zinc cleaning, therefore at least a 3 stage cleaning will be necessary for lead cleaning.

(2) At the zinc flotation, since the zinc content of rougher concentrate goes up to about 45 %, it is easy to get a zinc content of 52 % by only the 1st stage cleaning. Even if the number of cleaning stages is increased, the zinc content does not improve and the zinc recovery gets much worse.

	Zinc content	Zinc recovery
1st stage cleaning	52.0 %	82.0 %
2nd stage cleaning	54.0 %	74.0 %
3rd stage cleaning	55.0 %	62.0 %

Therefore, for zinc 1 stage cleaning is good enough.

(3) In general, in the practical operation, the number of cleaning stages used should be set 1 or 2 more than that of laboratorial batch test. So, it is considered that the necessary number of cleaning stages for lead flotation is 5 and for zinc 3 respectivery.

As stated below in 8-4, since ISCAYCRUZ ore is apt to be middling after grinding because of fine crystallized minerals, the tailing from lead cleaning has to be reground by the primary mill and the tailing from zinc cleaning has to be reground by the mill exclusively settled for this purpose.

8-3 Confirmation test

Confirmation tests have been carried out for Ore-M, Ore-A, Ore-B and Ore-C respectively under the most suitable conditions. The flowsheet is as shown in Fig. 15 and the test results are as shown in Tables 25-29.

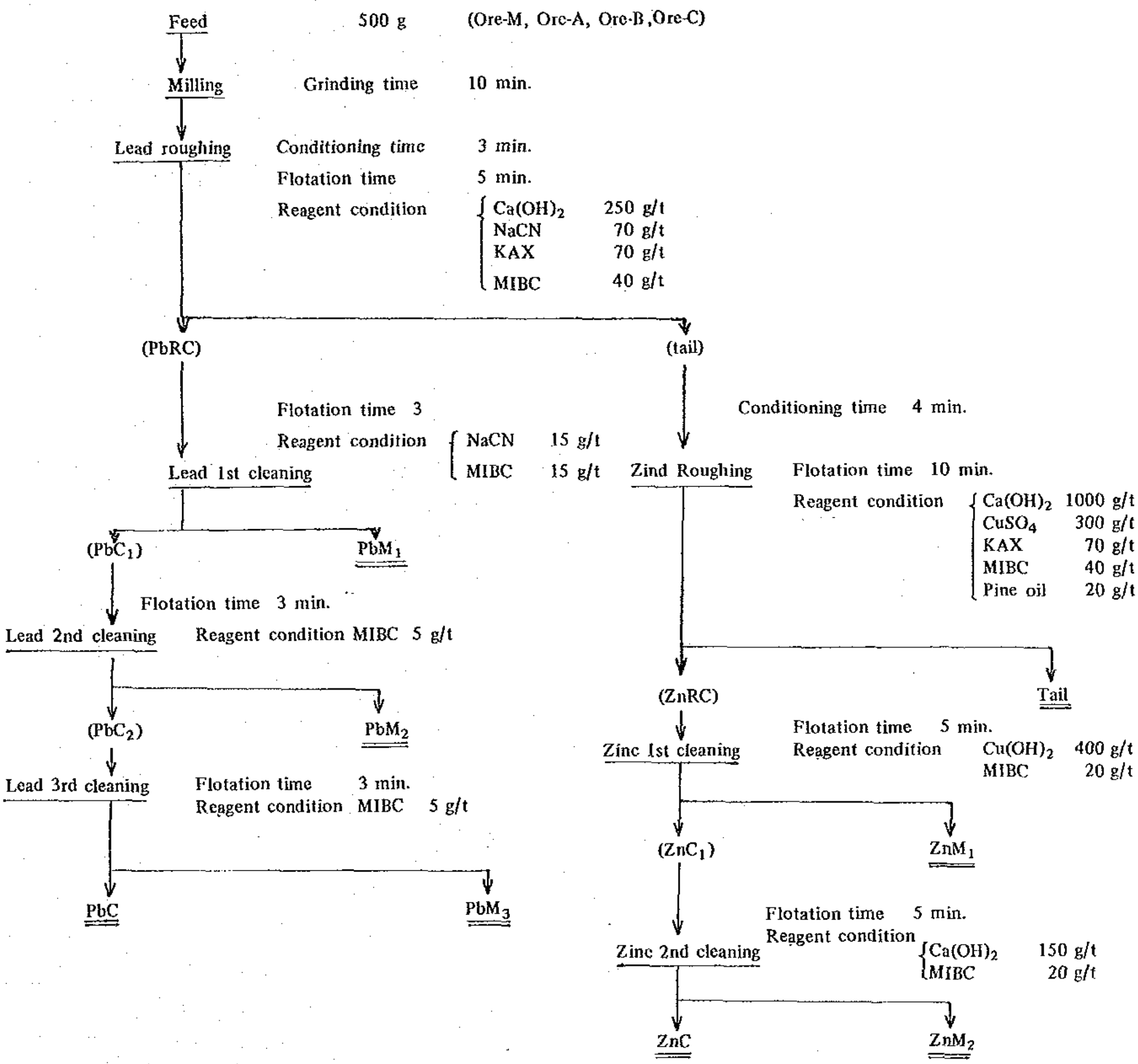

Fig. 15 Flowsheet of Confirmation tests

TAB. 26 The results of confirmation tests (Ore-M, averaged value)

Products	Weight	grade					recovery				
		Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
	%	%	%	%	g/t	%	%	%	%	%	%
Feed	100	0.08	1.4	18.9	86	19.2	100	100	100	100	100
PbRC	9.09	0.10	14.2	10.8	265	9.6	11.9	90.5	5.2	28.0	4.6
tail	90.91	0.08	0.15	19.7	68	20.1	88.1	9.5	94.8	72.0	95.4
ZnRC	38.17	0.16	0.20	45.9	137	9.6	75.4	5.4	92.7	60.9	19.2
Tail	52.74	0.02	0.11	0.74	18	27.7	12.7	4.1	2.1	11.1	76.2
ZnC1	30.17	0.18	0.17	52.2	158	8.0	67.9	3.7	83.4	55.7	12.6
ZnM1	8.00	0.07	0.29	22.1	56	15.7	7.5	1.7	9.3	5.2	6.6
ZnC	25.91	0.18	0.16	53.9	167	7.5	60.3	2.9	73.9	50.4	10.2
ZnM2	4.26	0.14	0.26	42.0	107	10.9	7.6	0.8	9.5	5.3	2.4
PbC1	2.80	0.14	42.4	6.1	582	7.0	4.7	83.3	0.9	19.0	1.0
PbM1	6.29	0.09	1.6	12.9	123	10.8	7.2	7.2	4.3	9.0	3.6
PbC2	2.00	0.15	57.5	5.2	730	6.6	3.8	80.7	0.5	17.0	0.7
PbM2	0.80	0.09	4.5	8.3	212	7.9	0.9	2.6	0.4	2.0	0.3
PbC	1.50	0.16	69.0	3.9	797	4.5	2.9	72.6	0.3	13.9	0.4
PbM3	0.50	0.15	23.2	8.9	530	12.8	0.9	8.1	0.2	3.1	0.3

TAB. 27 The results of confirmation tests (Ore-A, averaged value)

Product	Weight	grade					recovery				
		Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
	%	%	%	%	g/t	%	%	%	%	%	%
Feed	100	0.043	1.4	20.0	155	17.6	100	100	100	100	100
PbRC	9.81	0.072	13.2	10.3	450	12.5	16.4	91.5	5.1	28.6	7.0
tail	82.19	0.040	0.1	21.1	123	18.2	83.6	8.5	94.9	71.4	93.0
ZnRC	31.91	0.045	0.2	46.2	249	8.3	41.5	5.0	92.1	64.2	18.8
Tail	50.28	0.036	0.1	1.1	22	26.1	42.1	3.5	2.8	7.2	74.2
ZnC1	24.77	0.047	0.1	51.6	280	6.9	35.8	3.3	84.5	59.3	12.9
ZnM1	7.14	0.034	0.3	21.2	105	14.6	5.7	1.7	7.6	4.9	5.9
ZnC	28.09	0.047	0.1	53.6	299	6.3	30.8	2.4	75.2	54.2	10.0
ZnM8	4.68	0.046	0.3	39.7	168	10.8	5.0	0.9	9.3	5.1	2.9
PbC1	3.12	0.113	37.9	5.7	796	12.1	8.1	83.3	0.9	16.1	2.2
PbM1	6.69	0.053	1.7	12.4	289	12.7	8.3	8.2	4.2	12.5	4.8
PbC8	1.99	0.119	53.6	3.9	1084	10.3	5.5	75.2	0.4	14.0	1.2
PbM8	1.13	0.101	10.2	8.9	286	15.2	2.6	8.1	0.5	2.1	1.0
PbC	1.23	0.112	67.8	2.0	1198	4.1	3.2	58.9	0.1	9.6	0.3
PbM8	0.76	0.132	30.5	7.0	897	20.6	2.3	16.3	0.3	4.4	0.9

TAB. 28 The results of confirmation tests (Ore-B, averaged value)

Product	Weight	grade					recovery				
		Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
	%	%	%	%	g/t	%	%	%	%	%	%
Feed	100	0.106	1.6	18.8	117	18.5	100	100	100	100	100
PbRC	8.48	0.148	17.3	8.6	219	8.7	11.8	91.2	3.9	15.9	4.1
tail	91.52	0.102	0.2	19.7	107	19.3	88.2	8.8	96.1	84.1	95.9
ZnRC	36.64	0.203	0.2	47.9	241	9.3	70.1	4.7	93.4	75.6	18.4
Tail	54.88	0.035	0.1	0.9	18	26.1	18.1	4.1	2.7	8.5	77.5
ZnC_1	31.19	0.218	0.2	53.1	271	8.4	64.3	3.4	88.2	72.5	14.2
ZnM_1	5.45	0.114	0.4	18.0	66	14.2	5.8	1.3	5.2	3.1	4.2
ZnC	24.51	0.212	0.2	54.4	309	8.1	49.2	2.6	71.1	64.9	10.8
ZnM_2	6.68	0.241	0.2	48.2	132	9.5	15.1	0.8	17.1	7.6	3.4
PbC_1	2.88	0.208	47.3	4.8	452	7.3	5.6	84.8	0.7	11.1	1.2
PbM_1	5.60	0.118	1.8	10.6	99	9.5	6.2	6.4	3.2	4.8	2.9
PbC_2	2.03	0.210	62.3	3.7	543	6.0	4.0	78.8	0.4	9.4	0.7
PbM_2	0.85	0.202	11.3	7.5	235	10.5	1.6	6.0	0.3	1.7	0.5
PbC	1.53	0.194	71.1	2.3	557	3.2	2.8	67.9	0.2	7.3	0.3
PbM_3	0.50	0.258	35.2	8.1	498	14.7	1.2	10.9	0.2	2.1	0.4

TAB. 29 The results of confirmation tests (Ore-C, averaged value)

Product	Weight	grade					recovery				
		Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
	%	%	%	%	g/t	%	%	%	%	%	%
Feed	100	0.068	0.11	19.8	18	21.6	100	100	100	100	100
PbRC	7.44	0.093	0.48	13.2	18	12.3	10.2	33.7	5.0	7.6	4.2
tail	92.56	0.066	0.08	20.4	18	22.4	89.8	66.3	95.0	92.4	95.8
ZnRC	35.37	0.160	0.05	51.8	27	6.6	83.1	17.9	92.5	52.7	10.8
Tail	57.19	0.008	0.09	0.9	13	32.1	6.7	48.7	2.5	39.7	85.0
ZnC_1	28.99	0.182	0.05	58.9	29	4.6	77.3	13.7	86.1	46.9	6.1
ZnM_1	6.38	0.062	0.07	19.7	16	16.1	5.8	4.2	6.4	5.8	4.7
ZnC	25.22	0.190	0.05	60.7	30	4.0	70.5	11.9	77.1	42.0	4.6
ZnM_2	3.77	0.123	0.05	47.2	23	8.3	6.8	1.8	9.0	4.9	1.5
PbC_1	0.75	0.083	2.87	5.1	35	4.8	0.9	20.2	0.2	1.5	0.2
PbM_1	6.69	0.094	0.21	14.1	16	13.1	9.3	13.5	4.8	6.1	4.0
PbC_2	0.33	0.084	5.76	3.5	54	2.3	0.4	17.9	0.1	1.0	0.0
PbM_2	0.42	0.081	0.59	6.4	20	6.8	0.5	2.3	0.1	0.5	0.2
PbC	0.18	0.094	9.21	3.9	79	1.8	0.2	15.6	0.1	0.8	0.0
PbM_3	0.15	0.073	1.63	3.1	24	2.9	0.2	2.3	0.0	0.2	0.0

Based on the confirmation test results for Ore-M, the operational performances of flotation for Ore-M are estimated as follows:

- Lead concentrate:

  When the lead content of lead concentrate is 69.0 %, the recovery of lead will be;

	From lead concentrate of 3rd stage cleaning	72.6 %
+)	From tailing of lead cleaning (7.2+2.6+8.1)%x0.5=	9.0 %
	Total lead recovery	81.6 %

  And in the case of a lead content of 65.0 %, the recovery of lead is estimated as;

  81.6+(72.6-80.7)x(65.0-69.0)/(69.0-57.5)=84.4 %

  On the other hand, compared with zinc flotation, lead flotation is a little harder to obtain similar results of tests. So, it will be better to consider a safety factor of 95 % and set the estimated lead recovery as

  84.4 % x 0.95 = 80.0 %

  with a lead content of 65 %.

- Zinc concentrate:

  When the zinc content of zinc concentrate is 52.2 %, the recovery of zinc will be;

	From zinc concentrate of 1st stage cleaning	83.4 %
	From tailing of lead cleaning (4.3+0.4+0.2)%x0.7x0.834=	2.9 %
+)	From tailing of zinc cleaning 9.3%x0.5 =	4.7 %
	Total zinc recovery	91.0 %

  Since the operation of zinc flotation is comparatively more stable than lead flotation, it is able to adopt 91.0 % for the recovery of zinc with a zinc content of 52 %.

  The estimated performances of the flotation for Ore-M are summarized as the following in Table 30.

TAB. 30 The estimated performances of the flotation for Ore-M

Product	Weight	grade					recovery				
		Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
	%	%	%	%	g/t	%	%	%	%	%	%
Feed	100	0.08	1.4	18.9	86	19.2	100	100	100	100	100
Lead conc.	1.7	0.16	65	4.4	774	5.2	3.4	80	0.4	15.5	0.5
Zinc conc.	33.1	0.17	0.18	52	153	8.6	70.3	4.3	91	58.9	14.8
Tailing	65.2	0.03	0.34	2.5	34	24.9	26.3	15.7	8.6	25.6	84.7

(2) Based on the confirmation test results for Ore-A, Ore-B and Ore-C, the operational performances of flotation for each ore are estimated respectively as follows:

Ore-A: With a lead content of lead concentrate of 65 %, the recovery of lead is estimated as 75 %.
For zinc, the recovery is estimated as 91 % when the zinc content of zinc concentrate is 52 %.
Totally, more or less the same as in the case of Ore-M.

Ore-B: With a lead content of lead concentrate of 65 %, the recovery of lead is estimated as 83 %.
For zinc, the recovery is estimated as 94 % when the zinc content of zinc concentrate is 52 %.
This expected value of zinc recovery is very much better than in the case of Ore-M.

Ore-C: Since the lead grade of the crude ore is very low as 0.11 %, it seems to be difficult to recover the lead concentrate.
Therefore, for Ore-C, only zinc flotation will be applied.

Regarding zinc, the good performance of a zinc recovery of 98 % with a zinc content of 52 % is expected.

(3) From abovementioned estimations, the performance of mill operation with expected grades of crude ore can be estimated as the following in Table 31.

TAB. 31 The estimated performances of mill operation with expected grade

Product	Weight	grade				recovery			
		Cu	Pb	Zn	Ag	Cu	Pb	Zn	Ag
	%	%	%	%	g/t	%	%	%	%
Feed	100	0.10	1.61	15.9	35	100	100	100	100
Lead conc.	2.0	0.20	.65	4.0	265	4.0	80	0.5	15
Zinc conc.	26.9	0.26	0.26	52	75	70.5	4.3	88	58
Tailing	71.1	0.04	0.36	2.6	13	25.5	15.7	11.5	27

(4) The results of complete analysis for crude ore, lead concentrate, zinc concentrate and tailing are as follows in Table 32.

TAB. 32 The results of complete analysis of crude ore, lead/zinc concentrates and tailing

Components	Ore-M	Ore-A	Ore-B	Ore-C	Pb Conc.	Zn Conc.	Tailing
Ag (g/t)	80	180	83	16	770	150	17
Cu (%)	0.08	0.04	0.11	0.06	0.15	0.22	0.02
Pb (〃)	1.3	1.3	1.5	0.1	70.8	0.16	0.10
Zn (〃)	20.5	20.8	19.9	20.1	3.6	55.8	0.74
Cd (〃)	0.03	0.03	0.04	0.03	<0.01	0.10	<0.01
Sn (〃)	<0.005	<0.005	<0.005	<0.005	0.006	<0.005	<0.005
Fe (〃)	20.2	19.4	19.8	23.3	4.6	7.7	28.6
Sb (〃)	<0.001	<0.001	<0.001	<0.001	0.043	<0.001	<0.001
As (〃)	0.04	0.12	0.06	0.02	0.05	0.02	0.08
Bi (〃)	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.001
Hg (g/t)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ga (%)	0.004	0.001	0.008	0.001	<0.001	0.017	<0.001
Mn (〃)	0.12	0.10	0.12	0.13	0.02	0.05	0.13
T-S (〃)	30.8	31.2	30.6	35.4	17.6	33.1	33.0
SiO_2 (〃)	13.6	14.9	12.0	9.1	1.0	1.4	18.9
Al_2O_3 (〃)	2.0	1.5	1.9	1.5	0.30	0.11	2.5
CaO (〃)	4.2	3.9	5.6	2.9	0.58	0.04	5.6
MgO (〃)	2.1	1.8	2.5	1.5	0.25	0.03	2.5
LOI (〃)	5.8	5.1	6.0	7.7	-2.3	0.14	5.0

N.B. 1) Lead/zinc concentrate and tailing are the products of flotation for Ore-M under the most suitable conditions.

2) Lead conc. is the product of three stage cleaning and zinc conc. is of two stage cleaning.

3) "LOI" means "loss of ignition".

8-4 Studies for silver minerals

The results of various mill tests show very peculiar matter in that the major part of silver is not get into lead but zinc concentrate.

To find the reason of the matter, microscopic observations have been carried out for lead/zinc concentrates and tailing from the confirmation tests and also for pyrite from the ISCAYCRUZ ore deposits.

8-4-1 Results of observation

(1) Lead concentrate

By visual observation under the microscope, the distribution ratio of minerals are found as 60 to 75 % of galena, 5 to 10 % of sphalerite, 15 to 25 % of pyrite, 1 to 2 % of arsenopyrite, less than 1 % of chalcopyrite and a very small amount of canfieldite ($4Ag_2S(Sn,Ge)S_2$).

A part of sphalerite, pyrite and arsenopyrite exists in the shape of middling with galena. Only a few pure particles of chalcopyrite are found.

Canfieldite coexists with sphalerite which is in the shape of middling with galena and the size of its particles is 4 to 10 μm each.

(refer to Annex II, Photo. 9, 10)

(2) Zinc concentrate

The distribution ratio of minerals is found as 83 to 91 % of sphalerite, 3 to 8 % of pyrite, more or less 5 % of gangue rocks, less than 1 % of galena, also less than 1 % of chalcopyrite and a very small amount of canfieldite.

The most of the pyrite and gangue rocks are in the shape of middling with sphalerite. Galena exists in sphalerite as fine particles and chalcopyrite exists in sphalerite as many dots.

Canfieldite exists also in sphalerite and the size of its particles is 2 to 5 μm each.

(refer to Annex II, Photo. 11, 12 and Annex IV, Photo. (4))

(3) Tailing

The distribution ratio of minerals is found as 60 to 70 % of pyrite, 25 to 35 % of gangue rocks,1 to 5 % of hematite, 1 to 2 % sphalerite and less than 1 % of galena.

Sphalerite exists in the shape of both middling with pyrite and simple pure particles. And galena conforms middling with pyrite.

(refer to Annex II, Photo. 13, 14)

(4) Pyrite (Massive)

For studying silver minerals, microscopic observation has been carried out for massive pyrite. As for the results, a small amount of sphalerite, galena, pyrite, bornite(Cu_5FeS_4), covellite(CuS) and stannite(CuS·FeS·SnS), and also quite limited amounts of enargite (Cu_3AsS_4), argentite(Ag_2S),canfieldite and colusite have been found in massive pyrite.

Argentite exists independently in pyrite but sometimes coexists with galena and/or canfieldite with a particle size of a few to 30 μm.

Canfieldite exists independently in pyrite but sometimes also coexists with argentite with a particle size of 10 to 50 μm.

Stannite coexists with galena and sphalerite. Colusite exists with enargite.

Argentite, canfieldite, enargite and colusite seem to be the products at the later geological stage.

(refer to Annex II, Photo. 15, 16, 17, 18)

8-4-2 Behaviour of silver minerals

In ISCAYCRUZ ore, argentite and canfieldite have been found as the silver minerals. There are no popular silver minerals such as tetrahedrite and tennantite.

(1) Silver minerals exist in massive pyrite, lead and zinc concentrates.

In massive pyrite, argentite and canfieldite of a particle size of 2 to 20 μm , coexisting argentite of a particle size of 10 μm with galena and canfieldite of each particle size of 50 μm have been recognized.

(refer to Annex II, Photo. 15)

A few grains of sphalerite have been found in lead and zinc concentrates of a particle size of 2 to 10.

(refer to Annex Ⅱ, Photo. 15)

(2) As the result of quantitative analysis for galena and canfieldite by means of EPMA, it has been found that canfieldite has a silver grade of 79.55 %, galena in lead concentrate has a silver grade of 0.05 % and fine grain galena in sphalerite does not show any silver indication.

(3) Correlation between lead and silver (for flotation products with less than 10 % of zinc content) and between zinc and silver (for the flotation products with less than 1 % of lead content) have also been studied and the following have been found.

(1) Lead-silver has a positive correlation with a coefficient of correlation 0.94.

(2) Zinc-silver has a positive correlation with a coefficient of correlation 0.98.

As the result, it becomes clear that the recoverable silver consists of both silver minerals with galena and sphalerite.

From the abovementioned matters, the ways of existence of the silver minerals are considered as the following three cases:

1) In the shape of solid solution with galena,
2) Canfieldite of a particle size 2 to 10 μm with sphalerite,
3) Argentite and canfieldite of 2 to 50 μm with pyrite.

Especially canfieldite in sphalerite is very hard to liberate because of very fine particles, which are impossible to concentrate by flotation. So, canfieldite usually behaves with sphalerite and is recovered in the zinc concentrate.

This is the reason why 60 % of the silver content in the crude ore goes into the zinc concentrate.

By the same reason, it is considered that the silver minerals in pyrite go into the tailing.

9. TEST FOR TAILING AND WASTED WATER TREATMENT

9. Tests for tailing and waste water treatment

9-1 Settling velocity of tailing slime

Assuming the tailing of flotation is classified by cyclone, the overflow(tailing slime) from cyclone is fed into a thickener and the overflow from the thickener is repeated to grinding and flotation.

Based on the above assumption, the settling velocity has been measured by means of a mess cylinder.

The sample for the tests are rougher flotation tailing of Ore-M which is treated under the most suitable conditions of grinding and flotation.

This tailing sample in the shape of pulp is the under size of screening by 325 meshes standard screen.

The pulp density of the sample of tailing slime is 8.0 % and no flocculant is added.

The result of measurements are as shown in Table 33 and Fig. 16.

If the pulp density of tailing slime is condensed from 8 % to 40 %, the settling velocity becomes 9.8mm/min.

The tailing slime seems to be very easy to settle possibly because of the influence of lime which is added at the flotation circuit. So, it is concluded that it will be not necessary to put in any additional flocculant with the procedure of tailing treatment in the practical operation.

TAB. 33 Settling tests of tailing slime

Time	Length of saturated water	Pulp density
min.	mm	%
0	0	8.0
1	11.0	8.3
2	25.0	8.8
3	42.0	9.5
4	52.5	9.9
5	66.5	10.6
6	80.5	11.4
7	94.5	12.3
8	105.5	13.1
9	119.0	14.3
10	131.0	15.6
12	157.5	19.4
14	181.0	24.5
16	193.5	28.6
18	20.3.5	33.0
20	210.0	36.5
22	214.5	39.5
24	216.5	41.0
26	217.5	41.8
28	218.5	42.6
30	219.5	43.5
35	220.5	44.4
40	222.5	46.3
45	223.5	47.3
50	224.5	48.3
60	225.5	49.5

N.B. Sample: 41.7 g

Water content in pulp: 480 cc

pH; 9.38

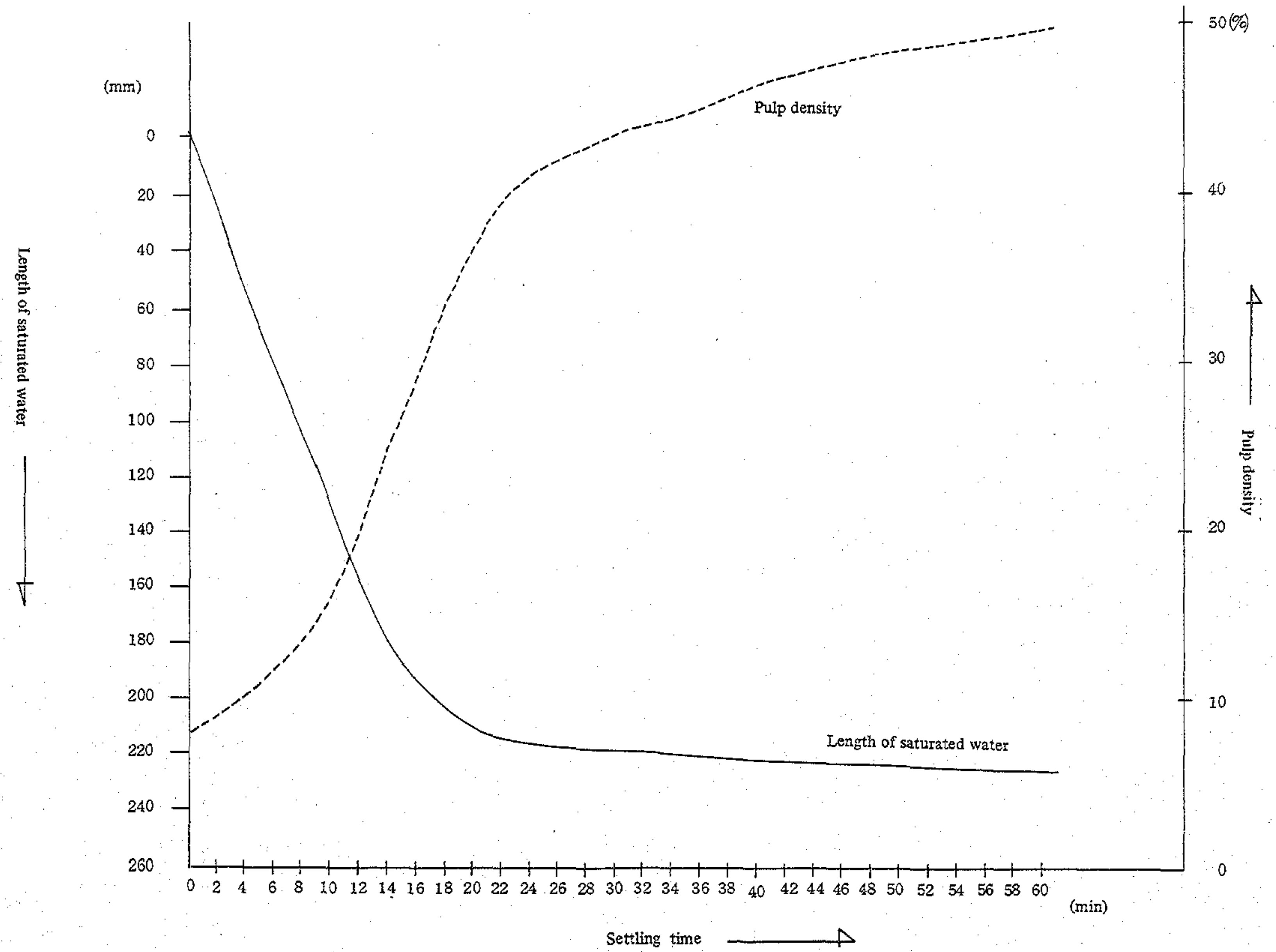

Fig. 16 Settling test of tailing slime

9-2 Analytical results of the wasted water

Analytical results of the wasted water are as shown in the following Table 34.

TAB. 34 Analytical results of the wasted water

pH	10.5	
Fe	< 0.05	ppm
Cu	2.0	"
Zn	0.02	"
Pb	< 0.02	"
Cd	< 0.01	"
As	< 0.02	"
CN	0.04	"
SO_4	745	"

It becomes clear that there will be no problem to discharge the wasted water after neutralization.

In the case of the practical operation, consideration must be given to using the water repeatedly in order to get enough and stable water supplement.

10. CONCLUSION

10. Conclusion

From the results of various tests concerning beneficiation for Iscay Cruz ore, the following matters are concluded.

10-1 The results of mineralogical study, EPMA and X-ray diffraction analysis:

(1) Zinc mineral is coarse grained sphalerite(ZnS)

(2) Lead mineral is coarse grained galena(PbS). But, some part of galena is existing in pyrite in the form of very thin vein.

(3) Copper minerals consist mostly of chalcopyrite($CuFeS_2$) with bornite(Cu_5FeS_4), covellite(CuS), enargite(Cu_3AsS_4), stannite (Cu_2FeSnS_4) and colusite ($Cu_3(As,Sn,V,Fe,Sb)S_2$).
Chalcopyrite, the major copper mineral, exists in sphalerite as very fine dots and other copper minerals exist in pyrite as fine particles.

(4) Silver minerals are argentite(Ag_2S)and canfieldite($4Ag_2S(Sn,Ge)S_2$). A part of canfieldite exists in sphalerite and a part of canfieldite and argentite are in pyrite. Since both silver minerals are in the form of too fine grain to liberate, they behave with sphalerite and pyrite in every milling procedure.

(5) Iron minerals are mainly pyrite(FeS_2) with arsenopyrite($FeAsS$), hamatite(Fe_2O_3) and pyrrohtite($Fe_{1-x}S$).

(6) Gangue rocks mainly consist of quartz, calcite and dolomite. As for the other kinds of gangue minerals, there is some siderite, sericite, chlorite and talc.

10-2 The results of charactors of the ore

The real specific gravity and the work index of the crude ore with expected grade is estimated as 3.8 and 11 kWh/t, respectively.

10-3 The results of mill tests

(1) The most suitable grinding size will be about 20 % of over 200 meshes and 80 % of under 200 meshes.

(2) From the general point of view considering the perfomances of tests, optional flexibility on the flotation method and so on, it is concluded that the most adequate flotation method for the Iscay Cruz ore is the straight differential flotation.

(3) The conditions of rougher flotation are:

Conditions of flotations	Lead flotation	Zinc flotation
Conditioning time	3 min.	4 min.
Flotation time	5 min.	10 min.
Reagents requirement		
Lime	250 g/t	1,000 g/t
NaCN	70 g/t	-
$CuSO_4$	-	300 g/t
KAX	70 g/t	70 g/t
MIBC	40 g/t	40 g/t
Pine oil	-	20 g/t

(4) At the cleaning flotation stage, it is necessary to add 15 g/t of sodium cyanide for the cleaning of lead flotation, and about 400 g/t of lime for the cleaning of zinc flotation.
The number of cleaning stages should be 5 for lead and 3 for zinc flotation in the case of the practical operation.

(5) The expected performance of flotation for Ore-M is as follows:

Product	Weight	grade					recovery				
		Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
	%	%	%	%	g/t	%	%	%	%	%	%
Feed	100	0.08	1.4	18.9	86	19.2	100	100	100	100	100
Lead conc.	1.7	0.16	65	4.4	774	5.2	3.4	80	0.4	15.5	0.5
Zinc conc.	33.1	0.17	0.18	52	153	8.6	70.3	4.3	91	58.9	14.8
Tailing	65.2	0.03	0.34	2.5	34	24.9	26.3	15.7	8.6	25.6	84.7

For the other kinds of ore samples, setting the same grades of each concentrate, the lead/zinc recoveries are able to be estimated as follows:

	Lead recovery	Zinc recovery
Ore-A	75 %	91 %
Ore-B	83 %	94 %
Ore-C	Not recovered	98 %

And the expected performances of the practically operating mill is estimated as in the following table:

Product	Weight	grade				recovery			
		Cu	Pb	Zn	Ag	Cu	Pb	Zn	Ag
	%	%	%	%	g/t	%	%	%	%
Feed	100	0.10	1.61	15.9	35	100	100	100	100
Lead conc.	2.0	0.20	65	4.0	265	4.0	80	0.5	15
Zinc conc.	26.9	0.26	0.26	52	75	70.5	4.3	88	58
Tailing	71.1	0.04	0.36	2.6	13	25.5	15.7	11.5	27

(5) The results of complete analysis of crude ore, lead/zinc concentrates and tailing are as shown in Table 32.

10-4 The results of the tests for tailing treatment

(1) The settling velocity of tailing slime is about 10 mm/min., and it will be not necessary to add any flocculant at the time of the tailing treatment procedure.

(2) As the quality of wasted water is very good as shown in Table 34, it is possible to use this wasted water in the operation repeatedly without any treatment. And the remaining water can be discharged after the neutralization.

11. CLOSING

11. Closing

Conclusively, despite the fact that the Iscay Cruz lead/zinc ore has a part which is apt to be middling, it may be possible to get a comparatively satisfactory performance of the milling operation without using any complicated method.

However, a part of ore which is apt to be middling will have the possibility of giving bad influences to the flotation, especially for lead.

And it is recommended to carry on some more continuous tests by means of a pilot plant to treat more samples in order to find out the effects of silver and copper minerals that coexist with spalerite, since this mineral's existing range is not clear as yet.

TABLE OF THE RESULTS OF FLOTATION TESTS

TAB. 5 Grinding tests of Ore-M

grinding time	Product	weight	grade				distribution			
			Cu	Pb	Zn	Ag	Cu	Pb	Zn	Ag
	mesh	%	%	%	%	g/t	%	%	%	%
0 min.	+ 48	28.85	0.096	1.07	20.4	95	28.8	20.7	30.2	31.3
	+ 65	13.50	0.095	1.27	20.6	85	13.4	11.5	14.2	13.1
	+100	11.48	0.095	1.56	19.4	92	11.4	12.0	11.4	12.0
	+150	8.03	0.093	1.53	19.2	79	7.8	8.2	7.9	7.2
	+200	5.43	0.093	1.66	19.5	73	5.1	6.1	5.4	4.5
	+270	5.01	0.085	2.16	19.2	89	4.4	7.3	4.9	5.1
	+325	3.61	0.088	2.10	19.2	85	3.3	5.1	3.6	3.5
	-325	24.09	0.103	1.80	18.1	85	25.0	29.1	22.4	23.3
	total	100	0.096	1.49	19.5	88	100	100	100	100
10 min.	+ 65	0.12	0.062	1.08	11.9	57	0.1	0.1	0.1	0.1
	+100	1.17	0.076	0.27	15.0	76	1.0	0.2	0.9	1.0
	+150	6.20	0.069	0.38	17.3	72	4.9	1.6	5.6	5.2
	+200	11.20	0.097	0.81	20.6	83	12.5	6.2	12.0	10.8
	+270	15.10	0.096	1.41	19.9	87	16.7	14.5	15.6	15.3
	+325	11.64	0.093	1.66	20.5	91	12.5	13.2	12.4	12.3
	-325	54.57	0.083	1.72	18.8	87	52.3	64.2	53.4	55.3
	total	100	0.087	1.46	19.2	86	100	100	100	100
15 min.	+ 65	–	–	–	–	–	–	–	–	–
	+100	0.14	0.062	0.63	11.5	49	0.1	0.1	0.1	0.1
	+150	2.27	0.081	0.38	17.1	64	2.1	0.6	2.1	1.7
	+200	7.87	0.097	0.43	18.7	68	8.9	2.2	7.9	6.4
	+270	24.07	0.092	1.20	19.9	80	25.7	19.1	25.7	22.9
	+325	10.24	0.089	2.01	19.3	95	10.6	13.6	10.6	11.6
	-325	55.41	0.082	1.76	18.1	87	52.6	64.4	53.6	57.3
	total	100	0.086	1.51	18.7	84	100	100	100	100
20 min.	+ 65	–	–	–	–	–	–	–	–	–
	+100	0.06	0.078	0.49	11.5	51	0.1	0.0	0.0	0.0
	+150	0.75	0.096	0.44	15.2	69	0.8	0.2	0.6	0.6
	+200	3.35	0.097	0.35	16.8	72	3.8	0.8	3.0	2.9
	+270	30.27	0.094	1.03	18.5	80	32.9	20.7	29.9	28.9
	+325	9.16	0.090	1.70	19.6	83	9.5	10.4	9.6	9.1
	-325	56.41	0.081	1.81	19.0	87	52.9	67.9	56.9	58.5
	total	100	0.086	1.50	18.8	84	100	100	100	100

TAB. 6 Grinding tests of Ore-A

grinding time	product	weight	grade				distribution			
			Cu	Pb	Zn	Ag	Cu	Pb	Zn	Ag
	mesh	%	%	%	%	g/t	%	%	%	%
10 min.	+ 65	0.12	0.033	0.15	10.6	48	0.1	0.0	0.1	0.0
	+100	1.68	0.041	0.18	16.8	95	1.6	0.2	1.4	1.1
	+150	8.09	0.045	0.39	18.8	123	8.4	1.9	7.6	6.8
	+200	12.70	0.043	0.67	18.7	127	12.7	5.3	12.0	11.0
	+270	17.10	0.064	1.42	19.4	93	25.4	15.0	16.7	10.8
	+325	10.54	0.037	1.43	20.0	151	9.1	9.3	10.6	10.9
	-325	49.77	0.037	2.22	20.6	175	42.7	68.3	51.6	59.4
	total	100	0.043	1.62	19.9	145	100	100	100	100
15 min.	+ 65	-	-	-	-	-	-	-	-	-
	+100	0.56	0.048	0.28	12.3	98	0.6	0.1	0.3	0.4
	+150	3.59	0.054	0.61	20.0	148	4.4	1.4	3.6	3.5
	+200	11.97	0.044	0.51	18.6	136	12.0	3.9	11.3	10.7
	+270	22.27	0.053	0.43	18.7	108	26.8	6.1	21.1	15.9
	+325	9.51	0.041	2.10	20.1	159	8.9	12.8	9.7	10.0
	-325	52.10	0.040	2.26	20.5	173	47.3	75.7	54.0	59.5
	total	100	0.045	1.56	19.8	151	100	100	100	100
20 min.	+ 65	-	-	-	-	-	-	-	-	-
	+100	0.10	0.065	0.91	12.6	90	0.2	0.1	0.1	0.1
	+150	1.29	0.040	1.24	19.5	155	1.2	1.0	1.3	1.3
	+200	8.18	0.044	0.49	18.3	141	8.3	2.6	7.9	7.2
	+270	28.42	0.049	0.44	15.9	121	32.1	8.1	23.7	21.4
	+325	8.72	0.039	1.75	20.6	172	7.8	9.9	9.4	9.3
	-325	53.28	0.041	2.27	20.6	183	50.4	78.3	57.6	60.7
	total	100	0.043	1.54	19.0	161	100	100	100	100

TAB. 7 *Grinding tests of Ore-B*

grinding time	product	weight	grade				distribution			
			Cu	Pb	Zn	Ag	Cu	Pb	Zn	Ag
	mesh	%	%	%	%	g/t	%	%	%	%
10 min.	+ 65	0.10	0.062	0.32	5.8	24	0.1	0.0	0.0	0.0
	+100	1.41	0.107	0.29	13.4	52	1.3	0.2	1.0	0.9
	+150	7.79	0.125	0.47	18.0	68	8.3	2.0	7.4	6.3
	+200	12.91	0.125	0.79	18.0	75	13.7	5.7	12.3	11.5
	+270	18.63	0.122	1.45	19.3	83	19.3	15.0	19.1	18.1
	+325	12.65	0.123	1.34	20.4	71	13.2	9.4	13.7	10.7
	-325	46.51	0.112	2.61	18.7	95	44.1	67.7	46.5	52.5
	total	100	0.118	1.80	18.8	84	100	100	100	100
15 min.	+ 65	–	–	–	–	–	–	–	–	–
	+100	0.54	0.101	0.32	12.4	54	0.5	0.1	0.4	0.3
	+150	3.96	0.105	0.45	16.6	60	3.6	1.1	3.5	2.8
	+200	8.81	0.105	0.58	17.6	75	8.0	3.2	8.2	7.8
	+270	21.35	0.138	1.19	20.3	81	25.6	15.7	22.8	20.4
	+325	12.60	0.113	1.48	19.1	78	12.4	11.5	12.7	11.6
	-325	52.74	0.109	2.10	18.9	92	49.9	68.4	52.4	57.1
	total	100	0.115	1.62	19.0	85	100	100	100	100
20 min.	+ 65	–	–	–	–	–	–	–	–	–
	+100	0.08	0.106	1.15	11.1	55	0.1	0.1	0.1	0.1
	+150	0.93	0.118	0.43	14.4	55	1.0	0.3	0.7	0.6
	+200	3.38	0.128	0.39	17.2	66	3.8	0.8	3.0	2.5
	+270	25.19	0.130	1.01	19.8	79	28.4	16.1	26.0	22.6
	+325	11.48	0.122	1.85	19.7	93	12.1	13.5	11.8	12.1
	-325	58.94	0.107	1.85	18.9	93	54.6	69.2	58.4	62.1
	total	100	0.115	1.58	19.1	88	100	100	100	100

TAB. 8 Grinding time of Ore-C

grinding time	product	weight	grade Cu	grade Pb	grade Zn	grade Ag	distribution Cu	distribution Pb	distribution Zn	distribution Ag
	mesh	%	%	%	%	g/t	%	%	%	%
10 min.	+ 65	0.08	0.033	0.11	8.1	8	0.0	0.1	0.0	0.0
	+100	1.00	0.048	0.08	13.2	12	0.7	0.8	0.7	0.9
	+150	5.88	0.062	0.08	18.9	12	5.3	4.9	5.7	5.2
	+200	10.71	0.068	0.08	19.6	16	10.6	8.9	10.7	12.7
	+270	15.93	0.070	0.08	20.0	16	16.2	13.2	16.3	18.9
	+325	11.16	0.073	0.08	20.6	16	11.8	9.2	11.8	13.2
	−325	55.24	0.069	0.11	19.4	12	55.4	62.9	54.8	49.1
	total	100	0.069	0.10	19.6	14	100	100	100	100
15 min.	+ 65	−	−	−	−	−	−	−	−	−
	+100	0.81	0.062	0.11	13.9	12	0.7	0.8	0.6	0.5
	+150	3.54	0.069	0.08	15.0	16	3.6	2.6	2.8	3.1
	+200	6.88	0.064	0.09	20.4	14	6.5	5.6	7.4	17.5
	+270	22.48	0.070	0.08	19.4	16	23.1	16.2	23.0	20.0
	+325	10.54	0.072	0.10	19.3	16	11.2	9.5	10.7	9.4
	−325	55.75	0.067	0.13	18.9	16	54.9	65.3	55.7	49.5
	total	100	0.068	0.11	19.0	18	100	100	100	100
20 min.	+ 65	−	−	−	−	−	−	−	−	−
	+100	0.81	0.067	0.16	13.3	14	0.8	1.2	0.5	0.7
	+150	0.94	0.114	0.08	16.4	14	1.5	0.7	0.8	0.8
	+200	3.16	0.065	0.08	19.3	14	3.0	2.3	3.1	2.6
	+270	29.03	0.027	0.09	20.0	17	30.2	24.0	29.7	29.3
	+325	9.66	0.071	0.11	20.2	17	9.9	9.7	9.9	9.7
	−325	56.40	0067	0.12	19.4	17	54.6	62.1	56.0	56.9
	total	100	0.069	0.11	19.6	17	100	100	100	100

TAB. 9 Flotation velocity tests (Ore-M)

grinding time	product	weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
10 min.	Feed.	100	0.097	1.56	20.1	90	19.7	100	100	100	100	100
	3 min.	35.6	0.213	3.10	49.1	196	8.7	78.3	70.6	86.8	78.0	15.8
	6 min.	5.8	0.112	3.30	26.1	113	13.4	6.7	12.3	7.5	7.3	3.9
	10 min.	4.2	0.051	1.24	8.6	48	16.1	2.2	3.3	1.8	2.2	3.4
	15 min.	4.0	0.032	0.58	3.0	30	16.4	1.3	1.5	0.6	1.3	3.3
	total	50.4	0.022	0.38	1.3	20	28.7	11.5	12.3	3.3	11.2	73.6
15 min.	Feed.	100	0.088	1.40	19.6	89	19.8	100	100	100	100	100
	3 min.	28.3	0.221	3.37	50.0	223	9.1	70.9	68.1	72.1	70.9	13.0
	6 min.	7.2	0.122	1.56	32.4	101	10.4	10.0	8.0	11.9	8.2	3.8
	10 min.	5.2	0.084	0.69	23.4	51	10.8	5.0	2.6	6.2	3.0	2.8
	15 min.	4.5	0.020	0.44	12.1	49	12.3	1.0	1.4	2.8	2.5	2.8
	total	54.8	0.021	0.51	2.5	25	28.0	13.1	19.9	7.0	15.4	77.6
20 min.	Feed.	100	0.088	1.41	20.4	87	19.9	100	100	100	100	100
	3 min.	29.2	0.204	3.26	46.4	207	9.1	67.6	67.4	66.7	69.1	13.4
	6 min.	6.8	0.123	1.53	30.9	101	10.9	9.5	7.4	10.3	7.9	3.7
	10 min.	4.9	0.088	0.74	34.2	67	11.0	4.9	2.6	8.2	3.8	2.7
	15 min.	5.3	0.055	0.46	12.2	43	15.9	3.3	1.7	3.2	2.6	4.7
	total	53.8	0.024	0.55	4.4	27	28.1	14.7	20.9	11.6	16.6	76.0

TAB. 10 Flotation velocity tests (Ore-A)

grinding time	product	weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
10 min.	Feed	100	0.047	1.46	19.9	153	17.9	100	100	100	100	100
	3 min.	36.0	0.056	2.60	46.3	348	8.1	43.1	64.1	84.0	81.9	16.2
	6 min.	6.4	0.053	1.37	25.0	146	9.7	7.3	6.0	8.1	6.1	3.4
	10 min.	3.5	0.044	1.04	15.5	68	10.8	3.3	2.5	2.7	1.6	2.1
	15 min.	1.5	0.042	0.72	7.6	51	11.1	1.3	0.7	0.6	0.5	0.9
	total	52.6	0.040	0.74	1.7	29	26.3	45.0	26.7	4.6	10.0	77.4
15 min.	Feed.	100	0.043	1.50	20.0	157	17.8	100	100	100	100	100
	3 min.	38.5	0.052	2.57	44.4	343	8.0	46.8	66.0	85.4	83.9	17.2
	6 min.	4.2	0.047	1.62	30.1	157	9.8	4.6	4.5	6.3	4.2	2.3
	10 min.	2.5	0.041	1.03	16.1	93	10.9	2.4	1.7	2.0	1.5	1.5
	15 min.	2.1	0.037	0.78	8.5	54	11.9	1.8	1.1	0.9	0.7	1.4
	total	52.7	0.036	0.76	2.0	29	26.2	44.4	26.7	5.4	9.7	77.6
20 min.	Feed	100	0.045	1.39	20.2	162	16.6	100	100	100	100	100
	3 min.	31.1	0.066	1.98	46.0	391	7.5	45.8	44.2	70.9	74.9	13.9
	6 min.	7.2	0.047	1.23	33.8	168	9.0	7.6	6.4	12.0	7.4	3.9
	10 min.	3.8	0.040	0.86	15.6	103	9.9	3.4	2.3	2.9	2.4	2.2
	15 min.	2.7	0.039	0.76	13.7	82	11.5	2.4	1.5	1.8	1.4	1.8
	total	55.2	0.033	1.15	4.6	41	23.9	40.8	45.6	12.4	13.9	78.2

TAB. 11 Flotation velocity tests (Ore-B)

grinding time	product	weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
10 min.	Feed	100	0.123	1.65	19.5	85	18.2	100	100	100	100	100
	3 min.	34.9	0.255	1.98	48.5	169	8.7	72.2	41.9	86.9	69.3	16.7
	6 min.	4.7	0.198	2.74	33.4	136	10.3	7.6	7.8	8.1	7.5	2.7
	10 min.	3.7	0.099	1.58	13.2	59	10.6	3.0	3.5	2.5	2.6	2.2
	15 min.	3.6	0.045	0.89	3.3	29	11.1	1.3	1.9	0.6	1.2	2.2
	Tail	53.1	0.037	1.39	0.7	31	26.1	15.9	44.9	1.9	19.4	76.2
15 min.	Feed	100	0.103	1.66	19.6	77	18.3	100	100	100	100	100
	3 min.	35.6	0.208	1.72	48.8	152	8.6	72.0	36.8	88.5	70.2	16.7
	6 min.	4.0	0.158	1.91	30.8	91	10.0	6.1	4.6	6.3	4.7	2.2
	10 min.	3.0	0.087	1.32	11.4	54	10.4	2.5	2.4	1.7	2.1	1.7
	15 min.	2.1	0.055	0.79	5.4	29	10.4	1.1	1.0	0.6	0.8	1.2
	Tail	55.3	0.034	1.66	1.0	31	25.9	18.3	55.2	2.9	22.2	78.2
20 min.	Feed	100	0.118	1.67	18.9	81	18.3	100	100	100	100	100
	3 min.	30.7	0.246	0.93	46.3	155	8.1	64.2	17.1	75.3	59.0	13.6
	6 min.	5.3	0.179	1.00	32.9	103	9.3	8.1	3.2	9.2	6.8	2.7
	10 min.	3.4	0.129	1.14	20.3	73	9.8	3.7	2.3	3.6	3.1	1.8
	15 min.	2.4	0.085	1.08	12.3	52	10.4	1.7	1.6	1.6	1.5	1.4
	Tail	58.2	0.045	2.18	3.4	41	25.3	22.3	75.8	10.3	29.6	80.5

TAB. 12 Flotation velocity tests (Ore-C)

grinding time	product	weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
10 min.	Feed	100	0.074	0.11	17.5	17	20.5	100	100	100	100	100
	3 min.	26.0	0.222	0.17	51.7	26	5.4	77.8	39.4	77.0	38.8	6.8
	6 min.	6.5	0.097	0.11	31.4	29	7.8	8.5	6.4	11.7	10.8	2.5
	10 min.	4.2	0.066	0.08	20.0	15	13.3	3.7	3.0	4.8	3.6	2.7
	15 min.	3.2	0.044	0.11	7.6	11	16.1	1.9	3.1	1.4	2.0	2.5
	Tail	60.1	0.010	0.09	1.5	13	29.1	8.1	48.1	5.1	44.8	85.5
15 min.	Feed	100	0.072	0.12	19.9	17	21.6	100	100	100	100	100
	3 min.	29.6	0.197	0.17	53.1	25	5.9	81.3	42.7	79.2	43.6	8.1
	6 min.	6.1	0.093	0.07	35.7	18	10.9	7.9	3.6	11.0	6.5	3.1
	10 min.	3.0	0.056	0.08	21.6	18	14.3	2.3	2.0	3.3	3.2	2.0
	15 min.	2.2	0.037	0.08	9.3	11	16.0	1.1	1.5	1.0	1.4	1.6
	Tail	59.1	0.009	0.10	1.9	13	31.2	7.4	50.2	5.5	45.3	85.2
20 min.	Feed	100	0.078	0.11	18.9	17	22.3	100	100	100	100	100
	3 min.	25.7	0.205	0.18	47.9	26	6.6	67.3	44.8	65.0	40.1	7.6
	6 min.	6.2	0.114	0.06	38.7	20	9.5	9.0	3.6	12.7	7.5	2.6
	10 min.	4.2	0.202	0.07	23.7	24	16.4	10.8	2.8	5.3	6.1	3.1
	15 min.	3.8	0.045	0.06	13.7	13	17.5	2.2	2.2	2.8	3.0	3.0
	Tail	60.1	0.014	0.08	4.5	12	31.1	10.7	46.6	14.2	43.3	83.7

TAB. 13 Influence of quantity of lime on flotation velocity (Ore-M)

quantity of lime	product	weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
lime 1.5 kg/t	Feed	100	0.088	1.42	18.9	87	19.0	100	100	100	100	100
	3 min.	33.4	0.199	38.2	47.5	202	8.8	75.4	90.1	83.9	77.9	15.5
	6 min.	6.3	0.132	0.85	29.9	91	12.7	9.4	3.8	9.9	6.6	4.2
	10 min.	4.4	0.050	0.43	10.1	47	14.7	2.5	1.3	2.3	2.4	3.4
	15 min.	3.9	0.033	0.28	3.0	37	16.1	1.5	0.8	0.6	1.7	3.3
	Tail	52.0	0.019	0.11	1.2	19	27.0	11.2	4.0	3.3	11.4	73.6
lime 2.5 kg/t	Feed	100	0.097	1.56	20.1	90	19.7	100	100	100	100	100
	3 min.	35.6	0.213	3.10	49.1	196	8.7	78.3	70.6	86.8	78.0	15.8
	6 min.	5.8	0.112	3.30	26.1	113	13.4	6.7	12.3	7.5	7.3	3.9
	10 min.	4.2	0.051	1.24	8.6	48	16.1	2.2	3.3	1.8	2.2	3.4
	15 min.	4.0	0.032	0.58	3.0	30	16.4	1.3	1.5	0.6	1.3	3.3
	Tail	50.4	0.022	0.38	1.3	20	28.7	11.5	12.3	3.3	11.2	73.6

N.B. – Grinding time: 10 min.

TAB. 15 Bulk differential flotation tests (1)

Test No.	Product	weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 8 − 1	Feed	100	0.082	1.41	18.2	79	17.9	100	100	100	100	100
	BRC	38.90	0.174	3.42	42.3	174	9.3	82.2	94.0	90.8	85.4	20.2
	Tail	61.10	0.024	0.14	2.7	19	23.4	17.8	6.0	9.2	14.6	79.8
	BC	30.28	0.209	2.89	51.3	198	8.3	77.1	61.9	85.6	75.4	14.1
	BM	8.62	0.049	5.26	10.9	92	12.7	5.1	32.1	5.2	10.0	6.1
	PbRC	2.47	0.145	33.44	16.3	476	5.8	4.3	58.4	2.2	14.9	0.8
	ZnC	27.81	0.215	0.18	54.4	173	8.6	72.8	3.5	83.4	60.5	13.3
	PbC	1.06	0.120	59.85	4.8	701	3.4	1.5	44.9	0.3	9.4	0.2
	PbM	1.41	0.163	13.58	25.0	307	7.6	2.8	13.5	1.9	5.5	0.6
No. 8 − 2	Feed	100	0.085	1.37	18.4	80	19.0	100	100	100	100	100
	BRC	40.61	0.172	3.07	41.0	168	9.2	82.4	90.9	90.8	85.8	19.6
	Tail	59.39	0.025	0.21	2.8	19	25.7	17.6	9.1	9.2	14.2	80.4
	BC	32.19	0.203	2.54	49.0	188	8.1	77.1	59.5	86.0	75.9	13.6
	BM	8.42	0.053	5.11	10.5	94	13.6	5.3	31.4	4.8	9.9	6.0
	PbRC	2.36	0.176	32.35	15.3	537	7.6	4.9	55.6	2.0	15.9	0.9
	ZnC	29.83	0.205	0.18	51.7	160	8.1	72.2	3.9	84.0	60.0	12.7
	PbC	0.93	0.160	63.04	4.1	865	4.1	1.8	42.7	0.2	10.1	0.2
	PbM	1.43	0.186	12.39	22.6	324	9.8	3.1	12.9	1.8	5.8	0.7
No. 8 − 3	Feed	100	0.090	1.39	17.8	76	18.3	100	100	100	100	100
	BRC	38.86	0.202	3.24	42.3	170	9.2	87.1	90.4	92.6	86.4	19.5
	Tail	61.14	0.019	0.22	2.2	17	24.0	12.9	9.6	7.4	13.6	80.5
	BC	31.03	0.233	2.62	50.3	188	8.4	80.1	58.3	87.9	76.6	14.1
	BM	7.83	0.082	5.71	10.6	96	12.7	7.1	32.1	4.7	9.8	5.4
	PbRC	2.54	0.185	29.64	14.4	483	6.8	5.2	54.0	2.1	16.1	0.9
	ZnC	28.49	0.237	0.21	53.5	162	8.5	74.8	4.3	85.8	60.5	13.2
	PbC	1.04	0.175	56.66	5.3	743	3.7	2.0	42.3	0.3	10.1	0.2
	PbM	1.50	0.192	10.91	20.8	303	8.9	3.2	11.7	1.8	6.0	0.7

TAB. 15 Bulk differential flotation tests (2)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 8 − 4	Feed	100	0.081	1.34	18.1	81	18.3	100	100	100	100	100
	BRC	35.60	0.158	3.42	42.9	166	9.1	68.8	90.9	84.4	72.9	17.7
	Tail	64.40	0.038	0.19	4.4	34	23.3	30.2	9.1	15.6	27.1	82.3
	BC	28.56	0.178	3.41	48.8	184	8.2	61.7	72.6	77.1	64.9	12.8
	BM	7.04	0.081	3.48	18.9	92	12.8	7.1	18.3	7.3	8.0	4.9
	PbRC	2.26	0.091	40.02	16.2	427	6.5	1.6	67.5	2.0	11.9	0.8
	ZnC	26.30	0.185	0.26	51.6	163	8.3	60.1	5.1	75.1	53.0	12.0
	PbC	1.10	0.070	62.50	4.9	598	3.3	1.0	51.3	0.3	8.1	0.2
	PbM	1.16	0.110	18.71	26.9	265	9.4	1.6	16.2	1.7	3.8	0.6
No. 8 − 5	Feed	100	0.078	1.41	18.0	80	17.8	100	100	100	100	100
	BRC	33.80	0.153	3.39	43.7	159	8.9	66.1	81.3	82.3	68.6	16.9
	Tail	66.20	0.040	0.40	4.8	38	22.3	33.9	18.8	17.8	31.4	83.1
	BC	28.05	0.170	2.94	49.5	173	8.0	61.2	58.5	77.2	60.7	12.6
	BM	5.75	0.066	5.61	15.8	110	13.1	4.9	22.8	5.1	7.9	4.3
	PbRC	2.10	0.102	36.67	13.7	396	7.0	2.7	54.6	1.6	10.4	0.8
	ZnC	25.95	0.176	0.21	52.4	155	8.0	58.5	3.9	75.6	50.3	11.8
	PbC	0.97	0.081	61.36	4.2	577	3.9	1.0	42.2	0.2	7.0	0.2
	PbM	1.13	0.120	15.47	21.9	240	9.2	1.7	12.4	1.4	3.4	0.6
No. 8 − 6	Feed	100	0.077	1.27	17.8	82	18.0	100	100	100	100	100
	BRC	34.27	0.145	2.40	43.0	162	9.8	64.4	64.8	82.7	67.8	18.7
	Tail	65.73	0.042	0.68	4.7	40	22.3	35.6	35.2	17.3	32.2	81.3
	BC	28.17	0.161	2.28	49.6	175	8.5	58.4	50.6	78.4	60.5	13.4
	BM	6.10	0.076	2.96	12.6	98	15.6	6.0	14.2	4.3	7.3	5.3
	PbRC	1.77	0.109	33.34	12.9	433	6.8	2.4	46.4	1.3	9.4	0.8
	ZnC	26.40	0.164	0.20	52.1	158	8.6	56.0	4.2	77.1	51.1	12.6
	PbC	0.82	0.098	57.63	4.3	578	3.5	1.0	37.1	0.2	5.8	0.2
	PbM	0.95	0.118	12.37	20.2	307	9.7	1.4	9.3	1.1	3.6	0.5

TAB. 15 Bulk differential flotation tests (3)

Test No.	Product	Weight	grade					recovery 率				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 8 − 7	Feed	100	0.085	1.38	18.0	82	19.1	100	100	100	100	100
	BRC	34.35	0.180	3.47	41.8	182	8.4	72.9	86.6	80.0	76.6	15.1
	Tail	65.65	0.035	0.28	5.5	29	24.7	27.1	13.4	20.0	23.4	84.9
	BC	28.80	0.199	3.38	46.9	195	7.6	67.3	70.6	75.3	68.8	11.5
	BM	5.55	0.085	3.97	15.2	114	12.4	5.6	16	4.7	7.8	3.6
	PbRC	2.10	0.105	42.10	12.2	537	6.4	2.6	64.2	1.4	13.8	0.7
	ZnC	26.70	0.206	0.30	49.6	168	7.7	64.7	6.4	73.9	55.0	10.8
	PbC	0.97	0.086	68.26	3.8	683	3.9	1.0	48.1	0.2	8.1	0.2
	PbM	1.13	0.121	19.65	19.5	412	8.4	1.6	16.1	1.2	5.7	0.5
No. 8 − 8	Feed	100	0.078	1.42	17.6	85	19.2	100	100	100	100	100
	BRC	33.94	0.165	3.34	40.3	190	8.2	71.4	79.6	77.8	75.9	14.5
	Tail	66.06	0.034	0.44	5.9	31	24.8	28.6	20.4	22.2	24.1	85.5
	BC	27.81	0.185	2.49	45.6	204	7.6	65.6	48.7	72.1	66.9	11.0
	BM	6.13	0.074	7.18	16.2	125	11.1	5.8	30.9	5.7	9.0	3.5
	PbRC	1.55	0.068	40.53	14.7	517	5.8	1.4	44.1	1.3	9.4	0.5
	ZnC	26.26	0.192	0.25	47.4	186	7.7	64.2	4.6	70.8	57.5	10.5
	PbC	0.37	0.013	66.67	3.2	717	2.9	0.1	17.3	0.1	3.1	0.1
	PbM	1.18	0.085	32.33	18.3	454	6.7	1.3	26.8	1.2	63	0.4
No. 8 − 9	Feed	100	0.079	1.32	19.0	83	17.9	100	100	100	100	100
	BRC	33.35	0.179	3.01	45.1	191	7.7	75.5	76.2	79.6	76.8	14.4
	Tail	66.65	0.029	0.47	5.8	29	23.0	24.5	23.8	20.4	23.2	85.6
	BC	27.48	0.197	2.19	50.8	207	7.0	68.4	45.6	73.5	68.5	10.8
	BM	5.87	0.096	6.87	19.7	118	11.0	7.1	30.6	6.1	8.3	3.6
	PbRC	1.51	0.090	35.36	17.6	535	5.9	1.7	40.5	1.4	9.7	0.5
	ZnC	25.97	0.203	0.26	52.7	188	7.1	66.7	5.1	72.1	58.8	10.3
	PbC	0.36	0.065	57.28	5.3	692	5.0	0.3	15.6	0.1	3.0	0.1
	PbM	1.15	0.098	28.50	21.5	486	6.2	1.4	24.9	1.3	6.7	0.4

TAB. 15 Bulk differential flotation tests (4)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 8 − 10	Feed	100	0.081	1.36	17.2	83	19.1	100	100	100	100	100
	BRC	28.03	0.165	4.08	40.7	187	7.8	57.3	84.1	66.5	62.9	11.4
	Tail	71.97	0.048	0.30	8.0	43	23.6	42.7	15.9	33.5	37.1	88.6
	BC	20.65	0.194	4.60	48.5	221	7.2	49.5	69.8	58.4	54.8	7.7
	BM	7.38	0.085	2.64	18.8	92	9.5	7.8	14.3	8.1	8.1	3.7
	PbRC	1.94	0.028	46.27	8.9	534	6.4	0.7	66.0	1.0	12.4	0.6
	ZnC	18.71	0.211	0.28	52.6	189	7.3	48.8	3.8	57.4	42.4	7.1
	PbC	1.05	0.007	65.28	3.5	671	3.8	0.1	50.4	0.2	8.4	0.2
	PbM	0.89	0.053	23.84	15.2	372	9.5	0.6	15.6	0.8	4.0	0.4
No. 8 − 11	Feed	100	0.086	1.37	19.0	85	19.6	100	100	100	100	100
	BRC	27.17	0.168	2.59	40.0	179	8.9	52.8	51.6	57.3	57.1	12.3
	Tail	72.83	0.056	0.91	11.1	50	23.7	47.2	48.4	42.7	42.9	87.7
	BC	18.56	0.207	2.64	49.8	219	7.6	44.3	35.9	48.7	47.9	7.2
	BM	8.61	0.085	2.49	19.0	91	11.6	8.5	15.7	8.6	9.2	5.1
	PbRC	1.64	0.071	26.60	14.4	441	6.2	1.3	31.9	1.2	8.5	0.5
	ZnC	16.92	0.220	0.32	53.2	198	7.7	43.0	4.0	47.5	39.4	6.7
	PbC	0.81	0.056	39.05	7.3	589	4.1	0.5	23.1	0.3	5.6	0.2
	PbM	0.83	0.086	14.45	21.4	296	8.2	0.8	8.8	0.9	2.9	0.3
No. 8 − 12	Feed	100	0.082	1.32	20.2	86	19.4	100	100	100	100	100
	BRC	26.30	0.151	1.21	38.8	168	9.6	48.2	24.2	50.6	51.7	13.0
	Tail	73.70	0.058	1.36	13.5	56	22.8	51.8	75.8	49.4	48.3	87.0
	BC	16.45	0.196	0.70	51.7	215	7.6	39.2	8.7	42.1	41.3	6.5
	BM	9.85	0.075	2.07	17.3	90	12.8	9.0	15.5	8.5	10.4	6.5
	PbRC	1.30	0.097	7.26	21.6	296	6.2	1.5	7.1	1.4	4.5	0.4
	ZnC	15.15	0.205	0.14	54.3	208	7.8	37.7	1.6	40.7	36.8	6.1
	PbC	0.55	0.078	14.78	13.2	417	4.9	0.5	6.1	0.4	2.7	0.1
	PbM	0.75	0.111	1.74	27.8	208	7.2	1.0	1.0	1.0	1.8	0.3

TAB. 18　Straight differential flotation tests (1)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 8 − 21	Feed	100	0.090	1.41	19.3	86	19.2	100	100	100	100	100
	PbRC	7.96	0.110	15.87	9.6	307	8.7	9.7	89.9	3.9	28.2	3.6
	tail	92.04	0.088	0.15	20.1	67	20.2	90.3	10.1	96.1	71.8	96.4
	ZnRC	33.25	0.201	0.21	51.0	151	8.1	74.5	5.1	88.1	58.2	14.0
	Tail	58.79	0.024	0.12	2.6	20	27.0	15.8	5.0	8.0	13.6	82.4
	ZnC	27.04	0.222	0.18	55.9	168	6.9	67.1	3.5	78.5	52.6	9.7
	ZnM$_1$	6.21	0.107	0.36	29.9	78	13.2	7.4	1.6	9.6	5.6	4.3
	PbC$_1$	3.36	0.128	36.19	5.3	582	6.1	4.8	86.6	0.9	22.6	1.1
	PbM$_1$	4.60	0.096	1.02	12.6	106	10.6	4.9	3.3	3.0	5.6	2.5
	PbC	2.05	0.136	55.33	3.7	796	3.9	3.1	80.8	0.4	18.9	0.4
	PbM$_2$	1.31	0.116	6.25	8.0	246	9.6	1.7	5.8	0.5	3.7	0.7
No. 8 − 22	Feed	100	0.084	1.37	18.7	81	17.6	100	100	100	100	100
	PbRC	6.48	0.121	18.74	9.5	350	9.8	9.4	88.4	3.3	28.2	3.6
	tail	93.52	0.081	0.17	19.3	62	18.1	90.6	11.6	96.7	71.8	96.4
	ZnRC	36.41	0.196	0.24	48.5	129	8.3	85.2	6.2	94.7	58.4	17.3
	Tail	57.11	0.008	0.13	0.6	19	24.3	5.4	5.4	2.0	13.5	79.1
	ZnC	30.69	0.218	0.19	54.1	141	7.1	79.7	4.2	89.0	53.7	12.4
	ZnM$_1$	5.72	0.080	0.48	18.8	66	15.1	0.5	2.0	5.7	4.7	4.9
	PbC$_1$	2.05	0.161	53.91	6.3	779	8.7	4.0	80.4	0.7	19.8	1.0
	PbM$_1$	4.43	0.103	2.46	11.0	152	10.3	5.4	8.0	2.6	8.4	2.6
	PbC	1.46	0.154	67.21	4.3	876	7.0	2.7	71.4	0.3	15.9	0.6
	PbM$_2$	0.59	0.179	21.00	11.2	540	12.9	1.3	9.0	0.4	3.9	0.4

TAB 18 Straight differential flotation tests (2)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 8 − 23	Feed	100	0.096	1.36	19.7	87	18.8	100	100	100	100	100
	PbRC	9.07	0.111	13.48	8.1	284	8.0	10.5	90.2	3.8	29.5	3.8
	tail	90.93	0.094	0.15	20.8	68	20.0	89.5	9.8	96.2	70.5	96.2
	ZnRC	37.35	0.166	0.20	48.8	139	8.4	64.8	5.5	92.6	59.5	16.6
	Tail	53.58	0.044	0.11	1.3	18	28.0	24.6	4.3	3.6	11.0	79.6
	ZnC	31.19	0.194	0.18	55.3	158	7.0	63.2	4.1	87.6	56.4	11.6
	ZnM1	6.16	0.025	0.30	16.0	44	15.4	1.6	1.4	5.0	3.1	5.0
	PbC1	2.55	0.158	43.57	5.1	674	6.7	4.2	81.9	0.7	19.7	0.9
	PbM1	6.52	0.093	1.71	9.3	132	8.5	6.3	8.1	3.1	9.8	2.9
	PbC	1.50	0.164	64.52	3.8	884	4.7	2.6	71.4	0.3	15.2	0.4
	PbM2	1.05	0.149	13.63	7.0	373	9.5	1.6	10.5	0.4	4.5	0.5
No. 8 − 24	Feed	100	0.100	1.27	18.5	87	19.2	100	100	100	100	100
	PbRC	7.99	0.109	14.02	10.2	297	9.9	8.7	88.2	4.4	27.2	4.1
	tail	92.01	0.108	0.16	19.2	69	20.0	91.3	11.8	95.6	72.8	95.9
	ZnRC	35.13	0.175	0.24	47.4	151	9.0	61.6	6.6	90.2	60.5	16.5
	Tail	56.88	0.052	0.11	1.8	19	26.9	29.7	4.9	5.4	12.3	79.4
	ZnC	29.69	0.201	0.21	52.2	167	8.0	59.9	4.9	83.9	56.7	12.3
	ZnM1	5.44	0.031	0.40	21.5	61	14.7	1.7	1.7	6.3	3.8	4.2
	PbC1	1.93	0.150	47.58	5.0	735	5.0	2.9	72.3	0.5	16.2	0.6
	PbM1	6.06	0.096	3.33	11.9	158	11.2	5.8	15.9	3.9	11.0	3.5
	PbC	1.35	0.147	60.08	3.4	911	3.9	2.0	63.9	0.2	14.1	0.3
	PbM2	0.58	0.157	18.47	8.7	325	9.9	0.9	8.4	0.3	2.1	0.3

TAB. 18 Straight differential flotation tests (3)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 8 − 25	Feed	100	0.105	1.38	18.1	87	18.9	100	100	100	100	100
	PbRC	5.99	0.114	20.28	9.5	378	8.8	6.5	87.9	31	25.9	2.8
	tail	94.01	0.104	0.18	18.6	69	19.5	93.5	12.1	96.9	74.1	97.2
	ZnRC	35.92	0.189	0.27	46.6	151	9.3	64.8	7.0	92.6	62.2	17.7
	Tail	58.09	0.052	0.12	1.4	18	25.9	28.8	5.1	4.3	11.9	79.5
	ZnC	29.50	0.214	0.24	53.0	171	8.1	60.1	5.1	86.6	57.7	12.7
	ZnM1	6.42	0.076	0.41	17.0	61	14.7	4.7	1.9	6.0	4.5	5.0
	PbC1	2.21	0.133	51.17	5.7	761	6.6	2.8	81.8	0.7	19.2	0.8
	PbM1	3.78	0.102	2.22	11.7	154	10.1	3.7	6.1	2.4	6.7	2.0
	PbC	1.47	0.118	66.53	3.8	884	4.3	1.7	70.8	0.3	14.9	0.3
	PbM2	0.74	0.164	20.67	9.6	518	11.3	1.1	11.0	0.4	4.3	0.5
No. 8 − 26	Feed	100	0.089	1.32	19.3	86	19.7	100	100	100	100	100
	PbRC	7.15	0.109	16.35	9.4	333	9.7	8.8	88.7	3.5	27.6	3.5
	tail	92.85	0.087	0.16	20.0	67	20.5	91.2	11.3	96.5	72.4	96.5
	ZnRC	36.07	0.193	0.22	49.0	143	9.5	78.4	6.2	91.8	59.9	17.4
	Tail	56.78	0.020	0.12	1.6	19	27.4	12.8	5.2	4.7	12.5	79.1
	ZnC	30.62	0.213	0.19	54.3	158	8.3	73.7	4.4	86.2	56.1	12.9
	ZnM1	5.45	0.077	0.43	19.7	61	16.3	4.7	1.8	5.6	3.9	4.5
	PbC1	2.33	0.135	46.21	5.2	732	6.8	3.6	81.6	0.6	19.8	0.8
	PbM1	4.82	0.096	1.92	11.4	140	11.1	5.2	7.0	2.9	7.8	2.7
	PbC	1.64	0.135	59.68	3.9	871	5.0	2.5	74.2	0.3	16.6	0.4
	PbM2	0.69	0.136	14.19	8.5	404	11.2	1.1	7.4	0.3	3.2	0.4

TAB. 18 Straight differential flotation tests (4)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 8 − 27	Feed	100	0.088	1.31	20.1	80	19.9	100	100	100	100	100
	PbRC	8.86	0.103	13.45	10.5	273	10.3	10.3	90.8	4.7	30.1	4.6
	tail	91.14	0.087	0.13	21.0	62	20.8	89.7	9.2	95.3	69.9	95.4
	ZnRC	37.35	0.184	0.18	49.3	130	9.8	78.1	5.1	91.6	60.5	18.3
	Tail	53.79	0.019	0.10	1.4	14	28.5	11.6	4.1	3.7	9.4	77.1
	ZnC	31.42	0.205	0.16	55.5	146	8.6	74.1	3.8	86.8	57.2	13.6
	ZnM1	5.93	0.059	0.29	16.1	45	15.8	4.0	1.3	4.8	3.3	4.7
	PbC1	2.22	0.141	47.17	5.4	706	7.3	3.5	79.8	0.6	19.5	0.8
	PbM1	6.64	0.090	2.17	12.3	128	11.3	6.8	11.0	4.1	10.6	3.8
	PbC	1.49	0.133	63.04	3.7	858	5.1	2.2	71.6	0.3	15.9	0.4
	PbM2	0.73	0.157	14.78	8.8	397	11.9	1.3	8.2	0.3	3.6	0.4
No. 8 − 28	Feed	100	0.086	1.41	20.4	89	19.9	100	100	100	100	100
	PbRC	8.29	0.102	15.30	11.1	300	10.3	9.9	89.9	4.6	27.9	4.3
	tail	91.71	0.084	0.15	21.2	70	20.8	90.1	10.1	95.4	72.1	95.7
	ZnRC	36.91	0.180	0.22	49.5	146	9.4	77.3	5.8	89.6	60.4	17.4
	Tail	54.80	0.020	0.11	2.2	19	28.5	12.8	4.3	5.8	11.7	78.3
	ZnC	29.65	0.205	0.18	56.4	167	8.1	70.9	3.8	82.0	55.6	12.1
	ZnM1	7.26	0.076	0.38	21.3	59	14.6	6.4	2.0	7.6	4.8	5.3
	PbC1	2.80	0.121	42.75	6.2	643	8.0	3.9	84.8	0.9	20.2	1.2
	PbM1	5.49	0.093	1.30	13.6	125	11.4	6.0	5.1	3.7	7.7	3.1
	PbC	1.91	0.123	59.13	4.9	804	7.0	2.7	80.0	0.5	17.2	0.7
	PbM2	0.89	0.117	7.61	8.8	297	10.2	1.2	4.8	0.4	3.0	0.5

TAB. 22 Straight differential flotation tests (1)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 9 − 1	Feed	100	0.087	1.21	18.7	83	19.0	100	100	100	100	100
	PbRC	9.27	0.104	11.74	10.4	281	10.0	11.1	90.0	5.2	31.6	4.8
	tail	90.73	0.085	0.13	19.6	62	19.9	88.1	10.0	94.8	68.4	95.2
	ZnRC	27.81	0.188	0.14	50.4	140	8.2	59.9	3.2	74.7	47.0	11.9
	Tail	62.92	0.040	0.13	6.0	28	25.2	29.0	6.8	20.1	21.4	83.3
	ZnC	20.86	0.200	0.12	55.2	152	7.6	47.9	2.1	61.4	38.4	8.3
	ZnM_1	6.95	0.150	0.20	35.8	102	9.9	12.0	1.1	13.3	8.6	3.6
	PbC_1	3.08	0.131	32.88	6.1	627	8.3	4.7	83.7	1.0	23.4	1.3
	PbM_1	6.19	0.090	1.23	12.6	109	10.8	6.4	6.3	4.2	8.2	3.5
	PbC	1.43	0.120	54.46	3.5	922	5.7	2.0	64.4	0.3	16.0	0.4
	PbM_2	1.65	0.140	14.17	8.4	371	10.6	2.7	19.3	0.7	7.4	0.9
No. 9 − 2	Feed	100	0.090	1.38	19.3	84	17.7	100	100	100	100	100
	PbRC	7.96	0.108	15.64	8.6	304	8.9	9.6	90.2	3.6	28.8	4.0
	tail	92.04	0.088	0.15	20.2	65	18.5	90.4	9.8	96.4	71.2	96.0
	ZnRC	36.05	0.191	0.20	47.0	136	8.9	76.7	5.3	87.9	58.5	18.2
	Tail	55.99	0.022	0.11	2.9	19	24.6	13.7	4.5	8.5	12.7	77.8
	ZnC	27.76	0.221	0.17	53.7	158	7.8	68.3	3.4	77.4	52.2	12.2
	ZnM_1	8.29	0.091	0.32	24.6	64	12.8	8.4	1.9	10.5	6.3	6.0
	PbC_1	2.78	0.142	42.08	4.9	654	6.4	4.4	84.8	0.8	21.6	1.0
	PbM_1	5.18	0.090	1.45	10.6	117	10.3	5.2	5.4	2.8	7.2	3.0
	PbC	1.91	0.157	58.50	3.2	837	4.8	3.3	80.9	0.3	19.0	0.5
	PbM_2	0.87	0.109	6.04	8.6	253	9.8	1.1	3.8	0.4	2.6	0.5

TAB. 22 Straight differential flotation tests (2)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 9 − 3	Feed	100	0.076	1.26	18.3	85	19.3	100	100	100	100	100
	PbRC	9.96	0.092	11.48	9.0	264	11.3	12.1	90.9	4.9	30.9	5.8
	tail	90.03	0.074	0.13	19.4	65	20.2	87.9	9.1	95.1	69.1	94.2
	ZnRC	31.39	0.156	0.16	46.2	138	8.3	64.7	4.0	79.2	51.2	13.5
	Tail	58.64	0.030	0.11	5.0	26	26.6	23.2	5.1	15.9	17.9	80.7
	ZnC	24.17	0.169	0.13	51.3	155	7.3	53.9	2.5	67.6	44.1	9.2
	ZnM_1	7.22	0.113	0.26	29.4	83	11.4	10.8	1.5	11.6	7.1	4.2
	PbC_1	2.99	0.117	35.13	4.9	626	8.9	4.6	83.5	0.8	22.0	1.4
	PbM_1	6.97	0.082	1.33	10.8	108	12.3	7.5	7.4	4.1	8.9	4.4
	PbC	1.69	0.117	53.98	3.3	872	6.8	2.6	72.5	0.3	17.3	0.6
	PbM_2	1.31	0.116	10.55	7.0	304	11.7	2.0	11.0	0.5	4.7	0.8
No. 9 − 4	Feed	100	0.081	1.37	18.6	87	18.4	100	10.0	100	100	100
	PbRC	9.99	0.107	12.30	9.7	265	9.6	13.2	89.9	5.2	30.3	5.2
	tail	90.01	0.078	0.15	19.6	67	19.4	86.8	10.1	94.8	69.7	94.8
	ZnRC	35.22	0.166	0.18	46.2	138	8.7	71.9	4.5	87.6	55.9	16.7
	Tail	54.79	0.022	0.14	2.4	22	26.3	14.9	5.6	7.2	13.8	78.1
	ZnC	25.87	0.191	0.15	53.5	164	7.9	60.8	2.8	74.5	48.8	11.1
	ZnM_1	9.35	0.096	0.25	26.0	66	11.0	11.1	1.7	1.31	7.1	5.6
	PbC_1	3.56	0.100	32.90	6.3	549	7.8	4.4	85.7	1.2	22.4	1.5
	PbM_1	6.43	0.111	0.89	11.6	107	10.6	8.8	4.2	4.0	7.9	3.7
	PbC	1.85	0.057	56.16	5.0	821	7.0	1.3	76.0	0.5	17.4	0.7
	PbM_2	1.71	0.146	7.74	7.6	255	8.6	3.1	9.7	0.7	5.0	0.8

TAB. 22 Straight differential flotation tests (3)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 9 − 5	Feed	100	0.087	1.31	17.8	87	19.2	100	100	100	100	100
	PbRC	10.09	0.117	11.83	9.7	287	9.7	13.6	91.0	5.5	33.6	5.1
	tail	89.91	0.083	0.13	18.7	64	20.2	86.4	9.0	94.5	66.4	94.9
	ZnRC	34.45	0.167	0.12	41.5	133	8.9	66.5	3.1	80.4	53.0	16.0
	Tail	55.46	0.031	0.14	4.5	21	27.3	19.9	5.9	14.1	13.4	78.9
	ZnC	23.99	0.212	0.10	52.8	165	8.3	58.8	1.8	71.2	45.6	10.4
	ZnM_1	10.46	0.064	0.16	15.6	61	10.3	7.7	1.3	9.2	7.4	5.6
	PbC_1	2.86	0.143	38.18	6.2	695	6.7	4.7	83.3	1.0	22.9	1.0
	PbM_1	7.23	0.107	1.40	11.1	128	10.9	8.9	7.7	4.5	10.7	4.1
	PbC	1.87	0.144	55.28	4.8	928	6.2	3.1	78.8	0.5	20.0	0.6
	PbM_3	0.99	0.140	5.98	9.0	254	7.8	1.6	4.5	0.5	2.9	0.4
No. 9 − 6	Feed	100	0.064	1.31	19.1	87	19.3	100	100	100	100	100
	PbRC	10.69	0.092	11.21	10.5	258	10.4	15.4	91.8	5.9	32.3	5.8
	tail	89.31	0.061	0.12	20.1	65	20.3	84.6	8.2	94.1	67.7	94.2
	ZnRC	34.95	0.100	0.13	48.2	131	9.3	71.9	3.6	86.2	53.7	16.8
	Tail	54.36	0.015	0.11	2.8	22	27.4	12.7	4.6	7.9	14.0	77.4
	ZnC	25.67	0.152	0.10	54.5	155	7.6	60.9	2.0	73.3	46.6	10.1
	ZnM_1	9.28	0.076	0.23	26.5	65	14.0	11.0	1.6	12.9	7.1	6.7
	PbC_1	2.91	0.107	37.44	5.9	650	7.1	4.9	83.5	0.9	22.1	1.1
	PbM_1	7.78	0.086	1.40	12.3	112	11.7	10.5	8.3	5.0	10.2	4.7
	PbC	1.96	0.104	53.45	4.6	864	6.0	3.2	80.3	0.5	19.8	0.6
	PbM_3	0.95	0.112	4.42	8.5	207	9.1	1.7	3.2	0.4	2.3	0.5

TAB. 22 **Straight differential flotation tests (4)**

Test No.	Product	weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9 − 7	Feed	100	0.053	1.30	17.64	86	18.48	100	100	100	100	100
	PbRC	8.64	0.103	13.46	9.92	298	9.08	16.8	89.7	4.9	30.0	4.2
	tail	91.36	0.048	0.15	18.36	65	19.37	83.2	10.3	95.1	70.0	95.8
	ZnRC	35.75	0.090	0.20	43.52	138	9.12	61.2	5.6	88.2	57.7	17.6
	Tail	55.61	0.021	0.11	2.19	19	25.96	22.0	4.7	6.9	12.3	78.2
	ZnC	28.66	0.100	0.18	49.65	155	7.80	54.1	4.0	80.7	51.7	12.1
	ZnM_1	7.09	0.053	0.30	18.77	73	14.47	7.1	1.6	7.5	6.0	5.5
	PbC_1	2.43	0.130	42.90	5.32	731	6.49	6.0	80.4	0.7	20.7	0.9
	PbM_1	6.21	0.092	1.94	11.72	129	10.10	10.8	9.3	4.2	9.3	3.3
	PbC	1.70	0.136	57.76	4.01	918	5.14	4.4	75.7	0.4	18.2	0.5
	PbM_3	0.73	0.117	8.30	8.39	297	9.62	1.6	4.7	0.3	2.5	0.4

TAB. 24 Tests for the number of cleaning stages (I. Case A, No. 1)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9－11	Feed	100	0.072	1.36	18.9	85	19.3	100	100	100	100	100
	PbRC	10.11	0.097	12.31	10.7	239	10.0	13.6	91.4	5.7	28.6	5.3
	tail	89.89	0.069	0.13	19.9	67	20.3	86.4	8.6	94.3	71.4	94.7
	ZnRC	36.50	0.129	0.16	47.7	135	9.3	65.5	4.3	91.9	58.2	17.7
	Tail	53.39	0.028	0.11	0.8	21	27.9	20.9	4.3	2.4	13.2	77.0
	ZnC_1	28.54	0.145	0.14	53.9	155	7.8	57.8	2.8	81.2	52.3	11.5
	ZnM_1	7.96	0.069	0.26	25.4	63	14.9	7.7	1.5	10.7	5.9	6.2
	ZnC	25.40	0.150	0.12	55.7	163	7.3	53.2	2.2	74.6	49.0	9.6
	ZnM_2	3.14	0.106	0.27	39.5	90	11.7	4.6	0.6	6.6	3.3	1.9
	PbC_1	2.92	0.122	39.09	6.0	555	7.0	4.9	83.8	0.9	19.2	1.1
	PbM_1	7.19	0.087	1.44	12.6	111	11.3	8.7	7.6	4.8	9.4	4.2
	PbC_2	2.03	0.132	54.54	4.9	714	6.2	3.7	81.3	0.5	17.2	0.7
	PbM_2	0.89	0.099	3.86	8.5	193	8.7	1.2	2.5	0.4	2.0	0.4
	PbC	1.47	0.132	65.76	3.6	864	3.9	2.7	71.0	0.3	15.1	0.3
	PbM_3	0.56	0.133	25.08	8.4	321	12.2	1.0	10.3	0.2	2.1	0.4

TAB. 24 Tests for the number of cleaning stages (I. case A, No. 2)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9 − 12	Feed	100	0.066	1.36	18.3	86	18.7	100	100	100	100	100
	PbRC	8.59	0.105	14.26	10.3	293	9.5	13.6	90.0	4.9	29.1	4.2
	tail	91.41	0.062	0.15	19.1	67	19.6	86.4	10.0	95.1	70.9	95.8
	ZnRC	37.07	0.125	0.21	45.6	139	9.4	70.0	5.6	92.3	59.6	18.6
	Tail	54.34	0.020	0.11	1.0	18	26.6	16.4	4.4	2.8	11.3	77.2
	ZnC_1	29.75	0.140	0.18	51.9	158	8.0	63.2	4.0	84.2	54.3	12.7
	ZnM_1	7.32	0.061	0.30	20.1	62	15.1	6.8	1.6	8.1	5.3	5.9
	ZnC	24.59	0.145	0.17	53.5	164	7.6	54.0	3.1	71.7	46.7	10.0
	ZnM_2	5.16	0.118	0.24	44.2	128	9.6	9.2	0.9	12.5	7.6	2.7
	PbC_1	2.50	0.135	44.45	5.8	681	6.9	5.0	81.6	0.8	19.7	0.8
	PbM_1	6.09	0.093	1.87	12.2	134	10.5	8.6	8.4	4.1	9.4	3.4
	PbC_2	1.75	0.146	60.46	4.7	856	6.2	3.8	77.7	0.5	17.3	0.5
	PbM_2	0.75	0.109	7.10	8.3	272	8.7	1.2	3.9	0.3	2.4	0.3
	PbC	1.35	0.149	71.75	3.9	931	4.6	3.0	71.1	0.3	14.5	0.3
	PbM_3	0.40	0.136	22.26	7.4	601	11.5	0.8	6.6	0.2	2.8	0.2

TAB. 24 Tests for the number of cleaning stages (2. Case B, No. 1)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9－13	Feed	100	0.083	1.35	19.0	87	18.9	100	100	100	100	100
	PbRC	9.62	0.103	12.77	10.1	264	9.8	12.1	90.7	5.1	29.0	5.0
	tail	90.38	0.081	0.14	19.9	68	19.8	87.9	9.3	94.9	71.0	95.0
	ZnRC	37.51	0.166	0.18	46.3	139	9.3	75.2	5.0	91.6	60.1	18.6
	Tail	52.87	0.020	0.11	1.2	18	27.3	12.7	4.3	3.3	10.9	76.4
	ZnC_1	29.26	0.190	0.16	52.7	162	8.0	67.0	3.4	81.4	54.4	12.4
	ZnM_1	8.25	0.082	0.26	23.6	60	14.1	8.2	1.6	10.2	5.7	6.2
	ZnC_2	25.65	0.197	0.14	54.4	170	7.6	60.8	2.7	73.6	50.2	10.3
	ZnM_2	3.61	0.142	0.26	41.1	101	11.0	6.2	0.7	7.8	4.2	2.1
	ZnC	21.11	0.202	0.13	54.8	172	7.4	51.3	2.0	61.1	41.8	8.3
	ZnM_3	4.54	0.174	0.21	52.3	162	8.2	9.5	0.7	12.5	8.4	2.0
	PbC_1	2.73	0.135	41.20	5.6	609	6.4	4.5	83.0	0.8	19.0	0.9
	PbM_1	6.89	0.091	1.51	11.9	127	11.1	7.6	7.7	4.3	10.0	4.1
	PbC_2	1.92	0.148	56.13	4.7	762	5.8	3.5	79.5	0.5	16.7	0.6
	PbM_2	0.81	0.103	5.82	7.9	246	7.8	1.0	3.5	0.3	2.3	0.3
	PbC_3	1.56	0.151	63.91	3.8	826	4.7	2.9	73.5	0.3	14.7	0.4
	PbM_3	0.36	0.134	22.41	8.4	484	10.5	0.6	6.0	0.2	2.0	0.2
	PbC	1.24	0.165	72.64	2.7	903	4.1	2.5	66.4	0.2	12.8	0.3
	PbM_4	0.32	0.099	30.06	8.1	526	7.2	0.4	7.1	0.1	1.9	0.1

TAB. 24 Tests for the number of cleaning stages
(2. case B, No. 2)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9 − 1 4	Feed	100	0.055	1.28	17.8	92	18.7	100	100	100	100	100
	PbRC	10.53	0.094	10.94	8.8	247	9.5	18.0	90.2	5.2	28.3	5.5
	tail	89.47	0.051	0.14	18.8	74	19.8	82.0	9.8	94.8	71.7	94.5
	ZnRC	35.83	0.095	0.18	45.5	155	9.2	61.6	5.2	91.9	60.6	17.5
	Tail	53.64	0.021	0.11	1.0	19	26.9	20.4	4.6	2.9	11.1	77.0
	ZnC1	27.62	0.102	0.16	52.2	181	8.0	50.6	3.6	81.3	54.5	11.7
	ZnM1	8.21	0.074	0.25	22.9	68	13.2	11.0	1.6	10.6	6.1	5.8
	ZnC2	24.20	0.105	0.15	54.0	190	7.3	46.0	2.8	73.7	50.1	9.4
	ZnM2	3.42	0.075	0.29	39.5	119	12.8	4.6	0.8	7.6	4.4	2.3
	ZnC	19.91	0.108	0.14	54.7	178	7.2	38.8	2.2	61.3	44.4	7.6
	ZnM3	4.29	0.093	0.18	51.1	123	7.8	7.2	0.6	12.4	5.7	1.8
	PbC1	2.74	0.127	37.65	4.7	634	6.2	6.4	80.8	0.7	18.9	1.0
	PbM1	7.79	0.082	1.54	10.3	111	10.7	11.6	9.4	4.5	9.4	4.5
	PbC2	1.85	0.140	52.82	3.5	825	5.4	4.8	76.5	0.4	16.6	0.6
	PbM2	0.89	0.099	6.13	7.1	238	7.7	1.6	4.3	0.4	2.3	0.4
	PbC3	1.51	0.147	61.69	3.1	909	4.7	4.1	72.9	0.3	14.9	0.4
	PbM3	0.34	0.112	13.41	5.5	452	8.8	0.7	3.6	0.1	1.7	0.2
	PbC	1.31	0.154	68.41	2.8	957	4.2	3.7	70.1	0.2	13.6	0.3
	PbM4	0.20	0.099	17.69	4.8	592	7.3	0.4	2.8	0.1	1.3	0.1

TAB. 25 Confirmation tests (1. Ore-M, No. 1)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
№ 9 − 21	Feed	100	0.079	1.42	18.8	85	19.4	100	100	100	100	100
	PbRC	9.54	0.103	14.28	10.9	247	9.6	12.5	90.6	4.7	27.7	4.7
	tail	90.46	0.076	0.15	19.6	68	20.5	87.5	9.4	94.4	72.3	95.3
	ZnRC	38.01	0.156	0.20	45.8	135	9.7	74.9	5.3	92.5	60.5	19.0
	Tail	52.45	0.019	0.11	0.7	19	28.3	12.6	4.1	1.9	11.8	76.3
	ZnC_1	29.57	0.177	0.17	52.2	156	7.9	66.3	3.6	82.0	54.4	12.1
	ZnM_1	8.44	0.080	0.29	23.3	61	15.8	8.6	1.7	10.5	6.1	6.9
	ZnC	24.44	0.183	0.16	53.9	164	7.5	56.6	2.8	69.9	47.4	9.4
	ZnM_2	5.13	0.149	0.23	44.5	116	10.1	9.7	0.8	12.1	7.0	2.7
	PbC_1	2.92	0.138	43.31	6.2	560	6.9	5.1	83.7	1.0	19.2	1.0
	PbM_1	6.62	0.088	1.48	13.0	109	10.7	7.4	6.9	4.6	8.5	3.7
	PbC_2	2.09	0.160	55.82	5.3	712	6.4	4.2	81.8	0.6	17.5	0.7
	PbM_2	0.83	0.085	3.22	8.4	178	8.1	0.9	1.9	0.4	1.7	0.3
	PbC	1.61	0.163	66.99	4.2	775	4.7	3.3	75.6	0.4	14.7	0.4
	PbM_3	0.48	0.148	18.34	8.9	501	11.9	0.9	6.2	0.2	2.8	0.3

TAB. 25 Confirmation tests (1. Ore-M, No. 2)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
No. 9 − 22	Feed	100	0.079	1.42	19.0	87	19.0	100	100	100	100	100
	PbRC	8.62	0.107	14.93	10.7	285	9.8	11.7	90.5	4.8	28.2	4.5
	tail	91.38	0.077	0.15	19.8	68	10.8	88.3	9.5	95.2	71.8	95.5
	ZnRC	38.34	0.156	0.20	46.0	139	9.6	75.6	5.4	93.0	61.4	19.5
	Tail	53.04	0.019	0.11	0.8	17	27.2	12.7	4.1	2.2	10.4	76
	ZnC1	30.79	0.178	0.18	52.2	161	8.1	69.1	3.8	84.7	57.0	13.2
	ZnM1	7.55	0.068	0.30	20.7	51	15.7	6.5	1.6	8.3	4.4	6.3
	ZnC	27.40	0.184	0.16	53.9	169	7.6	63.5	3.1	77.9	53.4	11.0
	ZnM2	3.39	0.130	0.31	38.2	93	12.2	5.6	0.7	6.8	3.6	2.2
	PbC1	2.66	0.135	44.36	6.0	611	7.1	4.6	83.0	0.8	18.7	1.0
	PbM1	5.96	0.094	1.79	12.7	139	11.0	7.1	7.5	4.0	9.5	3.5
	PbC2	1.90	0.148	59.69	5.1	755	6.8	3.6	79.8	0.5	16.5	0.7
	PbM2	0.76	0.102	6.04	8.4	252	7.8	1.0	3.2	0.3	2.2	0.3
	PbC	1.38	0.147	71.75	3.7	829	4.3	2.6	69.7	0.3	13.2	0.3
	PbM3	0.52	0.149	27.68	8.9	557	13.6	1.0	10.1	0.2	3.3	0.4

TAB. 25 Confirmation tests (2. Ore-A, No. 1)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9 − 2 3	Feed	100	0.043	1.38	20.2	156	17.8	100	100	100	100	100
	PbRC	10.05	0.073	12.56	10.4	435	12.5	17.0	91.3	5.2	27.9	7.1
	tail	89.95	0.040	0.13	21.2	125	18.4	83.0	8.7	94.8	72.1	92.9
	ZnRC	39.96	0.044	0.17	46.4	255	8.3	41.0	5.1	92.0	65.4	18.5
	Tail	49.99	0.036	0.10	1.1	21	26.6	42.0	3.6	2.8	6.7	74.4
	ZnC1	33.21	0.047	0.14	51.7	287	6.9	36.0	3.4	85.2	61.0	12.9
	ZnM1	6.75	0.032	0.34	20.2	101	14.8	5.0	1.7	6.8	4.4	5.6
	ZnC	29.48	0.048	0.12	53.5	303	6.4	33.0	2.6	78.3	57.2	10.6
	ZnM2	3.73	0.035	0.31	38.3	159	12.1	3.0	0.8	6.9	3.8	2.3
	PbC1	3.01	0.107	37.91	5.8	827	12.1	7.5	82.5	0.9	15.9	2.1
	PbM1	7.04	0.058	1.72	12.4	267	12.6	9.5	8.8	4.3	12.0	5.0
	PbC2	1.92	0.114	54.16	4.1	1125	10.6	5.1	75.2	0.4	13.8	1.2
	PbM2	1.09	0.094	9.28	8.9	303	14.8	2.4	7.3	0.5	2.1	0.9
	PbC	1.13	0.103	71.01	2.0	1290	4.1	2.7	58.0	0.1	9.3	0.3
	PbM3	0.79	0.130	30.07	7.0	889	20.0	2.4	17.2	0.3	4.5	0.9

TAB. 25 Confirmation tests (2. Ore-A, No. 2)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9 − 24	Feed	100	0.043	1.45	19.9	153	17.4	100	100	100	100	100
	PbRC	9.56	0.072	13.96	10.2	466	12.5	15.9	91.7	4.9	29.1	6.8
	tail	90.44	0.040	0.13	20.9	120	17.9	84.1	8.3	95.1	70.9	93.2
	ZnRC	39.87	0.045	0.18	45.9	243	8.3	41.7	4.8	92.2	63.3	18.9
	Tail	50.57	0.036	0.10	1.1	23	25.6	42.4	3.5	2.9	7.6	74.3
	ZnC_1	32.33	0.047	0.14	51.4	274	6.9	35.4	3.1	83.8	57.9	12.7
	ZnM_1	7.54	0.036	0.33	22.2	109	14.4	6.3	1.7	8.4	5.4	6.2
	ZnC	26.71	0.046	0.12	53.6	295	6.1	28.5	2.2	72.1	51.5	9.3
	ZnM_2	5.62	0.053	0.23	41.2	174	10.7	6.9	0.9	11.7	6.4	3.4
	PbC_1	3.22	0.118	37.97	5.6	766	12.1	8.8	84.0	0.9	16.1	2.2
	PbM_1	6.34	0.048	1.76	12.5	313	12.7	7.1	7.7	4.0	13.0	4.6
	PbC_2	2.06	0.124	53.14	3.8	1045	10.1	5.9	75.2	0.4	14.1	1.2
	PbM_2	1.16	0.108	11.03	9.0	270	15.7	2.9	8.8	0.5	2.0	1.0
	PbC	1.34	0.119	65.01	2.1	1120	4.1	3.7	59.8	0.1	9.8	0.3
	PbM_3	0.72	0.134	31.05	7.0	906	21.2	2.2	15.4	0.3	4.3	0.9

TAB. 25 Confirmation tests (3. Ore-B, No. 1)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9 − 25	Feed	100.	0.106	1.61	19.0	115	18.9	100	100	100	100	100
	PbRC	7.31	0.156	20.08	8.7	233	8.4	10.8	91.5	3.3	14.8	3.3
	tail	92.69	0.102	0.15	19.9	106	19.7	89.2	8.5	96.7	85.2	96.7
	ZnRC	36.78	0.204	0.19	48.8	240	9.2	70.7	4.3	94.2	76.9	18.5
	Tail	55.91	0.035	0.12	0.8	17	25.7	18.5	4.2	2.5	8.3	78.2
	ZnC1	32.42	0.214	0.17	53.1	265	8.6	65.4	3.4	90.3	74.6	15.2
	ZnM1	4.36	0.130	0.34	16.8	60	14.0	5.3	0.9	3.9	2.3	3.3
	ZnC	23.80	0.210	0.17	55.1	313	8.0	47.1	2.5	68.9	64.8	10.4
	ZnM8	8.62	0.225	0.17	47.3	131	10.2	18.3	0.9	21.4	9.8	4.8
	PbC1	2.99	0.207	46.87	4.8	431	6.8	5.9	87.4	0.7	11.2	1.1
	PbM1	4.32	0.121	1.54	11.3	96	9.6	4.9	4.1	2.6	3.6	2.2
	PbC8	2.19	0.216	61.59	3.7	529	6.0	4.5	84.1	0.4	10.1	0.7
	PbM8	0.80	0.182	6.58	7.7	162	9.0	1.4	3.3	0.3	1.1	0.4
	PbC	1.69	0.204	70.24	2.4	550	3.2	3.3	74.0	0.2	8.1	0.3
	PbM8	0.50	0.256	32.36	8.2	460	15.5	1.2	10.1	0.2	2.0	0.4

TAB. 25 Confirmation tests (3. Ore-B, No. 2)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9 − 26	Feed	100	0.106	1.61	18.5	118	18.5	100	100	100	100	100
	PbRC	9.64	0.142	15.15	8.6	208	9.0	12.9	91.0	4.6	17.0	4.7
	tail	90.36	0.102	0.16	19.6	109	19.6	87.1	9.0	95.4	83.0	95.3
	ZnRC	36.49	0.201	0.22	47.0	241	9.4	69.3	5.0	92.4	74.3	18.4
	Tail	53.87	0.035	0.12	1.0	19	26.5	17.8	4.0	3.0	8.7	76.9
	ZnC_1	29.96	0.223	0.18	53.2	278	8.3	63.0	3.4	85.8	70.4	13.4
	ZnM_1	6.53	0.103	0.39	18.8	70	14.3	6.3	1.6	6.6	3.9	5.0
	ZnC	25.23	0.214	0.17	53.8	305	8.3	51.0	2.7	73.1	65.0	11.3
	ZnM_2	4.73	0.269	0.25	49.8	134	8.2	12.0	0.7	12.7	5.4	2.1
	PbC_1	2.76	0.208	47.85	4.9	475	7.8	5.4	82.2	0.8	11.1	1.2
	PbM_1	6.88	0.116	2.03	10.2	101	9.4	7.5	8.7	3.8	5.9	3.5
	PbC_2	1.87	0.203	63.19	3.7	558	6.0	3.6	73.5	0.4	8.8	0.6
	PbM_2	0.89	0.220	15.61	7.4	301	11.8	1.8	8.7	0.4	2.3	0.6
	PbC	1.38	0.182	72.10	2.1	566	3.2	2.4	61.9	0.2	6.6	0.2
	PbM_3	0.49	0.261	38.10	7.9	537	13.8	1.2	11.6	0.2	2.2	0.4

TAB. 25 Confirmation tests (4. Ore-C, No. 1)

Test No.	Product	Weight	Grade					Recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9 − 27	Feed	100	0.067	0.11	19.3	18	22.1	100	100	100	100	100
	PbRC	7.25	0.094	0.48	13.1	19	12.0	10.1	33.2	4.9	7.4	3.9
	tail	92.75	0.064	0.08	19.8	18	22.9	89.9	66.8	95.1	92.6	96.1
	ZnRC	34.93	0.159	0.05	51.2	27	7.0	83.0	17.7	92.9	51.6	11.0
	Tail	57.82	0.008	0.09	0.7	13	32.5	6.9	49.1	2.2	41.0	85.1
	ZnC_1	28.29	0.181	0.05	58.9	30	4.6	76.8	13.3	86.5	45.8	5.9
	ZnM_1	6.64	0.062	0.07	18.7	16	16.9	6.2	4.4	6.4	5.8	5.1
	ZnC	24.18	0.191	0.05	61.1	31	3.8	69.2	11.4	76.7	40.9	4.2
	ZnM_2	4.11	0.124	0.05	45.8	22	9.3	7.6	1.9	9.8	4.9	1.7
	PbC_1	0.76	0.082	2.74	5.1	32	4.7	0.9	19.7	0.2	1.4	0.1
	PbM_1	6.49	0.095	0.22	14.0	17	12.9	9.2	13.5	4.7	6.0	3.8
	PbC_2	0.32	0.083	5.66	3.4	51	2.6	0.4	17.1	0.1	0.9	0.0
	PbM_2	0.44	0.081	0.62	6.4	19	6.2	0.5	2.6	0.1	0.5	0.1
	PbC	0.16	0.094	9.87	3.9	81	1.8	0.2	14.9	0.1	0.7	0.0
	PbM_3	0.16	0.072	1.45	2.8	21	3.3	0.2	2.2	0.0	0.2	0.0

TAB. 25, Confirmation tests (4. Ore-C, No. 2)

Test No.	Product	Weight	grade					recovery				
			Cu	Pb	Zn	Ag	Fe	Cu	Pb	Zn	Ag	Fe
		%	%	%	%	g/t	%	%	%	%	%	%
9 − 2 8	Feed	100	0.069	0.11	20.4	18	21.2	100	100	100	100	100
	PbRC	7.63	0.093	0.48	13.3	18	12.5	10.2	34.4	5.0	7.8	4.5
	tail	92.37	0.068	0.08	21.0	18	21.9	89.8	65.6	95.0	92.2	95.5
	ZnRC	35.81	0.161	0.05	52.4	27	6.3	83.3	17.9	92.1	53.8	10.7
	Tail	56.56	0.008	0.09	1.0	12	31.7	6.5	47.7	2.9	38.4	84.8
	ZnC_1	29.68	0.182	0.05	58.9	29	4.5	77.8	13.9	85.8	47.9	6.3
	ZnM_1	6.13	0.062	0.07	20.9	17	15.3	5.5	4.0	6.3	5.9	4.4
	ZnC	26.26	0.190	0.05	60.2	29	4.1	71.8	12.3	77.6	43.1	5.1
	ZnM_2	3.42	0.121	0.05	48.8	25	7.2	6.0	1.6	8.2	4.8	1.2
	PbC_1	0.74	0.083	2.99	5.1	37	5.0	0.9	20.8	0.2	1.6	0.2
	PbM_1	6.89	0.094	0.21	14.2	16	13.3	9.3	13.6	4.8	6.2	4.3
	PbC_2	0.34	0.086	5.86	3.6	57	2.1	0.4	18.7	0.1	1.1	0.0
	PbM_2	0.40	0.081	0.56	6.3	21	7.5	0.5	2.1	0.1	0.5	0.2
	PbC	0.20	0.094	8.68	3.9	77	1.8	0.3	16.3	0.1	0.9	0.0
	PbM_3	0.14	0.074	1.83	3.2	28	2.4	0.1	2.4	0.0	0.2	0.0

ANNEXED SHEETS

I APPARATUS FOR THE TEST

Equipment

Item	Equipment	Maker	Model	Spec. and Remark
Sample preparation	Sample breaker	Otsuka	R-52	125mmLx50mmW,400rpm,15kW
	Sample grinder	Otsuka	AG-6	135mmØ,420rpm,1.5kW
	Screen	San-ei	501	500mmØ,300rpm,0.4kW
Mineralogical study	Diamond cutter	Maruto	MC-420	
	Polishing machine	Marumoto	5627-62	
	Lapping machine	Marumoto	T-62	
	Lapping machine	Marumoto	7705-3	
	Reflecting microscope	Olympus	BHM	
	Camera	Olympus	PM104A	
Study of charactor of the ore	Apparatus of work index	Ogawa	OSK141	Hardgrove method
	Apparatus of real specific gravity			Picnometer method
	Apparatus of settling velocity			Mess cylinder method
Mill test	Ball mill	Kyokuto	B-1	153mmØx174mm,0.1kW
	Flotation machine	Ohta machinery	MS	150g/batch,750∿2,800rpm, 200W
	Flotation machine	Ohta machinery	MS	500g/batch,750∿2,800rpm, 200W

(1) for Sample preparation

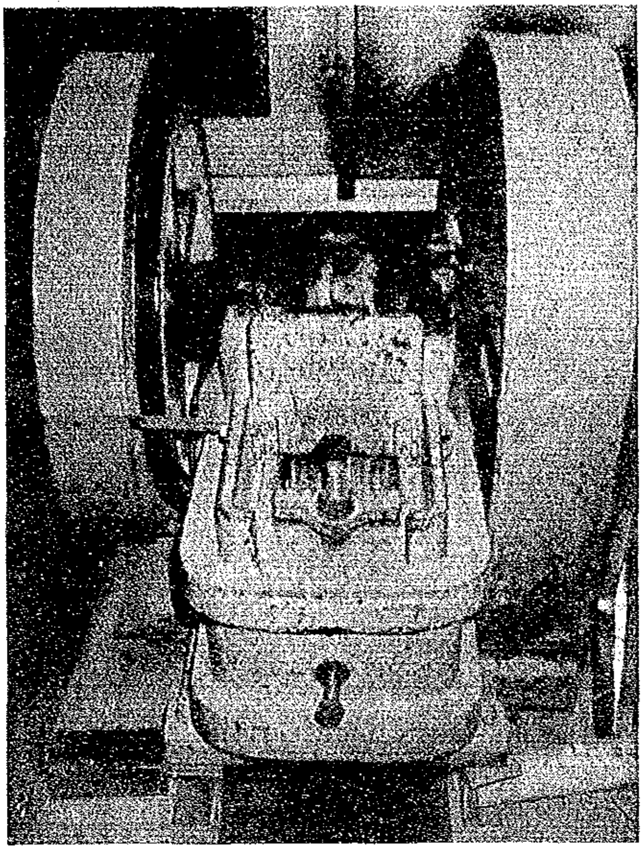

Photo. 1

Sample breaker for coarse grinding

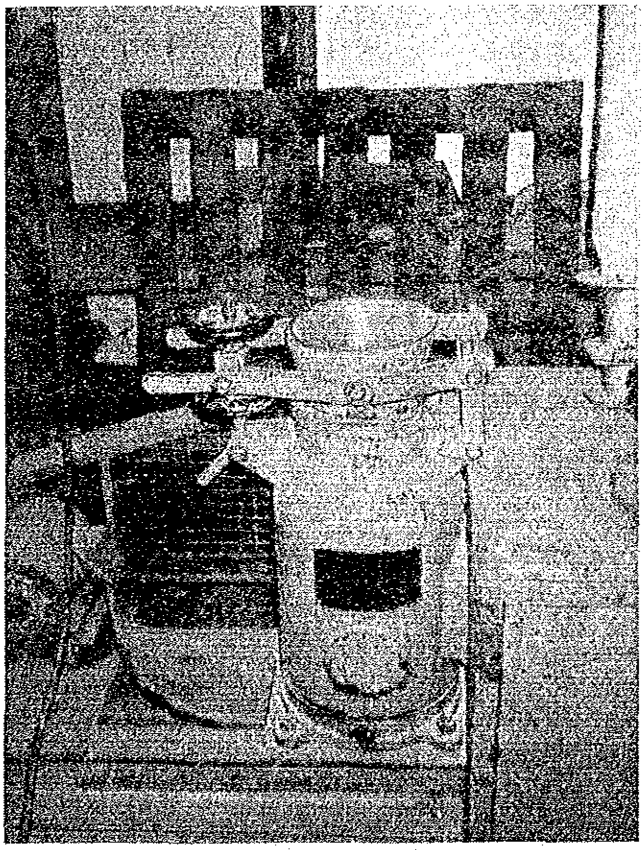

Photo. 2

Sample grinder for fine grinding

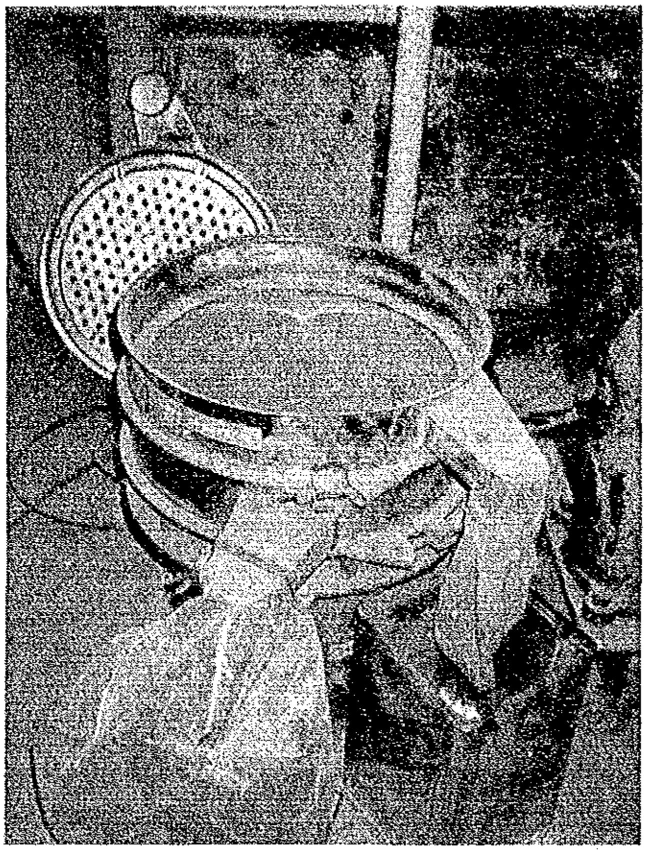

Photo. 3
Screen

(2) for mill tests

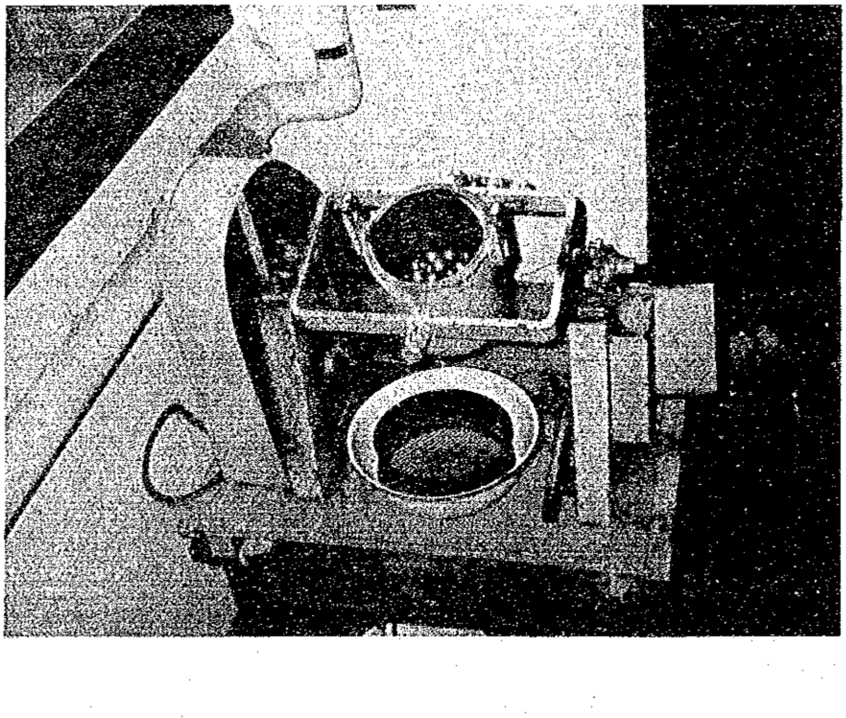

Photo. 4
Ball mill
in batch scale

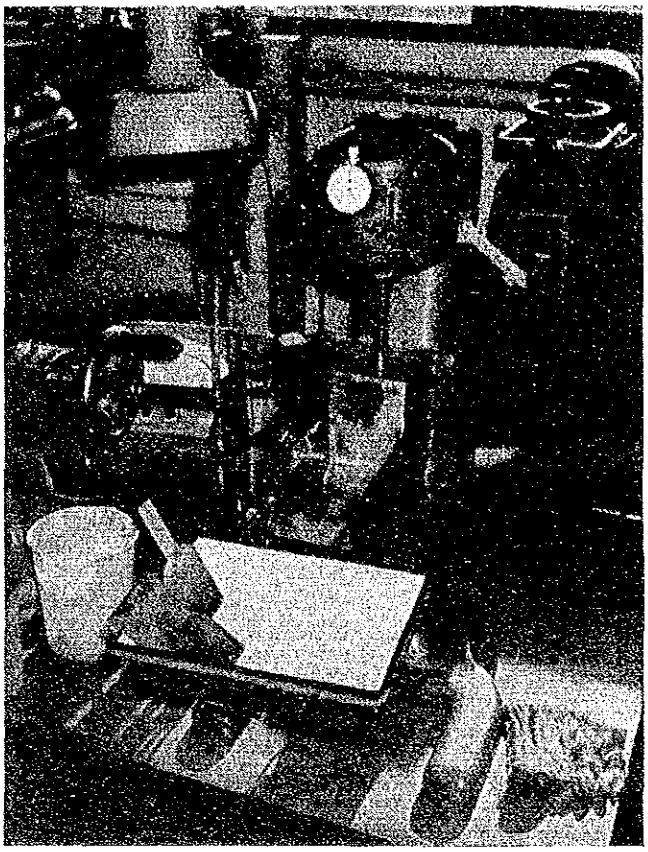

Photo. 5

Flotator (for 500 gr.) in batch scale

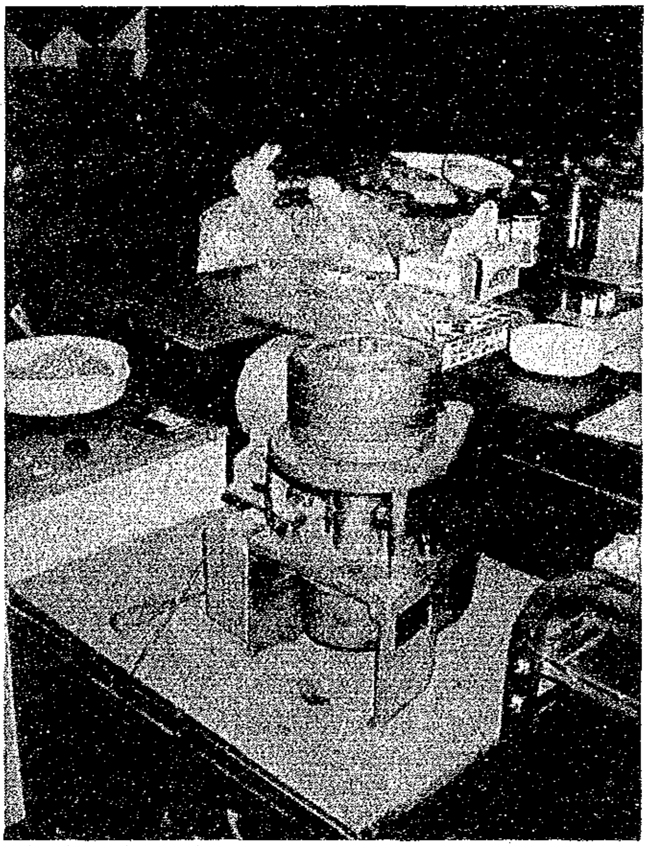

Photo. 6

Hardgrove testing apparatus