REPORT ON MINING DEVELOPMENT PLAN

OF

VALE DO RIBEIRA AREA

BRAZIL

REPORT OF METALLURGICAL INVESTIGATION

MARCH 1985

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

This report is the compilation of the result of metallurgical tests for the Mining Development Plan of the Vale do Ribeira area which was conducted on the basis of the scope of work concluded between both the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ) and the Departamento Nacional da Producão Mineral (DNPM) of the Federative Republic of Brazil in 1984.

The Perau new deposit consists of the ore minerals which are galena, sphalerite, pyrite and barite and gangue minerals such as quartz and amphibole. The grades are assumed to be around 4% Pb, 2% Zn, 80 g/t Ag and 18% BaO.

The metallurgical test, in the first, was planned for the both samples of the boring core of the new deposit and underground of the Perau mine, though, the underground samples which were collected from same ore horizon of the new deposit were provided to execute the fundamental metallurgical test because of that the drill core have been remained a small amount, after using for the other various tests, not for enough to execute the test. And the samples of the boring core were used only for the mineralogical fundamental and confirmative tests.

In the metallurgical test, the investigation of the particle size and flotation method based on the identification of the composition and occurrence of the minerals were studied to obtain the effective results of the separation and recovery of the valuable minerals. The properties of minerals were also investigated to collect the necessary data for the design of the dressing plant.

CHAPTER 2. OUTLINE OF METALLURGICAL TEST

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2–1 Name of Investigation

The metallurgical investigation for the preliminary study for the mining development plan of the Vale do Ribeira area in the Federative Republic of Brazil in 1984.

2–2 Purpose of Investigation

The purpose of metallurgical investigation is to establish the proper conditions of revoery of the valuable minerals for the ore of the silver bearing lead and zinc deposit in the Perau mine including the new ore deposit which was confirmed by the Japan–Brazil collaborative basic survey conducted from 1980 to 1983.

2–3 Period of Investigation

(1) Period of Experiment : From December 5, 1984
To January 25, 1985

(2) Period of Interpretation : From January 26, 1985
To March 9, 1985

2–4 Staffs Engaged in Investigation

Mitsubishi Metal Corporation

Supervisor Chief engineer	Naotoshi Nemoto
Engineer	Hajime Negishi
〃	Koji Kisawa
〃	Eitaro Hashimoto
〃	Tetsuo Nishimoto
〃	Masaji Usukura
〃	Toyosaburo Miyazaki

2–5 Place of Investigation

Mitsubishi Metal Corporation Central Research Institute

297 Kitabuskurocho–1, Omiyashi, Saitama Prefecture

2–6 Devices of Investigations

The devices used for various tests are shown in Table 1, and the detailes of devices and tests works are shown in Photo 1 to Photo 12.

Table 1 Test Devices

	Devices	Maker	Type	Remarks
Preparation of sample	Jaw crusher	Otsuka Ironworks	–	160L x 130W, 1.1 kW
	Roll crusher	Sato Manufactory	–	150W x 200φ, 250 rpm, 1.5 kW
	Disc mill	Kasuga Manufactory	BS-230	Preparation of sample
	Ro-tap shaker	Itoh Manufactory	03-501	290 rpm, stroke 28 mm
	Sample grinder	Ishikawa Factory	AGA	Preparation of sample for analysis
Identification of ore minerals	Bakelite solidification machine	Sugimoto Ironworks	–	Preparation of polished section
	Ore polishing machine	Marumoto Industries	Two-axis type 5627-51	"
	Automatic polishing machine	Struers	DP-U4	"
	Polarisation-microscope	Leitz	POL	Identification of minerals
Investigation of physical properties	W.I. measuring machine	Yoshida Manufactory	–	Hardglove method
	Determination of specific gravity	–	–	Pycnometer method
	Measurement of settling velocity	–	–	Measuring cylinder method
Flotation	Ball mill	Sugimoto Ironworks	–	150φ x 180W, 0.2 kW
	Flotation Machine	Denver Equipment	D-1	1200 ~ 1500 rpm, 0.2 kW
Analysis	EPMA Analyser	Japan Electronics	JCXA 733	Identification of minerals and elements
	X-ray Diffractometer	Philips	PW 1710	Identification of mineral composition
	Atomic absorption spectrophotometer	Nippon Jarrell Ash	PA-782	Microanalysis of elements
	Double-beam spectrophotometer	Hitachi Ltd.	200-20	Colorimetric analysis
	Inductively Coupled Algon Plasma Emission Spectrophotometer	Nippon Jarrell Ash	ICAP-575	Sequencial-multi system
	Fire Assaying Equipments			
	· Heavy oil furnace	Osaka Heavy Oil Furnace Manufactory	AF-30	For analysis of Au and Ag
	· Elema electric furnace	Toyo Konetsu Industries	CH-20	"
	Sulfur analysis device	Siliunit High-Temperature Ind.	TMH-2F	For analysis of sulfur

CHAPTER 3 METHOD OF METALLURGICAL TEST

CHAPTER 3 METHOD OF METALLURGICAL TEST

3–1 *Mineral Identification*

Tests were made in mineral identification on the following items for the purpose of obtaining the basic data required for flotation test by clarifying the mineral composition and the occurrence of minerals.

(1) Analysis of the components contained

(2) X-ray diffraction

(3) Microscopic observation

(4) EPMA (Electron Probe X-Ray Microanalyser)

3–2 Flotation Tests

Flotation Tests were preliminarily made for No. 1 and No. 2 ores. To select the conditions of flotation for recovering effectively the valuable minerals, the basic tests of each flotation process and the confirmative test were carried out on the basis of the result of the mineral identification tests mentioned above.

The items of the tests are described as follows;

(1) Preliminary test

(2) Basic test

1 Pb Flotation

(i) Comparative tests for performance of various collectors

(ii) Comparative tests for grinding time

(iii) Comparative tests for determination of pH

(iv) Test of collector in variable quantities

2 Ba* Flotation

(i) Comparative test of pH

(ii) Test of collector in variable quantities

(ii) Test of amount added of Sodium Oleate and Water Glass

3 Zn, Py** Flotation

(i) Comparative test of pH

(ii) Test of collector and activator in variable quantities

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* Ba : Abbreviation of Barite or Barium Sulfate

** Py : Abbreviation of Pyrite or Iron Sulfide

4 Test for confirmation

3–3 Test of Physical Properties

The following tests were made to obtain the basic data necessary for design of dressing plant.

(1) Specific gravity of ore minerals

(2) Determination of W. I. (Work Index)

(3) Grinding test

(4) Settling test of flotation tailings

(5) Analysis of waste water

CHAPTER 4 RESULT OF METALLURGICAL TEST

CHAPTER 4 RESULT OF METALLURGICAL TEST

4–1 *Investigation of Characters of Samples*

4–1–1 Kinds of Samples

The samples received include three kinds of ores such as the one consisting of the pieces of boring core, splitted and mixed up by those of the intersections in the hole AG–05 (at the depth of 355 m, 358 m and 354.65 m) and the hole AG–06 (at the depth of 327.60 m and 327.75 m), and other two kinds of ores from the Perau mine including the massive ore rich in barite and another massive ore rich in galena. These are hereafter called the Boring core, No. 1 ore and No. 2 ore respectively.

Table 2 Kinds of Tested Samples

Kinds of Samples	Form	Note
BORING CORE	Splitted core pieces	AG–05, AG–06 : 270 g
No. 1 Ore	Massive	Rich in barite : Ab. 50 kg
No. 2 Ore	Massive	Rich in galena : Ab. 50 kg

4–1–2 Analysis of Components Contained

The three kinds of ores were analyzed for each 18 components. Table 3 shows the assay results.

The values of each sample are as follows.

Kinds of Samples	Pb	Zn	*T–S	BaO	Ag
BORING CORE	4.4 %	3.1 %	10.5 %	36.3 %	108 g/t
No. 1 ore	5.5	0.5	7.9	29.1	53
No. 2 ore	20.7	0.4	11.6	0.21	204

*T–S : Total sulphur

No. 1 is low in Zn grade. No. 2 is high in Pb grade except in Zn and BaO grade.

4–1–3 Mineral Composition

(1) X-Ray Diffraction

X-ray diffraction test was made for each ore kinds, and the results are compiled in Table 4, and are shown in Appendix Fig. 1 to Fig. 3. While some difference of content can be seen among

Table 3 Assay of Samples

ELEMENT	BORING CORE	No. 1 ORE	No. 2 ORE.
Au (g/t)	0.03	0.50	0.83
Ag (g/t)	108	53	204
Cu (%)	0.03	0.17	0.45
Pb (%)	4.39	5.45	20.73
Zn (%)	3.13	0.50	0.35
Fe (%)	2.47	1.93	8.22
Cd (ppm)	70	23	10
Cl (ppm)	0	0	0
Bi (ppm)	0	0	0
As (ppm)	30	40	209
Sb (ppm)	34	51	163
T–S (%)	10.49	7.90	11.63
Al_2O_3 (%)	1.20	0.81	4.55
BaO (%)	36.33	29.13	0.21
P_2O_5 (%)	0.00	0.00	0.00
CaO (%)	5.96	10.93	4.40
MgO (%)	3.45	7.31	4.24
SiO_2 (%)	12.00	6.88	31.26

Table 4 X-Ray Diffraction

MINERAL	FORMULA	BORING CORE	No. 1 ORE	No. 2 ORE
Amphibole	$(Mg, Fe^{2})_7(Si\ x\ Oy)(OH)_2$	•	•	○
Barite	$BaSO_4$	◎	◎	◎
Calcite	$CaCO_3$	•	•	◎
Chlorite	$Mg_6Al\ x\ (SiO_4O_{10})(OH)_8$			○
Dolomite	$CaMg\ (CO_3)_2$	•	◎	△
Galena	PbS	◎	◎	◎
Mica	$KAl_2\ (AlSi_3O_{10})(OH)_2$	•	•	◎
Pyrite	FeS_2			◎
Quartz	SiO_2	•	△	◎
Sphalerite	ZnS	◎	◎	◎
Zeolite	$(Na)m\ (Al\ x\ SiyOz)\cdot nH_2O$	•	•	•

◎ Many detected　　△ Little detected
○ Usual detected　　• Less detected

Table 5 Mineral Composition of Samples

MINERAL		BORING CORE	No. 1 ORE	No. 2 ORE
Chalcopytite	($CuFeS_2$)	0.09 %	0.49 %	1.30 %
Galena	(PbS)	5.07	6.29	23.94
Sphaicrite	(ZnS)	4.67	0.75	0.52
Pyrite	(FeS_2)	1.18	1.03	14.50
Barite	($BaSO_4$)	55.32	44.36	0.32
TOTAL		66.33	52.92	40.58

the ores from the result of X-ray diffraction, the main valuable minerals consist of barite and galena, and sphalerite and pyrite were identified in addition. The main gangue minerals include quartz and dolomite, accompanied by calcite, chlorite, mica, amphibole and zeolite.

Calculation of the mineral compositions of the chalcopyrite, pyrite, sphalerite and barite as those containing Cu, Pb, Zn Fe and Ba was made on the basis of the grades of Table 3, and the results of the calculation are shown in Table 5.

(2) Microscopic Observation

The samples shown in Table 6 were observed under the microscope to investigate the size and occurrence of minerals.

Table 6 Samples Observed under the Microscope

BORING CORE	No. 1 ore	No. 2 ore
Core pieces	Flotation feed	Flotation feed
	Pb concentrate	Pb concentrate
	Zn concentrate	Zn concentrate
	Py concentrate	Py concentrate
	Barite concentrate	Barite concentrate
	Tailing	Tailing

Notes : The objects for microscopic observation include the products of the flotation test No. 3 in regard to the No. 1 ore, and those of the flotation test No. 4 in regard to the No. 2 ore.

The state of mineral particles in microscopic observation is shown in Photo 13 to Photo 50 in the collection of test data.

In the ore of the Boring core, galena is relatively coarse-grained and forms the middling with chalcopyrite, pyrite and sphalerite. The gangue minerals are irregular in shape. Spotty chalcopyrite is contained in some part. Pyrite shows paragenetic occurrence with gangue minerals forming middling.

Regarding the No. 1 and No. 2 ores, the result of microscopic observation of flotation feed and various flotation products is shown collectively in Table 7.

(3) EPMA Test

The tests were made on the Boring core, the Pb concentrate of No. 1 ore and the Pb concentrate of No. 2 ore for the silver minerals which could not be identified by microscopic observ-

Table 7 Microscopic observation of products of No. 1 and No. 2 Ores

	No. 1 ORE		No. 2 ORE	
	Constituent minerals	Degree of liberation, the other minerals of middling	Constituent minerals	Degree of liberation, the other minerals of middling
Feed Feed	Galena 1 % Pyrite, sphalerite 0.1 % each Chalcopyrite, very small amount The remain is gangue minerals	99 %, gangue minerals pyrite	Galena 15 ~ 20 % Pyrite 15 ~ 20 % Chalcopyrite, sphalerite each < 1 % Covelline, hornite very small amount	80% pyrite, gangue mineral 80% galena, gangue mineral
Pb conc.	Galena 60 ~ 70% Sphalerite 5 % Pyrite 1 % Chalcopyrite 0.1 % Covelline very small amount	99%, mainly sphalerite 50%, pyrite, galena	Galena 60 % Pyrite 30 % Chalcopyrite, sphalerite, covelline each 1~ 2 Bornite very small amount	99%, sphalerite, pyrite 99%, galena, gangue minerals
Zn conc.	Sphalerite 45% Pyrite 45% Chalcopyrite, galena very small amount	99%, pyrite and gangue minerals 99%, sphalerite and gangue minerals	Pyrite 95 % Chalcopyrite, galena, sphalerite very small amount	100% (middling 0.1%)
Py conc.	Mainly pyrite > sphalerite 0.5% very small amount Gangue minerals : calcite 90%, barite 10%, quartz and others	100% – 1% –	Pyrite 5%, galena 1%, Sphalerite, chalcopyrite very small amount Gangue minerals: quartz (feldspar), hornblende 70 ~ 80%, calcite, barite 10 ~ 20% each	80 ~ 90 % mainly gangue minerals
Ba conc.	Barite 40 ~ 50% Calcite 50 ~ 60% Sulfide < 1%, fine-grained, mainly pyrite	each 100 %	Barite 30 ~ 40 % Calcite 50 % Quartz and others 10 ~ 20 % Sulfide 1, mainly pyrite, galena, sphalerite very small amount	100 % –
Tailing	Quartz (feldspar) 70%, calcite 10 ~ 20%, barite 10 ~ 20%, biotite < 5% amphibole < 5%, sulfide 0.1%, mainly pyrite, very fine-grained	Mostly liberated	Barite 20 ~ 30 % Calcite 5 % Quartz and others 70 ~ 80 % Sulfide 1%, mainly pyrite, galena very small amount	100 % –

ation. The results are shown in Photo 51 to Photo 79.

The result of the test leads to the assumption that, regarding the Boring core, Ag mineral of the Ag-Sb-S system exists in pyrite as andorite (Pb Ag Sb_3 S_6). The Pb concentrate of the No. 1 ore was determined at two places: the one (A) seems to be stromeyerite (Ag Cu S) of Cu–S system showing a spotty occurrence in galena which forms middling with chalcopyrite, and the other (B) filling the crack between galena and chalcopyrite. In the Pb concentrate of the No. 2 ore, Ag mineral is assumed as Ag-tetrahedrite of the Cu–S system in chalcopyrite.

4–2 Preliminary Flotation Test (Test No. 1 to No. 4)

Preliminary flotation tests were conducted for the No. 1 ore and the No. 2 ore to estimate the behavior of lead, zinc, pyrite and barite in each flotation process.

The tests were made on the conditions such as 10 minutes of grinding time, 19° to 22°C at the pulp temperature and 20 % of pulp density.

The result of the tests is shown in Appendix Table 1 and 2. These results led to the assumption in the following.

(1) For the No. 1 ORE

(i) Since the grade of copper in the feed and Pb concentrate are low, it is difficult to reccover copper concentrate.

(ii) Since the grade of zinc in the feed is low, it will be difficult to recover zinc concentrate.

(iii) It is necessary to use NaCN and $ZnSO_4$ at the same time to depress zinc and iron in lead concentrate.

(iv) Because of low recovery of lead in lead concentrate, selection of collector will be required.

(v) Because of insufficient separation of barite, selection and proper amount added of collector will be necessary investigated.

(2) For the No. 2 ORE

(i) Since the copper grade in the feed and the lead concentrate is low, it is difficult to recover copper concentrate.

(ii) Because of high grade of lead in the feed, lead concentrate was obtained in a high recovery.

(iii) Because of low grade of zinc in the feed, zinc tends to migrate to lead concentrate. Therefore, it will be difficult to recover zinc concetnrate.

(iv) Because the contents of $BaSO_4$ both in the feed and the barite concentrate are low, it will be difficult to recover barite concentrate.

4–3 Flotation Test of No. 1 ORE

The following tests were conducted to obtain the proper conditions of which are lead flotation, zinc flotation, pyrite flotation and barite flotation on the basis of the results of mineral identification and preliminary tests.

4–3–1 Flotation Test of Lead

(1) Comparative Tests of Various Collectors (Test No. 5 to No. 7–3)

In order to select the proper collector for lead flotation, the flotation test was carried out using the collectors such as IPX*, NaEX* + AP#404*, NaEX, AP#404 and AP#208*.

The result of the test is shown in Appendix Table 3 and Fig. 1.

(i) In the case of using IPX, the best recovery of lead of 88 % in lead concentrate was obtained. However, the rates of distribution of zinc and iron were 54 % and 16 % respectively, showing an insufficient depression of zinc.

(ii) In the case of using NaEX, the quantity of 20 g/t resulted in to fail in obtaining good flotation froth, and it was increased to 1.5 to three times. However, the recovery showed the figures such as 80 to 82 % in lead, 37 to 47 % in zinc and 5 to 16 % in iron, being low in lead as compared with IPX.

(iii) In the case of AP#404, the recoveries were 79 % in lead, 12 % in zinc and 2 % in iron, showing lower recovery of lead than in the case of IPX.

(iv) In the case 40 g/t of the blende of NaEX and AP#404 at the ratio of 1:1 was used, the recoveries were 85 % in lead, 56 % in zinc and 21 % in iron, showing the lower selectivity than IPX.

(v) In the case of AP#208, the recoveries were 55 % in lead, 11 % in zinc and 1 % in iron. It was proved that this reagent was improper for lead flotation, although the distribution of zinc and iron had been depressed.

It is judged, therefore, that the independent use of IPX or the use in combination with AP# 404 would lead to a higher recovery for lead flotation.

Notes: * IPX........... Iso propyl xanthate
NaEX .... Sodium ethyl xanthate
AP#404, 208 ... Aero Promoter, ACC Brand

(2) Grinding Time Variation Test (Test No. 8 to 10)

The distribution pattern of lead, zinc and iron in lead concentrate with variation of grinding time was investigated on the basis of varying time such as seven minutes, 10 minutes and 15 minutes.

The results of the test are shown in Appendix Table 4 and Fig. 2. These results led to make clear the matters in the following;

(i) While the distribution of lead in lead concentrate at the grinding time of seven minutes, 10 minutes and 15 minutes were 88 %, 89 % and 87 %, showing almost the same level, the grade was raised to the figures such as 60 %, 63 % and 68 % respectively with increasing of the grinding time.

(ii) The distribution of zinc was shown to be 54 %, 34 % and 20 %, and those of iron were 16 %, 9 % and 5 %, showing that the distribution of zinc in lead concentrate was decreased with increasing of the grinding time, and that the liberation between lead and zinc, and/or iron became better.

Above-mentioned, it is assumed that the higher degree of liberation with the grinding time of about 15 minutes will result in to prevent adulteration of lead concentrate by zinc and iron. However, since excessive grinding time tends to lower the separability by over grinding.

(3) pH Variation Test (Test No. 11 to No. 13)

It was investigated the variations of the lead, zinc and iron in lead concentrate with the change of pH. The values of pH were selected to be 6, 8.4, 10 and 11 and the flotation froth could not be recovered in condition of pH 12.

Sulphuric acid (H_2SO_4) for the acid side and lime for the alkaline side were used to control pH. The results of the test are shown in Appendix Table 5 and Fig. 3.

The result in the above make clear the following matters.

(i) The lead distribution in the lead concentrate showed the percentages such as 89, 89, 86 and 85 corresponding to the pH values such as 6, 8.4, 10 and 11 respectively, showing that a little higher values in around the neutral.

(ii) The zinc distribution in the lead concentrate showed the percentages such as 90, 34, 27 and 48, and the iron distribution 12, 9, 4 and 3 respectively, showing that Zn and Fe were depressed on alkaline side of pH 8.4 and pH 10.

As the above-mentioned, it is considered that flotation in pH 6 should be avoided because of adulteration of lead concentrate by zinc as high as 90 %, and that pH value of 8.4 is suitable because the lead distribution at this pH value is better, although the result of flotation at Ph 8.4

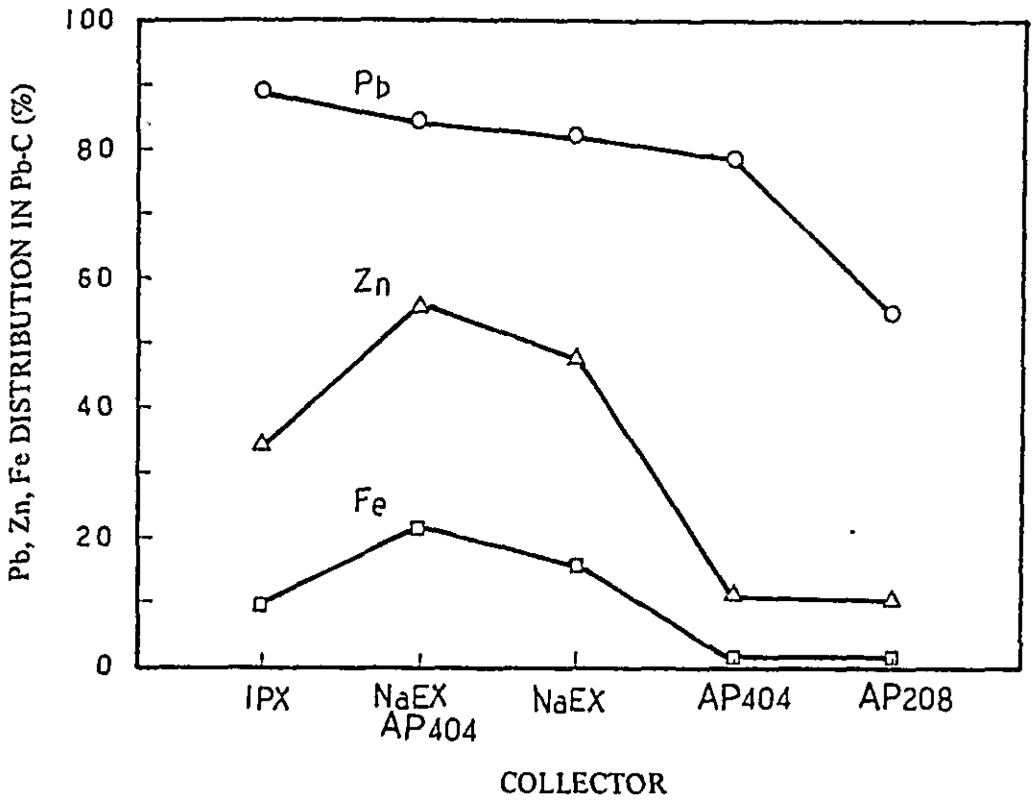


Fig. 1 Relationship between Various Collectors and Distribution of Lead, Zinc and Iron in Lead Concentrate of No. 1 Ore

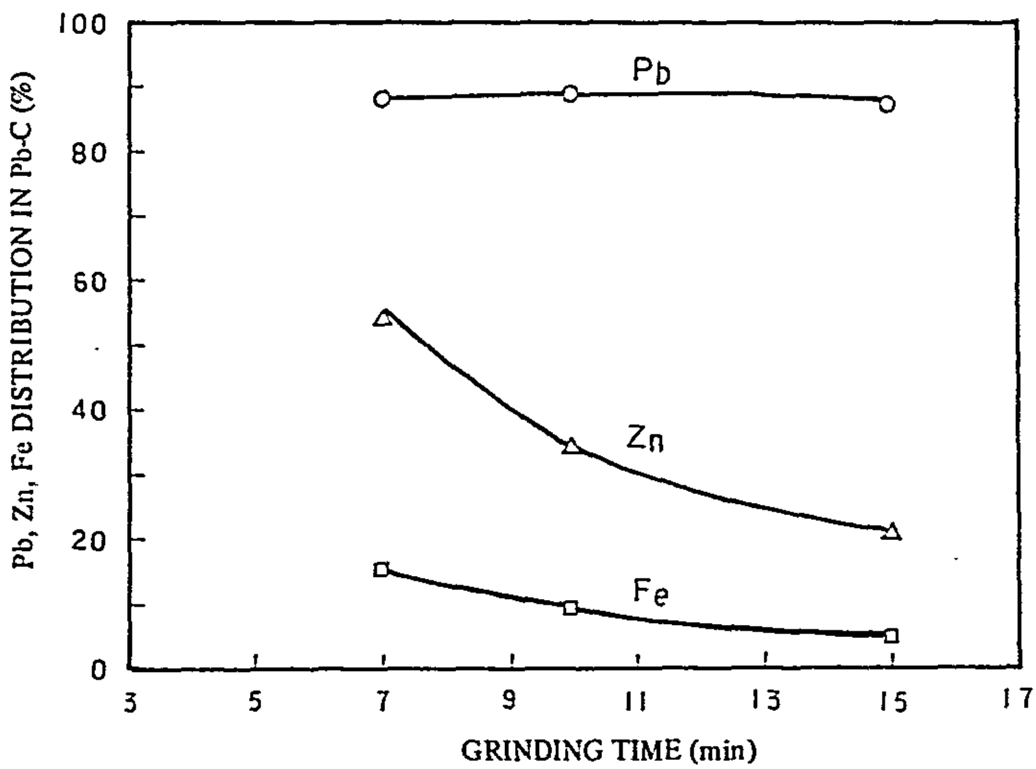


Fig. 2 Relationship between Grinding Time and Distribution of Lead, Zinc and Iron in Lead Concentrate of No. 1 Ore

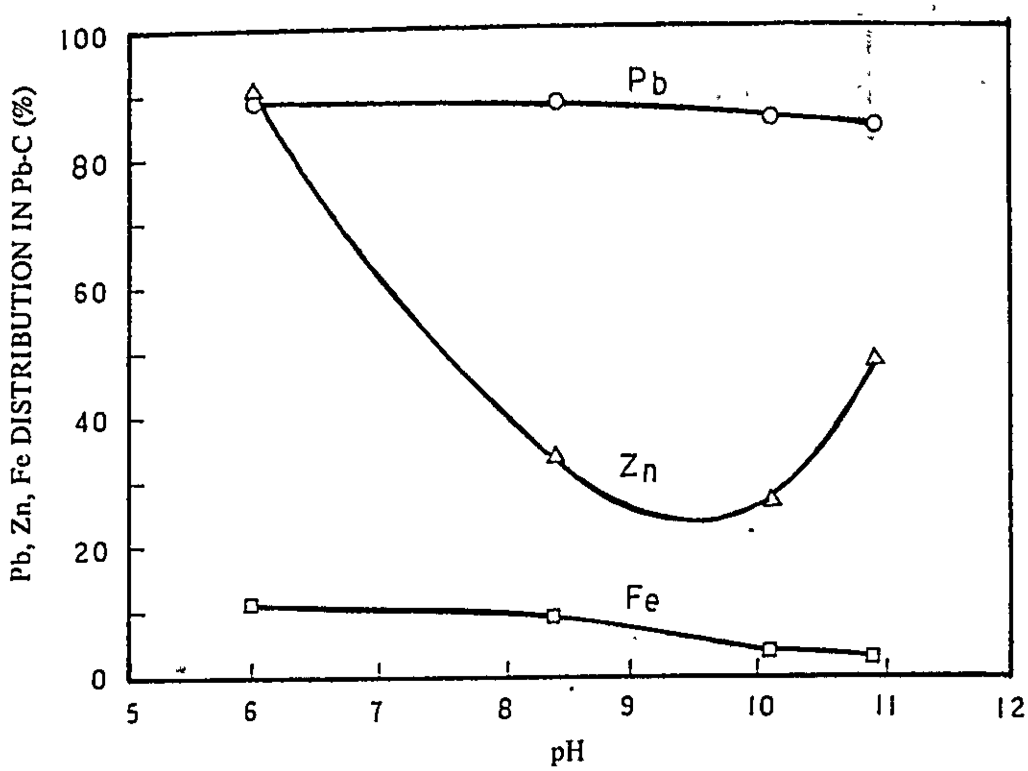


Fig. 3 Relationship between pH and Distribution of Lead, Zinc and Iron in Lead Concentrace of No. Ore

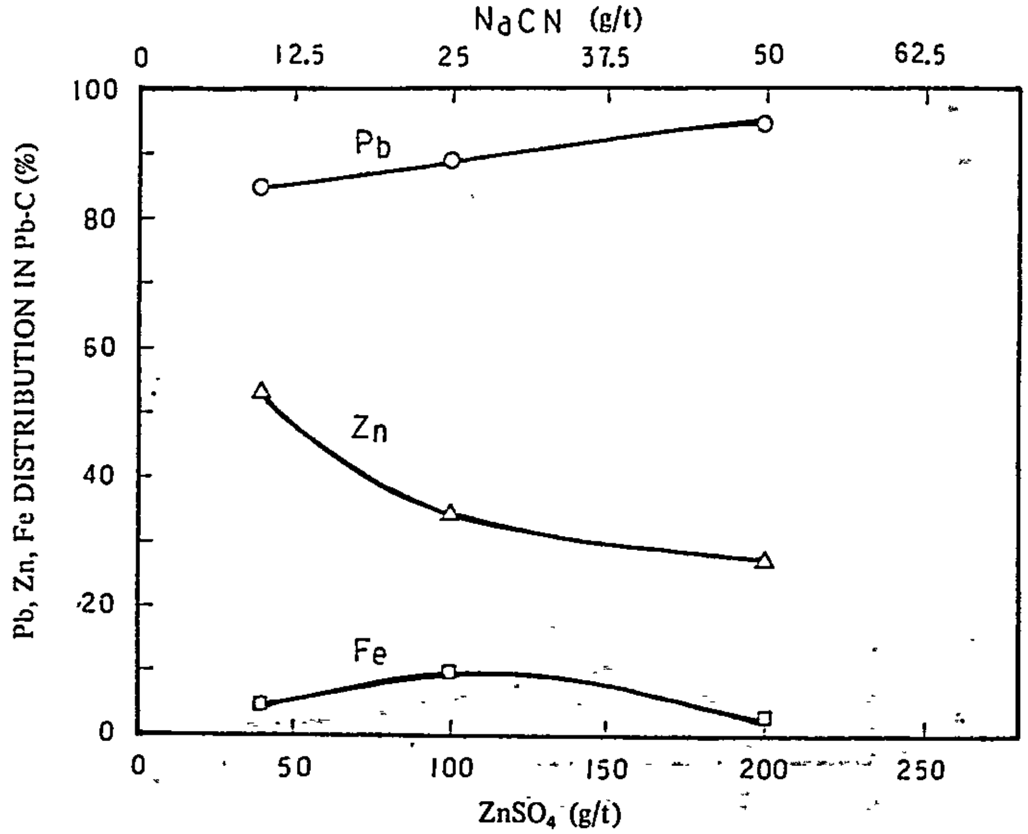


Fig. 4 Relationship between Amount of Depressant and Distribution of Lead, Zinc and Iron in Lead Concentrate of No. 1 Ore

and pH 10 are almost the same.

(4) Depressant Variation Test (Test No. 9, No. 14 to No. 16)

Since it was clarified that the depressant of NaCN in combination with $ZnSO_4$ depress zinc and iron and give a favorable effect to flotation, the distribution of lead, zinc and iron in the lead concentrate was investigated by varying the quantity of the depressants with the ratio of 1:4. The quantities of NaCN and $ZnSO_4$ were used as 10:40, 25:100 and 50:200 g/t.

The results of tests are shown in Appendix Table 6 and Fig. 4. These results led to make clear the following facts.

(i) The distribution of lead in the lead concentrate was improved in such as way from 85 to 89, and to 95 % with the increase of depressants of NaCN and $ZnSO_4$ in quantities such as 10:40, 25:100 and 50:200 g/t respectively.

(ii) The distribution of zinc and iron were lowered in such way as 53, 34 and 27 % and 5, 9 and 3 % respectively, becoming better in separability among lead, zinc and iron.

As the above-mentioned, it can be considered that the suitable quantity of NaCN and $ZnSO_4$ as depressors would be about 50 and 200 g/t.

Because of the increasing of NaCN added leads to the elution of gold and silver will have an unfavorable effect on control of water pollution, excessive quantity of NaCN should be avoided.

4–3–2 Barite Flotation Test

The tests were made on pH variation, and comparison and amount variation of a variety of collectors for the sinks after separation of lead, zinc and iron, for the purpose of selecting the proper conditions of recovering the barite concentrate.

(1) Comparative Test of pH (Test No. 17 to No. 19)

Flotation tests were conducted using AP#825 and AP#845 as collectors, and water glass as selectivity assisting agent, each 50, 25 and 200 g/t, varying pH in a range of five to seven. Flotation was tested in weak acid to neutral circuit since adulteration by gangue minerals was anticipated in alkaline circuit.

The result of the test is shown in Appendix Table 7 and Fig. 5. The following facts were made clear from the result above-mentioned.

(i) The grade and distribution of $BaSO_4$ are 56 to 13 % at pH 5,59 to 28 % at pH 6 and 58 to 43 % at pH 7 respectively, showing a more favorable result obtained on neutral side than acid side.

(2) Variation Test of Collectors (Test No. 20 to 23)

Flotation behavior of barite was investigated using collectors such as AP#825 and AP#845, and water glass as selectivity assisting agent, varying the amount of collectors. Flotation pH was kept at 7 which showed a favorable result in the previous test.

The result is shown in Appendix Table 8 and Fig. 6.

Fig. 6 shows the following facts.

(i) The collectors such as AP#825 and AP#845 showed no slectivity against barite, and a large quantity of the amount of collectors resulted in to lower the grade.

(ii) Increase of amount of water glass showed some improvement in the grade without lowering the distribution of barite.

Although the collectors such as AP#825 and AP#845 were used to recover barite, but effective separation of barite have not been obtained, therefore it is necessary to investigate other collectors.

(3) Variation Test of Sodium Oleate and Liquid Glass (Test No. 24 and No. 25)

On the basis of the knowledge obtained in the preceding clause, the variation tests were made using sodium oleate (hereafter abbreviated as NaOl) as collector and water glass as selectivity assisting agent in a ratio of amount of 2 : 3, and kerosene as frother was used as required.

Appendix Table 9 and Fig. 7 show the result of the test. The result of the Test No. 21 was also added in Fig. 7, in which barite concentrate of relatively high grade was obtained by using AP# 825 and AP#845.

The following facts were made clear from the result above-mentioned.

(i) Increase of NaOl and water glass from 400 : 600 g/t to 800 : 1200 g/t resulted in to raise the grade and distribution of the concentrate from 76 and 30 % to 86 and 65 %.

(ii) NaOl shows more selectivity for barite than AP#825 and AP#845.

Based on these, it is necessary to use a considerably large quantity of NaOl and water glass and to repeat cleaning at least five to six times.

Although the test was commenced with pH 7 taking care of the effect of gangue minerals and calcium, but finally pH rised up to 7.8. This fact suggests that a scope remains for investigation of flotation in alkaline circuit.

4–3–3 Flotation Test of Zinc and Pyrite

It was assumed as the result of the preliminary test that it was difficult to recover separately the zinc and pyrite concentrates because of low grade of zinc and pyrite in the crude ore. However, the following tests were conducted with a conception that the concentrates might be recovered even though in a small quantity, if the flotation is made on a condition suitable for recovery of the concentrates.

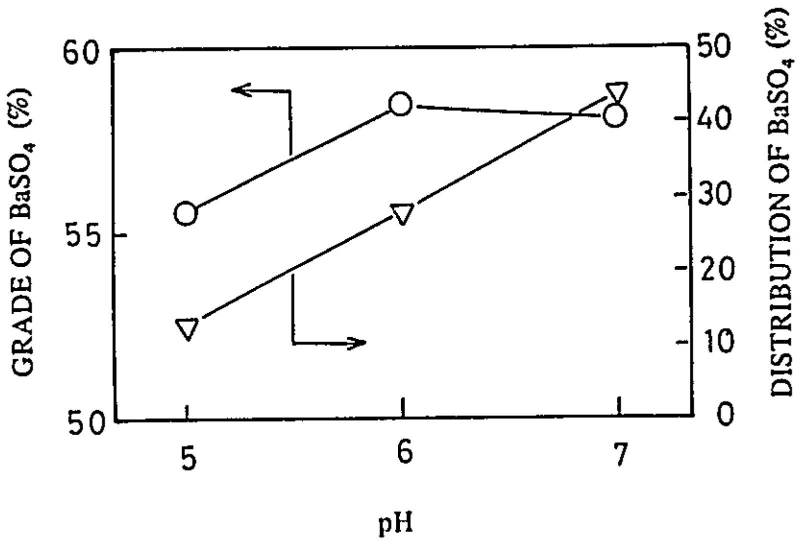


Fig. 5 Relationship between pH, and Grade and Distribution of $BaSO_4$ in Barite Concentrate of No. 1 Ore

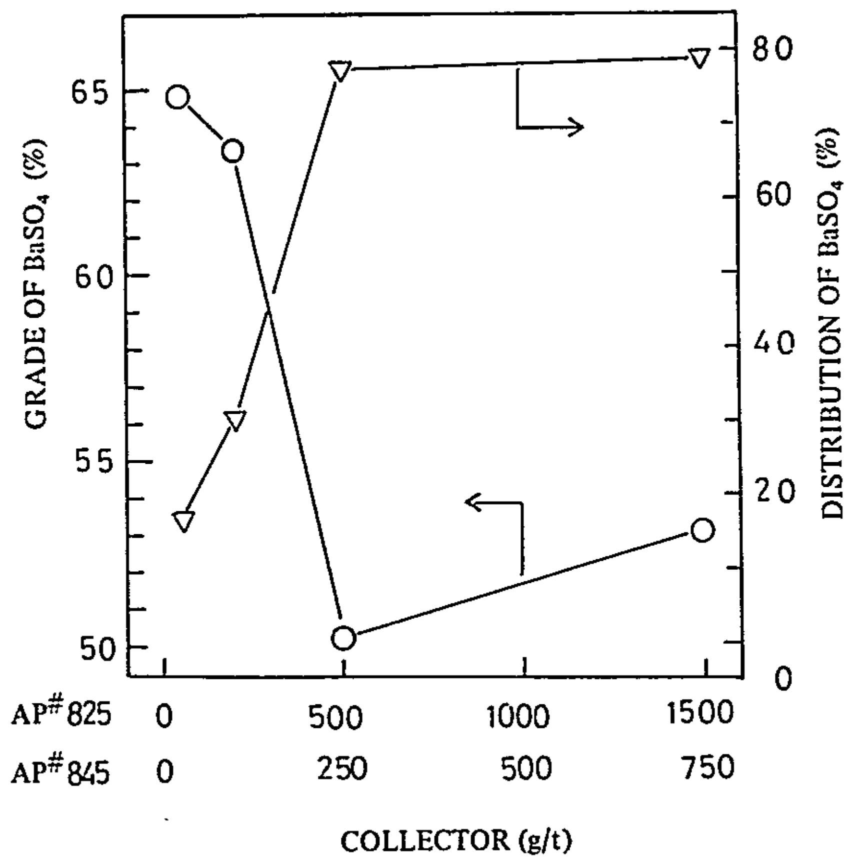


Fig. 6 Relationship between Amount of Collector, and Grade and Distribution of $BaSO_4$ in Barite Concentrate of No. 1 Ore

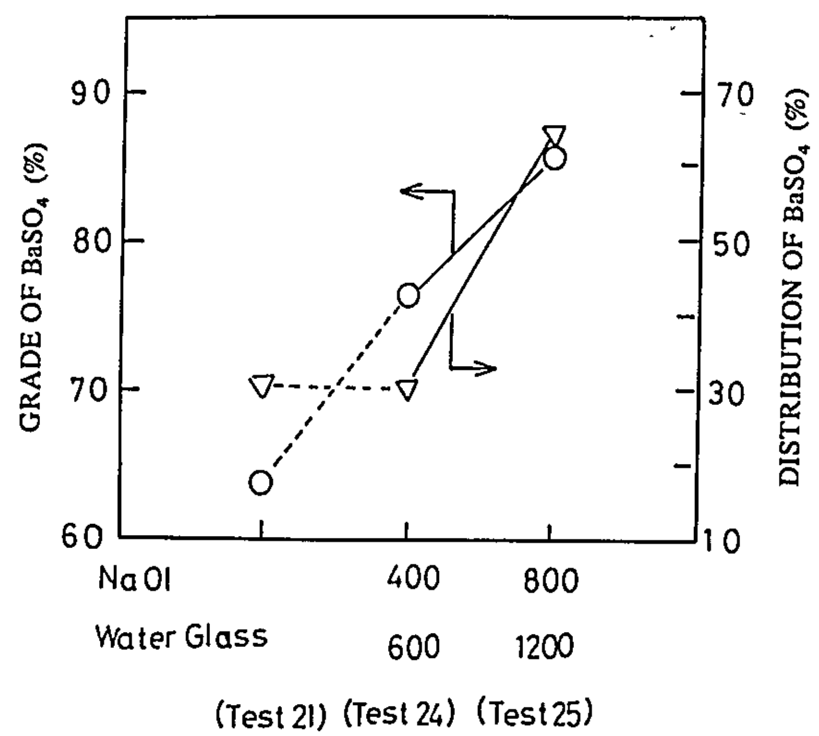


Fig. 7 Relationship between Amount of NaOL and Water Glass, and Grade and Distribution of $BaSO_4$ in Barite Concentrate of No. 1 Ore

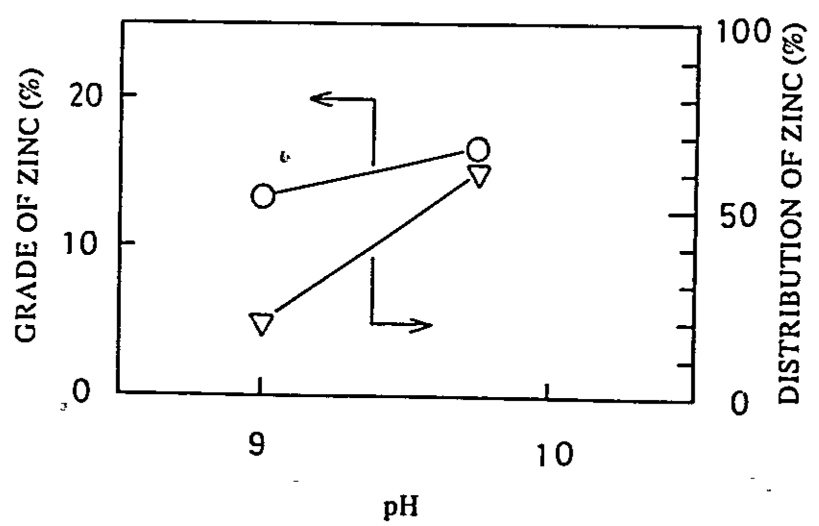


Fig. 8 Relationship between pH, and Grade and Distribution of Zinc in Zinc Concentrate of No. Ore

The pulp density was kept, in the test, to be 30 % for the recovery of these concentrate, because of low grade of zinc and iron in the feed.

(1) Comparative Tests of pH (Test No. 26 and No. 27)

Flotation behavior of zinc and iron was investigated varying flotation pH from 9 to 10 in the flotation.

In the test at pH 9, collector of AP#404 was used for the lead flotation, and IPX for the zinc and pyrite flotation. On the other hand, in the test at pH 10, combined dosage of AP#404 and IPX in a ratio of 1 : 1 was used for lead flotation and IPX was used for zinc and pyrite flotation.

Appendix Table 10 and Fig. 8 show the result of the test. The following facts were made clear from the result above-mentioned.

(i) In the case of pH 10, the grade of zinc and the distribution in zinc concentrate were raised, and iron showed the similar tendency.

Regarding the zinc cleaner tailings which is the pyrite concentrate, in the both case of pH 9 and pH 10, the following figures were shown: 0.50 % and 0.40 % in zinc grade, 4.68 % and 2.54 % in iron grade, 6.71 % and 0.22 % in zinc distribution and 9.63 % and 0.43 % in iron recovery, showing that pyrite concentrate had not been separated from zinc.

It is judged from the above that it is necessary for separation and recovery of each zinc concentrate and pyrite concentrate, to raise pH and to use the increased dosage of $CuSO_4$ as activator.

(2) Variation Test of Reagents and Comparative Test of pH (Test No. 29 to No. 31)

Test were made on zinc flocation varying pH from 10 to 11 and 12.

Appendix Table 11 and Fig. 9 show the result of the test. The following facts were made clear from the result above-mentioned.

(i) The iron grade in zinc concentrate are 26 to 28 % corresponding to pH 10 and pH 11, which was dropped to 4 % at pH 12. Therefore, it is necessary to raise pH up to 12 for separation of zinc and iron.

(ii) While the pyrite concentrate corresponds to zinc cleaner tailings (ZnCl T), the grade and distribution of iron in $ZnCl_1$ T were shown to be 22 % and 9 % at pH 12, and those of $ZnCl_2$ T were 22 % and 4 % respectively, showing a considerably high grade of iron, though the recovery is low.

Although the variative effect of reagent can not be made clear since pH was varied at the same time, it is assumed that the addition of $CuSO_4$ is effective, and consequently, the flotation around pH 12 should be required to obtain high grade zinc and pyrite concentrates from the crude ore of low content in zinc and iron.

(3) Variation Test of Reagents (Test No. 31 to 34)

The tests were made on the grade and distribution of zinc and iron in zinc flotation at pH 12 varying amount of IPX as collector and $CuSO_4$ as activator, because the effect of the amount of reagent for the separation of zinc and parite was not clarified in the previous test as described above.

Appendix Table 12 and Fig. 10 show the result of the test. The following facts were made clear from the result above-mentioned.

(i) The flotation at pH 12 will lead to produce zinc concentrate of about 50 % in zinc grade, even if the amount of reagent is varied.

(ii) The effect of IPX and $CuSO_4$ was not so great.

(iii) The recovery of zinc concentrate was as low as 30 to 50 % because of low grade of zinc in the feed. Adulteration of zinc concentrate even by small amount of other minerals brought immediate decreasing of zinc grade, leading to fluctuation of grade and distribution of zinc in the concentrate.

It is estimated, therefore, from the above that the flotation at pH 12 would lead to produce the zinc concentrate of about 50 % in zinc grade with distribution of about 40 %.

4–4 Flotation Test of No. 2 ORE

Since it is known from the result of microscopic observation that the degree of liberation of galena is 80 %, which is low as compared with 90 % of the No. 1 ore because of some difference in type of ore between the No. 1 and No. 2 ore, effect of grinding time, effect of amount of collector added as well as depressant were investigated in the lead flotation test.

Regarding the zinc and pyrite flotation, effect of pH, and effect of amount of collector as well as depressant added were investigated.

It was known that the content of barite is small from the result of microscopic observation, preliminary test and chemical analysis of samples. It was, therefore, put out of object of recovery, and no test was made.

4–4–1 Lead Flotation Test

(1) Comparative Test of Grinding Time (Test No. 35 to 37)

Tests for lead roughing and lead cleaning were conducted each one time with ball mill pulp density of 60 % varying grinding time for seven, 10 and 15 minutes, and with flotation pulp density of 20 % at the pulp temperature of 19° to 22°C.

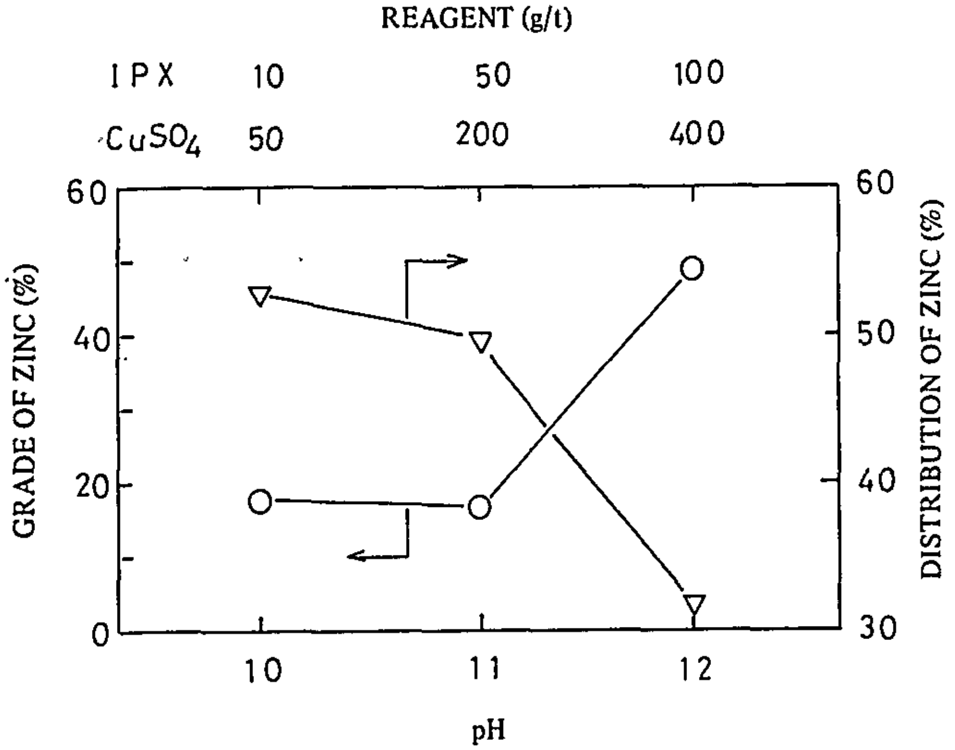


Fig. 9 Relationship between pH, $CuSO_4$ and I.P.X. and Grade and Distribution of Zinc in Zinc Concentrate of No. 1 Ore

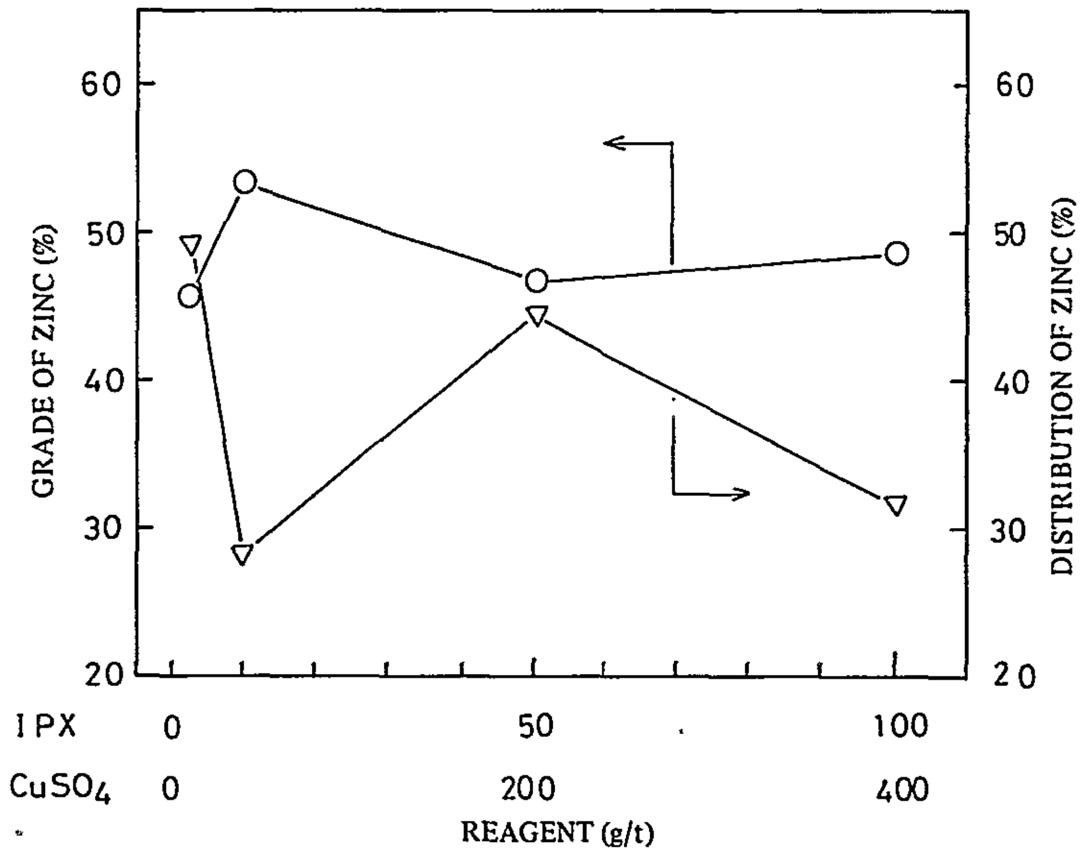


Fig. 10 Relationship between Amount of I.P.X. and $CuSO_4$, and Grade and Distribution of Zinc in Zinc Concentrate of No. 1 Ore

The result of the tests is shown in Appendix Table 13, Fig. 11 and Fig. 12. The result in the above led to make clear the following facts.

(i) Lead distribution in the lead concentrate was raised from 77 % through 82 % to 89 with the increase of grinding time such as 7, 10 and 15 minutes.

(ii) The distribution of zinc was shown to be 63, 59 and 74 % and that of iron 29, 19 and 32 %, showing the lowest values in both components at the grinding time of 10 minutes.

(iii) Lead grades in the lead concentrate were shown to be 64, 72 and 70 % corresponding to the grinding time of 7, 10 and 15 minutes, showing the highest at 10 minutes. However, the better result was indicated on the whole by the grinding time of 15 minutes from the standpoint of the lead recovery.

Thus it is assumed that the lead concentrate of high grade could be obtained with the high distribution by increasing the grinding time.

(2) Variation Test of Collectors (Test No. 38 to 41)

The distribution of lead, zinc and iron was investigated in both case of collectors using IPX independently and in combination with AP#404. The grinding time was to be 15 minutes.

The result of the test is shown in Appendix Table 14, Fig. 13 and Fig. 14. The result above-mentioned led to make clear the following facts.

(i) Increase of the amount of AP#404 and IPX from 25 + 5 g/t to 50 + 10 g/t resulted in to raise the lead distribution from 74 % to 92 %. But increase the collector further more than that, no effect of raise in lead distribution was shown.

(ii) The comparison between independent use of 50 g/t of IPX and combined use of 10 + 50 of IPX and AP#404 showed 93 % and 92 % in lead distribution in the lead concentrate, showing no difference, 79 % and 78 % in zinc distribution, and 26 % and 25 % in iron distribution, showing not much difference in either case.

(iii) The comparison of lead grades in the lead concentrate for the amount of AP#404 and IPX such as 25 + 5 g/t, 50 + 10 g/t and 100 + 20 g/t showed to be 71, 71 and 68 % respectively, showing that a little higher values were shown in the case of combined use.

As the above-mentioned, it is considered that the combination of IPX and AP#404 is more suitable for the collector in lead flotation and that the dosage will be about 10 + 50 g/t.

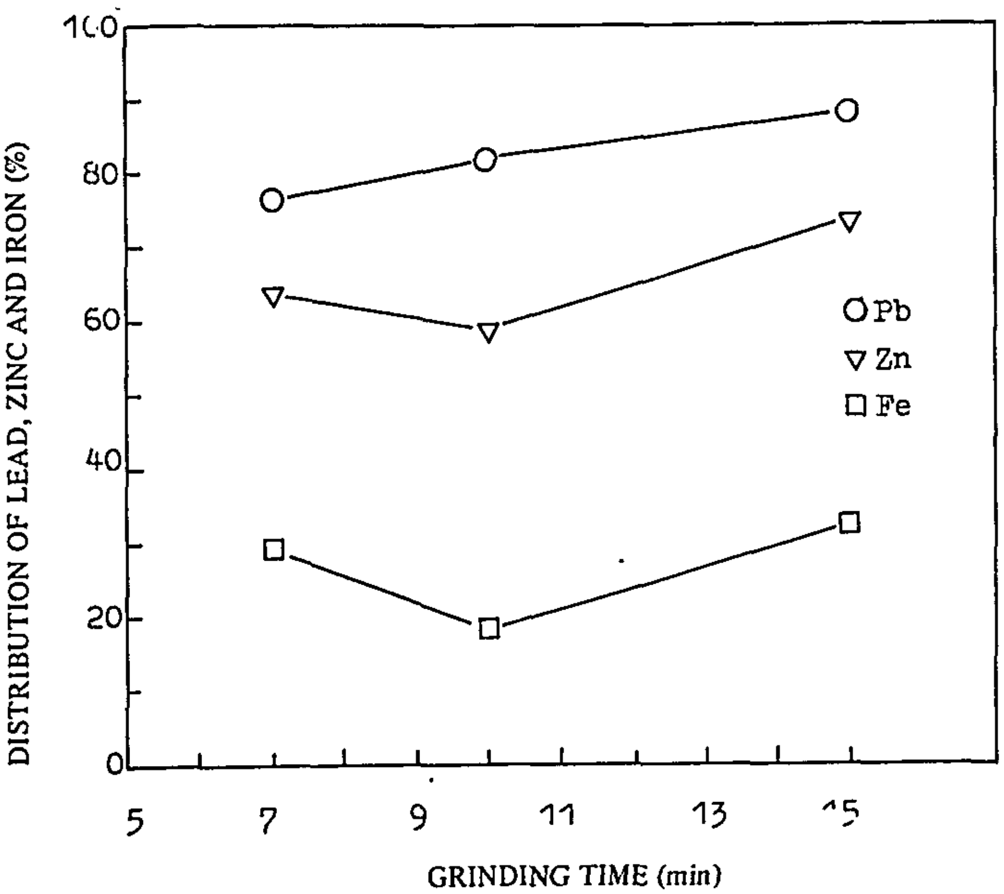


Fig. 11 Relationship between Grinding Time and Distribution of Lead, Zinc and Iron in Lead Concentrate of No. 2 Ore

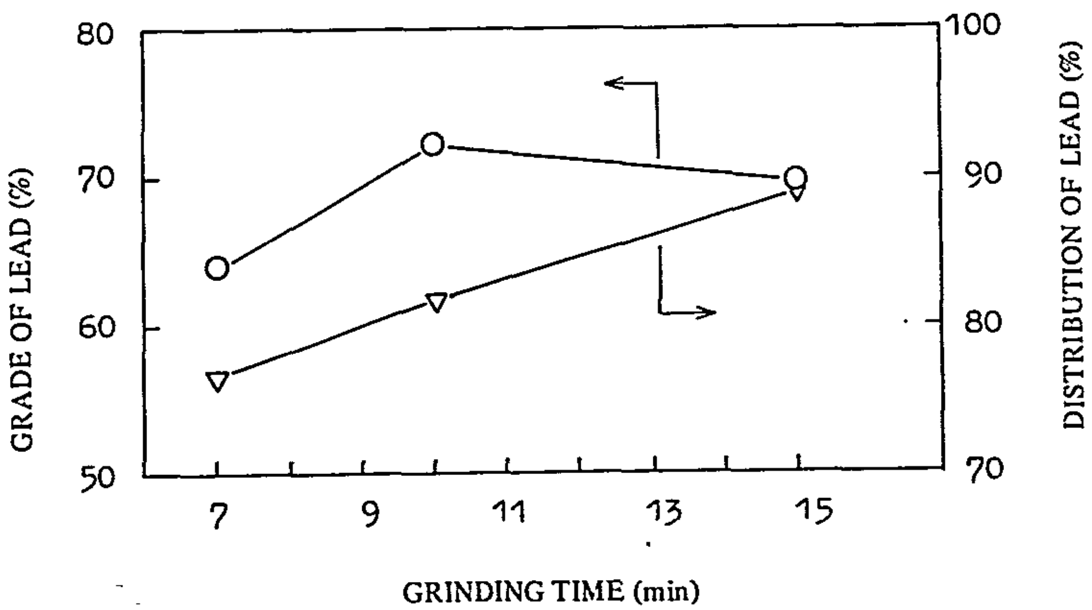


Fig. 12 Relationship between Grinding Time and Grade and Distribution of Lead in Lead Concentrate of No. 2 Ore

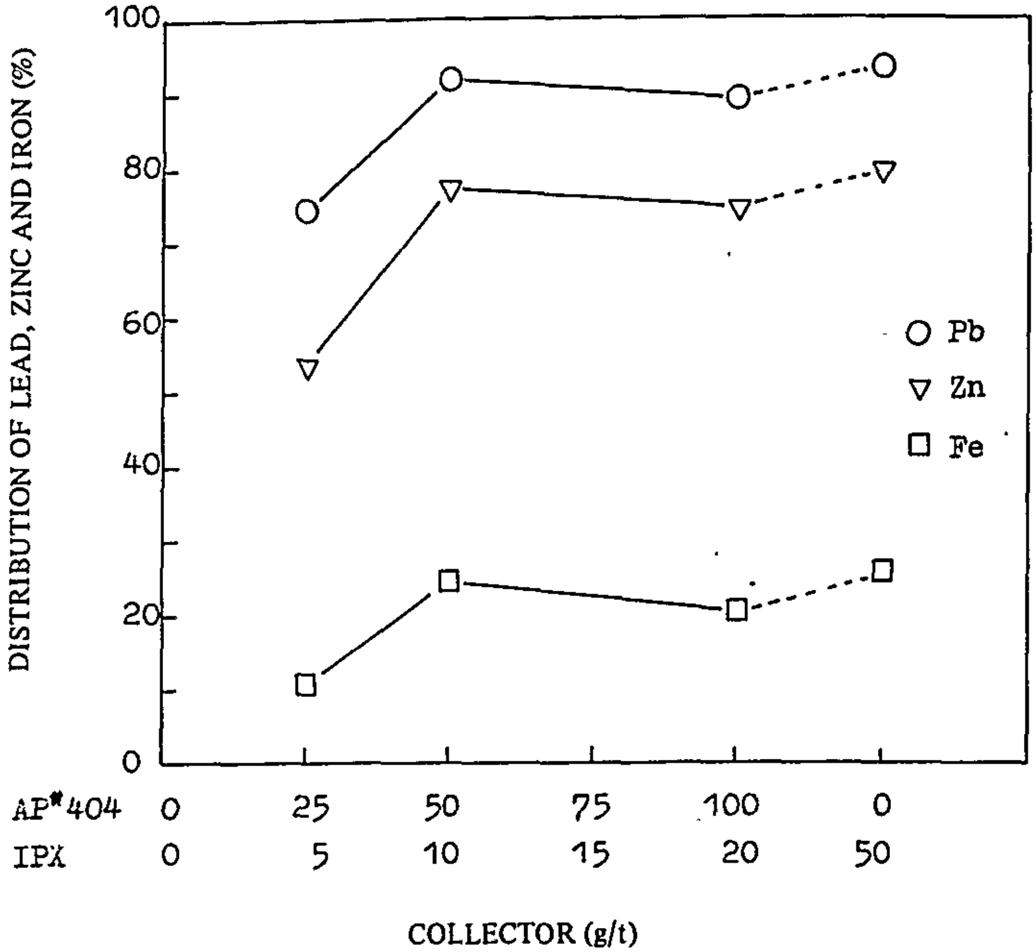


Fig. 13 Relationship between Amount of Collector and Distribution of Lead, Zinc and Iron in Lead Concentrate of No. 2 Ore

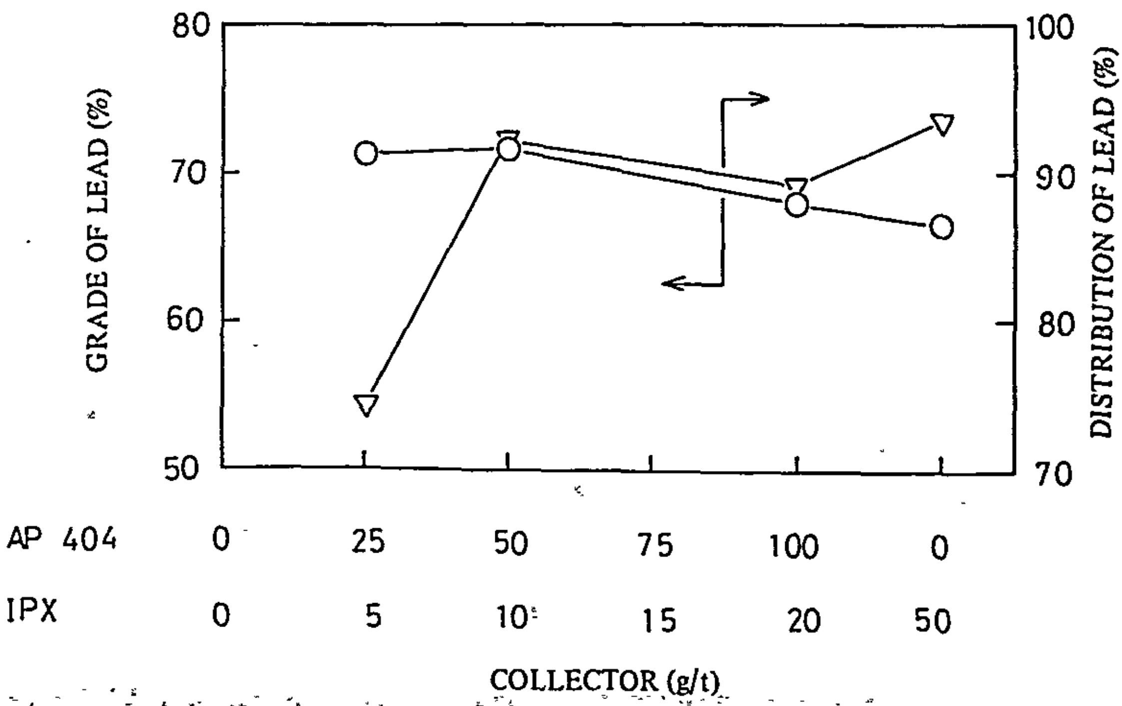


Fig. 14 Relationship between Amount of Collector, and Lead Grade and Distribution in Lead Concentrate of No. 2 Ore

(3) Variation Test of Depressant

Investigation was made on distribution of lead, zinc and iron in the case of varied addition of depressant, using 50 + 10 g/t of AP#404 and IPX as collector, which was proved to be favorable in the test described in the preceding clause, and adding NaCN and $ZnSO_4$ as depressor in a ratio of 1 : 4 for combined use.

The result of the test is shown in Appendix Table 15, Fig. 15 and Fig. 16.The result above-mentioned led to make clear the following facts.

(i) The lead distribution in the lead concentrate showed not much difference by increased the amount of depressant, showing the values of about 90 %, but the lead grade showed some rise.

(ii) In regard to distribution of zinc and iron in the lead concentrate, that of zinc was lowered from 78 % to 53 %, and that of iron from 16 % to 15 % by increased amount of NaCN and $ZnSO_4$ from 50 + 200 g/t to 100 + 400 g/t, showing the effect of depression against zinc. of depression against zinc.

It is assumed, as above-mentioned, that the amount of about 50 + 200 g/t of NaCN and $ZnSO_4$ is suitable for obtaining the lead concentrate of high grade and high distribution.

4–4–2 Flotation Test of Zinc and Pyrite

(1) Comparative Test of pH (Test No. 44 to 46)

The test was made on distribution of lead, zinc and iron in flotation of zinc and pyrite on the conditions such as grinding time of 15 minutes, 20 % in pulp density and amount of 50 + 10 g/t of collectors such as IPX and AP#404, while the value of pH were 8.3 in lead roughing, six in zinc and pyrite bulk flotation, and those varied of 10, 11 and 12 in zinc roughing and zinc cleaning. As for the pyrite concentrate, $ZnCl_2$ T described in the table was regarded as the pyrite concentrate.

The results of the test are shown in Appendix Table 16, and Fig. 17 to Fig. 20. The result above-mentioned led to the following facts.

(i) Because of the low grade of zinc in the zinc concentrate, the test in which pH was varied from 10 to 11 and 12 resulted in to show a very low grade of zinc of only four per cent, which was the highest value shown at pH 12.

(ii) Zn distribution in zinc concentrate is as 4 to 7 %, showing that most of zinc moved to most of zinc moved to the lead concentrate.
the lead concentrate.

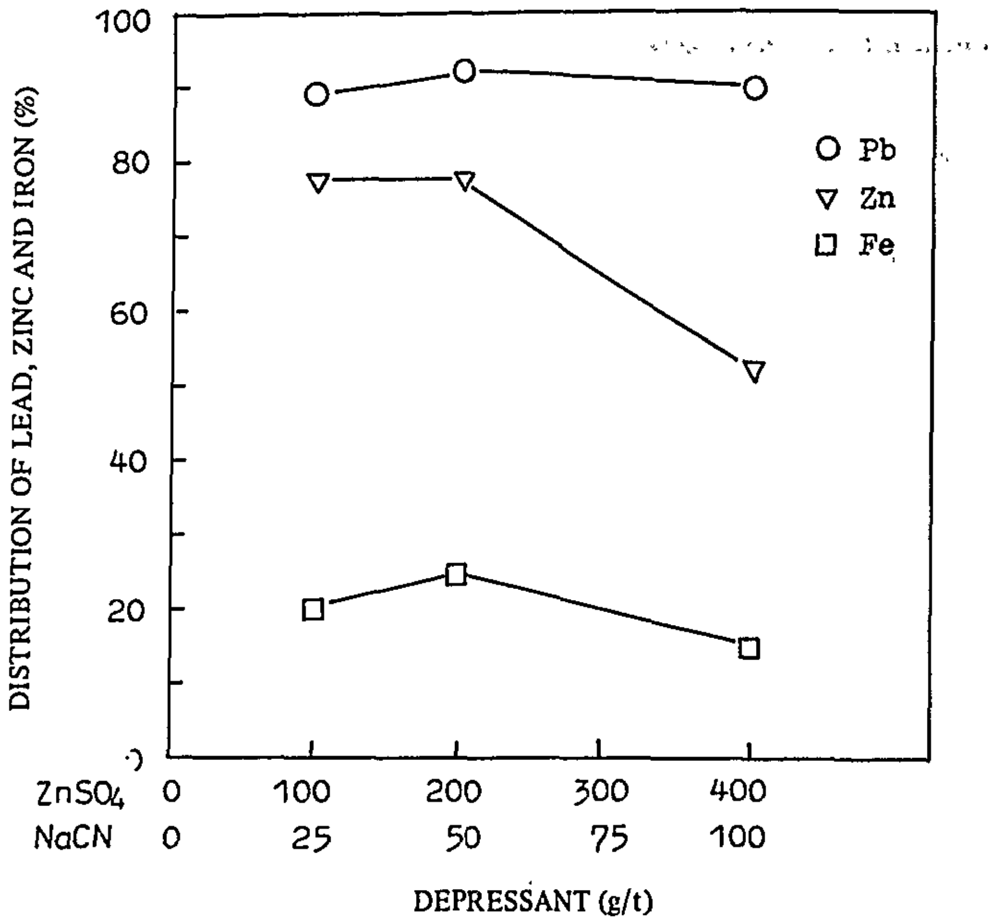


Fig. 15 Relationship between Amount of Depressant and Distribution of Lead, Zinc and Iron in Lead Concentrate of No. 2 Ore

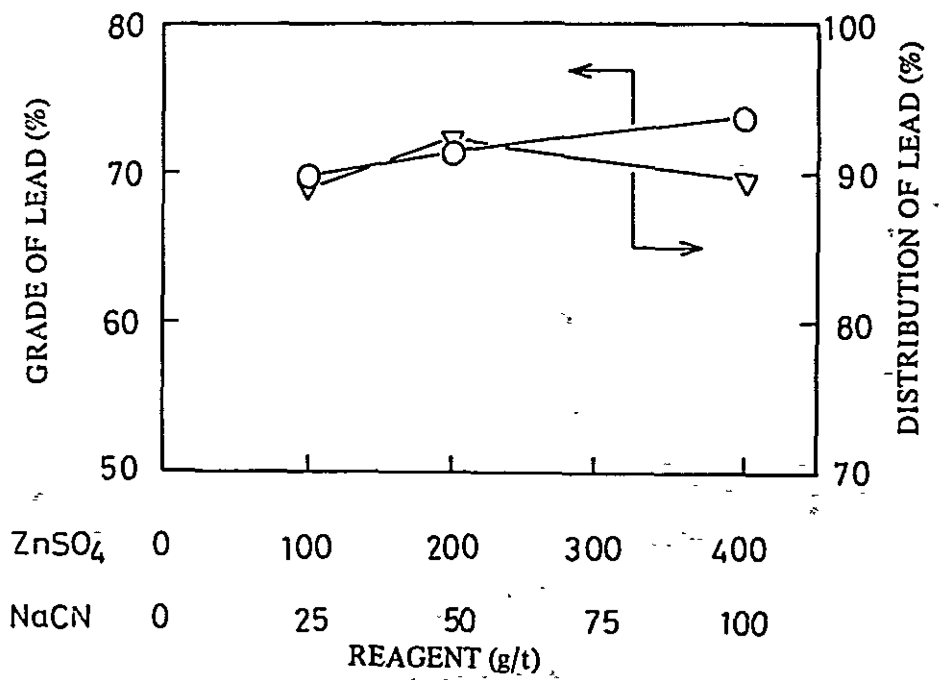


Fig. 16 Relationship between Amount of Depressant, and Lead Grade and Distribution in Lead Concentrate of No. 2 Ore

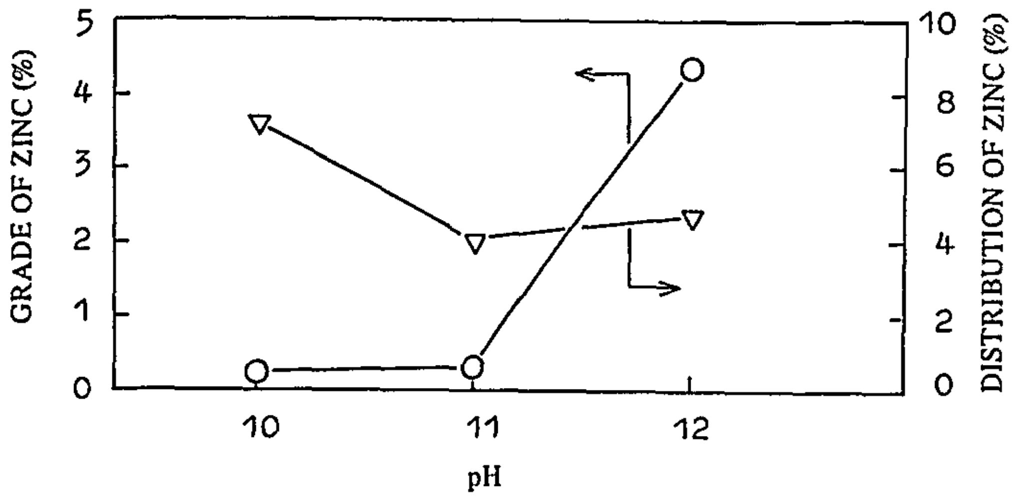


Fig. 17 Relationship between pH, and Zinc Grade and Distribution in Zinc Concentrate of No. 2 Ore

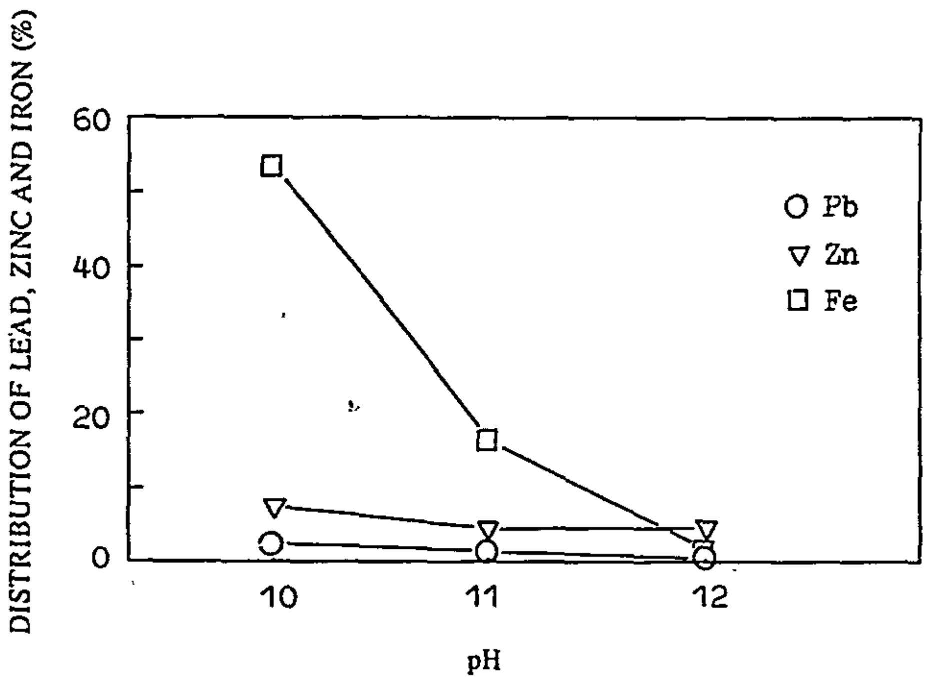


Fig. 18 Relationship between pH and Distribution of Lead, Zinc and Iron in Zinc Concentrate of No. 2 Ore

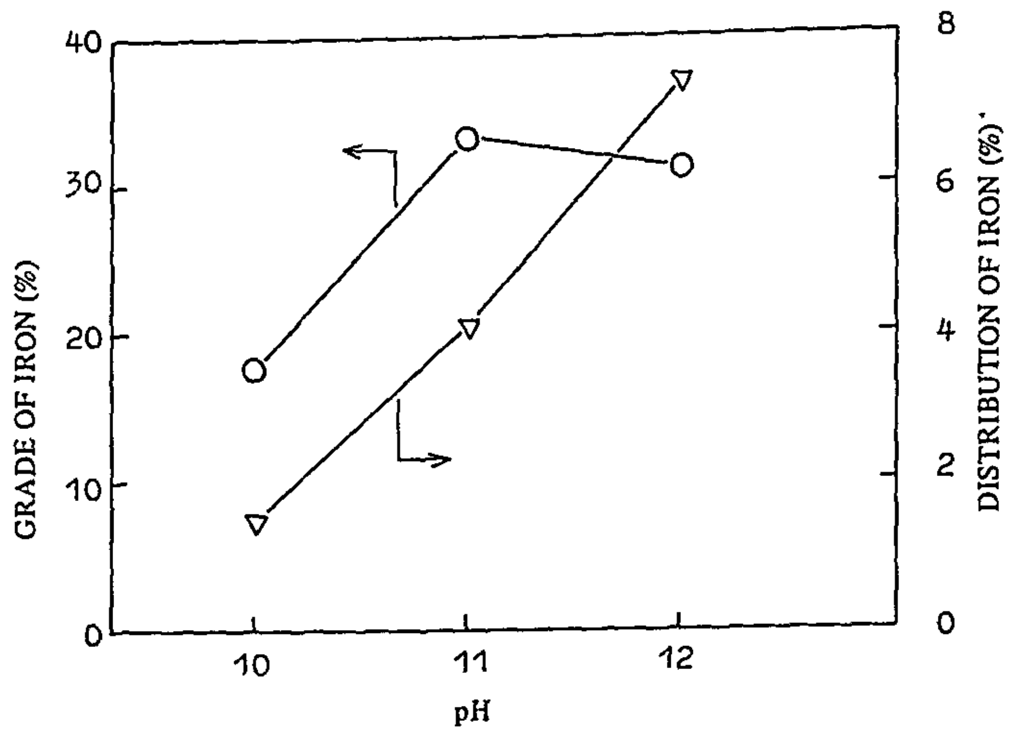


Fig. 19 Relationship between pH, and Iron Grade and Distribution in Pyrite Concentrate of No. 2 Ore

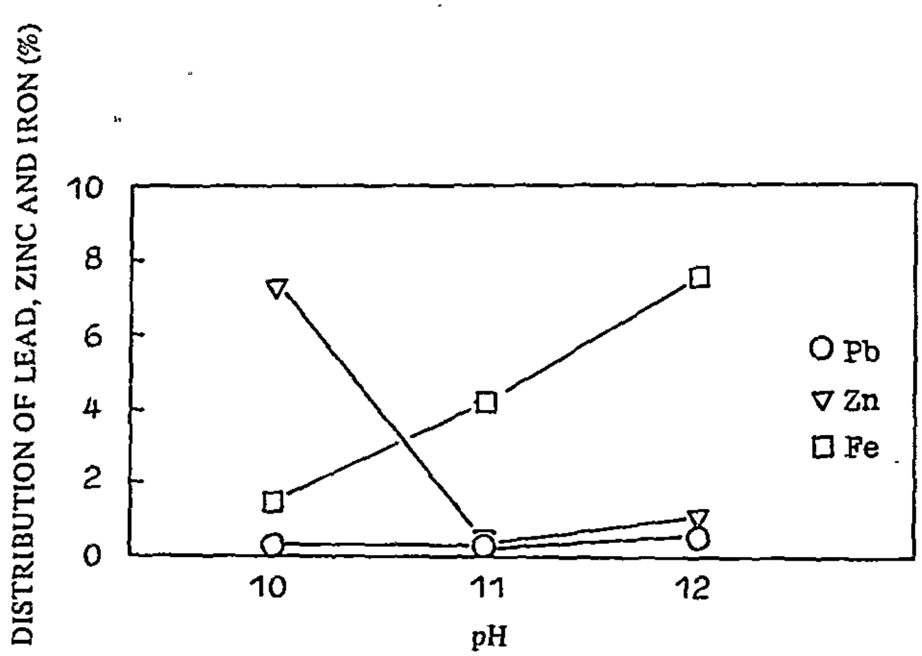


Fig. 20 Relationship between pH and Lead, Zinc and Iron Distribution in Pyrite Concentrate of No. 2 Ore

(iii) The grade and sitribution of iron in the pyrite concentrate were 18 and 2 % respectively at pH 10, 34 and 4 % at pH 11, and 32 and 7 % at pH 12, showing that pyrite concentrate can be obtained at pH 11 to 12, while the result showed the low recovery of pyrite.

(iv) High value of iron in zinc concentrate shown as 22 to 39 % leads to the judgement that separation of zinc and iron is to be difficult.

Above-mentioned, it is addumed that it is difficult to recover the zinc concentrate because of very low grade of zinc in the feed such as 0.4 % as compared with 20 % of the lead grade, although some improvement of zinc grade can be expected at pH 12 as in the case of the sample No. 1.

Regarding the pyrite concentrate, although that of iron grade of 32 to 34 % can be obtained at the high value of pH 11 and pH 12, the iron distribution was a little less than 10 %.

(2) Variation Test of Activator (Test No. 47 to 49)

Since the zinc grade of the zinc concentrate was previously described as low as 4 %, the test was made to improve the zinc grade on the conditions such as flotation pH of 12, flotation pulp density of 30 %, amount of collector PIX of 5 g/t, and varied amount of activator $CuSO_4$ such as 0, 40 and 200 g/t. $ZnCl_2$ T was used as pyrite concentrate.

The results of the test are shown in Appendix Table 17 and Fig. 21 to Fig. 24. The result above-mentioned led to make clear the following facts.

(i) Zinc grade and zinc distribution in the zinc concentrate were 9 % and 12 % respectively in the case that collector IPX of 5 g/t was used without the addition of $CuSO_4$, and 18 % and 7 % respectively in the case of the amount of 15 g/t of IPX and 40 g/t of $CuSO_4$, showing the improvement of the grade with increased amount of activator.

(ii) Iron grade of the zinc concentrate was 17 to 24 %, which proved that it was difficult to separate zinc from pyrite.

(iii) In terms of pyrite concentrate, although the iron grade and iron distribution were 21 to 22 % and 7 % respectively in both case of usage of only IPX with addition of 5 g/t and combined usage with $CuSO_4$ of 40 g/t they were 37 % and 5 % respectively in the case of combined usage of IPX of 15 g/t and $CuSO_4$ of 200 g/t, showing that the increase of amount of $CuSO_4$ resulted in to improve iron grade.

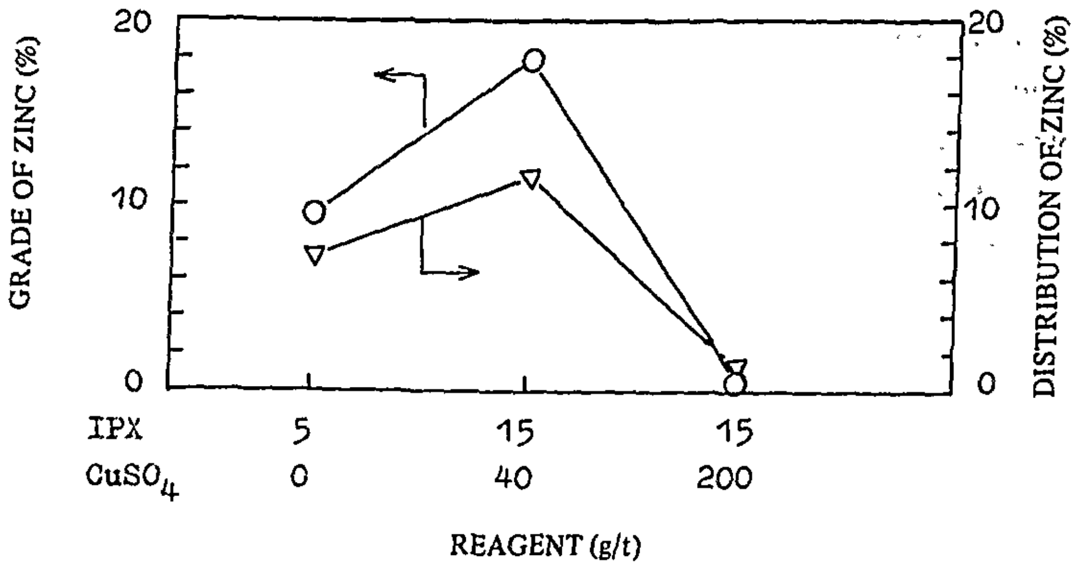


Fig. 21 Relationship between Amount of Activitor, and Zinc Grade and Distribution in Zinc Concentrate of No. 2 Ore

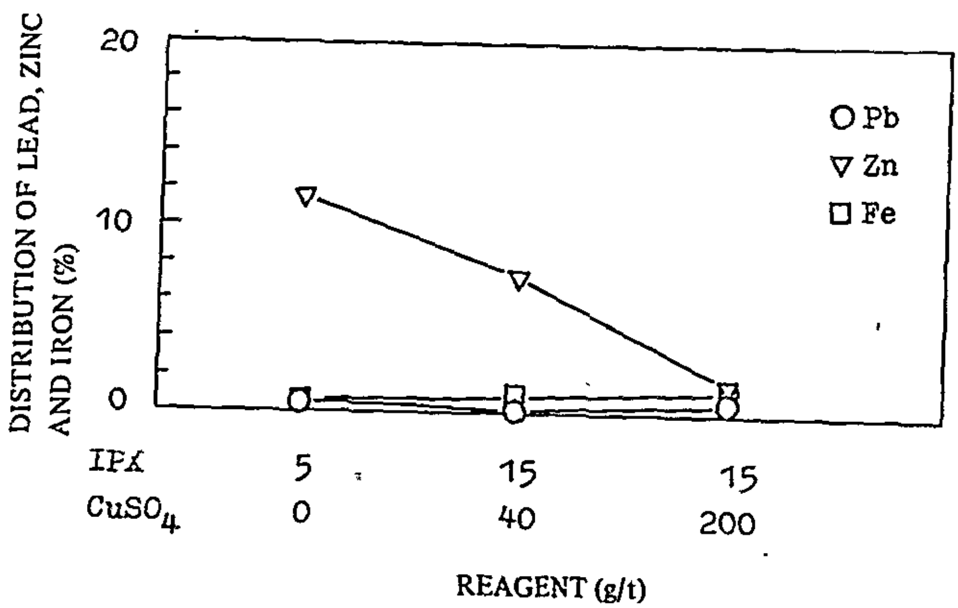


Fig. 22 Relationship between Amount of Activator and Lead, Zinc and Iron Distribution in Zinc Concentrate of No. 2 Ore

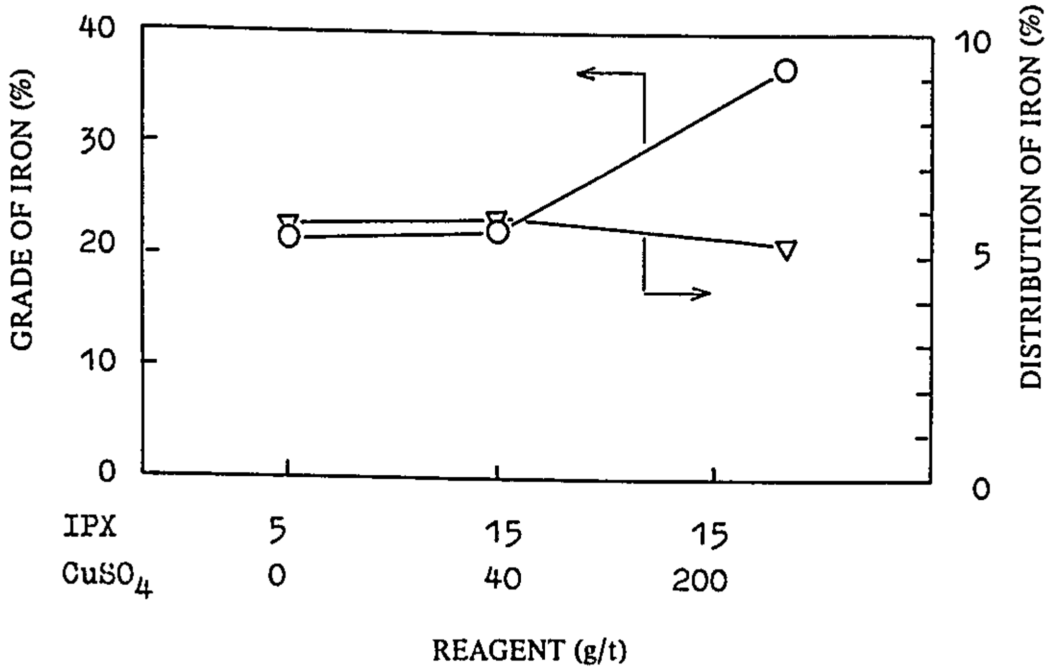


Fig. 23 Relationship between Amount of Activitor, and Fe Grade and Distribution in Pyrite Concentrate of No. 2 Ore

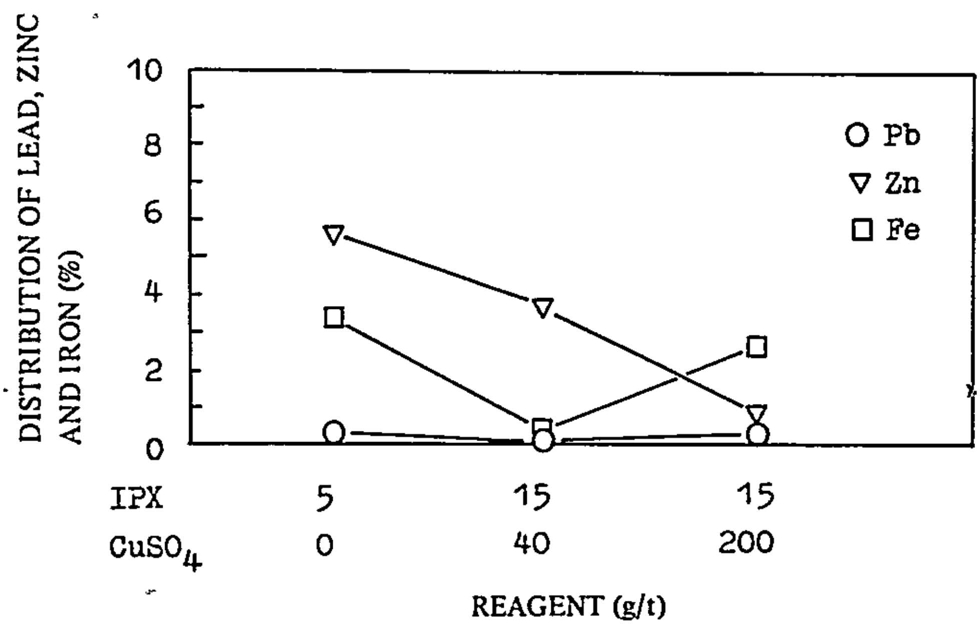


Fig. 24 Relationship between Amount of Activator and Lead, Zinc and Iron in Pyrite Concentrate of No. 2 Ore

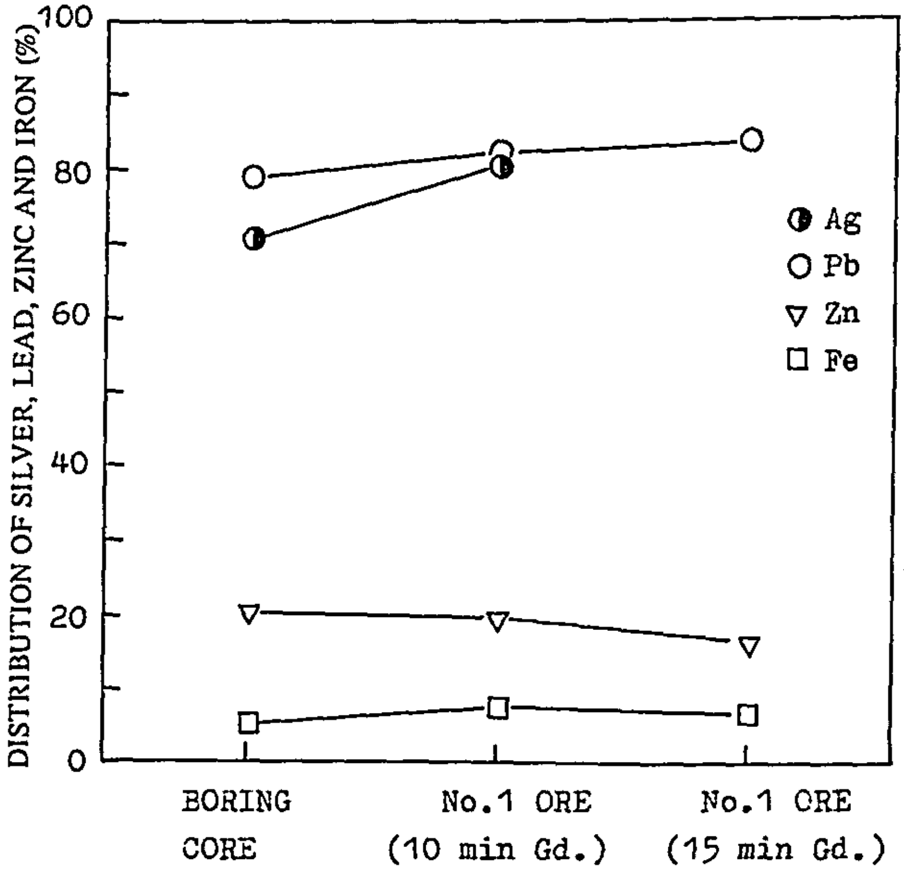


Fig. 25 Distribution of Silver, Lead, Zinc and Iron in Lead Concentrate both for No. 1 Ore and BORING CORE Sample

From the above, it is thought that too low grade of zinc in the feed led to the production of zinc concentrate of 18 % in zinc grade with distribution of only 7 %, and it is considered that the recovery of zinc is difficult.

Regarding the pyrite concentrate, when supposed that $ZnCl_1T$ and/or $ZnCl_2T$ be regarded as the pyrite concentrate, pyrite concentrate of 33 % in iron grade and 28 % in iron distribution was obtained at the time of addition of 15 g/t of IPX and 200 g/t of $CuSO_4$. Thus, it is expected that the concentrate of more than 40 % in iron grade could be obtained by further investigation of the processing system.

4–5 Confirmation Test (Test No. 50 to 52)

A series of flotation test for confirmation was conducted on the No. 1 ore and the Boring core on the basis of the proper conditions which were obtained from the preliminary tests and the basic tests so far carried out for the No. 1 and No. 2 ore.

The results of the tests are shown in Appendix Table 18 and Fig. 27 to Fig. 31, and the assay result of the components of each flotation product in Test No. 50 is shown in Table 8. These results led to make clear the following facts.

(i) 80 % of silver was recovered from the No. 1 ore and 70 % from the Boring core. It was estimated for the Boring core that more than 80 % of recovery could be obtained by repeating the process, because 16 % of silver has flowed out to the tailings of lead cleaning.

(ii) Lead recovery was 82 % for the No. 1 ore and 79 % for the Boring core. In terms of the Boring core, it is estimated that the recovery can be improved to more than 80 % by repeated processing because 11 % of lead flowed out to the tailings of lead cleaning.

(iii) The lead grade of lead concentrate was 57 % for the No. 1 ore and 37 % for the Boring core, showing a low grade in the Boring core. This is because $BaSO_4$ 27 % in grade adulterated the lead concentrate, and therefore it seems that the lead grade can be improved by depressing $BaSO_4$.

(iv) The zinc grade of the zinc concentrate was not improved by increasing the grinding time, and the recovery was lowered on the contrary.

It is likely from the above that zinc flowed out to the tailings due to overgrinding, which leads to the necessity of stage grinding.

(v) The zinc grade is about 52 % in both the No. 1 ore and the Boring core, and the zinc grade is high in the concentrate for the No. 1 ore despite the low grade of the feed.

(vi) The recovery showed a low value for the both samples such as 38 % for the No. 1 ore and 50 % for the Boring core.

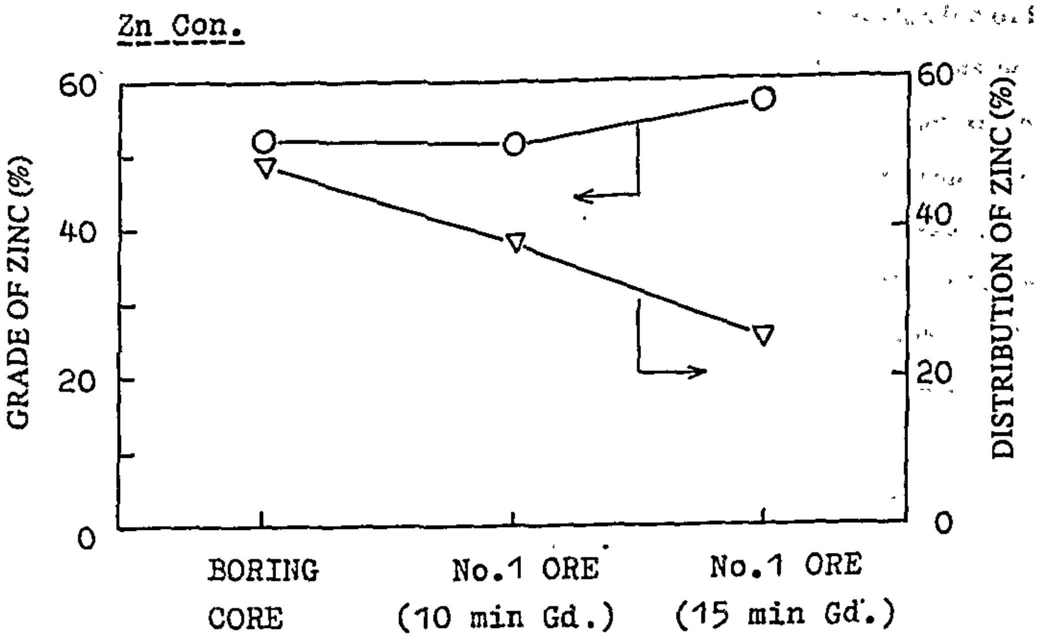


Fig. 26 Zinc Grade and Distribution in Zinc Concentrate both for No. 1 Ore and BORING CORE Sample

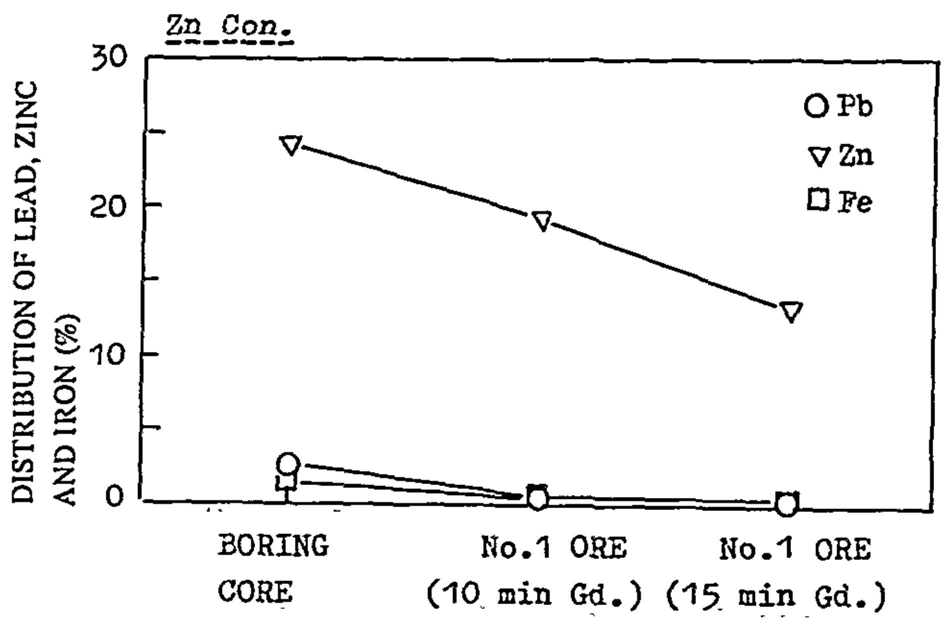


Fig. 27 Distribution of Lead, Zinc and Iron in Zinc Concentrate both for No. 1 Ore and BORING CORE Sample

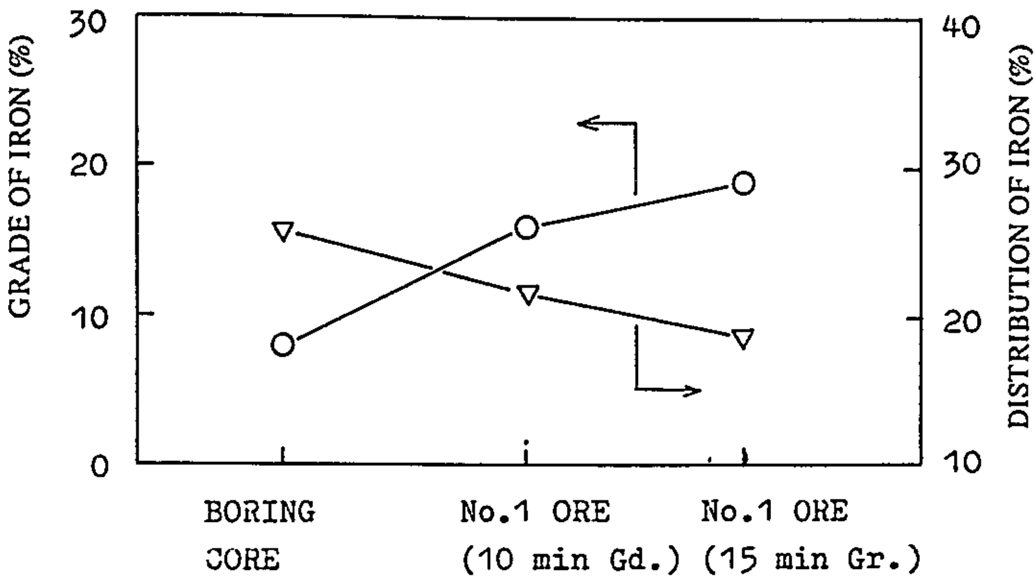


Fig. 28 Iron Grade and Distribution in Pyrite Concentrate both for No. 1 Ore and BORING CORE Sample

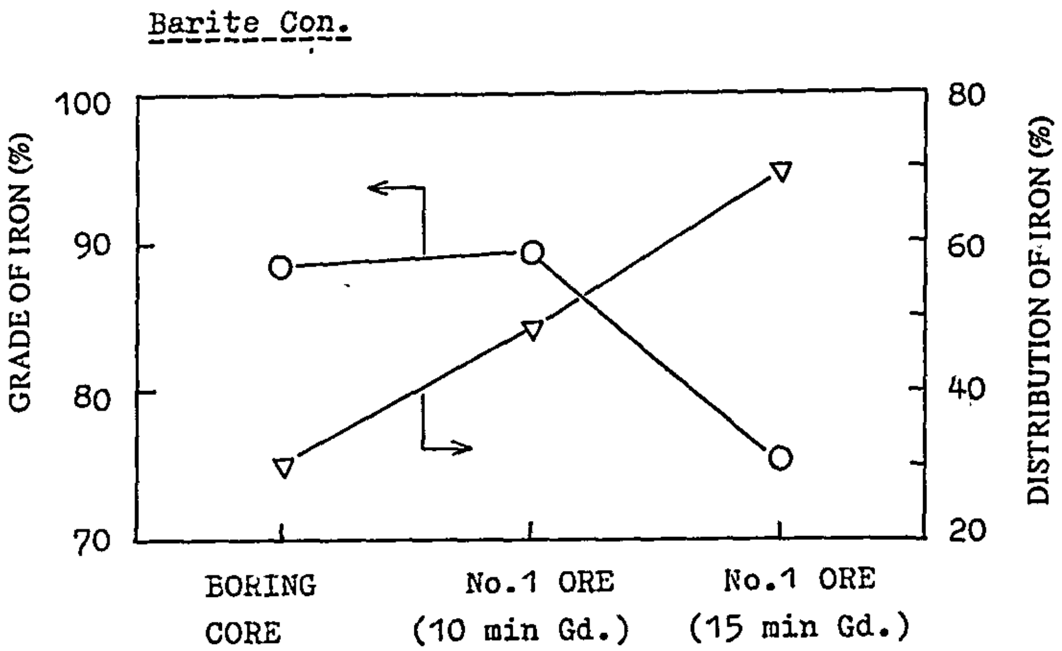


Fig. 29 Grade and Distribution of $BaSO_4$ in Barite Concentrate both for No. 1 Ore and BORING CORE Sample

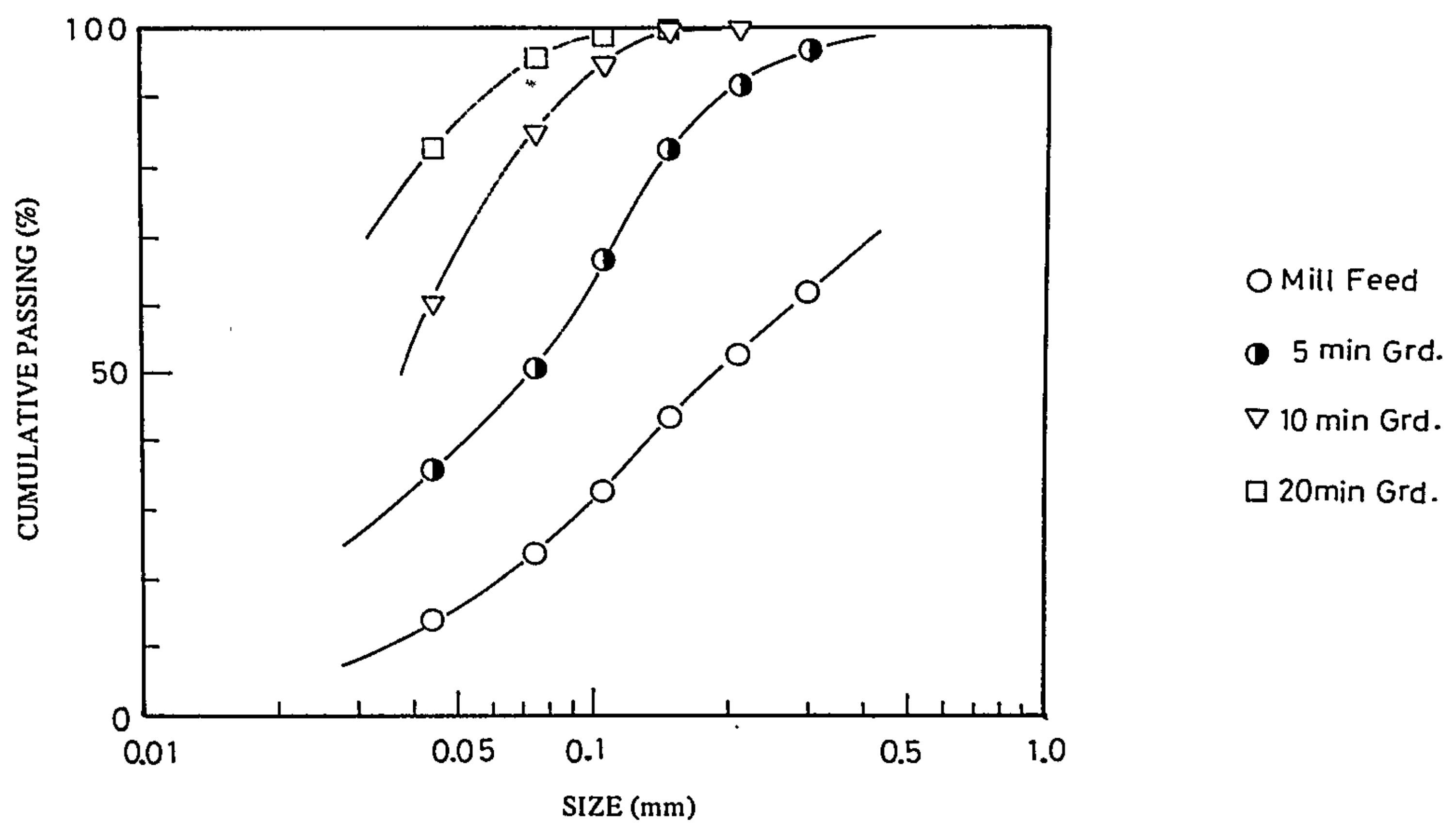


Fig. 30 Size Distribution Curve of No. 1 Ore

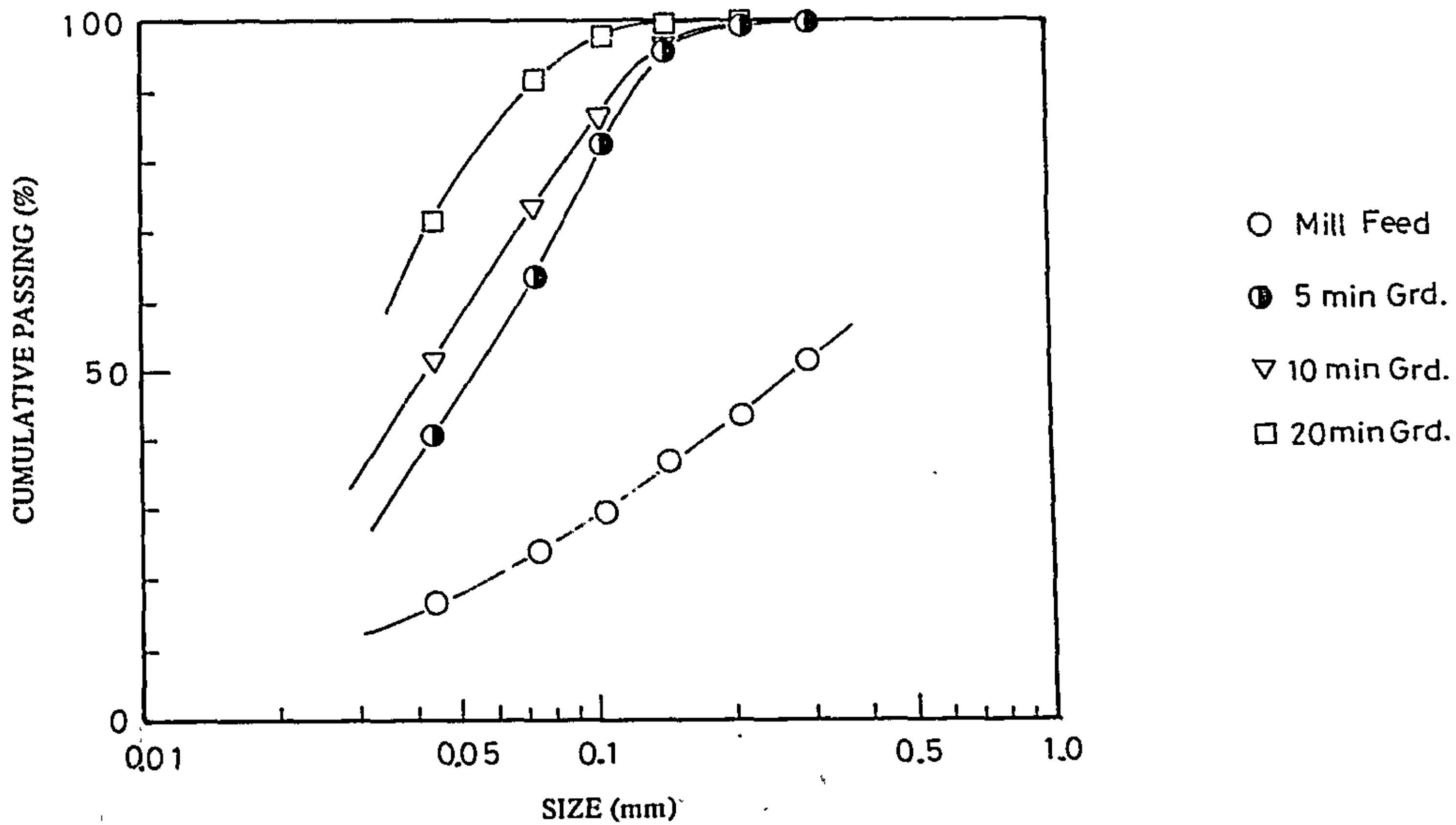


Fig. 31 Size Distribution Curve of No. 2 Ore

The low recovery for the Boring core sample is attributed to the mixing of 11 % of zinc into the tailings of zinc roughing, which seems to have been caused by oxidation of sphalerite in course of time.

(vii) It is difficult to recover pyrite concentrate because of the low grade of the feed.

(viii) Barite concentrate was recovered with the grade of 89 % $BaSO_4$ and the recovery of 50 % for the No. 1 ore, and with the grade of 87 % $BaSO_4$ and the recovery of 25 % for the Boring core.

Table 8 Assay of Products in Test No. 50

ELEMENT	Pb–C	Zn–C	Py–C	Ba–C	T
Au (g/t)	1.7	0.5	0.5	0	0.5
Ag (g/t)	447	149	77	3	9
Cu (%)	0.34	0.26	0.22	0.06	0.06
Pb (%)	56.82	8.25	2.30	0.50	1.59
Zn (%)	1.64	51.86	2.16	0.05	0.46
Fe (%)	1.33	2.99	16.35	0.19	2.47
Cd (ppm)	64	2437	52	1	2
Cl (ppm)	0	0	0	0	0
Bi (ppm)	0	0	0	0	0
As (ppm)	28	48	851	18	20
Sb (ppm)	36	54	27	29	8
Sul-S (%)	9.54	27.79	16.38	0.19	0.14
Al_2O_3 (%)	0.23	0.10	0.57	0.03	2.44
$BaSO_4$ (%)	14.60	1.36	21.98	85.22	6.14
P_2O_5 (%)	0	0.03	0.02	0.01	0.01
CaO (%)	3.23	2.36	8.30	3.20	15.10
MgO (%)	3.02	0.63	4.84	1.65	12.91
SiO_2	2.70	1.04	3.72	1.46	18.26

4–6 Test of Physical Properties and Other Tests

4–6–1 Determination of Specific Gravity of Ore

The result of determination of specific gravity of the No. 1 ore and the No. 2 ore by pycnometer method is shown in Table 9.

No determination of specific gravity was made on the Boring core because of scarcity of the sample.

Table 9 Specific Gravity

Type of ore	Specific gravity
No. 1 ore	3.62
No. 2 ore	3.60

4–6–2 Determination of Work Index (W.I.)

Work Index (W.I.) was determined for the No. 1 and No. 2 ore by the Hardglove method, and the result is shown in the Table 10.

Table 10 Work Index of Samples

Type of ore	W.I. value (kWh/M.T.)
Sample No. 1 ORE	15.04
Sample No. 2 ORE	15.77

4–6–3 Grindability Test of Ore

The relationship between grinding time and the particle size was investigated by test ball mill for the No. 1 ore and the No. 2 ore with the pulp density of 60 % varying the grinding time for 5 minutes, 10 minutes and 15 minutes.

The results of the test are shown in Table 11, Table 12, Fig. 30 and Fig. 31.

Table 11 Grindability Test of No. 1 Ore

Size	Feed		5 min Grd.		10 min Grd.		20 min Grd.	
(mm)	W (%)	ΣW(%)	W(%)	ΣW(%)	W(%)	ΣW(%)	W(%)	ΣW(%)
0.297	38.14	38.14	3.20	3.20	0.00	0.00	0.00	0.00
0.210	9.62	47.76	5.31	8.51	0.20	0.20	0.06	0.16
0.149	8.71	56.47	9.06	17.57	0.56	0.76	0.16	0.22
0.105	10.87	67.34	16.15	33.72	4.48	5.24	0.90	1.12
0.074	9.56	76.90	15.81	49.53	9.85	15.09	3.11	4.23
0.044	10.08	86.98	14.61	64.14	24.71	39.80	12.96	17.19
–0.044	13.02	100.00	35.86	100.00	60.20	100.00	82.81	100.00
Total	100.00		100.00		100.00		100.00	

Weight (g) 1)..... 495 2).... 493.4 3).... 497.7 4).... 498.5

Table 12 Grindability Test of No. 2 Ore

Size (mm)	Feed		5 min Grd.		10 min Grd.		20 min Grd.	
	W (%)	ΣW(%)	W (%)	ΣW (%)	W (%)	ΣW(%)	W (%)	ΣW(%)
0.297	48.31	48.31	0.27	0.27	0.00	0.00	0.00	0.00
0.210	8.25	56.56	0.65	0.92	1.03	1.03	0.08	0.08
0.149	6.73	63.29	3.69	4.61	2.63	3.66	0.32	0.40
0.105	7.32	70.61	13.05	17.66	9.85	13.51	2.12	2.52
0.074	5.74	76.35	18.60	36.26	13.03	26.54	6.01	8.53
0.044	7.16	83.51	23.19	59.45	21.91	48.45	19.88	28.41
–0.044	16.49	100.00	40.55	100.00	51.55	100.00	71.59	100.00
Total	100.00		100.00		100.00		100.00	

Weight (g) 1) ..... 493.3 2) ..... 490.4 3) ..... 497.4 4) 499.1

4–6–4 Settling Test of Flotation Tailings

Settling test was made on the flotation tailings by measuring cylinder method.

The results of the test are shown in Table 13 and Fig. 32.

The test was made using flocculants because settling velocity is low and the boundary of the precipitated materials is indistrinct in the case of natural settling.

Table 13 Settling Test of Flotation Tailing

	A	B
PAC amount (ppm)*	100	150
A–100 amount (ppm)**	2	1
Settling velocity (m/hr)	15.7	15.3
SS of processing water (ppm)	14.8	22.6
pH of processing water (ppm)	7.4	7.3
Quantity of precipitates after 15 minutes (g/ℓ)	70.8	72.5

* Polyalumium Chliride

** Acc Co.

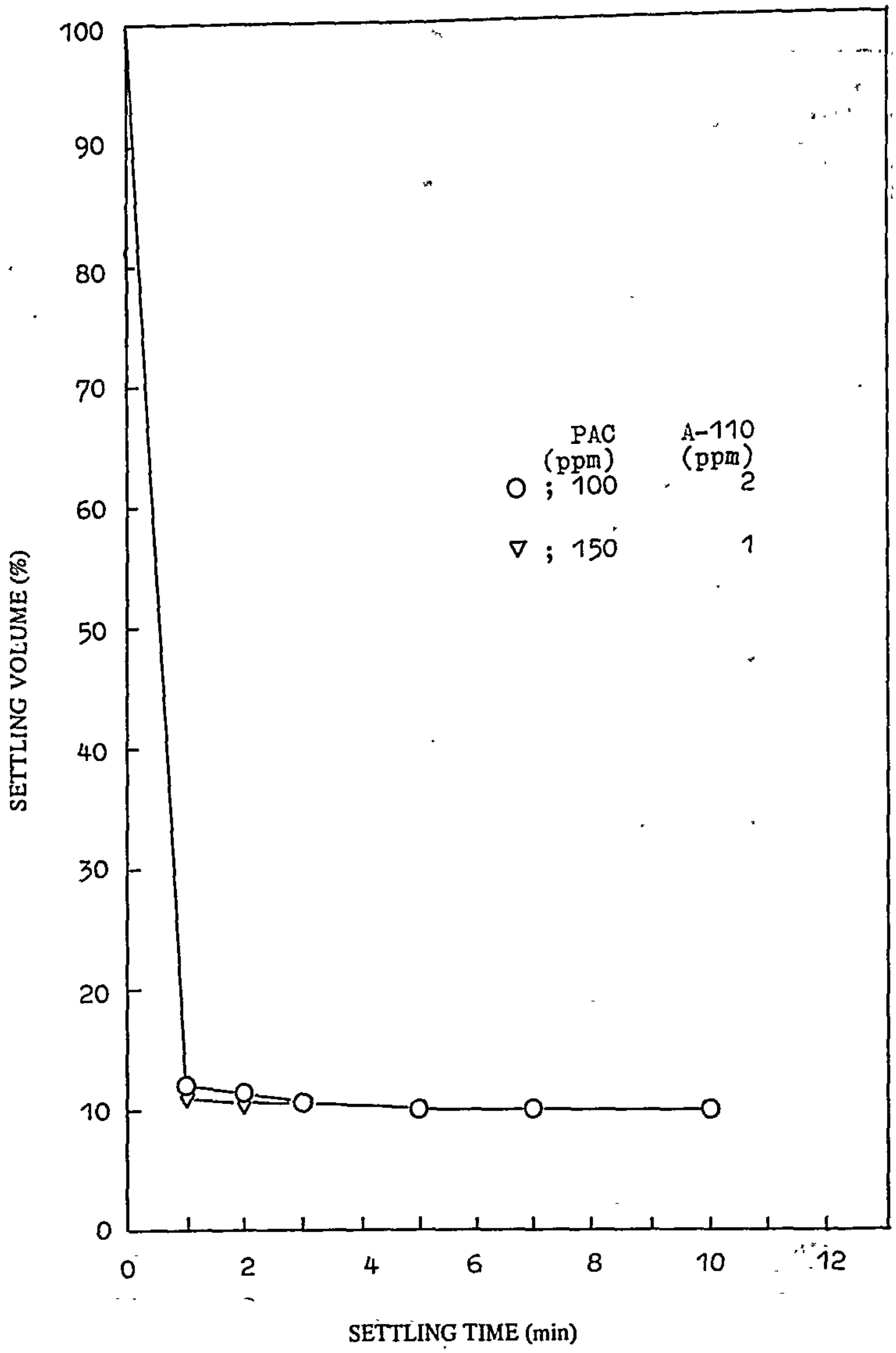


Fig. 32 Settling Curve of Flotation Tailings

4–6–5 Analysis of Waste Water of Flotation Test

The waste water obtained by filtering each pulp of concentrates and tailings produced by the flotation tests were analyzed for pH and other eight components.

Table 14 shows the result.

Table 14 Analysis of Filtrate Water

Products	pH	Assay (mg/l)							
		Fe	Cu	Pb	Zn	Cd	CN	As	SO_4
Pb-C	8.7	0	0.14	0	0	0	3.5	0	76.13
Zn-C	12.0	0	0	0	0.02	0	0	0	22.63
Py-C	12.1	0	0.17	0	0.01	0	0.09	0	41.15
Ba-C	8.3	0	0.87	0	0.12	0	0.9	0	96.70
T	9.8	0.05	1.94	0.09	0.10	0	2.0	0	222.03

The environmental standard of water quality in the drainage area from the Perau mine is regulated such as less than 1 ppm Cu, 0.1 ppm Pb, 5 ppm Zn, 0.01 ppm Cd, 0.1 ppm As, 0.2 ppm CN and pH 5.0 to 9.0. As the elements such as Cu, CN, pH and others in the drainage at the plant operation can be considered beyond these figures from result of the tests, its treatment have to be taken into account.

The method of treatment for CN with hypochlorous acid and pH with H_2SO_4 and others will be considered.

CHAPTER 5 CONCLUSION

CHAPTER 5 CONCLUSION

The metallurgical test was conducted on the samples of the stratabound silver bearing lead and zinc ore from the Perau mine and the new deposit for the purpose of establishing proper conditions to recover the valuable minerals. As a result, the following informations were obtained.

1. The assay results of samples show the low grade of zinc in the No. 1 ore, however, similar grades to those of the Boring core.

The No. 1 ore was mainly tested because of scarcity in quantity of the Boring core.

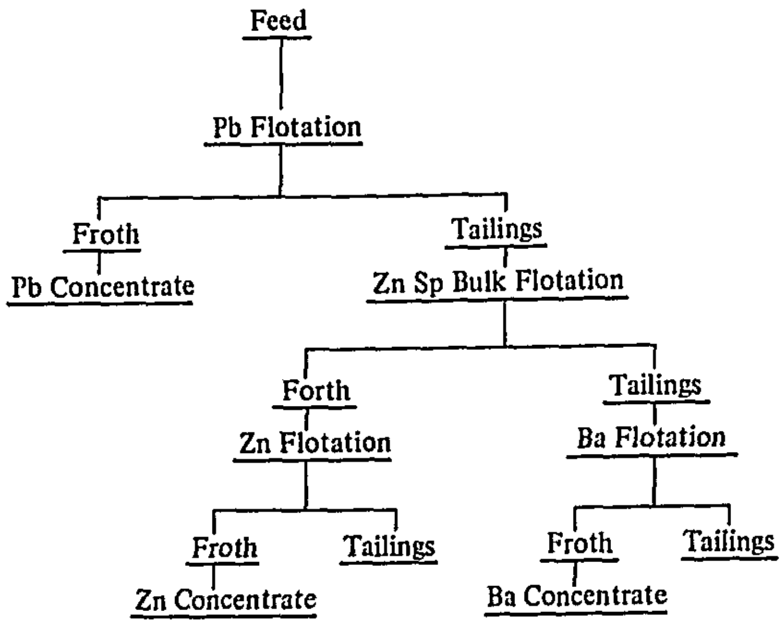
	Grade of component					
Kind of sample	Ag (g/t)	Pb (%)	Zn (%)	Fe (%)	Sul–S (%)	BaSO (%)
BORING CORE	108	4.39	3.13	2.47	10.49	36.33
No. 1 Ore	53	5.45	0.50	1.93	7.90	29.13
No. 2 Ore	204	20.73	0.35	8.22	11.63	0.21

2. It was confirmed from the result of X-ray diffraction and microscopic observation that the lead, zinc, iron and barium minerals occur forming galena, sphalerite, pyrite and barite. The other minerals such as quartz, dolomite, calcite, chlorite, mica, amphibole and zeolite were confirmed to be present as gangue minerals.

3. In the EPMA analysis, the silver minerals are observed in galena, chalcopyrite and pyrite in a spotted form or filling the cracks, which are estimated to occur as andorite and stromeyerite.

4. Galena and sphalerite have been liberated more than 95%, forming a product of 80% minus 74 μ (minus 200 mesh), and the samples should be ground to the extent of the result of this test to obtain the well liberation.

5. Regarding the flotation method, the semi-bulk differential flotation, showing as follows, would be most suitable.



6. The conditions of the flotation for the lead are considered to be appropriate as follows; 30 % in pulp density, 80 % of minus 200 mesh in size of grind, neutral in pH, collector: IPX 50 g/t, and depressant: NaCN 40 g/t and $ZnSO_4$ 140 g/t.

7. The conditions of the flotation for the zinc are considered to be appropriate as follows; 30 % in pulp density, 90 % of minus 200 mesh in size of grind, pH: 11 to 12, collectors: IPX 60 g/t, and activator: $CuSO_4$ 300 g/t.

8. The conditions of barite flotation are considered to be appropriate as follows; 30% in pulp density, 90 % of minus 200 mesh, pH: alkaline, collector: sodium oleate 400 g/t, frother: kerosene 200 g/t and selectivity assisting agent: water glass 1,200 g/t.

9. It is not economical to recover pyrite concentrate because of the low grade of the crude ore.

10. In flotation of barite, it is necessary to repeat cleaning more than five times in order to obtain the barite concentrate more than 90% in grade.

11. The expected result of the flotation will be shown as follows; Lead concentrate: 60 % in lead grade and 90 % in recovery of lead, zinc concentrate: 50 % in zinc grade and 80 % in recovery of zinc, barite concentrate: 90 % in $BaSO_4$ grade and 60 % in recovery of $BaSO_4$.

APPENDICES

1. Samples, Devices of Investigation and Laboratory Works (Photo 1 ~ 12)

Photo 1.
Unpacked Samples

Photo 2.
Samples

Above: No. 2 ORE
Below: No. 1 ORE

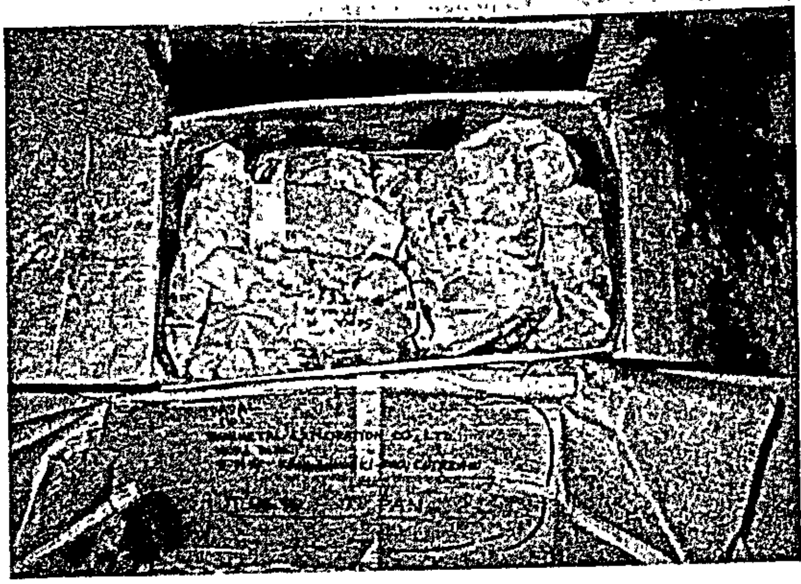


Photo 3.
Samples No. 1 ORE

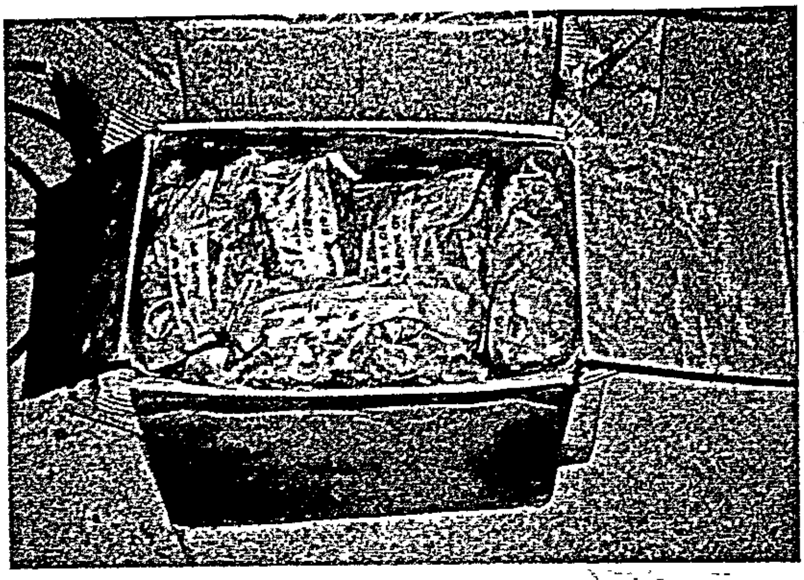


Photo 4.
Samples No. 2 ORE

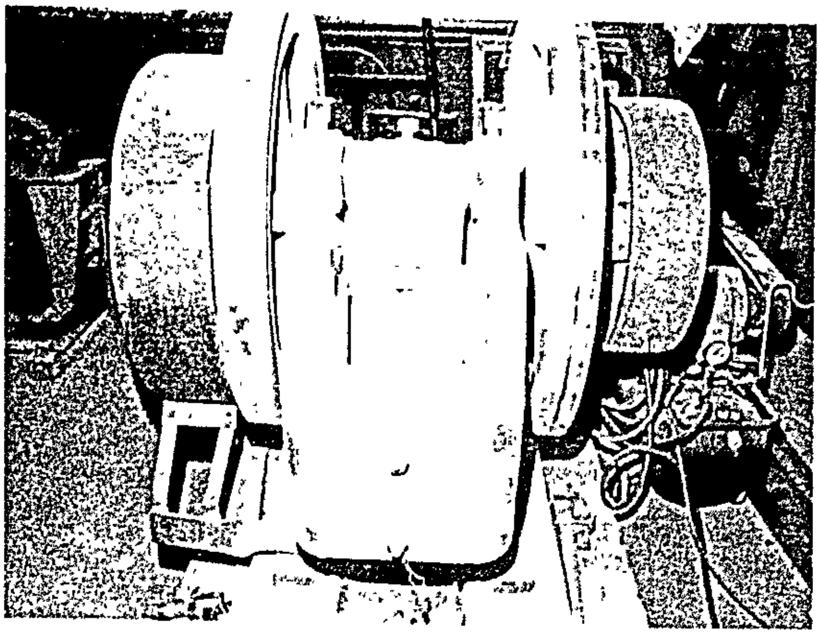


Photo 5. Jaw Crushing Test Machine

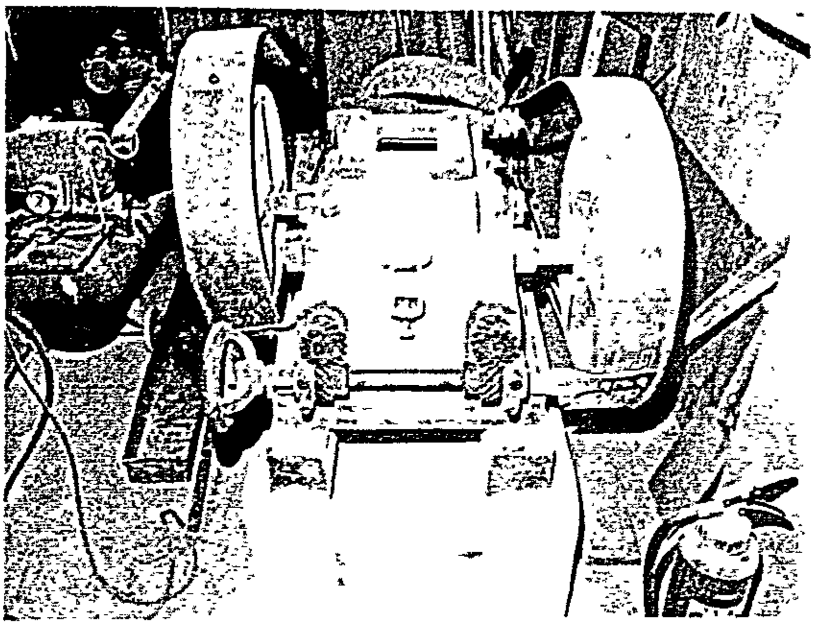


Photo 6. Roll Crushing Test Machine

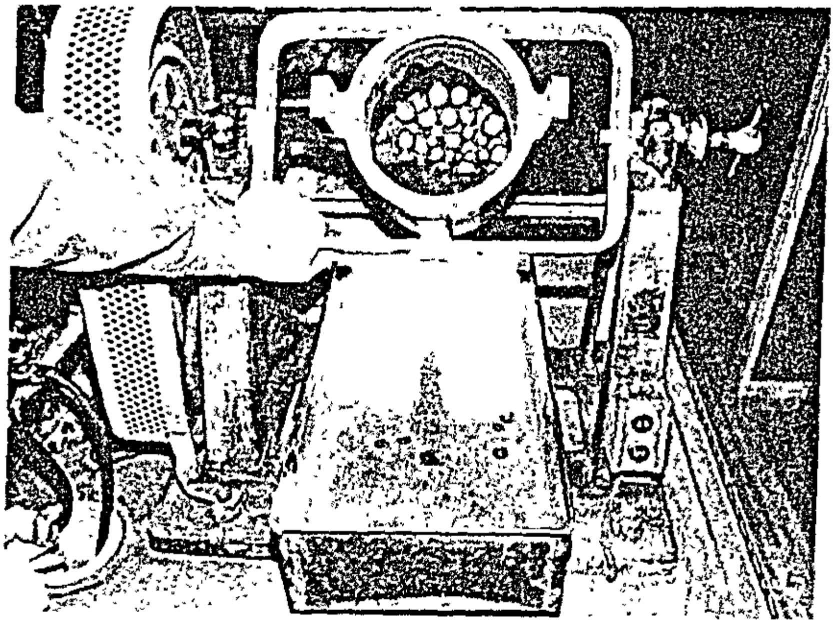


Photo 7. Ball Milling Test Machine

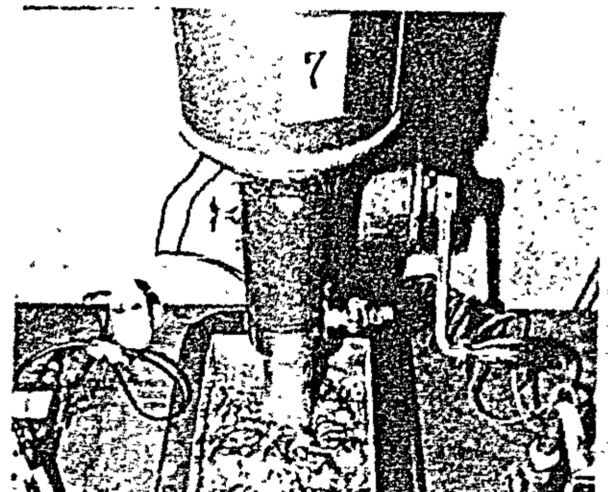


Photo 8. Pb Flotation with Deover Lad.
Flotation Machine

Photo 9. Hardgrove Grindability Machine

Photo 10. Microscopic Observation

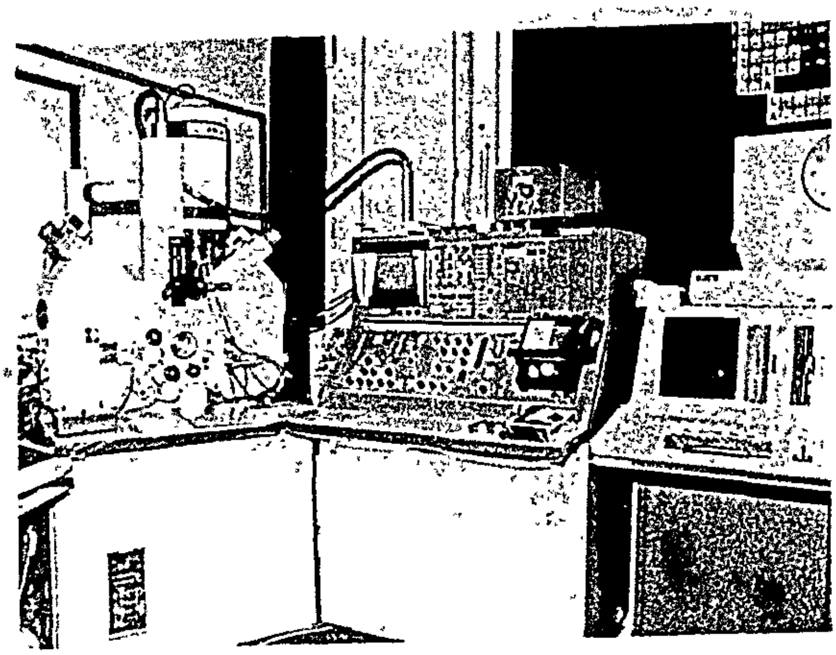


Photo 11. Electron Prob X-ray Microanalyser

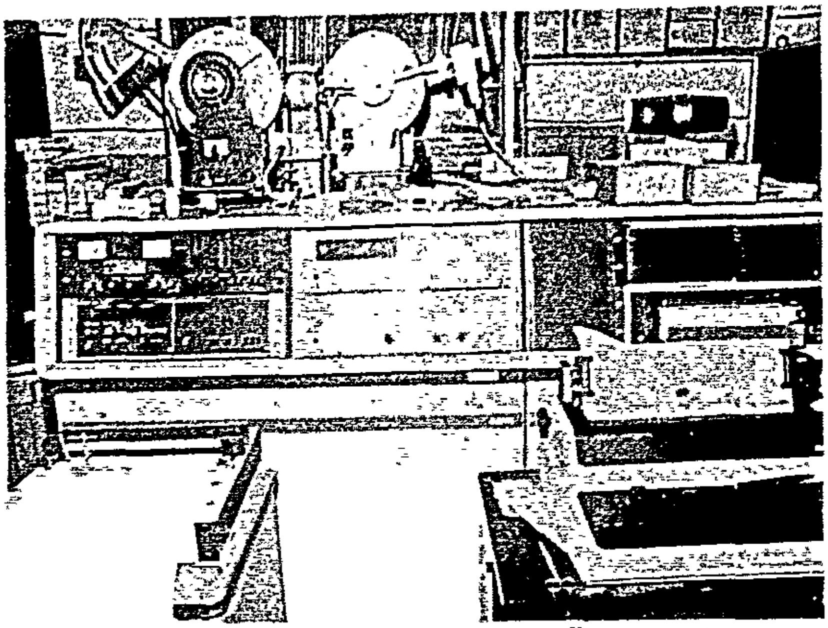


Photo 12. X-ray Diffractometer

2. X-RAY DIFFRACTION OF SAMPLES

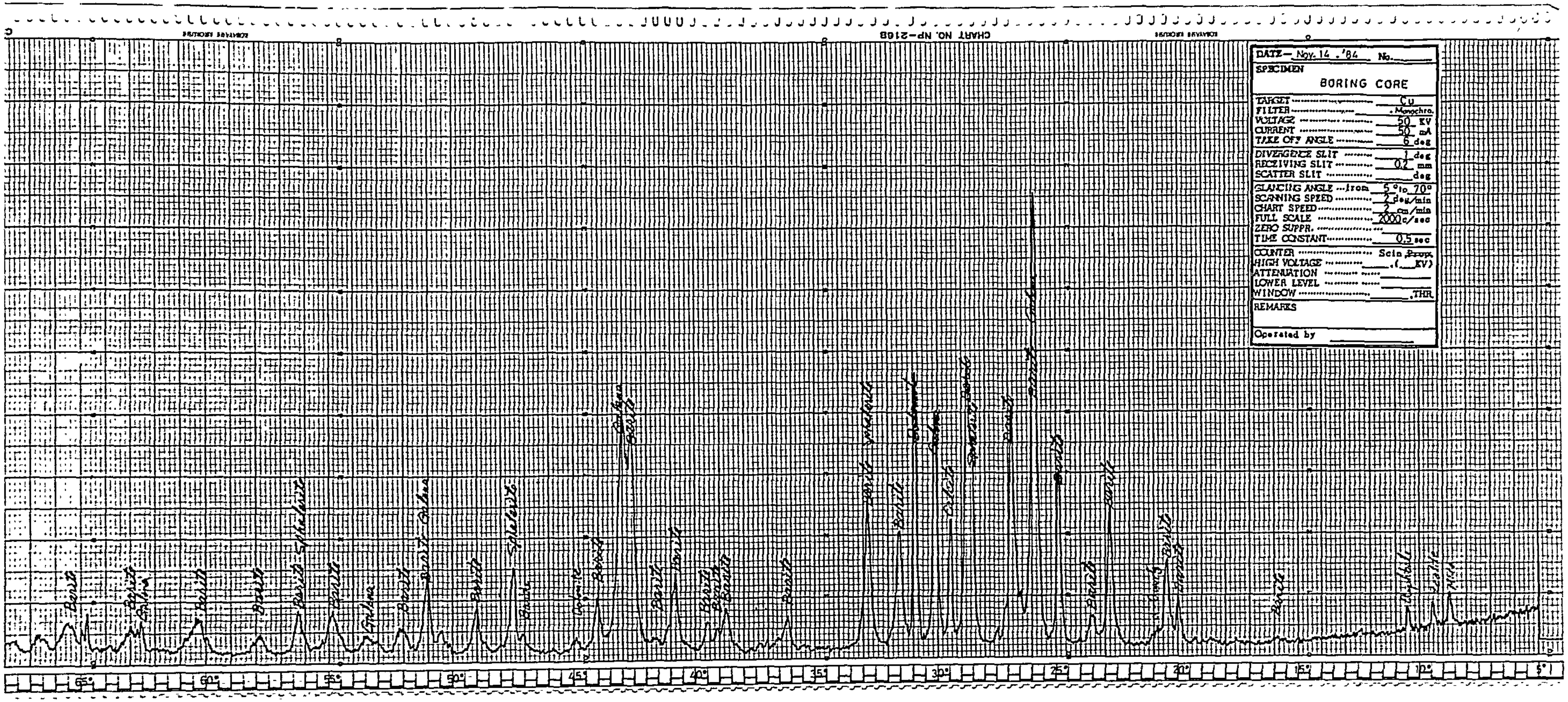


Fig. A—1 X-Ray Diffraction Chart of Boring Core

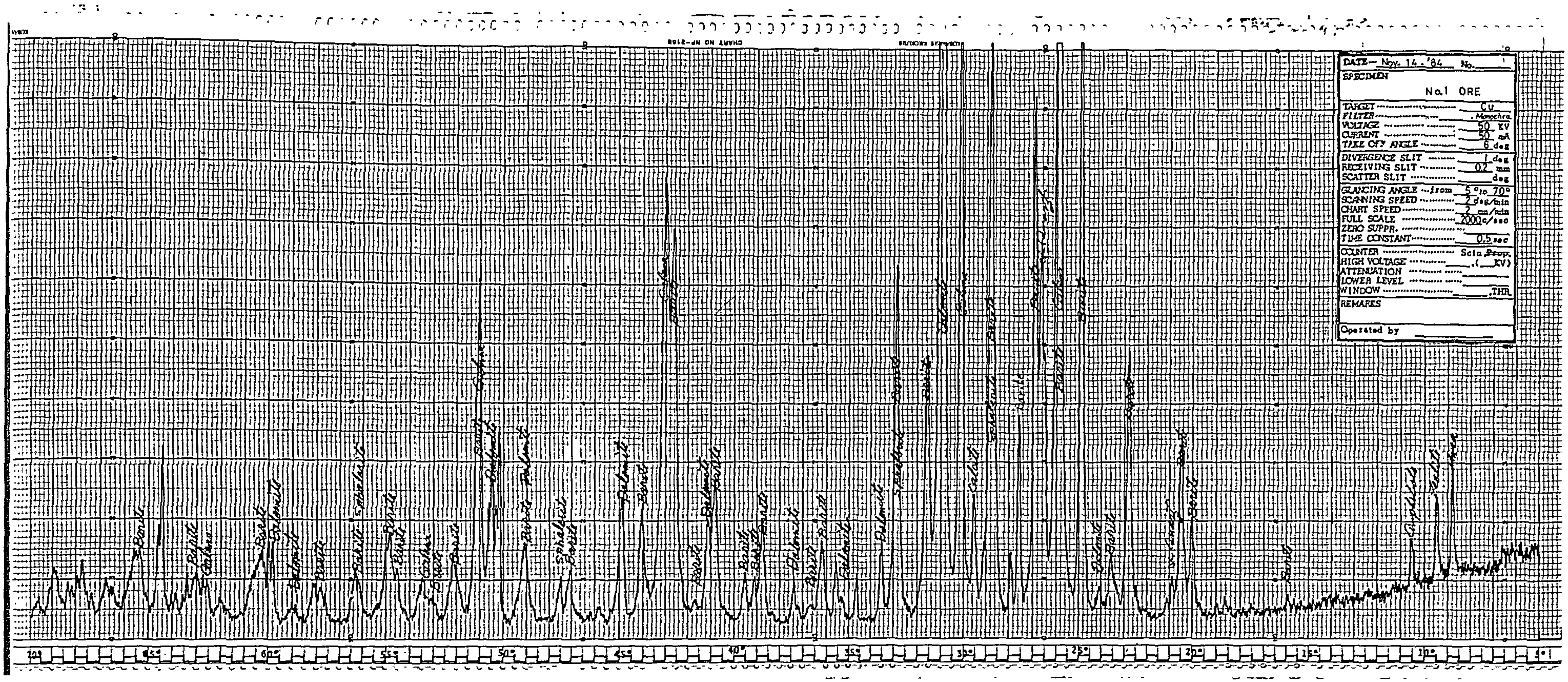


Fig. A–2 X-Ray Diffraction Chart of No. 1 Ore

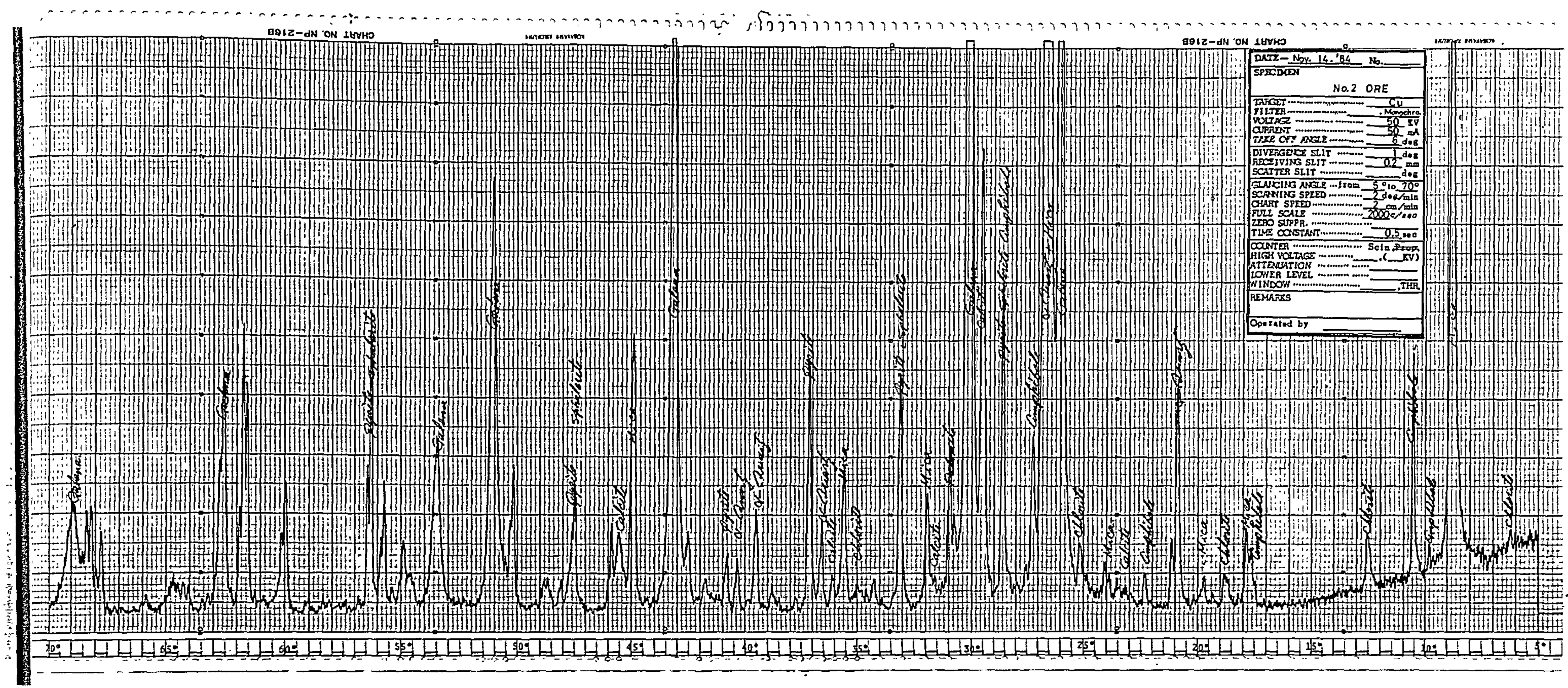


Fig. A-3 X-Ray Diffraction Chart of No. 2 Ore

3. MICROPHOTOGRAPH (Photo 13 to 50)

The abbreviations in the photo indicate the following minerals.

Am	: Amphibole	G	: Gangue
Ba	: Barite	Gl	: Galena
Bi	: Biotite	Li	: Limonite
Ca	: Calcite	Py	: Pyrite
Cp	: Chalcopyrite	Q	: Quartz
Cv	: Covelline	Sp	: Sphalerite
F	: Feldspars		

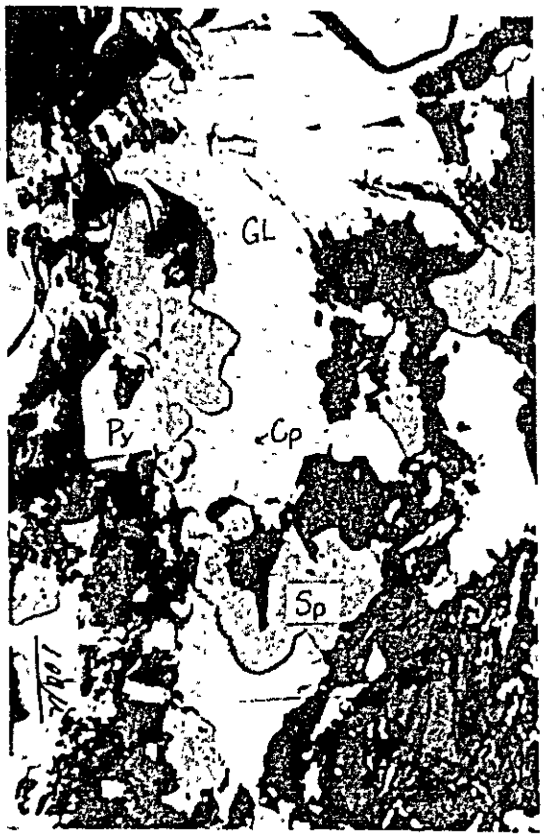


Photo 13.
BORING CORE

Coarse middling consisting mainly of galena, gangue minerals and sphalerite. Pyrite, chalcopynte and sphalerit are included in galena. Gangue minerals are irregular in shape, and include chalcopyrite in a spotty form, showing paragenetic occurrence in a form of middling.

0 200μ x 80

Photo 14.
BORING CORE

Same as Photo 13

0 100μ x 160

Photo 15.
No. 1 Ore: Flotation feed

Coarse middling composed of pyrite, chalcopyrite and gangue minerals (center). Galena forms middling with gangue minerals.

0 200μ x 80

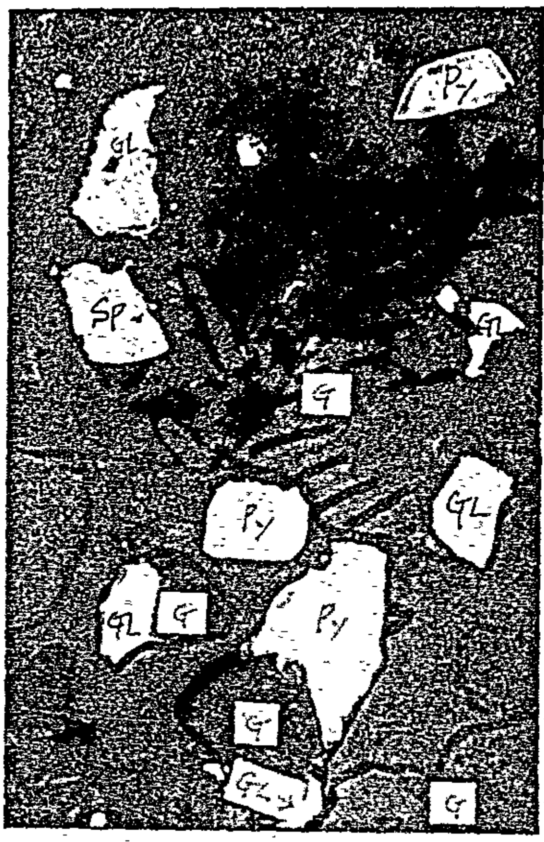


Photo 16.
No. 1 Ore: Flotation feed

Consists of middling of galena and gangue minerals, middling of galena and sphalerite, and independent sphalerite.

0 200μ x 80

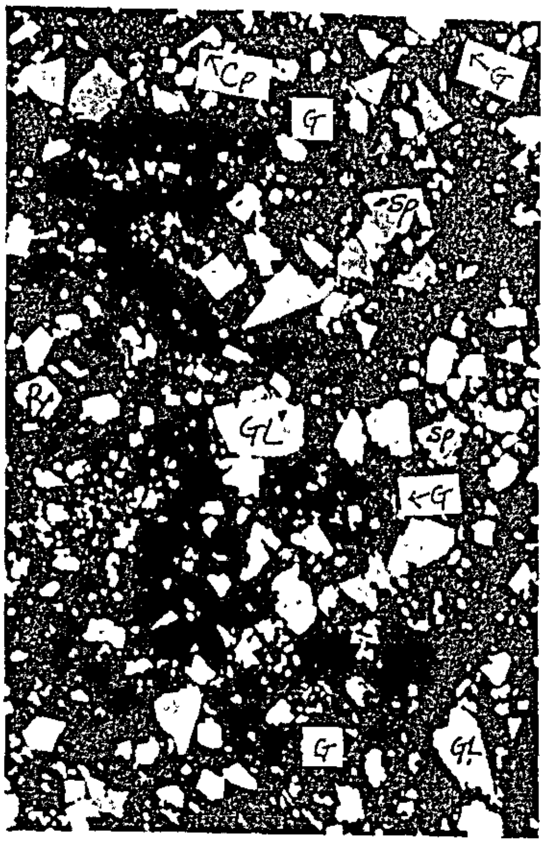


Photo 17.
No. 1 Ore: Pb Concentrate

Mainly composed of galena and sphalerite. Pyrite and chalcopyrite are present each one grain in photo.

0 100μ

x 160

Photo 18.
No. 1 Ore: Pb Concentrate

Consists of galena, sphalerite, gangue minerals and covelline. Pyrite and chalcopyrite are not observed. Sphalerite forms the grains brownish in color.

0 100μ

x 160

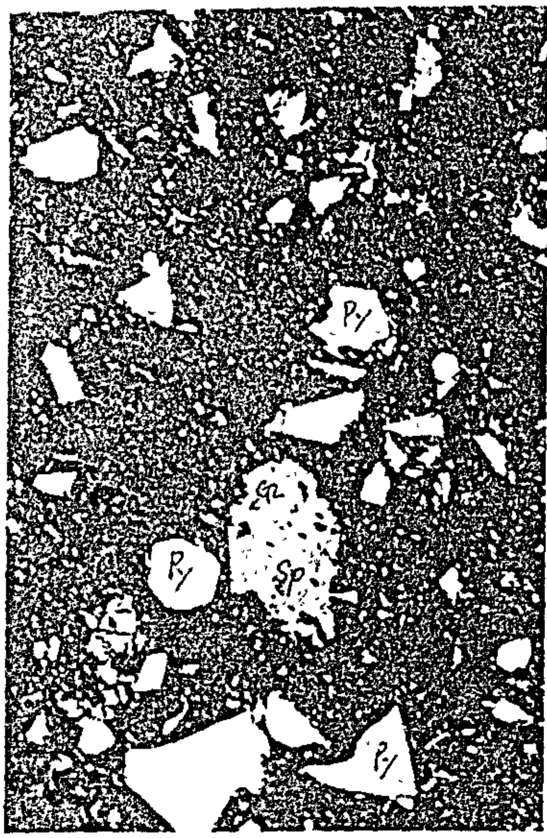


Photo 19.
No.·1 Ore: Zn Concentrate

· *Mostly consist of the free particles of sphalerite, pyrite and gangue minerals. Sphalerite at the center is accompanied by tiny particles of galena.*

0 100μ x 160

Photo 20.
No. 1 Ore: Zn Concentrate

Mostly composed of the free particles of pyrite, sphalerite and chalcopyrite. Galena is present only in the form of inclusion in gangue minerals.

0 100μ x 160

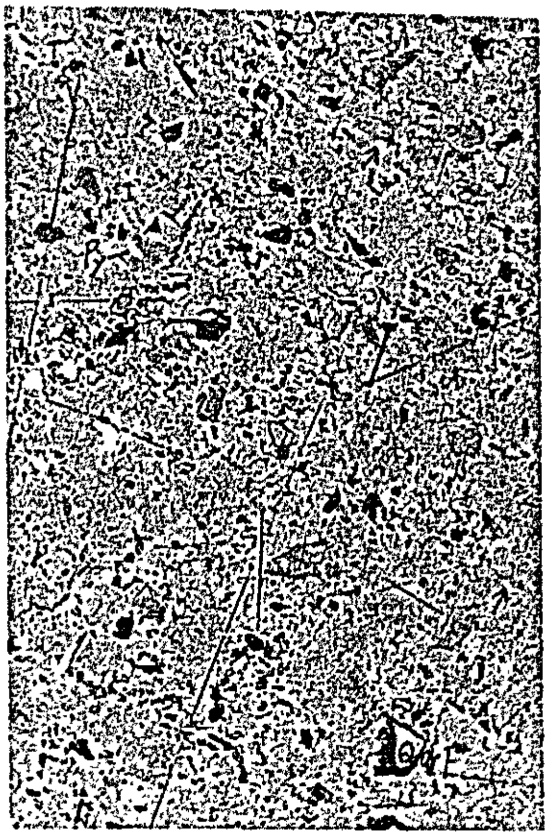


Photo 21.
No. 1 Ore: Py Concentrate

Tiny crystals of pyrite are scattered. Gangue minerals consist of hard quartz and feldspar, and soft barite and calcite. The formers show strong relief (lower right).

0 100μ x 160

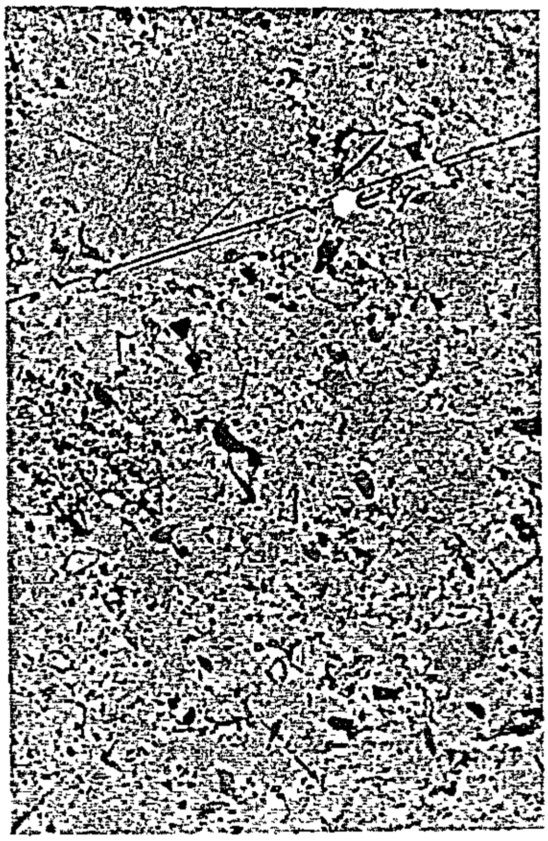


Photo 22.
No. 1 Ore: Py Concentrate

The latters show an indistinct boundary with barelite matrix because of similar color and reflectivity.

Same as Photo 21.

0 100μ x 160

Photo 23.
No. 1 Ore: Ba Concentrate

A small amount of pyrite are scattered. Hard gangue minerals are found in a very small amount.

0 100μ x 160

Photo 24.
No. 1 Ore: Ba Concentrate

Same as Photo 23.

0 100μ x 160

Photo 25.
No. 1 Ore: Tailing

Pyrite, galena and limonite are scattered. Hard gangue minerals are dominant.

0 100μ x 160

Photo 26.
No. 1 Ore: Tailing

Same as Photo 25.

0 100μ x 160

Photo 27.
No. 2 Ore: Flotation feed

Galena is present as free particles, and forms middling with pyrite. Very fine-grained white minerals are galena and pyrite.

0 100μ x 80

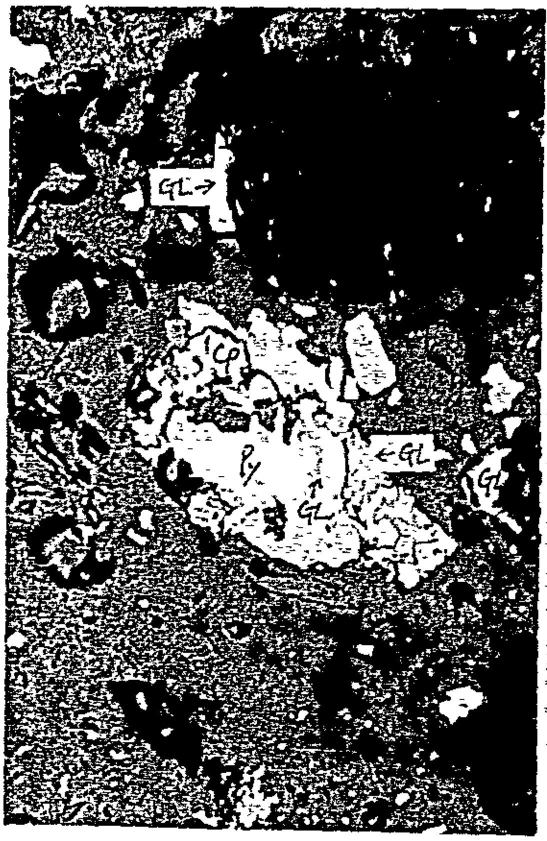


Photo 28.
No. 2 Ore: Flotation feed

Middlings consisting of galena and gangue minerals, and pyrite, chalcopyrite, galena and gangue minerals are observed.

0 100μ x 80

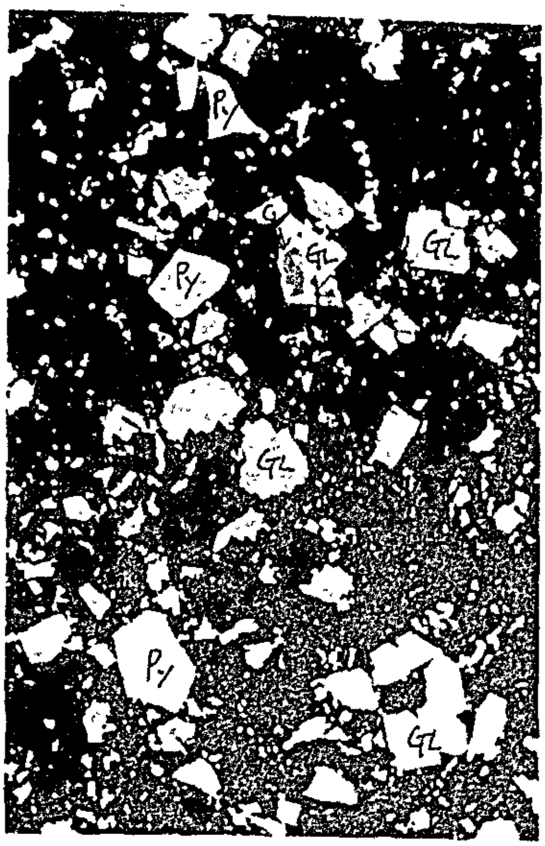


Photo 29.
No. 2 Ore: Pb Concentrate

Mainly composed of free particles of galena and pynte. Sphalente is present in small quantity.

0 100μ x 160

Photo 30.
No. 2 Ore: Pb Concentrate

Same as Photo 29.

0 100μ x 160

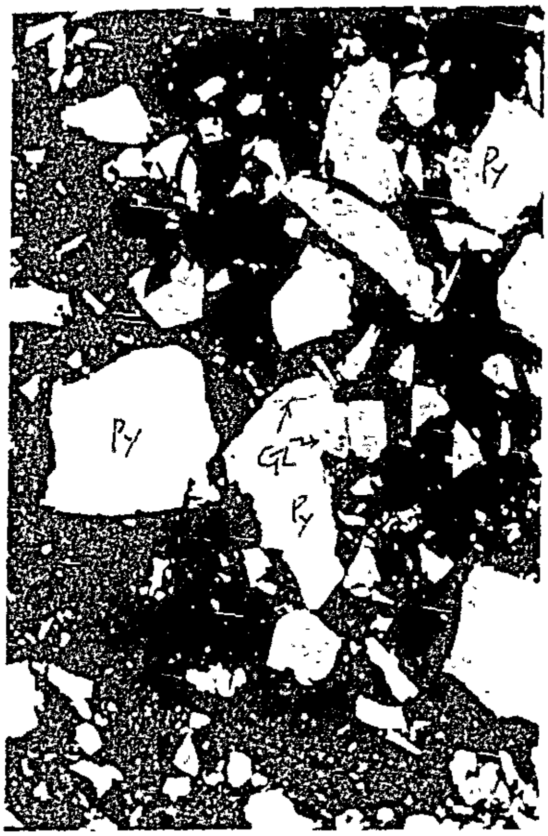


Photo 31.
No. 2 Ore: Zn Concentrate

Mostly composed of free particles of pyrite. Middlings consisting of pyrite and galena, and gangue minerals and present in small quantity.

0 100μ x 160

Photo 32.
No. 2 Ore: Zn Concentrate

Same as Photo 31.

0 100μ x 160

Photo 33.
No. 2 Ore: Py Concentrate

Most of the bright minerals are pyrite. Galena is present in small quantity.

0 100μ x 160

Photo 34.
No. 2 Ore: Py Concentrate

Same as Photo 33.

0 100μ x 160

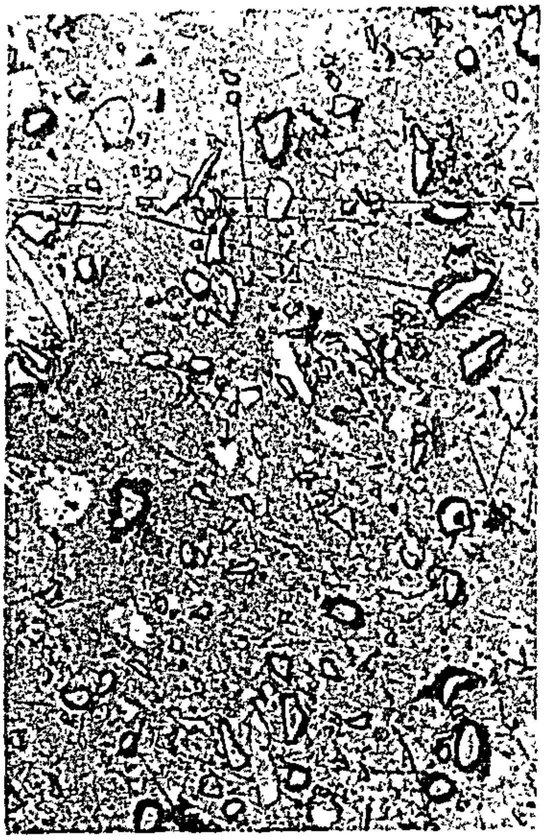


Photo 35.
No. 2 Ore: Ba Concentrate

Most of the white particles are pyrite. Barite occupies a part of the particles showing a similar tone to bakelite matrix. *Middling of galena and gangue minerals are observed in Photo 24.*

0 100μ x 160

Photo 36.
No.2 Ore: Ba Concentrate

Same as Photo 35.

0 100μ x 160

Photo 37.
No. 2 Ore: Tailing

Tiny particles of pyrite are scattered.

0 100μ x 160

Photo 38.
No. 2 Ore: Tailing

Same as Photo 37.

0 100μ x 160

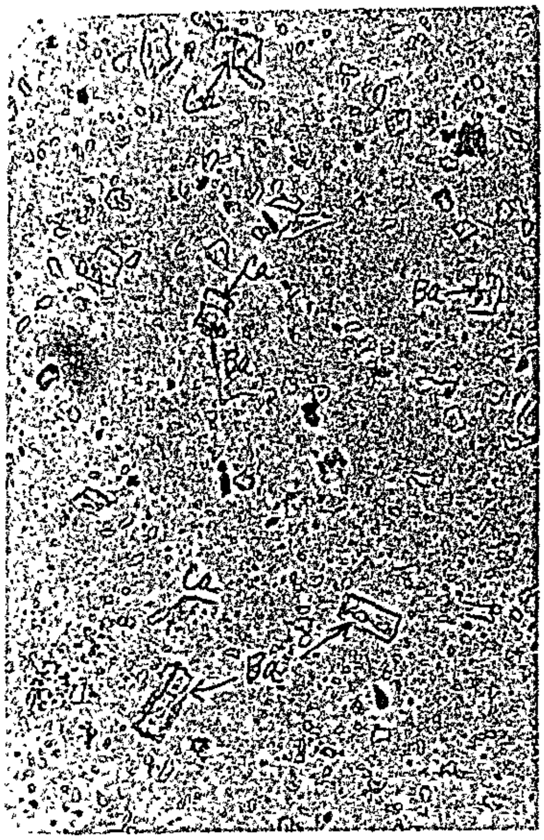


Photo 39.
No. 1 Ore: Py Concentrate
(Open Nicols)

Most of the transparent particles are calcite. Barite is small in quantity.

0 100μ x 255

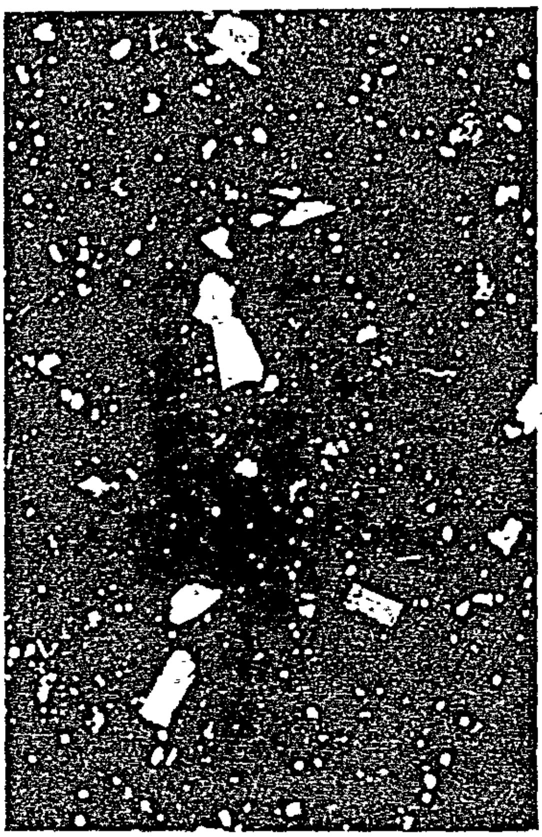


Photo 40.
No. 1 Ore: Py Concentrate
(Cross Nicols)

Same as Photo 39.

0 100μ x 255

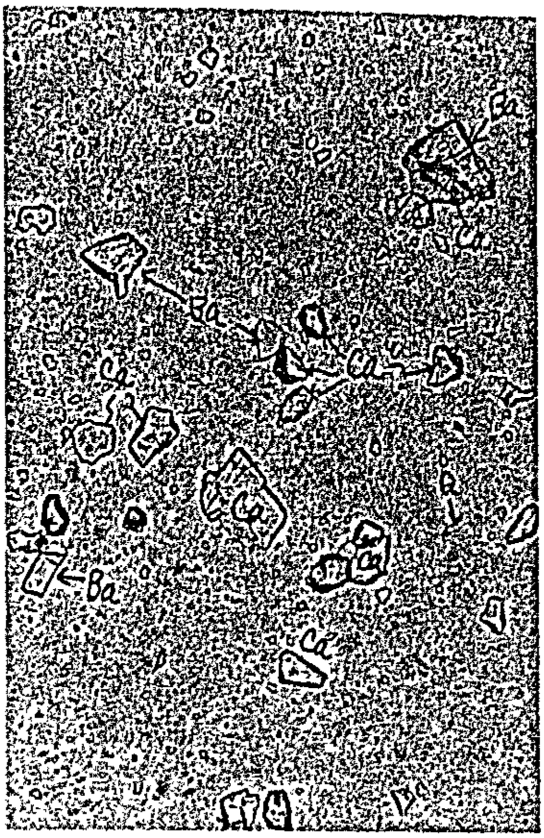


Photo 41.
No. 1 Ore: Ba Concentrate
(Open Nicols)

Mostly consist of calcite, accompanied by a small amount of barite and quartz.

0 100μ x 105

Photo 42.
No. 1 Ore: Ba Concentrate
(Cross Nicols)

Same as Photo 42.

0 100μ x 105

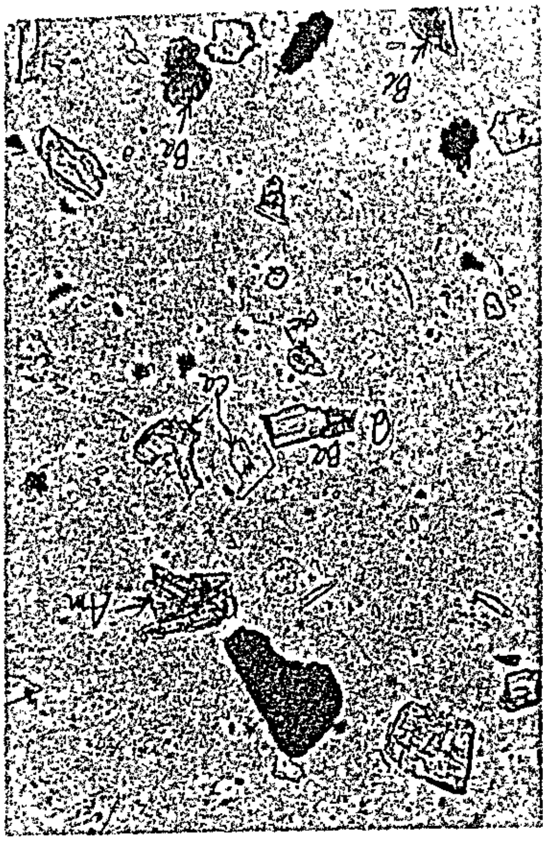


Photo 43.
No. 1 Ore: Tailing
(Open Nicols)

Mainly composed of calcite and quartz (partly feld-spar ?). Biotite and amphibole are found in small quantity.

0 100μ x 105

Photo 44.
No. 1 Ore: Tailing
(Cross Nicols)

Same as Photo 43.

0 100μ x 105

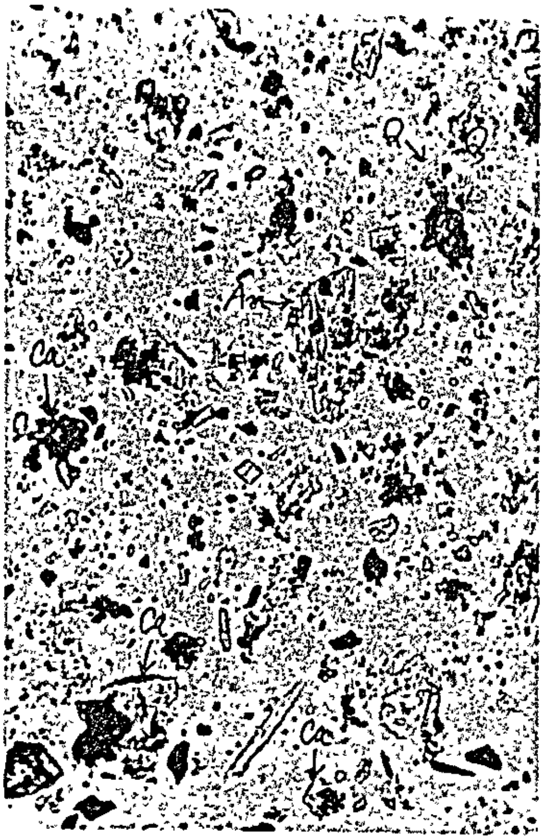


Photo 45.
No. 2 Ore: Py Concentrate
(Open Nicols)

Transparent particles consist mainly of quart (and feldspar ?), amphibole and calcite. Amphibole is primetric, sometimes showing a cluster form (center of the photo).

0 100μ x 255

Photo 46.
No.2 Ore: Py Concentrate
(Cross Nicols)

Same as Photo 45.

0 100μ x 255

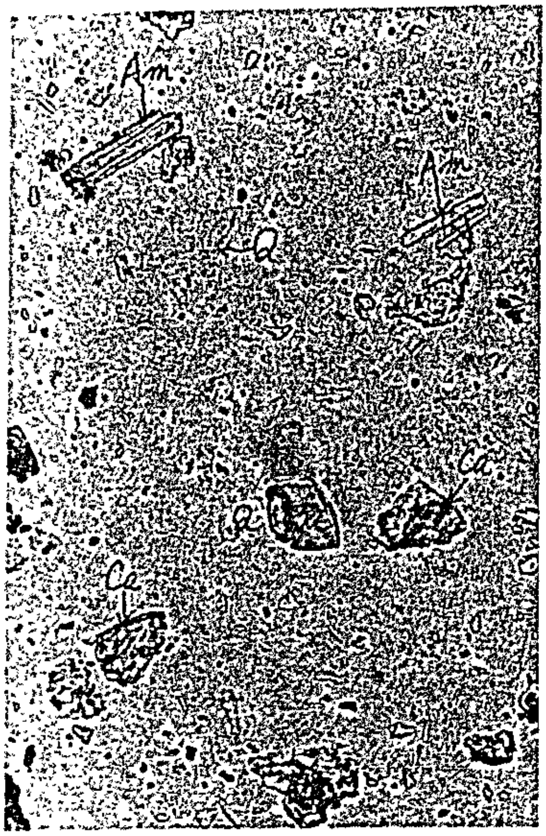


Photo 47.
No. 2 Ore: Ba Concentrate

Composed of calcite, quartz (feldspar) amphibole and barite.

0 100μ x 255

Photo 48.
No. 2 Ore: Ba Concentrate
(Cross Nicols)

Same as Photo 48.

0 100μ x 255

Photo 49.
No. 2 Ore: Tailing

Mainly consists of quartz (feldspar), calcite and amphibole.

0 100μ x 255

Photo 50.
No. 2 Ore: Tailing
(Cross Nicols)

Same as Photo 49.

0 100μ x 255

4. RESULT OF EPMA TEST

Photo 51 to 57 ...... BORING CORE

Photo 58 to 64 ...... NO. 1 ORE (Part A)

Photo 65 to 71 ...... NO. 1 ORE (Part B)

Photo 72 to 78 ...... NO. 2 ORE

SAMPLE	BORING CORE
VOLTAGE	20 KV
CURRENT	0.05 μA
MAGNIFICATION	*3000

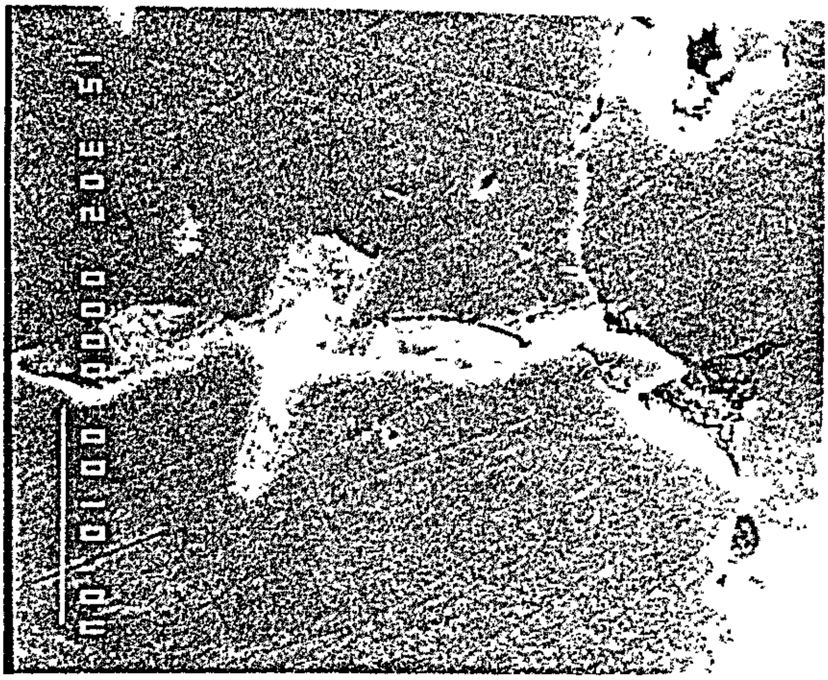


Photo 51.
Secondary Electron Image

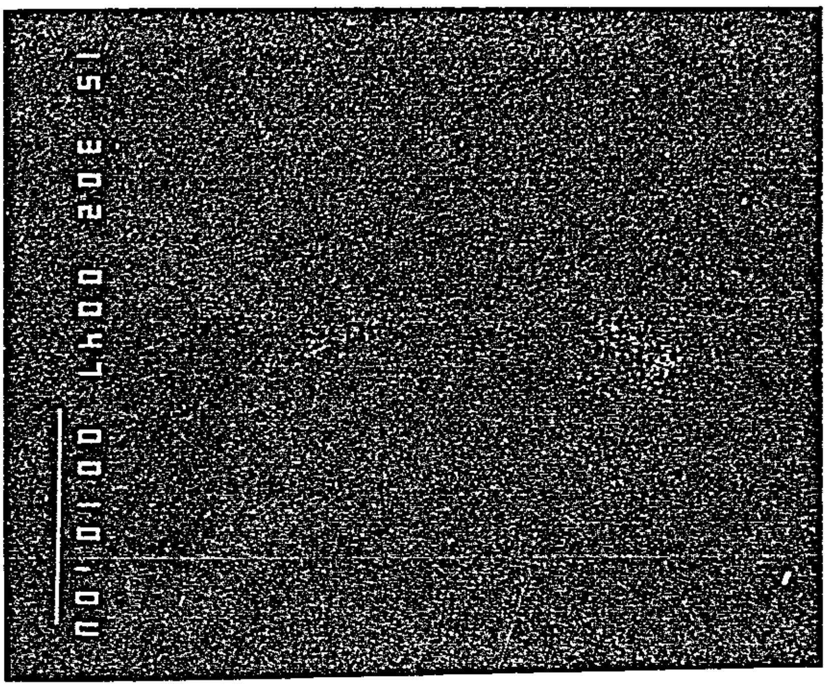


Photo 52.
Ag Lα Image

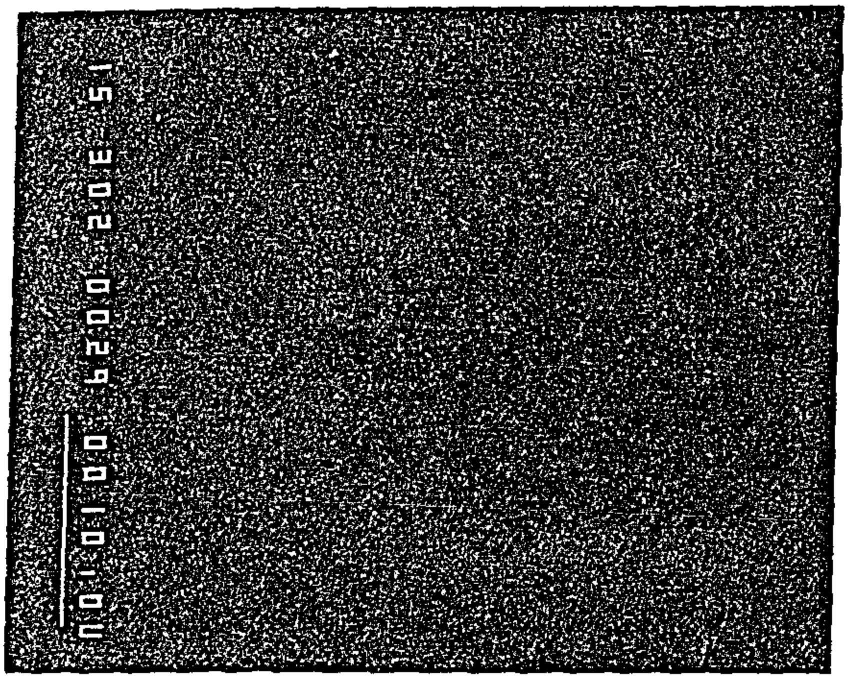


Photo 53.
Cu Kα Image

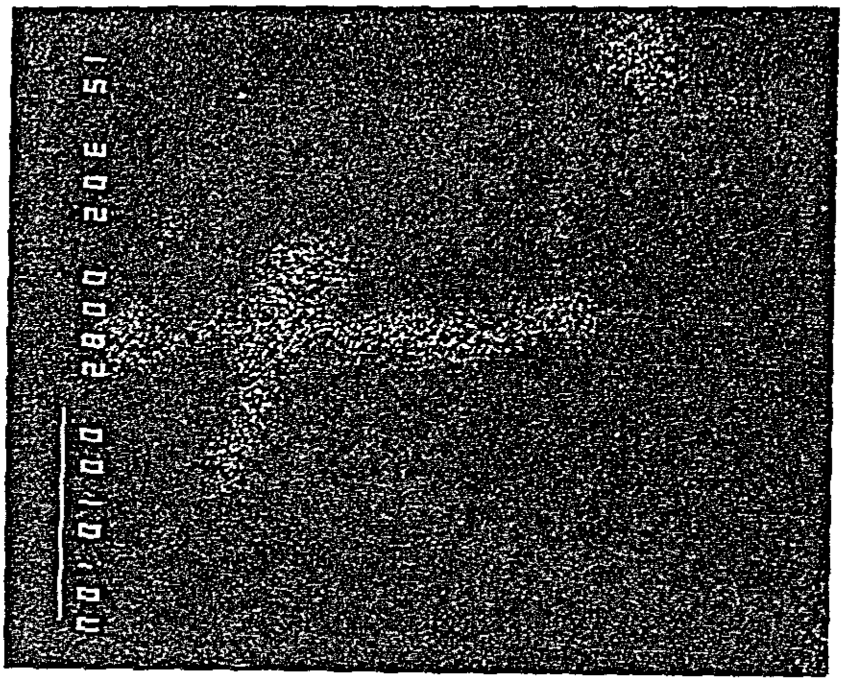


Photo 54.
Pb Mα Image

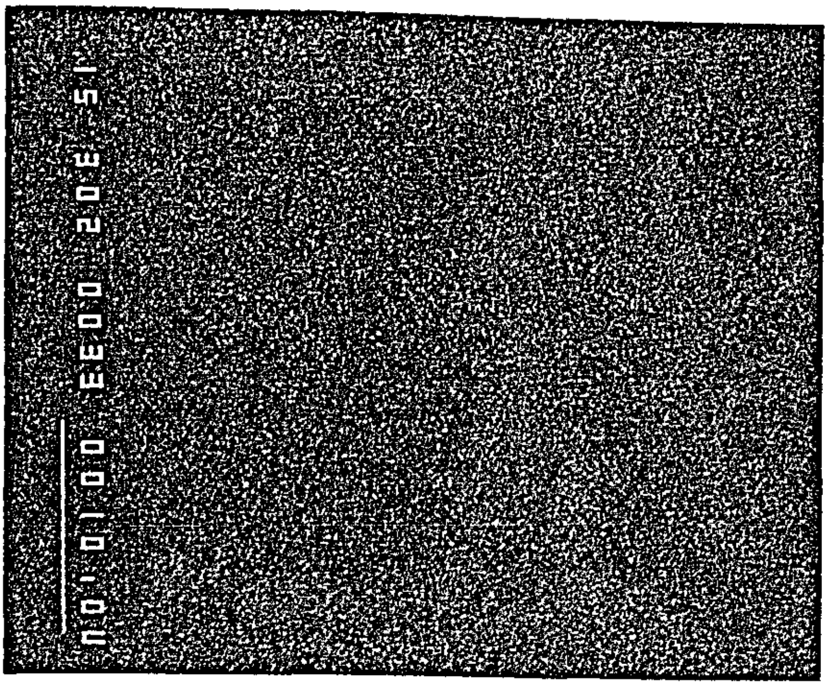


Photo 55.
As Lα Image

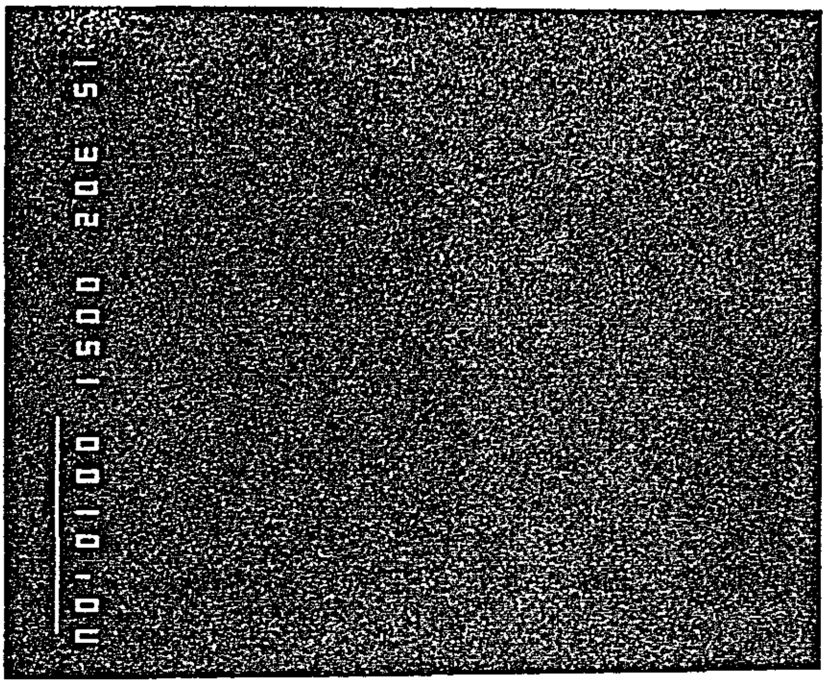


Photo 56.
Sb Lα Image

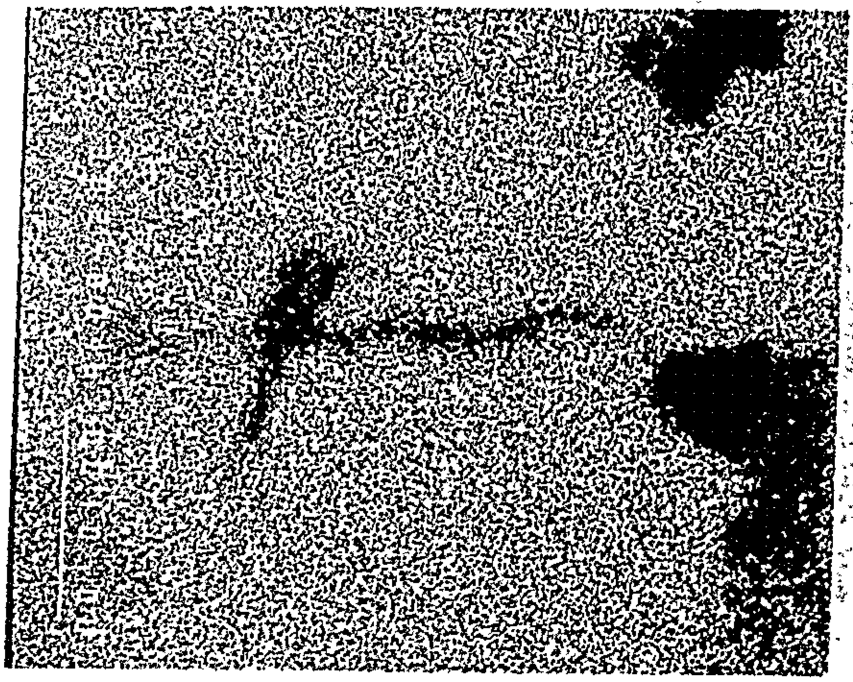


Photo 57.
A Kα Image

SAMPLE	No. 1 ORE (A)
VOLTAGE	20 KV
CURRENT	0.05 μA
MAGNIFICATION	*3000

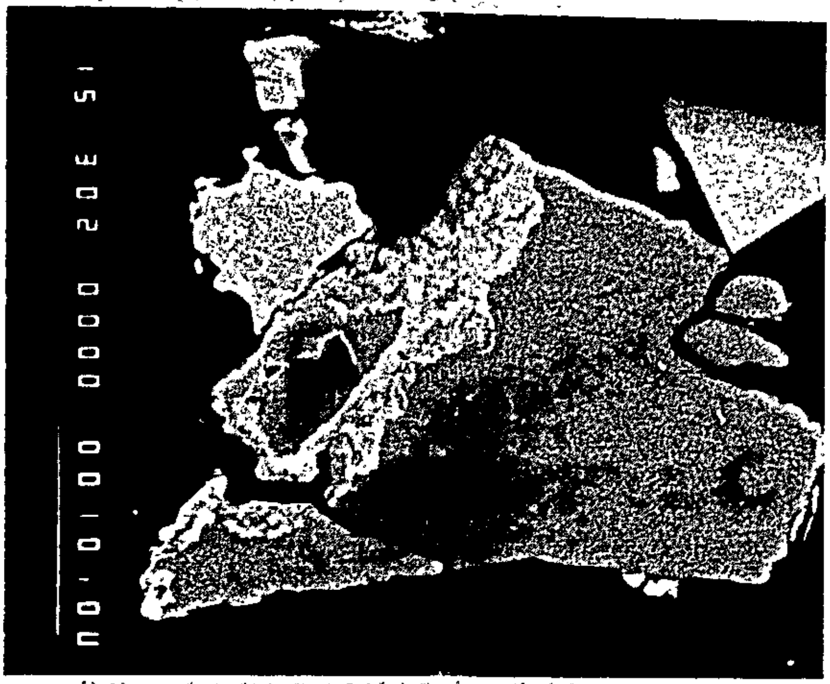


Photo 58.
Secondary Electron Image

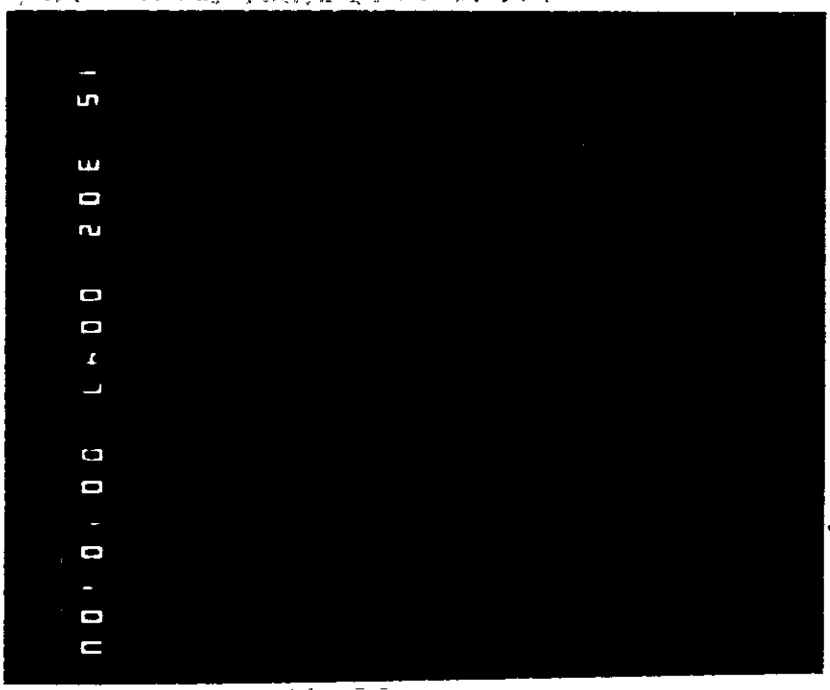


Photo 59.
Ag Lα Image

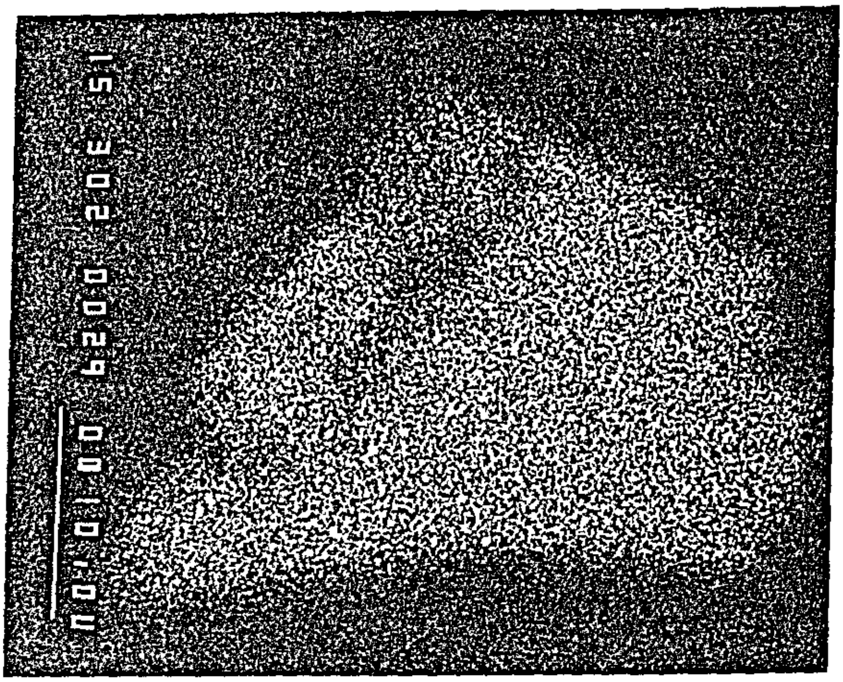


Photo 60.
Cu Kα Image

Photo 61.
Pb Mα Image

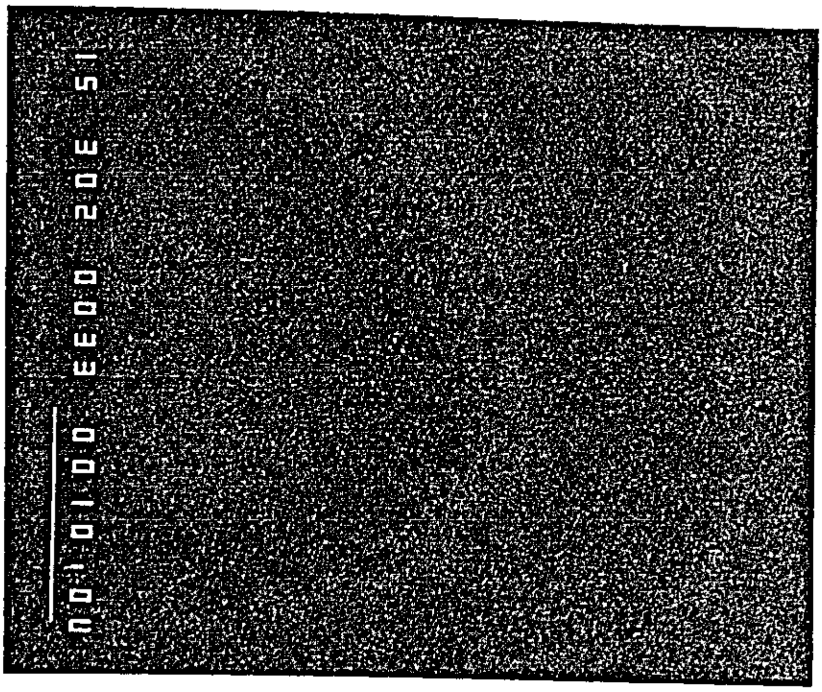


Photo 62.
As Lα Image

Photo 63.
Sb Lα Image

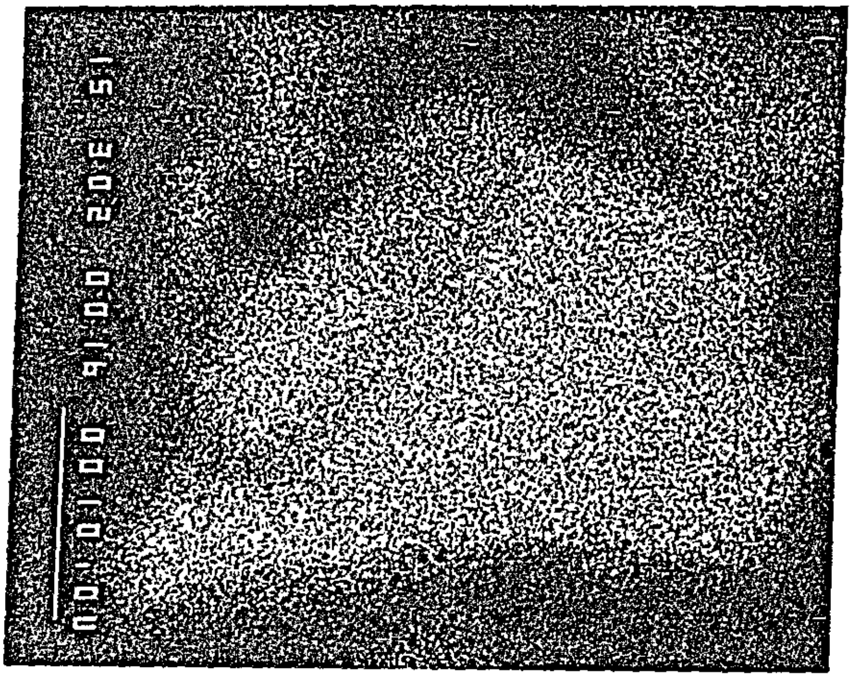


Photo 64.
S Kα Image

SAMPLE	No. 1 ORE (B)
VOLTAGE	20 KV
CURRENT	0.05 μA
MAGNIFICATION	*3600

Photo 65.
Secondary Electron Image

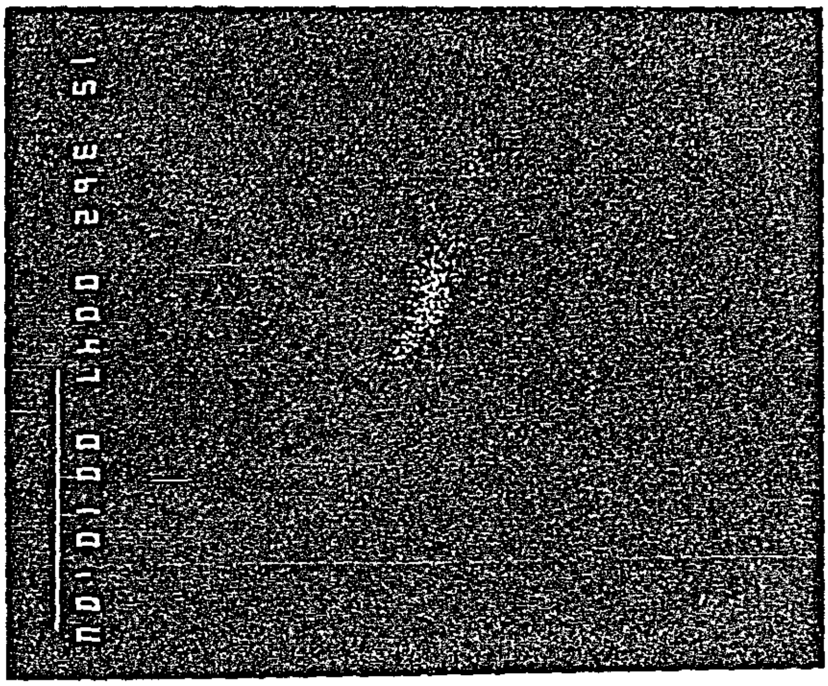


Photo 66.
Ag Lα Image

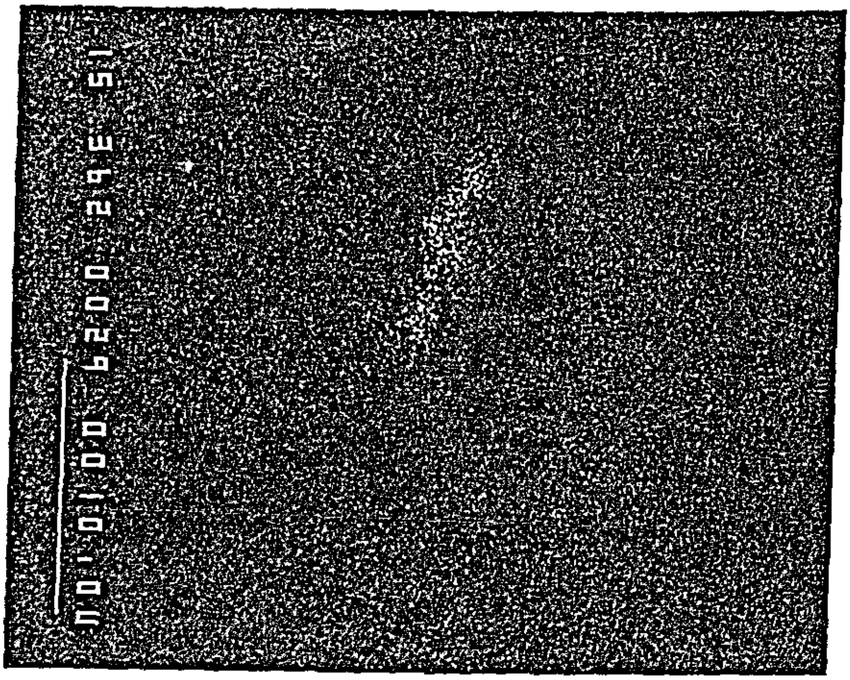


Photo 67.
Cu Kα Image

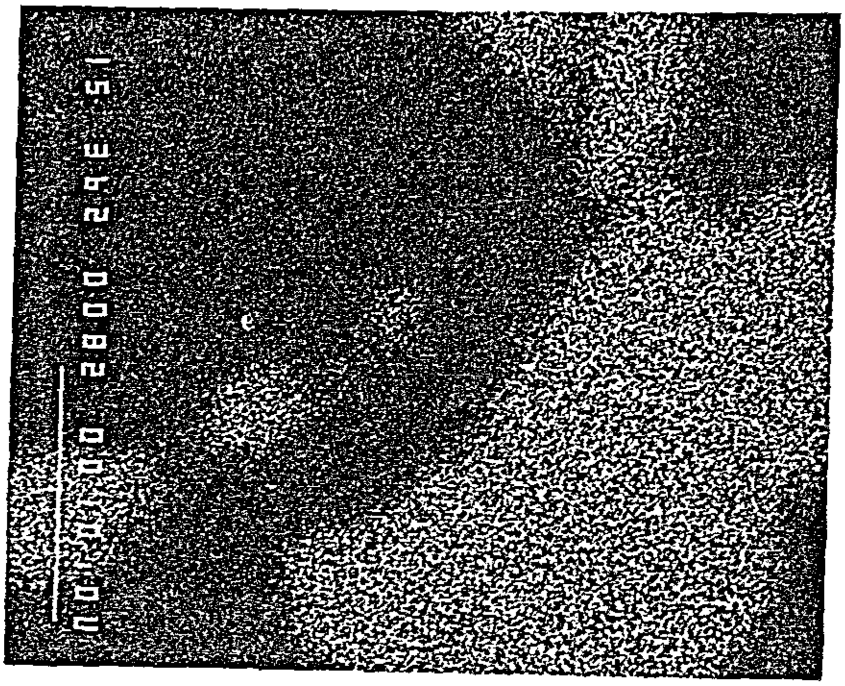


Photo 68.
Pb Mα Image

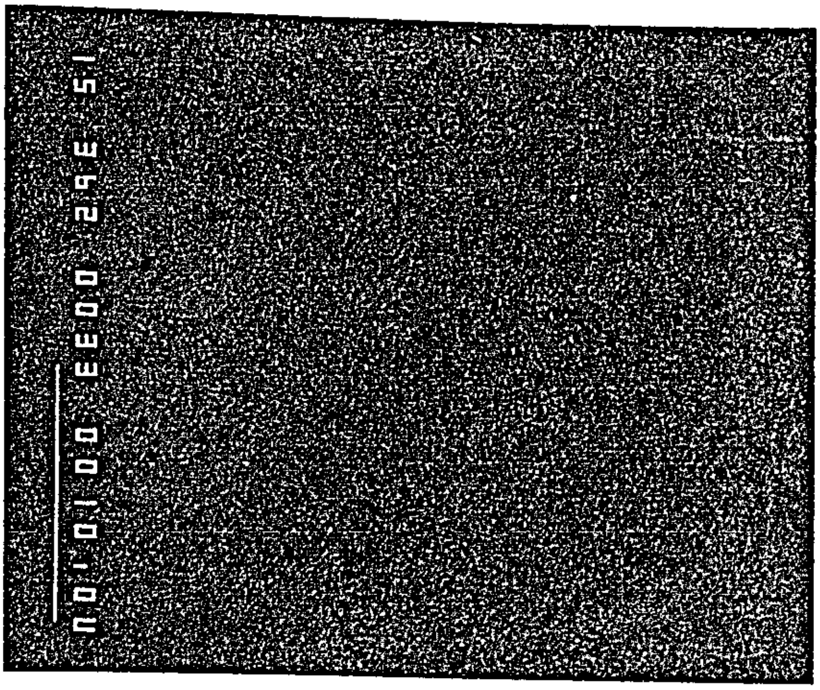


Photo 69.
As Lα Image

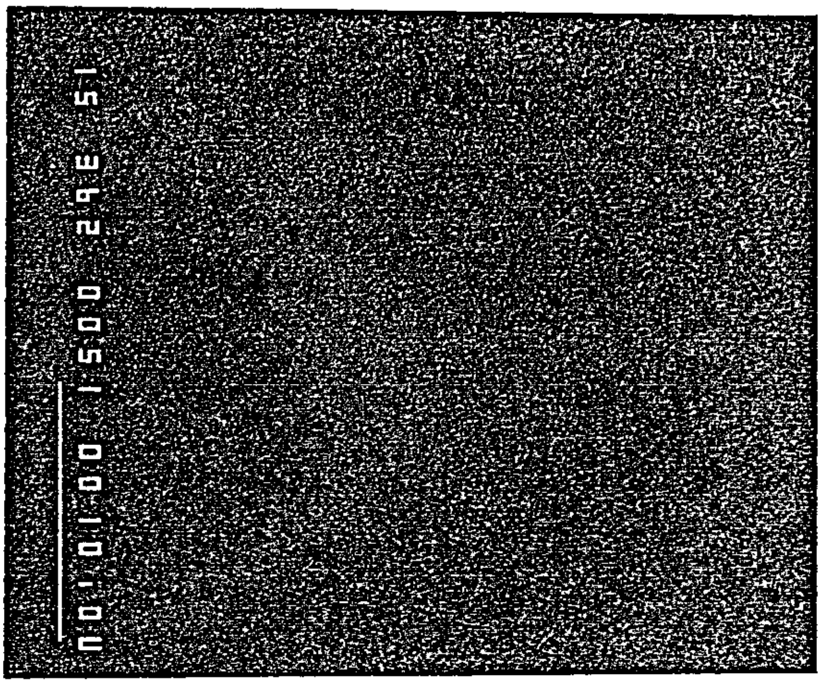


Photo 70.
Sb Lα Image

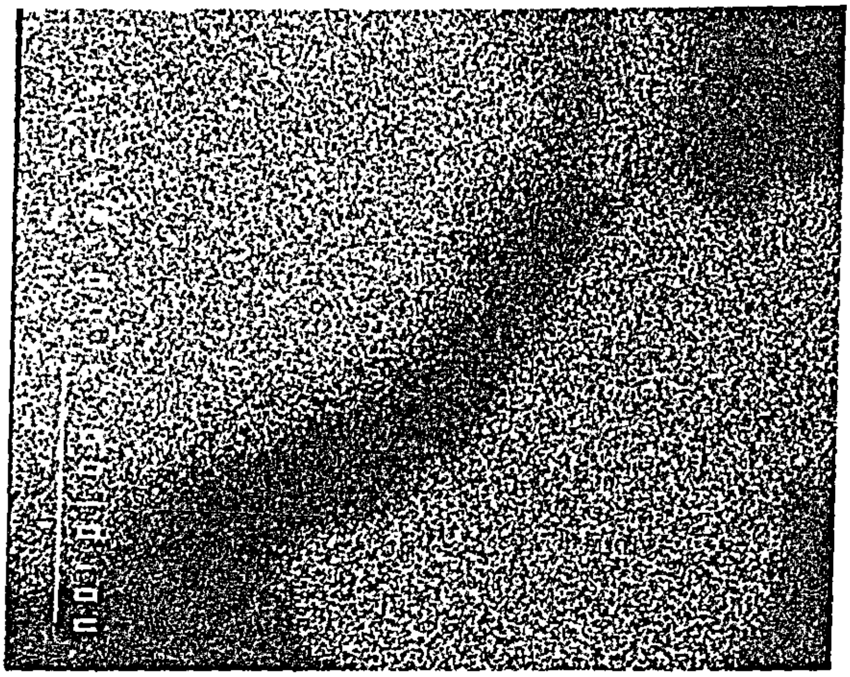


Photo 71.
S Kα Image

SAMPLE	No. 2 ORE
VOLTAGE	20 KV
CURRENT	0.05 μA
MAGNIFICATION	*3000

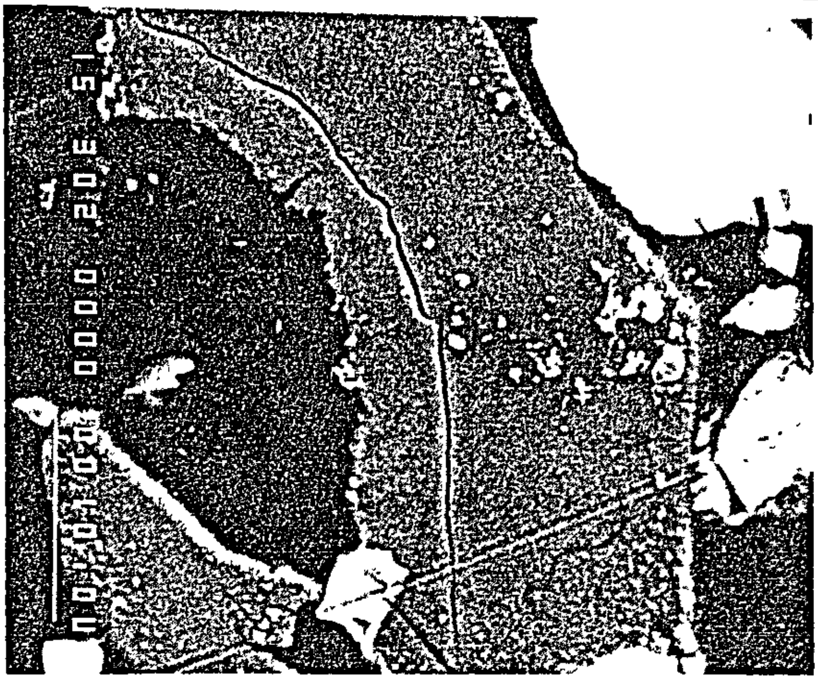


Photo 72.
Secondary Electron Image

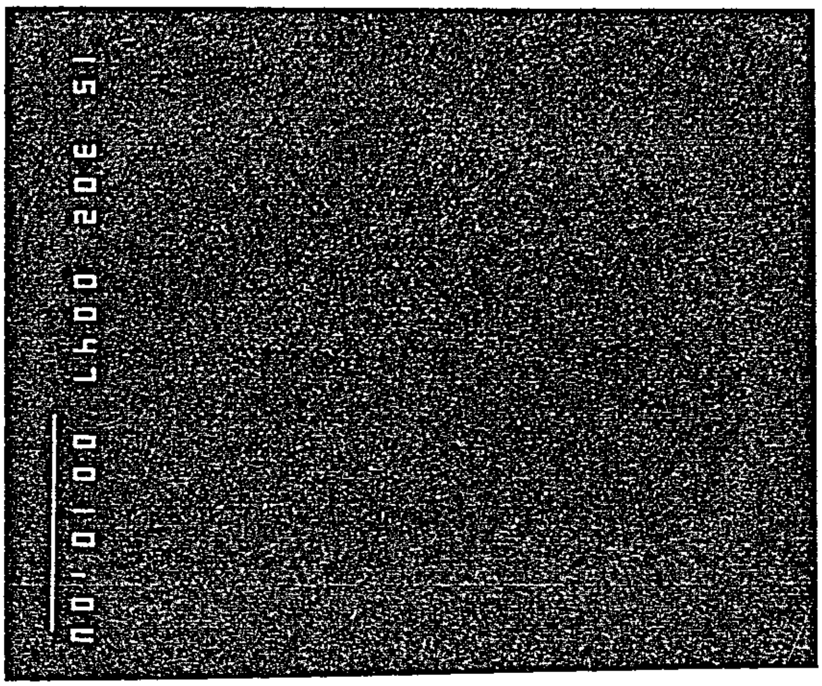


Photo 73.
Ag Lα Image

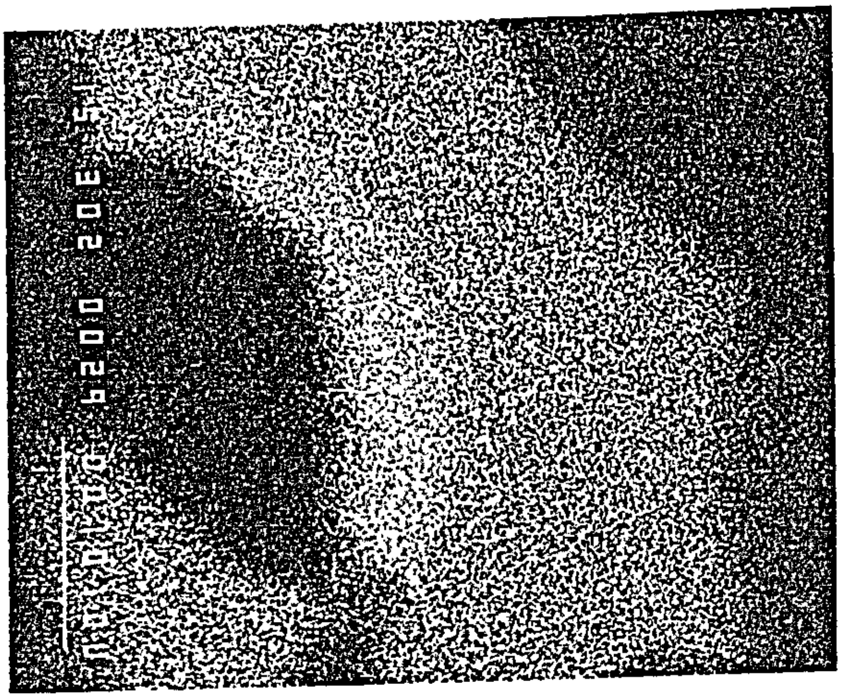


Photo 74.
Cu Kα Image

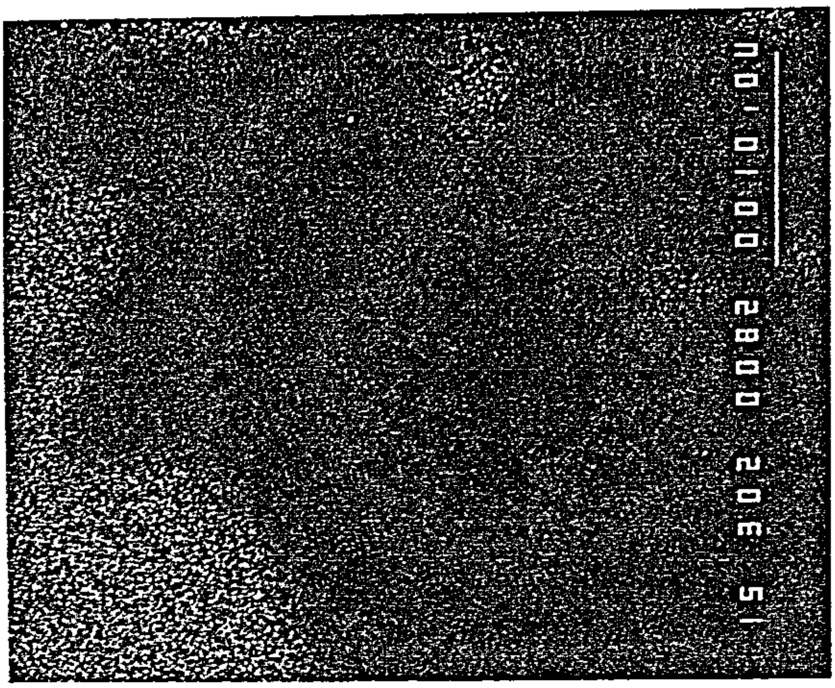


Photo 75.
Pb Mα Image

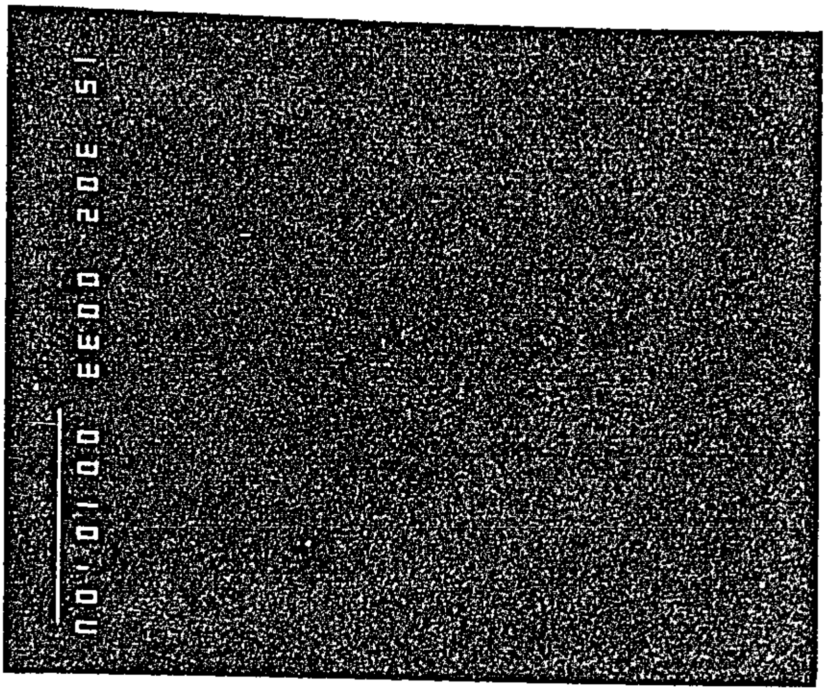


Photo 76.
As Lα Image

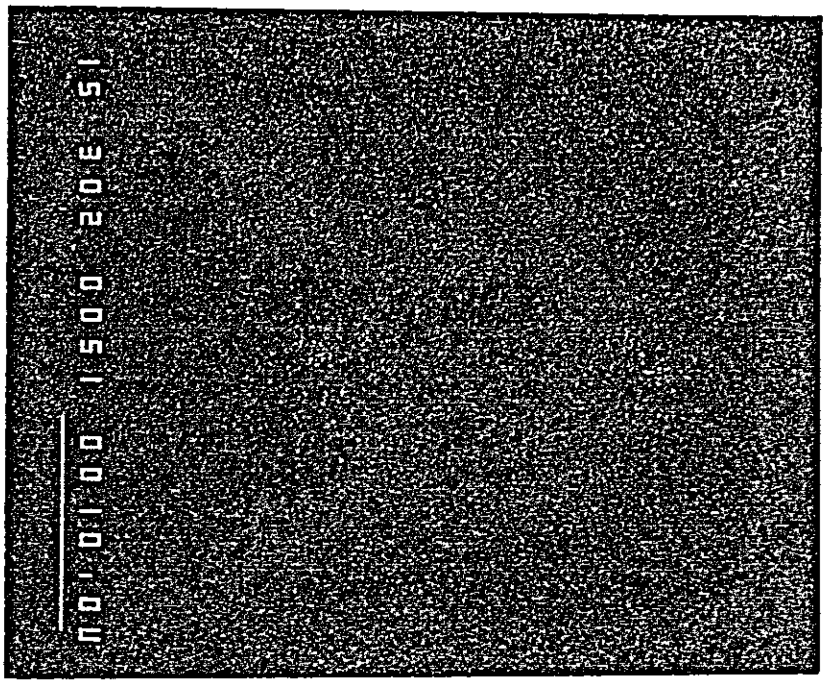


Photo 77.
Sb Lα Image

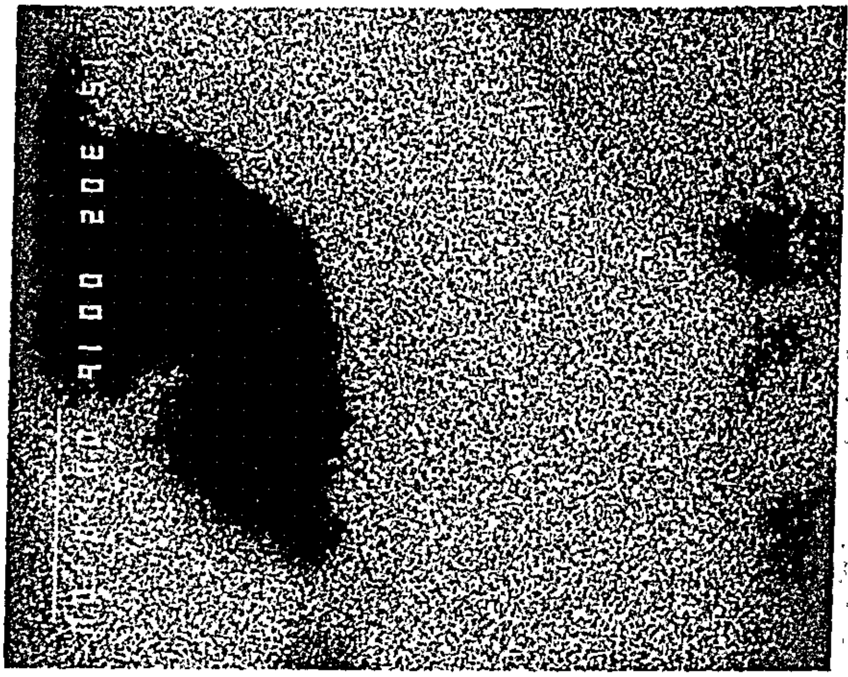


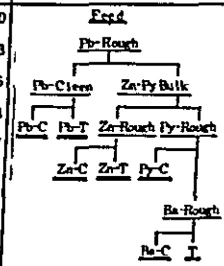
Photo 78.
S Kα Image

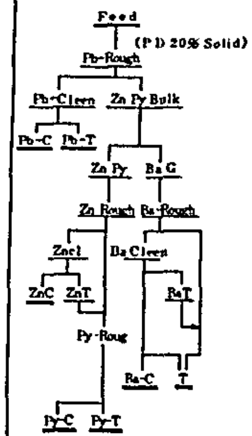
5. Results of Flotation Test

Table A−1 Preliminary Flotation Tests of No. 1 Ore

TEST No.	OPERATION	TIME (min) CON.	TIME (min) FLT.	pH	NaCN	IPX	AP 404	CuSO4	AP 845	Water Glass	H2SO4 / Lime	NIKKO +10	PRODUCTS	WEIGHT (%)	ASSAY (%) Cu	ASSAY Pb	ASSAY Zn	ASSAY Fe	ASSAY *Sul-S	ASSAY BaSO4	DISTRIBUTION (%) Cu	DIST. Pb	DIST. Zn	DIST. Fe	DIST. *Sul-S	DIST. BaSO4
1	Pb Rough	5	10	90	15	14	10					40 / 20	Feed	100.00	0.18	6.00	0.60	2.07	2.13	43.22	100.00	100.00	100.00	100.00	100.00	100.00
	Pb Clean		5	85								20	Pb − C	8.37	0.33	58.05	5.99	3.02	11.18	7.40	15.76	80.95	83.57	12.21	43.95	1.43
	Zn/Py Bulk	5	5	65		5		50			1,330 / −	40	Pb − T	3.92	0.04	5.21	0.55	2.24	0.69	43.58	0.89	3.10	3.59	4.24	1.27	3.95
	Zn Rough	5	5	110		5		600			− / 400	40	Zn − C	2.24	0.31	5.62	1.00	20.53	22.39	16.24	3.95	2.09	3.73	22.17	23.52	0.84
	Py Rough		5	45							6,000 / −		Zn − T	5.85	0.23	1.98	0.20	1.95	0.45	42.66	7.67	1.93	1.95	5.51	1.24	5.77
	Ba Rough	3	10	66					90	150 / 10			Py − C	2.09	0.11	2.24	0.20	2.19	0.57	43.32	1.31	0.78	0.70	2.21	0.56	2.10
													Ba − C	52.57	0.23	1.02	0.05	1.51	0.50	45.44	68.99	8.93	4.38	38.35	12.35	55.27
													T	24.96	0.01	0.46	0.05	1.27	1.46	53.04	1.43	1.92	2.08	15.31	17.11	30.64
2	Pb Rough	6	7	88	20 / 100	10	10					40 / 20	Feed	100.00		5.93	0.58	2.00	41.45			100.00	100.00	100.00	100.00	
	Pb Clean		5	81								20	Pb − C	6.94		64.11	1.87	1.12	4.90			75.09	22.45	3.89	0.82	
	Zn/Py Bulk	5	5	65		100		50			1110 / −	10 / 20	Pb − T	1.50		11.12	0.76	2.00	37.40			2.82	1.98	1.51	1.36	
	Zn Rough	5	7	105 (92)		100		200			− / 400	40 / 20	Zn − C	2.73		15.46	11.81	17.36	8.20			7.12	55.73	23.71	0.54	
	Py Rough		10	62		50					220 / −		Py − C	0.84		6.36	0.71	5.17	34.20			0.90	1.03	2.18	0.70	
	Ba Rough	5	10	62 (78)					100 / 20	200 / 10	140 / −		Py − T	2.29		1.50	0.15	2.00	41.58			0.58	0.59	2.29	2.29	
	Ba Clean		10	60					30	50	220 / 100		Ba − C	72.62		1.00	0.10	1.37	52.82			12.25	12.56	49.80	92.53	
													T	13.08		0.56	0.25	2.54	5.60			1.24	5.66	16.62	1.76	

REAGENTS (g/t)

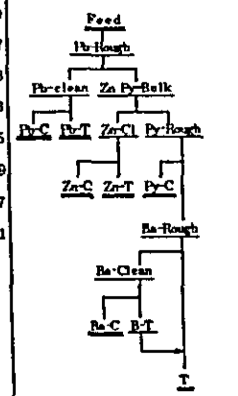




* Sul-S---- Sulfide Sulphur excepted Sulphur in $BaSO_4$

Table A–2 Preliminary Flotation Test of No. 2 Ore

TEST No.	OPERATION	TIME (min) CON.	TIME (min) FLT.	pH	NaCN / ZnSO4	HX	AP #401	CuSO4	AP #845	Water Glass	H_2SO_4 / Lime	NIKKO #10	PRODUCTS	WEIGHT (%)	ASSAY (%)						DISTRIBUTION (%)					
																Pb	Zn	Fe	BaSO4			Pb	Zn	Fe	BaSO4	
3	Pb Rough	5	10	7.8	15	14	10					40 20	Feed	10000	046	2117	0.40	864	1147	112	10000	10000	10000	100.00	10000	10000
	Pb Clean		5	7.8								20	Pb – C	2928	125	6609	100	702	1799	0.36	7976	9140	73.79	23.79	4593	9.37
	Zn.Py Bulk	5	7	7.8		5		50				40 20	Pb – T	1031	0.30	941	040	1180	1200	1.34	6.74	4.58	1039	14.08	1079	1228
	Zn Rough		5	11.4		10		200			– / 800	40	Zn – C	942	016	314	020	3350	3693	0.60	329	1.40	475	3655	30.36	5.03
	Py Rough		5	5.8		5					4,410 / –	30	Zn – T	592	015	174	025	1473	1450	096	193	049	373	1009	7.48	5.05
	Ba Rough	5	7	60					90	150			Py – C	3.25	0.11	283	010	848	757	076	078	043	082	3.19	2.14	2.19
	Ba Clean		5	60						20	– / 1000		Ba – C	995	025	122	0.10	380	0.50	382	5.42	0.57	2.51	4.37	043	3377
													T	3187	0.03	0.75	0.05	2.15	103	114	2.08	1.13	401	793	2.87	3231
4	Pb Rough	6	10	7.9	20 / 100	10	10					40 20	Feed	10000		2194	0.27	8.56	096			10000	100.00	100 00	100.00	
	Pb Clean		5	7.9								20	Pb – C	2976		67.30	0.61	7.27	002			91.30	66.32	25.27	0.62	
	Zn Py Bulk	5	10	61		100 20		50			1,780 / –	40	Zn – C	11.44		6.35	040	38.91	0.24			3.31	1671	51.97	2.86	
	Zn Rough	5	7	10.3		100		200			– / 260	20	Py – C	478		8.11	0.20	7.61	1.20			1.77	3.49	4.25	5.97	
	Zn Clean		7	11.3							– / 300	20	Ba – C	1974		2.00	010	405	2.36			1.80	7.21	9.34	48.46	
	Zn Scav		5	6.3							1,780 / –	20	T	3428		1.17	0.05	2.29	1.18			182	6.27	917	4209	
	Ba Rough	5	10	6.3					90	200																



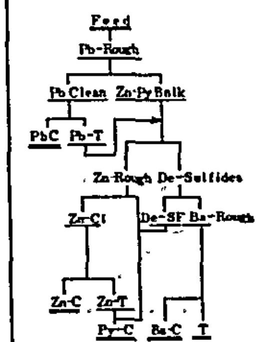


Table A–3 Comparative Pb Flotation Tests of Various Collectors of No. 1 Ore

TEST No.	OPERATION	TIME (mn) CON.	TIME (mn) FLT.	pH	Na EX	AP #404	AP #208	Z-200	NaCN	ZnSO₄	MIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) Pb	ASSAY (%) Zn	ASSAY (%) Fe	DISTRIBUTION (%) Pb	DISTRIBUTION (%) Zn	DISTRIBUTION (%) Fe
5	Pb Rough	5	10	9.2	20 10				25	100	70	Feed	10000	5.42	048	1.77	100 00	100 00	100 00
	Pb Clean		5	87							30	Pb−C	725	61.17	3.13	3.80	8187	47.41	15.54
												Pb−T	261	5.16	101	3.51	2.48	5.50	5.16
												T	9014	094	0.25	1.56	15.65	4709	7930
6	Pb Rough	5	10	91		20			25	100	70	Feed	10000	4.18	055	187	100 00	100.00	100 00
	Pb Clean		5	87							30	Pb−C	5.26	63.01	1.21	0.59	7918	11.57	166
												Pb−T	407	10.25	081	176	998	600	3.83
												T	9067	050	0.50	1.95	10.84	82.43	94.51
7	Pb Rough	5	10	91			20		25	100	70	Feed	10000	480	066	1.93	100 00	100 00	100.00
	Pb Clean		5	86							30	Pb−C	4.34	6076	161	0.59	5491	10.53	1.33
												Pb−T	492	12.06	0.81	180	12.36	601	4.59
												T	9074	173	061	2.00	32.73	8346	9408
7−2	Pb Rough	5	10	92	20	20			25	100	70	Feed	10000	5.71	062	2.11	100 00	100 00	100 00
	Pb Clean		5	87							30	Pb−C	8.20	5909	4.24	5.41	8494	5643	2103
												Pb−T	3.23	6.03	2.83	468	341	1483	7.16
												T	8857	075	020	1.71	11.65	28.74	7181
7−3	Pb Rough	5	10	92	60			70	25	100	70	Feed	10000	606	061	1.96	100 00	100 00	100 00
	Pb Clean		5	8.7							20	Pb−C	768	63.41	2.93	1.17	80.36	3682	460
												Pb−T	4.30	2.93	1.82	2.24	2.08	12.80	5.37
												T	88.02	121	0.35	2.00	17.56	50.38	9003

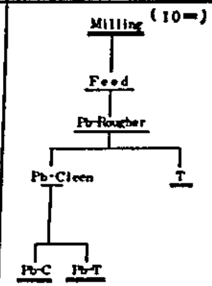


Table A–4 Pb Flotation Test on Grinding Time of No. 1 Ore

TEST №	OPERATION	CONDIONS: TIME (m) CON.	FLT.	pH	REAGENTS (g/t) HX	NaCN	ZnSO4			H_2SO_4	Lime	MIBC	RESULTS: PRODUCTS	WEIGHT (%)	ASSAY (%)	Pb	Zn	Fe		DISTRIBUTION (%)	Pb	Zn	Fe		
8	Pb Rough	5	5	81	20	25	100					50 20	Feed	10000		5.84	0.48	183			100 00	100.00	100 00		
(7 m)	Pb Clean		5	82								20	Pb - C	858		5993	3.03	3.36			87.99	5449	15.77		
													Pb - T	3.24		6.43	2.62	644			3.56	17.79	11.41		
													T	88.18		056	015	1.51			8.45	27.72	72.82		
9	Pb Rough	5	5	84	20	25	100					50 20	Feed	10000		5.55	067	1.78			100 00	100 00	100 00		
(10 m)	Pb Clean		5	81								20	Pb - C	7.85		62.81	2.93	2.15			88.79	34.21	945		
													Pb - T	280		5.00	3.03	634			2.52	12.63	996		
													T	89.35		054	040	161			869	5316	8059		
10	Pb Rough	5	5	84	20	25	100					50 20	Feed	10000		5.44	0.76	1.84			100 00	100 00	100.00		
(15 m)	Pb Clean		5	81								20	Pb - C	698		67.99	2.22	1.22			87.26	2046	462		
													Pb - T	2.91		6.12	1.82	312			3.27	699	493		
													T	9011		057	061	185			945	7255	9045		

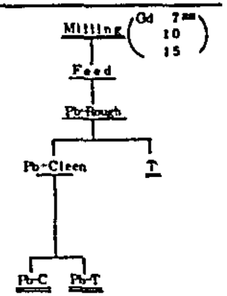


Table A–5 Pb Flotation Test on pH of No. 1 Ore

TEST №	OPERATION	CONDIONS: TIME (m) CON.	TIME (m) FLT.	pH	REAGENTS (g/t) IPX	NaCN	$ZnSO_4$	H_2SO_4	Lime	MIBC	RESULTS: PRODUCTS	WEIGHT (%)	ASSAY (%) Pb	Zn	Fe	DISTRIBUTION (%) Pb	Zn	Fe
11	Pb Rough	5	5	6.0 (7.5)	20	25	100	2,000		50 20	Feed	100.00	5.71	0.56	187	100.00	100.00	100.00
	Pb Clean		5	59				360		20	Pb - C	8.54	5970	5.85	2.54	89.25	89.94	1163
											Pb - T	225	349	0.50	744	1.38	2.03	8.97
											T	8921	060	005	166	9.37	803	7940
12	Pb Rough	5	5	100 (89)	20	25	100		1,600	50 20	Feed	10000	5.58	054	189	100.00	100.00	100.00
	Pb Clean		5	101						20	Pb - C	7.16	66.73	2.02	093	85.69	2679	3.52
											Pb - T	2.35	944	1.41	2.49	397	6.13	309
											T	9049	064	040	195	10.39	6708	93.39
13	Pb Rough	5	5	109	20	25	100	580	1,660	50 20	Feed	10000	5.11	067	178	100.00	100.00	100.00
	Pb Clean		5	105				220	320	20	Pb - C	6.73	6421	484	068	8456	4842	2.57
											Pb - T	2.67	1059	2.83	2.34	5.52	11.21	3.50
											T	90.60	0.56	0.20	185	992	40.37	9393

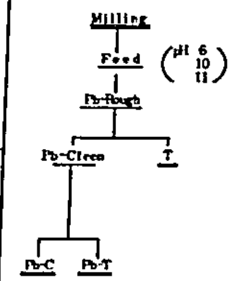


Table A-6 Pb Flotation Tests of Depressants of No. 1 Ore

TEST No	CONDIONS								RESULTS							
	OPERATION	TIME (mn)		pH	REAGENTS (g/t)				PRODUCTS	WEIGHT (%)	ASSAY (%)			DISTRIBUTION (%)		
		CON.	FLT.		HX	NaCN	ZnSO$_4$	MIBC			Pb	Zn	Fe	Pb	Zn	Fe
14	Pb Rough	5	5	82	20	10	40	50 20	Feed	10000	5.37	063	1.73	100 00	100 00	100 00
	Pb Clean		5					20	Pb - C	779	58.36	4.24	122	84.67	52.76	5.48
									Pb - T	2.55	4.38	2.72	2.39	2.16	1149	3.64
									T	89.56	079	0.25	1.76	1317	35.75	90.88
16	Pb Rough	5	5	82	20	50	200	50 20	Feed	10000	5.09	0.55	1.88	100 00	100 00	100.00
	Pb Clean		5					20	Pb - C	7.34	65.70	2.02	0.83	9477	27.13	3.24
									Pb - T	2.76	2.15	141	2.54	1.17	7.12	372
									T	8990	0.23	040	1.95	406	65.75	93.04

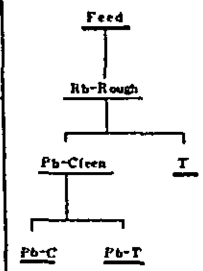


Table A–7 Barite Flotation Tests on pH of No. 1 Ore

TEST No	OPERATION	TIME (min) CON.	TIME (min) FLT.	pH	IPX	NaCN / $ZnSO_4$	$CuSO_4$	Water Glass	AP #825	AP #845	H_2SO_4	MIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) $BaSO_4$	DISTRIBUTION (%) $BaSO_4$
		CONDIONS			REAGENTS (g/t)								RESULTS			
17	Pb Rough	5	10	88	20	25/100						50 20	Feed	100.00	45.66	100.00
	De Sulfide	5	10	62			100				710	50 30	Pb - C	9.82	13.44	2.89
	Ba Rough	5	10	5 (7.0)				200	50	25	4,350		De-SF	2.10	21.96	1.01
	Ba Clean		5	5 (6.0)							310		Ba - C	10.26	55.60	12.50
													Ba - T	6.83	54.44	2.21
													T	70.99	48.54	75.46
18	Pb Rough	5	10	85	20	25/100						50 20	Feed	100.00	45.43	100.00
	De Sulfide	5	10	60	20		100				580	30	Pb - C	9.79	14.42	3.11
	Ba Rough	5	10	60 (70)				200	50	25	680 310		De - SF	3.40	23.36	1.75
	Ba Clean		5	59 (7.8)							90		Ba - C	21.69	58.54	27.95
													Ba - T	11.68	57.42	52.43
													T	53.44	44.58	
19	Pb Rough	5	10	87	20	25/100						50 20	Feed	100.00	43.65	100.00
	De Sulfide	5	10	60	20		100				670	30	Pb - C	10.00	15.90	3.64
	Ba Rough	5	10	68				200	50	25	270		De - SF	4.40	27.40	2.76
	Ba Clean		5	70 (78)							40		Ba - C	32.30	58.16	43.04
													Ba - T	13.42	42.08	12.94
													T	39.88	41.18	37.62

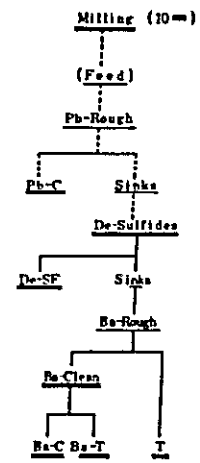


Table A–8 Barite Flotation Tests of Collectors of No. 1 Ore

TEST No.	OPERATION	TIME (m) CON.	TIME (m) FLT.	pH	IPX	NaCN / ZnSO4	CuSO4	Water Glass	AP #825	AP #845	H2SO4	MIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) BaSO4	DISTRIBUTION (%) BaSO4
20	Pb Rough	5	10	8.8	20	25/100						50 20	Feed	100.00	47.27	100.00
	De Sulfide	5	10	6	20		100				1,680	40	Pb - C	9.54	14.40	2.90
	Ba Rough	5	10	7				50	50	25	310		De - SF	4.33	29.32	2.68
	Ba Clean		5	7							70		Ba - C	11.76	64.80	16.12
													Ba - T	7.59	59.98	9.63
													T	66.78	48.60	68.67
21	Pb Rough	5	10	8.8	20	25/100						50 20	Feed	100.00	46.21	100.00
	De Sulfide	5	10	6.0 (8.0)	20		100				1,240	40	Pb - C	8.79	13.70	2.66
	Ba Rough	5	10	7 (7.8)				50	100	50	220		De - SF	3.35	21.80	1.58
	Ba Clean		5	7 (7.8)							90		Ba - C	22.03	63.64	30.33
													Ba - T	17.99	56.80	22.11
													T	47.66	42.00	43.32
22	Pb Rough	5	10	8.8	20	25/100						50 20	Feed	100.00	34.48	100.00
	De Sulfide	5	10	6.0 (8.0)	20		100				1,020	40	Pb - C	10.32	15.98	4.78
	Ba Rough	5	10	7 (7.8)				100	500	250	220		De - SF	4.14	26.96	3.24
	Ba Clean		5	7 (7.8)							90		Ba - C	53.04	50.20	77.21
													Ba - T	25.84	17.38	13.03
													T	6.66	9.04	1.74
23	Pb Rough	5	10	8.8	20	25/100						50 20	Feed	100.00	42.05	100.00
	De Sulfide	5	10	6.0	20	10	100				1,020	40	Pb - C	9.97	21.58	5.12
	Ba Rough	5	10	7 (7.8)				750	1,500	750	220		De - SF	4.23	27.56	2.77
	Ba Clean 1		5	7 (7.8)							90		Ba C	62.29	53.02	78.54
	Clean 2		5	7 (7.6)							90		Ba Cl1T	5.92	38.22	5.38
	Clean 3		5	7 (7.5)							40		Ba Cl2T	6.10	21.60	3.13
													Ba Cl3T	3.69	44.46	3.90
													T	7.80	6.26	1.16

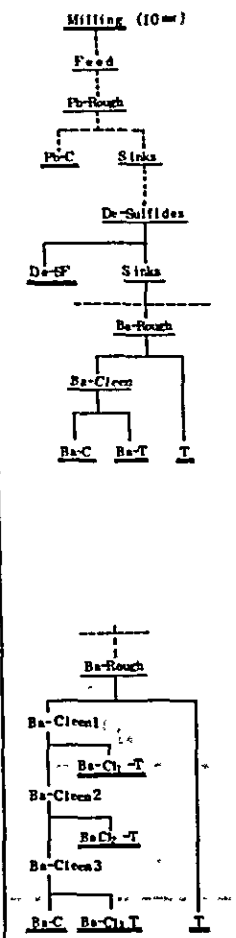
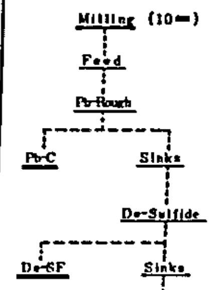


Table A–9 Barite Flotation Tests of NaOL and Water Glass of No. 1 Ore

TEST No.	OPERATION	TIME (m) CON.	TIME (m) FLT.	pH	IPX	NaCN / $ZnSO_4$	$CuSO_4$	Water Glass	NaOL	Kerosene	H_2SO_4	MIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) $BaSO_4$	DISTRIBUTION (%) $BaSO_4$
24	Pb Rough	5	10	8.9	20	25/100						50 20	Feed	100.00	46.72	100.00
	De Sulfide	5	10	6.0 (8.0)	20		100				1,240	40	Pb-C	8.35	16.08	2.87
	Ba Rough	5	10	7 (7.9)				600	400	120	360		De-SF	4.59	28.04	2.76
	Ba Clean 1		5	7 (7.8)							90		Ba-C	18.47	76.42	30.21
	Ba Clean 2		5	7 (7.6)							90		$BaCl_1T$	21.60	49.40	22.84
													$BaCl_2T$	21.44	62.46	28.66
													T	25.55	23.16	12.66
25	Pb Rough	5	10	8.9	20	25/100						50 20	Feed	100.00	43.36	100.00
	De Sulfide	5	10	6.0	20		100					40	Pb-C	10.78	19.22	4.78
	Ba Rough	5	10	7 (7.9)				1,200	800	180	1,200		De-SF	4.67	30.98	3.34
	Ba Clean 1		5	7 (7.8)							440		Ba-C	32.71	85.82	64.75
	Ba Clean 2		5	7 (7.8)						20	130		$BaCl_1T$	6.59	28.62	4.35
	Ba Clean 3		5	7 (7.5)							90		$BaCl_2T$	10.84	41.04	10.26
													$BaCl_3T$	6.85	59.42	9.39
													T	27.56	4.94	3.13



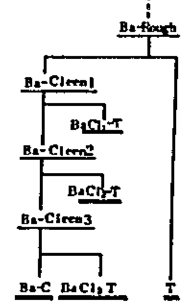
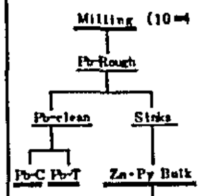


Table A–10 Zn · Py Flotation Tests of pH of No. 1 Ore

TEST No.	OPERATION	TIME (m) CON.	TIME (m) FLT.	pH	REAGENTS (g/t) IPX	AP #101	NaCN	$ZnSO_4$	$CuSO_4$	H_2SO_4	Lime	MIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) Pb	Zn	Fe	DISTRIBUTION (%) Pb	Zn	Fe
26	Pb Rough	5	10	Natural	10	20	25	100				50 20	Feed	100.00	5.44	022	141	100 00	100 00	100 00
	ZnPy Bulk	5	10	Natural	50				100			40	Pb - C	694	62.83	121	049	8005	3875	241
	Zn Rough	5	10	9 (8.5)	50				200		210		Pb - T	323	981	091	1.76	5.82	1356	402
	Zn Clean		5	9							60		Zn - C	0.32	1611	1322	1863	095	1958	423
													Zn R T	2.02	157	0.20	2.54	0.58	187	364
													Zn Cl T	291	2.07	0.50	468	1.11	671	963
													T	84.58	074	005	1.27	1149	1953	7607
27	Pb Rough	5	10	Natural	10	10	25	100				50 20	Feed	100.00	5.64	052	1.67	100 00	100 00	100 00
	ZnPy Bulk	5	10	6	50				100	1010		40	Pb - C	7.24	66.17	161	1.22	8493	2249	5.28
	Zn Rough	5	10	10	50				200		280		Pb - T	3.06	600	1.51	2.29	3.25	890	418
	Zn Clean		5	10							400		Zn - C	187	5.72	1645	25.36	1.90	5935	2834
													Zn R T	3.08	198	016	2.83	108	089	520
													Zn Cl T	0.28	2.98	040	2.54	015	022	043
													T	8447	058	0.05	1.12	8.69	815	5657



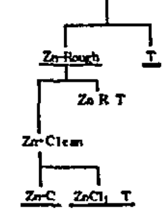


Table A−11　Zn · Py Flotation Test of Reagents and pH of No. 1 Ore

TEST No.	OPERATION	TIME (m) CON.	TIME (m) FLT.	pH	REAGENTS (g/t) IPX	NaCN	ZnSO4	CuSO4	H2SO4	Lime	MIBC	PRODUCT	WEIGHT (%)	ASSAY (%) Pb	Zn	Fe	DISTRIBUTION (%) Pb	Zn	Fe
29	Pb Rough	5	10	Natural (7.8)	20	25	100				50 10	Feed	100.00	5.64	0.63	2.60	100.00	100.00	100.00
	ZnPyBulk	5	10	6 (7.5)	50			100			10	Pb - C	10.00	50.04	2.02	1.34	88.73	32.26	5.16
	Zn Rough	5	10	10	10			50	930	300	10	Zn - C	1.89	5.27	17.46	26.04	1.77	52.81	19.00
	Zn Clean		5	10						50		Zn RT	2.87	1.24	0.25	1.71	0.63	1.14	1.89
												ZnCl1 T	0.43	3.97	0.35	4.63	0.30	0.24	0.77
												T	84.81	0.57	0.10	2.24	8.57	13.55	73.18
30	Pb Rough	5	10	Natural	20	25	100				50 10	Feed	100.00	5.77	0.50	2.11	100.00	100.00	100.00
	ZnPy Bulk	5	10	6 (7.8)	50			100	1,260			Pb - C	9.54	52.91	2.12	4.39	87.43	40.47	19.83
	Zn Rough	5	10	11 (9.0)	50			200		250		Zn - C	1.53	2.80	16.25	28.28	0.74	49.80	20.51
	Zn Clean1		5	11						500		Zn RT	1.90	1.28	0.10	1.95	0.42	0.38	1.76
	Zn Clean2		5	11						400		ZnCl1 T	0.34	3.34	0.61	7.41	0.20	0.42	1.19
												ZnCl2 T	0.10	6.20	1.31	11.21	0.11	0.26	0.53
												T	86.59	0.74	0.05	1.37	11.10	8.67	56.18
31	Pb Rough	5	10	Natural	20	25	100				50 10	Feed	100.00	6.56	0.54	2.02	100.00	100.00	100.00
	ZnPy Bulk	5	10	6 (8.0)	50			100	1,310		20	Pb - C	9.47	53.72	2.42	1.46	77.52	42.54	6.83
	Zn Rough	5	10	12	100			400		850	10	Zn - C	0.35	3.06	48.94	4.29	0.16	31.83	0.74
	Zn Clean1		5	12						900	10	Zn RT	2.47	2.22	0.66	10.29	0.84	3.03	12.56
	Zn Clean2		5		2			30		700		ZnCl1 T	0.85	2.50	1.87	22.14	0.32	2.95	9.30
												ZnCl2 T	0.36	3.53	5.35	22.04	0.19	3.58	3.92
												T	86.50	1.59	0.10	1.56	20.97	16.07	66.65

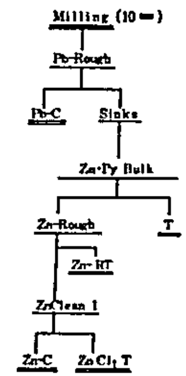


Table A–12 Zn · Py Flotation Test of Reagents of No. 1 Ore

TEST No.	OPERATION	TIME (mn) CON.	TIME (mn) FLT.	pH	REAGENTS (g/t) IPX	NaCN	ZnSO4	CuSO4	H2SO4	Lime	MIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) Pb	Zn	Fe	DISTRIBUTION (%) Pb	Zn	Fe
32	Pb Rough	5	10	Natural (7.8)	20	25	100				50 10	Feed	100.00	5.53	0.51	1.64	100.00	100.00	100.00
	ZnPy Bulk	5	10	6.0 (7.8)	20			100	750		40	Pb C	10.37	48.45	2.52	1.46	90.76	51.01	9.23
	Zn Rough	5	7	12 (11.5)	10			50		700	20 10	Zn - C	0.27	3.60	53.38	4.00	0.18	28.21	0.66
	Zn Clean 1		5	12						800		Zn R T	2.19	0.86	0.25	6.97	0.34	1.07	9.29
	Zn Clean 2		5	12	4					650	10	Zn R T	0.69	2.78	0.76	25.01	0.35	1.03	10.55
												ZnCl2 T	0.54	4.69	9.74	27.11	0.46	10.30	8.95
												T	85.94	0.51	0.05	1.17	7.91	8.38	61.32
33	Pb Rough	5	10	Natural (7.8)	20	25	100				50 10	Feed	100.00	4.95	0.51	1.70	100.00	100.00	100.00
	ZnPy Bulk	5	10	6.0 (7.8)	20			100	890		40	Pb - C	10.11	45.02	1.92	1.46	91.97	38.04	8.68
	Zn Rough	5	7	12 (11.7)	25			20		850	30	Zn - C	0.55	4.48	45.61	5.22	0.50	49.26	1.69
	Zn Clean 1		5	12						450	10	Zn R T	2.61	1.81	0.35	13.02	0.96	1.79	20.03
												Zn Cl1 T	0.62	5.21	2.02	21.26	0.65	2.46	7.77
												T	86.11	0.34	0.05	1.22	5.92	8.45	61.83
34	Pb Rough	5	10	Natural (7.8)	20	25	100				50 10	Feed	100.00	4.82	0.53	1.69	100.00	100.00	100.00
	ZnPy Bulk	5	10	6 (7.8)	20			100	890		40	Pb - C	9.90	45.27	2.22	1.34	92.89	41.15	7.84
	Zn Rough	5	7	12	50			200		820	10	Zn - C	0.51	4.45	46.82	3.80	0.47	44.76	1.15
	Zn Clean 1		5	12						660		Zn R T	2.47	0.74	0.30	12.48	0.36	1.39	18.23
	Zn Clean 2		5	12						620		ZnCl1 T	0.51	2.74	0.96	26.92	0.29	0.92	8.12
												ZnCl2 T	0.21	5.52	9.38	19.11	0.24	3.69	2.37
												T	86.40	0.32	0.05	1.22	5.73	8.09	62.29

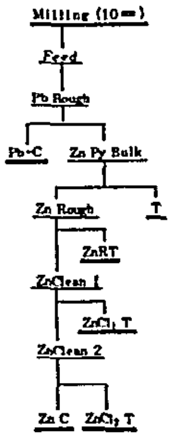


Table A–13 Pb Flotation Tests on Grinding Time of No. 2 Ore

TEST No.	OPERATION	TIME (mn) CON.	TIME (mn) FLT.	pH	REAGENTS (g/t) IPX	NaCN	ZnSO4	HIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) Pb	Zn	Fe	DISTRIBUTION (%) Pb	Zn	Fe
35	Pb Rough	5	7	Natural	20	25	100	50 20	Feed	10000	2210	034	909	10000	100.00	10000
(7 mn)	Pb Clean1		5	8.1				20	Pb - C	2644	6403	081	1000	7661	6340	2909
	Pb Clean2		5	8.2					Pb - T	6.18	4733	091	7.02	1324	1665	477
									T	6738	333	010	892	1015	1995	66.14
36	Pb Rough	5	7	Natural	20	25	100	50 20	Feed	10000	2272	022	8.78	10000	10000	10000
(10 mn)	Pb Clean1		5	8.2				20	Pb - C	2568	7231	0.50	634	81.73	5919	1856
	Pb Clean2		5	8.2					Pb - T	3.56	4611	0.50	5.97	7.22	8.20	242
									T	7076	355	010	980	1105	3261	7902
37	Pb Rough	5	7	Natural	20	25	100	50 20	Feed	10000	2183	0.31	8.42	10000	10000	100.00
(15 mn)	Pb Clean1		5	8.2				20	Pb - C	2780	6979	081	975	8886	7373	3218
	Pb Clean2		5	8.2					Pb - T	401	1421	030	1063	261	394	5.06
									T	6819	273	010	7.75	853	2233	6276

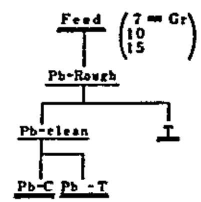


Table A–14 Pb Flotation Tests of Collectors of No. 2 Ore

TEST No.	OPERATION	TIME (m) CON.	TIME (m) FLT.	pH	AP 404	IPX	NaCN	ZnSO₄	MIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) Pb	ASSAY (%) Zn	ASSAY (%) Fe	DISTRIBUTION (%) Pb	DISTRIBUTION (%) Zn	DISTRIBUTION (%) Fe
38	Pb Rough	5	7	Natural (7.9)	–	50	50	200	50 20	Feed	10000	21.88	0.39	861	100.00	100.00	100.00
	Pb Clean		5	8.1					20	Pb-C	30.74	66.53	1.01	7.36	95.45	79.16	26.27
										Pb-T	4.15	10.37	0.40	12.29	1.97	4.24	5.93
										T	65.11	1.54	0.10	8.97	4.58	16.60	67.80
39	Pb Rough	5	7	Natural (7.9)	25	5	50	200	50 20	Feed	10000	22.48	0.36	898	100.00	100.00	100.00
	Pb Clean		5	8.1					20	Pb-C	23.46	71.28	0.81	4.19	74.37	53.11	10.95
										Pb-T	3.57	33.01	0.61	6.68	5.24	6.09	2.66
										T	72.97	6.28	0.20	10.63	20.39	40.80	86.39
40	Pb Rough	5	7	Natural	50	10	50	200	50 20	Feed	10000	22.63	0.38	984	100.00	100.00	100.00
	Pb Clean		5	8.1					20	Pb-C	29.16	71.48	1.01	8.29	92.11	77.82	24.57
										Pb-T	3.27	13.29	0.50	11.41	1.92	4.32	3.79
										T	67.57	2.00	0.10	10.43	5.97	17.86	71.64
41	Pb Rough	5	7	Natural	100	20	50	200	50 20	Feed	10000	23.23	0.33	10.83	100.00	100.00	100.00
	Pb Clean		5	8.1					20	Pb-C	30.46	67.99	0.81	7.18	89.13	74.66	20.19
										Pb-T	3.55	11.07	0.50	13.26	1.69	5.37	4.34
										T	65.99	3.23	0.10	12.39	9.18	19.97	75.47

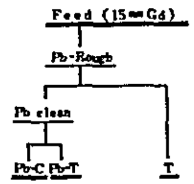


Table A–15 Pb Flotation Tests of Depressants of No. 2 Ore

TEST No.	CONDIONS												RESULTS													
	OPERATION	TIME (m)		pH	REAGENTS (g/t)								PRODUCTS	WEIGHT (%)	ASSAY (%)						DISTRIBUTION (%)					
		CON.	FLT.		IPX	NaCN	$ZnSO_4$			H_2SO_4	Lime	MIBC				Pb	Zn	Fe				Pb	Zn	Fe		
42	Pb Rough	5	7	Natural	50	10	25	100				50 20	Feed	10000		2242	020	996				100.00	100.00	100 00		
	Pb Clean		5	8.1								20	Pb-C	28.57		6983	101	5.75				8900	77.95	16.49		
													Pb-T	341		1768	040	10.53				269	3.68	360		
													T	6802		274	010	11.70				8.31	1837	7991		
43	Pb Rough	5	7	Natural	50	10	100	400				50 20	Feed	10000		2297	0.32	8.53				100 00	100 00	100 00		
	Pb Clean		5	81								20	Pb-C	27.88		7376	061	4.56				8955	5239	1490		
													Pb-T	344		1545	050	1185				232	530	478		
													T	6868		272	020	998				8.13	4231	8032		

Table A-16 Zn · Py Flotation Tests on pH of No. 2 Ore

TEST No.	OPERATION	TIME (m) CON.	TIME (m) FLT.	pH	REAGENTS (g/t) AP 404	IPX	NaCN	ZnSO4	CuSO4	H2SO4	Lime	MIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) Pb	Zn	Fe	DISTRIBUTION (%) Pb	Zn	Fe
44	Pb Rough	5	7	Natural	25	5	50	200				50 20	Feed	10000	22.58	0.33	8.75	100.00	100.00	100.00
	Zn Py Bulk	5	10	6.0		20			100	880		40	Pb-C	3076	68.96	0.81	6.77	93.93	75.39	23.80
	Zn Rough	5	5	10 (8.8)		50			200		300	20	Zn-C	1209	4.07	0.20	38.50	2.18	7.32	53.22
	Zn Clean1		5	10								20	Zn RT	350	1.74	0.10	4.09	0.27	1.06	1.64
	Zn Clean2		5	10							100	20	ZnCl1T	098	3.67	0.10	10.84	0.16	0.30	1.22
													ZnCl2T	074	7.24	0.10	17.73	0.24	0.22	1.50
													T	5193	1.40	0.10	3.14	3.22	15.71	18.62
44-2	Pb Rough	5	7	Natural	50	5	50	200				50 20	Feed	10000	24.13	0.28	8.58	100.00	100.00	100.00
	Zn PyBulk	5	10	8.0 (7.5)		20			100	1,010		40	Pb-C	2395	70.24	0.71	4.04	69.72	59.85	11.27
	Zn Rough	5	5	10		50			200		100	20	Zn-C	1900	34.14	0.30	22.96	26.88	20.06	50.81
	Zn Clean1		5	10							130	20	Zn RT	1.86	3.14	0.10	3.04	0.24	0.66	0.66
	Zn Clean2		5	10							130	20	ZnCl1T	084	4.30	0.10	5.99	0.15	0.30	0.59
													ZnCl2T	0.52	6.90	0.10	10.12	0.15	0.18	0.61
													T	5383	1.28	0.10	5.75	2.86	18.95	36.06
45	Pb Rough	5	7	Natural	50	10	50	200				50 20	Feed	10000	22.06	0.28	8.45	100.00	100.00	100.00
	ZnPy Bulk	5	10	6.0		20			100	1,010		40	Pb-C	3334	62.58	0.61	6.42	94.50	73.18	25.33
	Zn Rough	5	5	11		50			200		400	20	Zn-C	394	5.70	0.30	34.36	1.02	4.26	16.03
	Zn Clean1		5	11							400	20	Zn RT	374	2.98	0.10	17.16	0.51	1.35	7.60
	Zn Clean2		5	11							400	20	ZnCl1T	478	2.39	0.10	35.84	0.52	1.72	20.29
													ZnCl2T	104	4.53	0.10	33.65	0.21	0.37	4.14
													T	5316	1.35	0.10	4.23	3.24	19.12	26.61
46	Pb Rough	5	7	Natural	50	10	50	200				50 20	Feed	10000	22.29	0.33	7.61	100.00	100.00	100.00
	ZnPy Bulk	5	10	6.0		20			100	1,140		40	Pb-C	3240	64.89	0.71	3.92	94.35	69.68	16.70
	Zn Rough	5	5	12 (11.0)		50			200		1,200	20	Zn-C	0.36	13.06	4.44	21.96	0.21	4.85	1.04
	Zn Clean1		5	12 (11.7)							1,400	20	Zn RT	995	1.74	0.20	25.48	0.78	6.02	33.31
	Zn Clean2		5	12							1,000	20	ZnCl1T	265	3.21	0.20	29.52	0.38	1.60	10.27
	Zn Clean3		5	12							1,700	20	ZnCl2T	1.78	6.02	0.20	31.94	0.48	1.08	7.49
													ZnCl3T	249	9.76	0.20	27.95	1.09	1.51	9.14
													T	5037	1.20	0.10	3.33	2.71	15.26	22.05

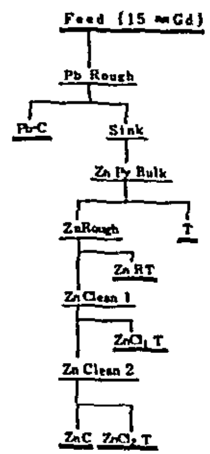


Table A−17 Zn · Py Flotation Tests of Activator of No. 2 Ore

TEST No.	OPERATION	TIME (min) CON.	FLT.	pH	Ace +401	IPX	NaCN	$ZnSO_4$	$CuSO_4$	H_2SO_4	Lime	HIBC	PRODUCTS	WEIGHT (%)	ASSAY (%) Pb	Zn	Fe	DISTRIBUTION (%) Pb	Zn	Fe
					REAGENTS (g/t)															
47	Pb Rough	5	7	Natural (7.8)	50	5	50	200				50 20	Feed	10000	22.42	0.32	891	100 00	100 00	100 00
	ZnPyBulk	5	10	6.0 (7.8)		20			100	550		10	Pb - C	2997	6897	0.71	4.52	92.22	6690	15.21
	Zn Rough	5	5	12.0 (11.8)		15			40		900		Zn - C	013	12.92	17.96	21.39	007	7.21	0.31
	Zn Clean1		5	12.0 (11.8)							650	5	Zn RT	13.35	2.41	010	3165	1.43	4.20	47.41
	Zn Clean2		5	12.0 (11.8)							650		ZnCl1T	1.86	2.42	0.10	22.01	0.20	0.58	4.59
	Zn Clean3		5	12.0							650	5	ZnCl2T	265	5.48	010	22.06	065	083	6.57
	Zn Clean4		5	12.0							650		ZnCl3T	318	17.46	010	22.05	2.48	100	7.88
													ZnCl4T	083	2109	161	2305	0.78	418	2.14
													T	48.03	1.01	010	2.95	2.17	15.10	15.89
48	Pb Rough	5	7	Natural (7.8)	50	5	50	200				50 10	Feed	10000	25.57	0.35	8.51	100 00	100 00	100 00
	ZnPyBulk	5	10	6.0 (7.8)		20			100	660		10	Pb - C	3217	70.82	071	463	8911	6473	17.51
	Zn Rough	5	5	12.0 (11.8)		5					900		Zn - C	043	3018	948	15.68	0.51	1157	079
	Zn Clean1		5	12.0							700	5	Zn RT	13.59	108	010	33.32	0.57	385	53.21
	Zn Clean2		5	12.0							600		ZnCl1T	2.15	3.83	010	2709	0.32	061	5.85
	Zn Clean3		5	12.0							650	5	ZnCl2T	2.70	1994	0.50	2129	2.11	3.83	6.76
													ZnCl3T	181	5443	040	1183	3.86	2.05	2.52
													T	4715	191	010	2.23	3.52	1336	1236
49	Pb Rough	5	7	Natural (7.8)	30	20	50	200				50 10	Feed	10000	2624	0.22	841	100 00	100 00	100 00
	ZnPyBulk	5	10	6.0		30			100	440		10	Pb - C	37.58	6606	0.40	701	9462	6985	31.32
	Zn Rough	5	5	12.0		15			200		900		Zn - C	061	2643	050	2377	062	1.42	173
	Zn Clean1		5	12.0							800	5	Zn RT	864	1.34	010	2600	044	401	2670
	Zn Clean2		5	12.0							400		ZnCl1T	415	2.16	010	3318	0.34	193	1638
	Zn Clean3		5	12.0							500	5	ZnCl2T	118	4.32	010	3698	019	055	5.20
													ZnCl3T	1.86	823	010	3032	0.58	086	669
													T	45.98	183	010	2.19	321	21.38	1198

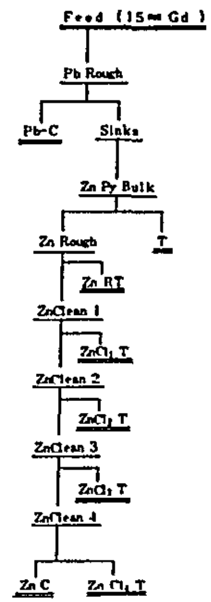


Table A-18 Confirmation Test of No. 1 Ore

TEST No	OPERATION	TIME (min) CON.	TIME (min) FLT.	pH	REAGENTS (g/t) IPX	NaCN/$ZnSO_4$	$CuSO_4$	Na_2SiO_3/NaOL	Kerosene	H_2SO_4	Lime	HBC	PRODUCTS	WEIGHT (%)	ASSAY (%) Ag	Pb	Zn	Fe	Sul-S	$BaSO_4$	DISTRIBUTION (%) Ag	Pb	Zn	Fe	Sul-S	$BaSO_4$
50	Pb Rough	5	5	Natural (8.3)	20	50/200						50 10	Feed	10000	491	607	0.75	166	1.56	4663	100.00	100.00	100.00	100.00	10000	100.00
(10 min)	Pb clean		5	6.3								10	Pb−C	8.82	447	5682	164	1.33	954	1460	8030	8250	1931	707	5398	2.76
	Zn-PyBulk	5	10	6.0 (7.4)	20		100			970		30	Pb−T	3.51	34	3.32	103	095	0.22	48.74	243	192	483	201	0.50	3.67
	Zn Rough		7	12 (11.7)	50		200				350	10	Zn−C	055	149	825	5186	2.99	2779	136	168	0.75	3833	100	9.87	002
	Zn Clean 1		5	12							300	20	Zn RT	7.43	22	215	0.46	3.04	014	4340	333	263	456	1361	067	6.91
	Zn Clean 2		5	12							300	10	$ZnCl_3T$	2.19	77	2.30	2.16	16.35	16.38	2198	3.44	083	633	2162	23.06	103
	Zn Clean 3		5	12							450		Ba CC	25.40	3	042	015	0.19	0.17	8880	1.55	1.76	5.09	2.91	2.77	48.36
	DeSulfides	5	10	6.0 (7.2)	5					440			Ba FC	12.13	3	050	0.05	0.19	0.19	85.22	0.74	100	0.81	1.39	148	22.17
	Ba Rough	5	10	7 (7.9)				1200/800	130	290			BaCl T	1709	7	101	0.31	1.71	051	2860	244	2.84	707	1761	5.59	10.48
	Ba Clean 1		5	7 (7.5)						110			$BaCl_4$ T	1.11	4	0.42	0.21	0.57	0.17	72.56	0.09	0.08	0.31	0.38	012	1.72
	Ba Clean 2		5	7 (7.5)					20	110			T	21.77	9	1.59	0.46	2.47	0.14	6.14	400	5.69	13.36	32.40	1.96	2.88
	Ba Clean 3		5	7						90																
	Ba Clean 4		5	7					20	80																
	Ba Clean 5		5	7						80																
51	Pb Rough	5	5	Natural (8.3)	*15/17	40/160						50 10	Feed	100.00		5.88	0.86	178	1.21	4724		100.00	100.00	100.00	10000	100.00
(15 min)	Pb Clean		5	6.3									Pb−C	844		58.15	164	133	7.17	11.96		8344	16.02	6.29	49.89	2.14
	ZnPyBulk	5	10	6.0 (7.4)	20		100			880			Pb−T	4.56		3.17	0.98	200	0.10	4850		246	5.17	5.11	0.38	468
	Zn Rougher		5	12.0 (11.5)	50		100				500		Zn−C	0.39		307	56.98	3.42	2957	0.80		0.20	25.81	0.75	9.54	001
	Zn Clean 1		5	12.0							250		ZnRT	5.44		1.91	1.33	3.71	0.85	42.18		1.77	8.37	11.32	3.81	486
	Zn Clean 2		5	12.0							300		Zn ClT	1.78		3.92	5.90	1901	21.50	16.60		1.18	1213	1893	3148	062
	DeSulfides		10	6.0 (7.3)	5					290		20	Ba−C	43.54		0.38	0.36	0.67	0.09	75.42		281	18.14	1636	3.23	6953
	Ba Rough	5	10	7.0 (8.0)				1200/800	150	260			BaClT	18.94		1.26	0.31	190	0.05	32.92		4.06	6.80	20.19	0.78	13.20
	Ba Clean 1	5	5	7.0 (7.6)					20	90			$BaCl_4T$	2.61		0.59	0.26	1.33	0.14	3980		0.26	0.78	1.95	0.30	2.20
	Ba Clean 2		5	7.0						60			T	1430		1.57	0.41	2.38	0.05	916		3.82	6.78	1910	0.59	2.76
	Ba Clean 3		5	7.0					20	40																
	Ba Clean 4		5	7.0						40																
	[illegible]																									

* 1) pH of ( ) ··· indicate after pH
2) Usual Dosage of IPX/AP # 404 aforementioned

Table A−19 Confirmation Test of BORING CORE

TEST No	OPERATION	CONDIONS: TIME (m)											RESULTS: PRODUCTS	WEIGHT (%)	ASSAY (%)						DISTRIBUTION (%)					
		CON.	FLT.	pH	REAGENTS (g/t): IPX	NaCN / ZnSO₄	CuSO₄	Na₂SiO₃ / NaCL	Kerosene	H₂SO₄	Lime	HIBC			Ag	Pb	Zn	Fe	Sul-S	BaSO₄	Ag	Pb	Zn	Fe	Sul-S	BaSO₄
52	Pb Rough	5	5	Natural (8.4)	30	50/200						40	Feed	10000	87	4.39	341	276	322	50.34	100.00	1000 0	100.00	100.00	1000 0	100.00
	Pb Clean		5	84								−	Pb − C	9.39	651	3700	729	162	9.54	2704	70.35	7914	2007	5.52	27.82	5.04
	Zn fy Bulk	5	10	60	20		100			2950		80	Pb − T	1187	118	406	375	228	396	5902	16.12	10.98	1305	982	1460	13.92
	Zn Rough	5	10	12.0	50		200				4060	20	Zn − C	3.21	170	6.90	5201	257	1007	460	6.28	505	4897	299	1004	029
	Zn clean		5	120				130/800			3660	20	Zn RT	939	40	100	390	760	802	36.26	432	214	10.74	25.89	2339	676
	De Sliming	5	10	4.0 (7.8)	5					890			Ba − C	14.51	2	026	0.26	038	0.20	8700	0.33	086	111	200	090	2508
	Ba Rough	5	10	7.0 (7.8)				130/800	140	450			BaCl T	22.52	4	017	056	257	154	6224	104	087	370	2099	1077	2784
	Ba Clean 1		5	7.0 (7.8)						260			BaCl₂ T	1085	4	024	031	162	126	7716	050	059	0.99	638	425	1664
	Ba Clean 2		5	7.0 (7.8)						260			T	18.26	5	009	026	399	145	1220	106	037	137	2641	823	443
	Ba Clean 3		5	7.0 (7.8)						260																