REPUBLIC OF INDONESIA
IRON SAND DEVELOPMENT PROJECT IN IOGJAKARTA
PRELIMINARY SURVEY REPORT

July 1971

prepared for
Overseas Technical Cooperation Agency
Government of Japan

by
Iron Sand Group of
Japanese Survey Team for Mining and
Manufacturing Industry Development in Indonesia

PREFACE

Submitted herewith is a pre-feasibility report on the Iron Sand Development Project in Jogjakarta for which the Government of Indonesia requested the technical and economic cooperation of the International Governmental Group on Indonesia.

In response to a request of the Government of Indonesia, the Overseas Technical Cooperation Agency was entrusted by the Government of Japan with the implementation of the survey and organized a survey team consisting of two experts, Messrs. H. Watanabe and M. Sato on iron sand deposit and Mr. Y. Kawasaki an expert on transportation. The team was dispatched to Indonesia during the period between March 3, to March 23, 1971.

In the course of the survey, the team collected necessary data including samples of iron sand and carried out discussions with officials concerned. After returning to Japan, the team analyzed the collected data and incorporated the results in this report.

It is our sincere hope that this report will be of great help in expediting the implementation of the project as well as cementing friendly relations between our two nations.

In closing, I would like to express my sincere appreciation to the officials of the Department of Mines, BAPPENAS, P. N. ANEKA TAMBANG and other Authorities concerned for their kind cooperation.

May, 1971

Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

CONTENTS

I. Summary

a) The preliminary survey was made in an area of about 3,000 hectares extending 35 km along the shore, for iron sand deposits in the Jogjakarta area. This survey showed that the amount of magnetic ore (concentrate), at Fe 55%, is about 25,500,000 tons. This an extremely large iron sand deposit. Furthermore, since it extends beyond the area investigated, the actual potentiality is even larger.

However, the Fe grade is relatively low, being Fe 55%, hence it will be necessary to upgrade it to about Fe 57%. Further study must be made on whether or not this grade of concentrate can be successfully mined to produce a higher grade of concentrate with a minimum loss.

b) Upgrading of the Fe grade

The iron sand in Jogjakarta consists of rather coarse grains and contains considerable middling of magnetite. Therefore, it is not easy to obtain high-grade concentrate (Fe 57～58%) by ordinary magnetic separators.

In the batch tests which were performed, we were able to obtain a high-grade concentrate, but in practice many problems would arise. It is therefore necessary to carry out a feasibility study on the upgrading by grinding the middling with magnetic separators suitable for this type of iron sand.

With respect to the grinding, there is also the possibility of producing pellet feed ore, but this must be studied separately.

c) There are two alternative ways of transporting the iron-sand concentrate. One is to use the existing railway and ship it from Jjilatjap port, and the other is to build a new port near the mining area.

The use of the existing railway involves such problems as the improvement of the railway, investigation of the strength of bridges and the clearance of tunnels, reinforcement of locomotives and cars, installation of train-crossing tracks, transport facilities up to the nearest railway station, as well as others. Furthermore, the cost of rail transport is estimated to be higher than the construction of new port.

Nothing definite can yet be said about the construction of a new port before investigating the natural conditions. However, in comparison with the railroad, transportation through a port will require less operation and maintenance, and it is also possible to formulate appropriate plans to deal with the larger vessels being built today. The initial capital investment may be large. However, even considering the depreciation of the port, the transportation costs may be reduced from that of the railway (about five hundred million Rupiahs per year). However, a definite conclusion can only be drawn, after a survey of the natural conditions.

d) Feasibility study for magnetic separation

In this preliminary survey, the quality of iron sand and its general characteristics have only been estimated by making minor tests. In order to determine how practical it is to upgrade the ore, which is an important problem, further studies of its feasibility must be made. These are as follows: grinding of middling; selection of a magnetic separator, characteristics of the ore; feeding condition of ore; and rejection of coarse grains.

The samples tested in this survey do not necessarily represent accurately the respective sectors of ore deposit in magnetic percentage, ore grade, character, grain size, etc. Therefore, further studies with regard to the commercial feasibility must be made.

e) Expenses necessary for the development of this mine

As can be seen from the above discussion, there are some problems concerning the grade of ore. However, commercialization is possible provided the ore can be upgraded to an acceptable point by concentration. In such a case, annual production of 1, 000, 000 tons would be feasible as far as ore reserves are concerned.

In this case, the construction cost of these facilities is expected to be US$4, 619, 000 and the civil-engineering works at the site to be 530 million rupiahs; but please note that in these figures the construction costs of port or railway facilities are not included. (For the building of a new port and its facilities, the building cost may be about US$8, 334, 000 or about 3, 000 million rupiahs.)

f) Profitability

It is not yet determined whether the ore will be transported by the existing railway, or by a new port. However, as an example, take the case of transporting by railway and shipping from Tjilatjap port. Then, the price of concentrated ore with Fe 57% (CIF 15.5 ¢/%), minus 10% export duty, will be US$7.96 per ton. With the freight, depreciation, interest on the capital, etc. deducted, the production cost per ton is US$7.57. Thus, the final profit is estimated to be about US$0.39 per dry metric ton of the concentrated ore. However, the expenses for railway facility improvements are not included.

On the other hand, in the case of constructing a new port, the railway freight is not required. Therefore, even considering the depreciation of the port, the profit may be increased from that of the railway transport.

II Introduction

2-1 Purpose of the Survey

The BAPPENAS of the Republic of Indonesia is requesting the International Governmental Group on Indonesia to assist in the development of the iron sand deposits near Jogjakarta, as a national project from F.Y. 1971 to 1972, by means of a foreign loan.

The project concerns the iron sand deposits extending in the area along the shore, 50 km south-west of Jogjakarta. The amount of magnetized-ore reserves is reported to be about 40,000,000 tons.

In Tjilatjap, 200 km west of this area there also exists a similar deposit, and a plant with an annual capacity of 300,000 dry metric tons of concentrate is now in operation; the magnetic percentage is 20% and the Fe grade of the ore is 57~58%. Therefore, if the iron sand in Jogjakarta is similar to that of Tjilatjap, the project should be profitable. However, before embarking on this venture, it is necessary to ascertain the amount of ore reserves, and also to study in detail the necessary mining facilities, inland transport facilities and port facilities, which are significant factors in the production cost.

This preliminary survey has been made in order to understand the actual situation and the project itself. Its purpose is to determine whether the Japanese Government should extend a loan in yen towards the project.

2-2 Organization of the Survey Group

Members;

Yoshiichi Kawasaki	Third Regional Harbor Construction Bureau, Ministry of International Trade and Industry
Hajime Watanabe	Nikko Consulting and Engineering Co., Ltd.
Masanobu Sato	Nikko Consulting and Engineering Co., Ltd.

2-3 Schedule of the Survey Group

March 3: Left Tokyo at 9:00 a.m. and arrived at Djakarta at 7:10 p.m.

4: Had discussions with officials of the Japanese Embassy about the survey, then went to Ministry of Mines to report to the Minister. Afterwards had talks with Mr. Panggabean, Planning Chief of P.N. Aneka Tambank, about the survey of iron sand in Jogjakarta.

5: Talks with Mr. Hadijanto, President of P.N. Aneka Tambang, and Mr. Panggabean, acquiring the necessary data.

6: Called on Mr. Boedidrjo, Head of the Harbour Department.

7: Left Djakarta at 10:30 a.m. and arrived at Jogjakarta at 11:30 a.m. Later left Djakarta at 2:00 p.m. and arrived at Tjilatjap at 6:00 p.m.

March	8:	Inspection of the iron sand mining works in Tjilatjap as well as the port. Left Tjilatjap at 3:00 p.m. and arrived at Jogjakarta at 7:00 p.m.
	9 to 17:	Survey of the iron sand deposit in Jogjakarta. (Called on the Semarang Railway Control Office, on March 10.)
	18:	Left Jogjakarta at 3:20 p.m. and arrived at Djakarta at 4:00 p.m.
	19:	Discussion at the Japanese Embassy and at P.N. Aneka Tambang; received reference data at P.N. Aneka Tambang.
	20:	Interim report to the Japanese Embassy about the survey results.
	21:	Arrangement of data
	22:	Submitted the interim reports giving explanations of them to BAPPENAS, the Ministry of Mines, and P.N. Aneka Tambang.
	23:	Left Djakarta at 8:30 a.m. and arrived in Tokyo at 10:00 p.m.

2-4 Acknowledgement

Generous cooperation was extended to the survey team by the Indonesian Government and the ministries concerned, especially the Ministry of Mines and the Ministry of Transportation, P.N. Aneka Tambang and BAPPENAS. Thanks are especially due to the following persons.

Ministry of Mines:	
(Chief of the Planning Department)	Mr. Ridwan Mahmud
	Mr. S. H. Hutagalung
P.N. Aneka Tambang:	
(President)	Mr. Hadijanto Martosubroto
	Mr. S. Panggabean
	Mr. Ischaidir
BAPPENAS:	
	Mr. Sugen Sundjaswadi
Ministry of Transportation:	
(Chief of the Harbour Department)	Mr. Boediargo

III Supply and Demand of Iron Sand

Nowadays titaniferous iron sand is an important material for sinter feed. About 90% of the mined iron sand is consumed for this purpose, the remainder for electrically produced pig iron. In Japan, iron sand consumption was about 1,500,000 metric tons in 1969, of which 600,000 metric tons were imported, while in 1970 it was about 1,400,000 metric tons with 700,000 metric tons being imported. During the past five years, the reserves in Japan were reduced to half, and the depletion will be intensified in the future, with imports becoming more and more predominant. The demand for iron sand for producing sinter feed will increase proportionately with the expansion of the iron and steel industry. The consumption during and after 1973 is therefore expected to reach more than 4,000,000 metric tons per year.

Fig. I Location map of Iron Sand Deposit in JOGJAKARTA

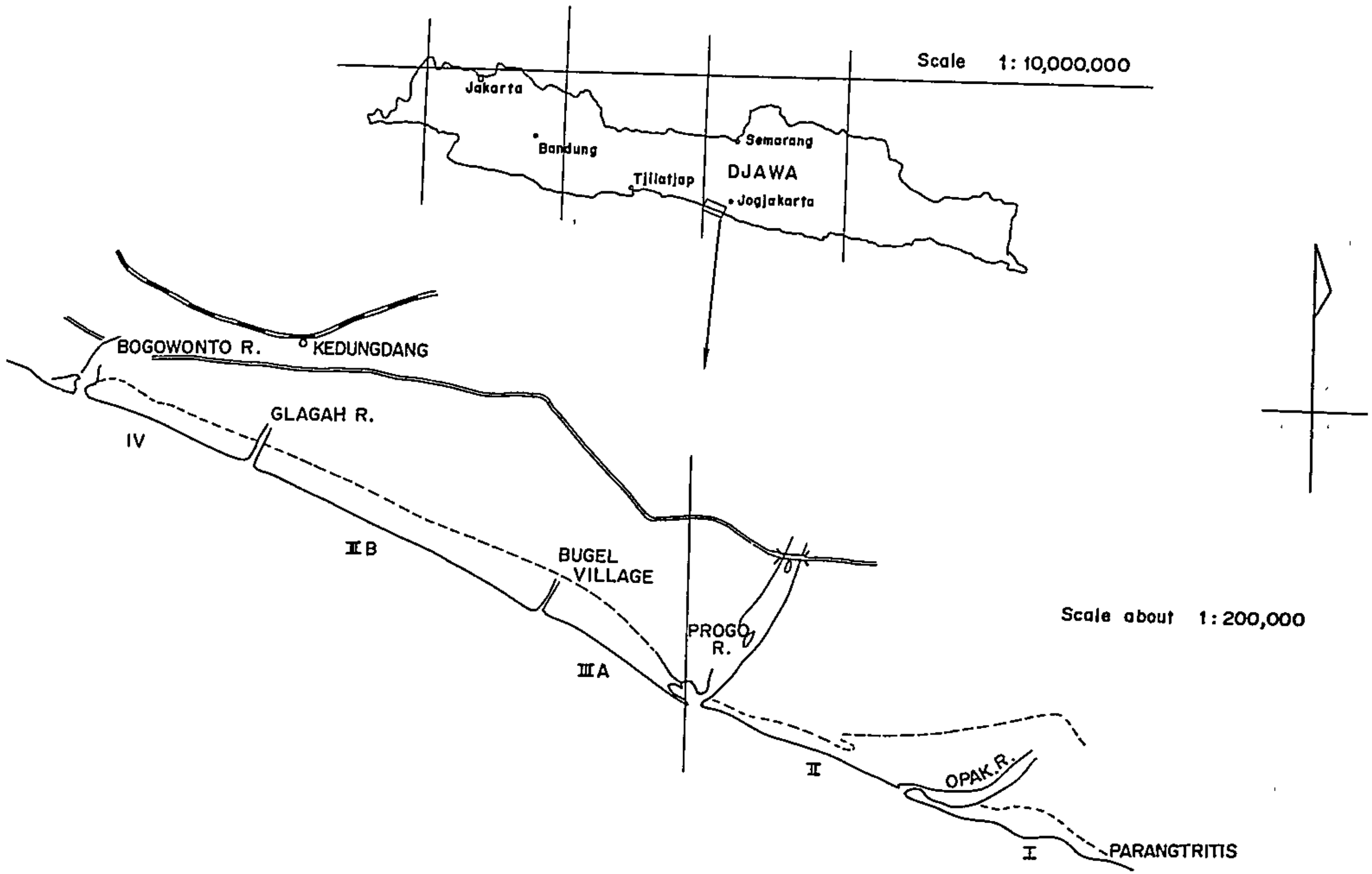
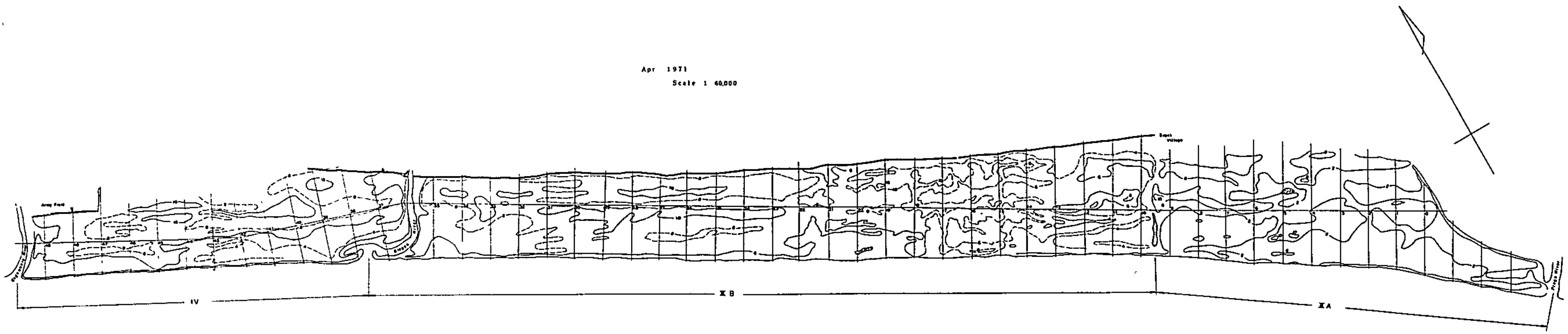
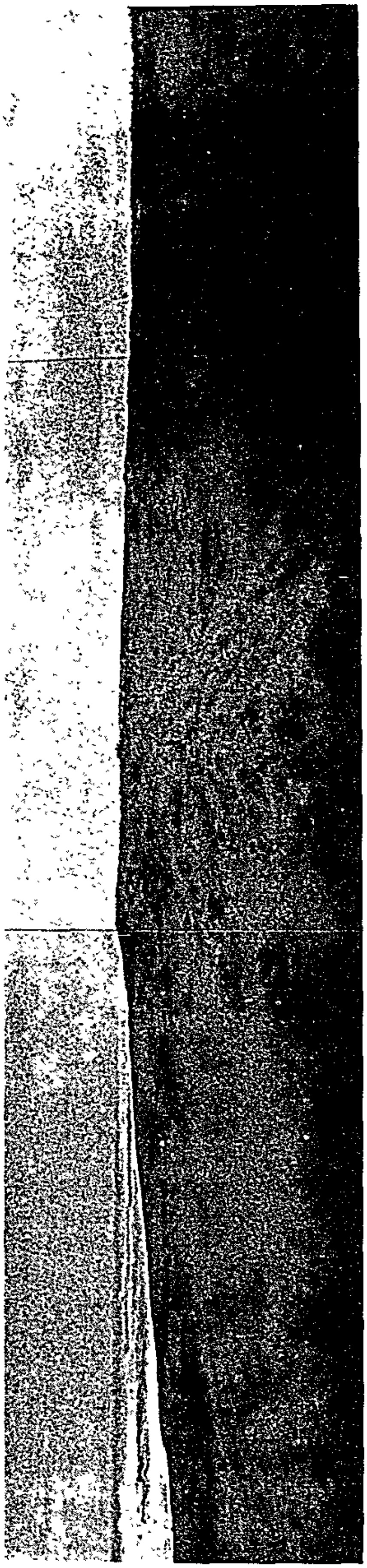
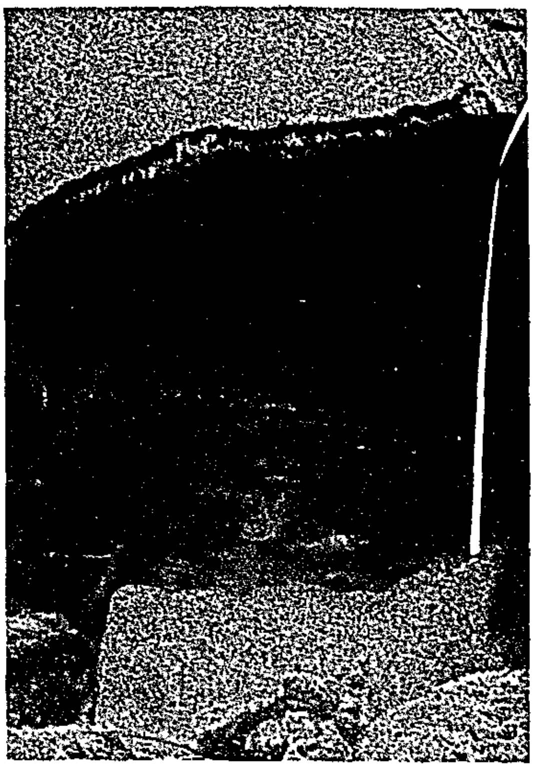


Fig. II Exploration Map of Iron Sand Deposit in JOGJAKARTA





Iron Sand Deposit Area near JOGJAKARTA (III A District)



Section of Iron Sand Deposit near JOGJAKARTA

Scene of Sampling Works

Microscopic Photo of Origin Rock (JOGJAKARTA Iron Sand)

Photo I

Preparate x 33 ⑪

Photo II

Preparate x 33 ⑪

scale; 0 500 1,000 μ

Marks ;

Pl ;	Plagioclase
Aug ;	Augite
Mag ;	Magnetite
R - P ;	Orthorhombic Pyroxene

Concentrate (Tjilatjap)

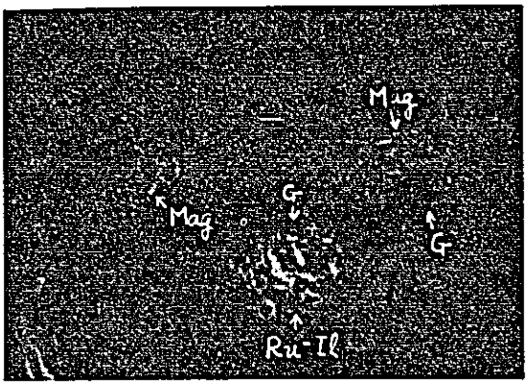


Photo. 1 Polish Section × 80

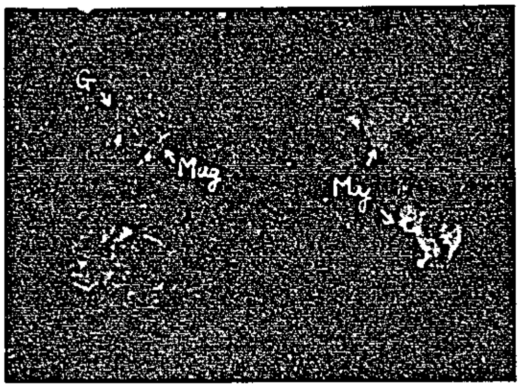


Photo. 2 Polish Section × 80

0 100 200
×80Scale: (μ)

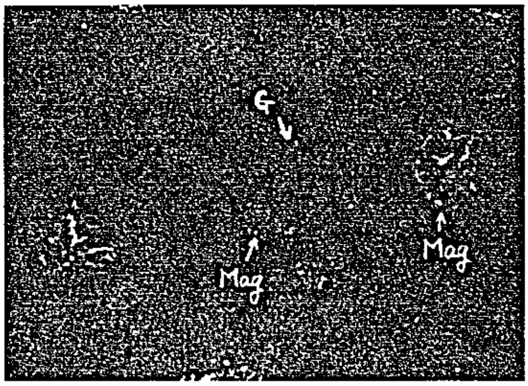


Photo. 3 Polish Section × 80

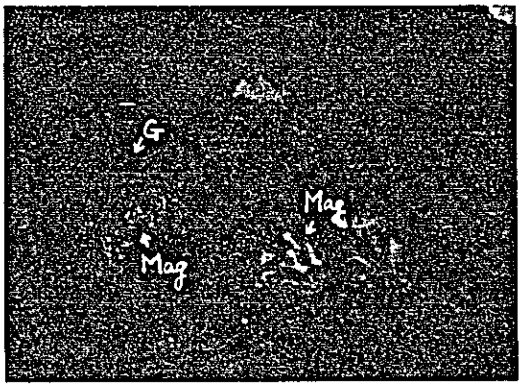


Photo. 4 Polish Section × 80

Photo. 5 Polish Section × 360

Photo. 6 Polish Section × 360

0 25 50 75 100
×360Scale: (μ)

Marks:

- Mag ; Magnetite
- Il; Ilmenite
- Ru ; Rutile
- G ; Gangue

Concentrate (Jogjakarta) by D.C. Magnet Separator

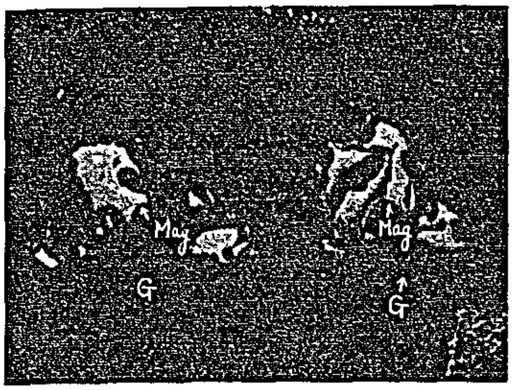


Photo. 7 Polish Section +48 mesh × 90

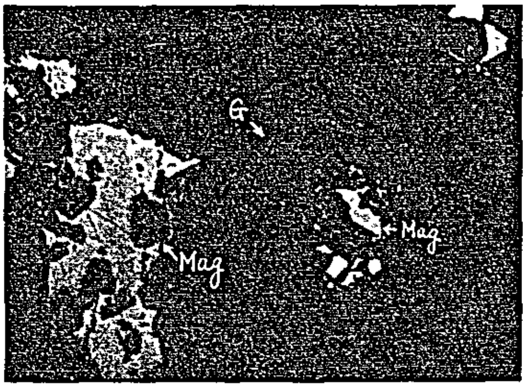


Photo. 8 Polish Section +48 mesh × 90

×90 Scale: 0 100 200 (μ)

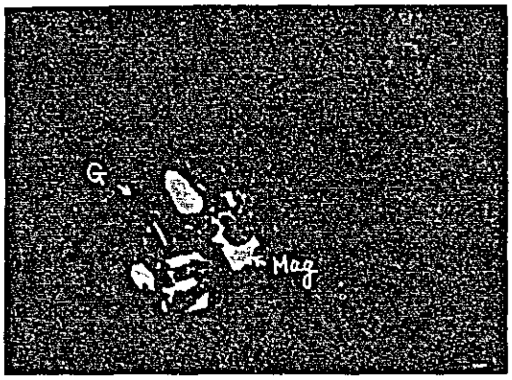


Photo. 9 Polish Section +65 mesh × 90

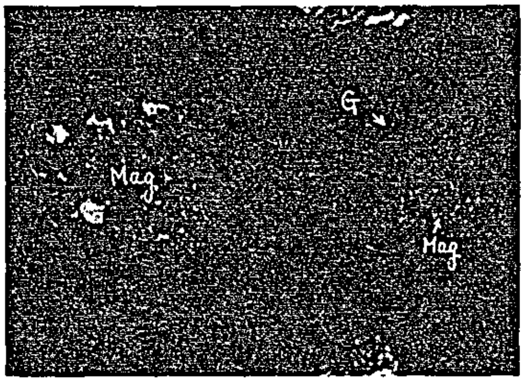


Photo. 10 Polish Section + 65 mesh × 90

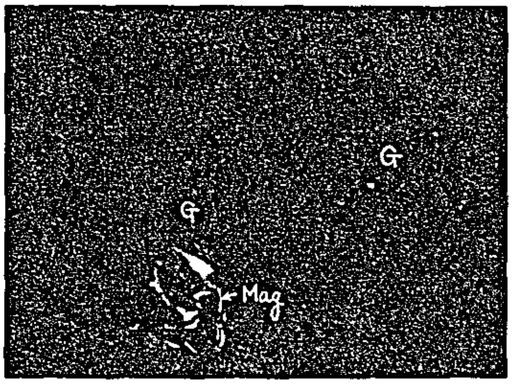


Photo. 11 Polish Section + 115 mesh × 135

×135 Scale: 0 50 100 150 200 (μ)

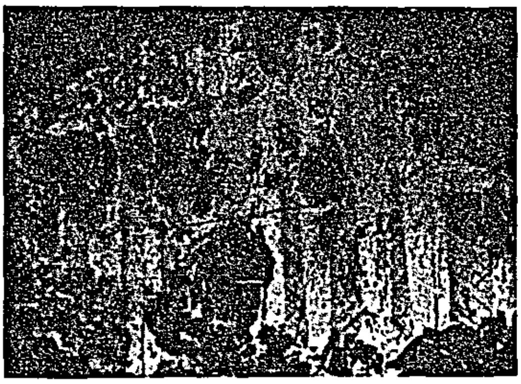


Photo. 12 Polish Section + 115 mesh × 360

×360 Scale: 0 25 50 75 100 (μ)

Concentrate (Jogjakarta) by A.C. Magnetic Separator

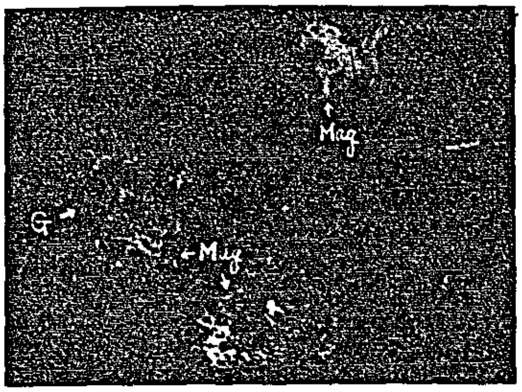


Photo. 13 Polish Section +65 mesh × 90

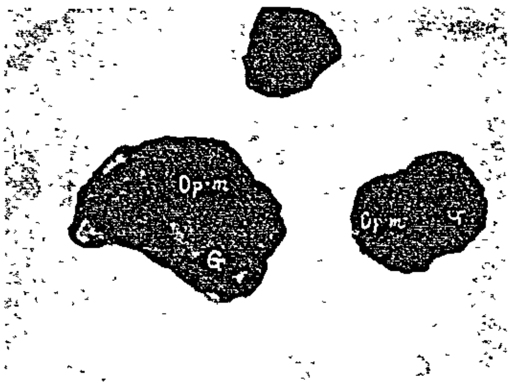


Photo. 16 Unpolish Sample -48/+65 mesh × 90

Photo. 14 Polish Section + 65 mesh × 90

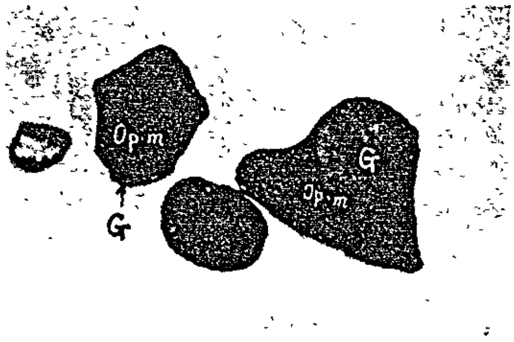


Photo. 17 Unpolish Sample -48/+65 mesh × 90

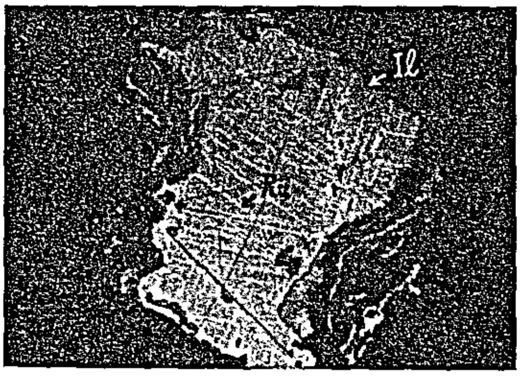


Photo. 15 Polish Section + 65 mesh × 360

Photo. 18 Unpolish Sample -48/+65 mesh × 90

×360 Scale: 0 25 50 75 100 (μ)

×90 Scale: 0 100 200 (μ)

Marks: Op·m ; Opaque mineral

IV. Preliminary Survey

4-1 Purpose

The existence of iron sand is to be expected throughout the whole area along the beach between Tjilatjap and Jogjakarta, over a length of about 156 km. However the survey was made only on the iron sand deposits in an area of about 3,000 hectares extending 35 km, between the Paragantritis and the Bogowonto Rivers along the beach. The items of survey were the following.

a) Geography and geology
b) Estimation of the ore reserves
c) Investigation of the mining methods
d) Investigation of the separation methods
e) Investigation of the transportation routes
f) Environmental survey for estimating the construction expenses

4-2 Outline of the Results

(1) Geography and Geology

i. Geography and Geology

The coastal plain is about 10 to 25 km wide, but the area surveyed for iron sand was limited to only about 1 to 1.5 kilometers width along the seashore. To the north is a hilly area, with older brecciated andesite of Oligocene to Miocene as the base, covered with limestone unconformably. In addition there exists occasionally tuff layers at the planes of unconformity.

Iron sand deposits are distributed throughout this plain, but the portion suitable for commercial mining is in an area of 1.0~1.5 km in width along the coast line. In this area of iron sand deposits, there are three to four rows of dunes with heights of about 5 to 10 meters. However, on the whole, the array is irregular.

The ore deposit is titaniferous iron sand. The ore is composed mainly of magnetite, and the accessory minerals are ilmenite and rutile. This ore probably originates in the andesite which is widely distributed in the northern mountains.

Judging from the state of the dunes and the pitting, the distribution of the iron sand deposits is irregular. The portion near surface is disturbed, and so in this place, sedimentation is not clear. In general, however, the whole area seems to be a complex formation composed of several centimeters of iron sand lamellaes.

The disturbance of the surface portion appears to have been caused by strong winds in the monsoon season (from September to October). As for the formation below the deposits, according to Mr. Aliamin (a member of the Geological Institute of Bandung) who carried out a rough survey in this area last year, there was no clay layer at the bottom and by digging about 12 m a layer of large-gravel (5~10 cm in diameter) was reached. But the state of grading, magnetic percentage, etc. were not determined.

ii. Origins of the Iron Sand

As for the origin of iron sand, the following are considered possible. During the land formation, which followed the orogenic movement of the middle Miocene, there occurred innumerable faults in the andesite. Subsequently, due to the rupture of these faults, weathering and erosion, magnetite, ilmenite and rutile flowed out, concentrating at the river-sides and later flowing to the beach. After that, the deposit was enriched during the Cenozoic transgression, resulting in the current situation.

The difference between the iron content of the sand at Jogjakarta and Tjilatjap, about 200 km away, seems largely due to the distance from the original rocks. That is, in the ore deposit in Tjilatjap, which is further away than Jogjakarta, a rounding phenomenon has taken place to a greater degree causing the grains to be smaller in size and the isolation into simple substances better.

iii. Microscopic Observation of Magnetic Concentrate and the Original Rock

a. Magnetized Ore of Iron Sand in Jogjakarta

In the table below, the magnetic concentrate at Jogjakarta and Tjilatjap as observed through a microscope are compared.

Sample (Concentrate)	Mesh	Mineral			Middling		Remarks
		Mag.	Ti-Mag.	Gang	Mag. G	Ti-Mg G	
Tjilatjap	About 100 ~ 200	++++	+	±	±	±	
Jogjakarta	+48	+		±	++	±	
	+65	+++	+	+	+	±	
	+115	+++	+	+	+	±	

Note: Mag. ... Magnetite, Ti-Mag ... Titan-Magnetite
G ... Gangue

Microphotographs show that fine magnetite is distributed in the iron sand grains at Tjilatjap and coarse magnetite in those at Jogjakarta. Furthermore, the reduction in grain size has not progressed very far in the iron sand at Jogjakarta. Consequently, it should be considered that there may not be much fine liberated magnetite in the iron sand at Jogjakarta. This may present one difficulty in upgrading the ore.

b. Observation of the Original Rock

Dark-greyish andesite, considered to be the original rock, was observed through a microscope. Plagioclase, rhombic augite and augite were observed as the phenocryst constituents, with plagioclase and augite as the ground-mass. In addition, such opaque minerals as magnetite and ilmenite were also found to be distributed in it. The andesite is typical in that plagioclase is found in large quantities filling the fine grains of augite in thin sections. (See attached photograph.)

Constituent minerals

Phenocryst: Plagioclase, rhombic augite and augite
magnetite, ilmenite

Ground mass: Plagioclase, augite

(2) Ore Reserve

i. Calculation Blocks of the Ore Reserves

In order to calculate the size of the ore reserves, the following five blocks, also used by P. N. Aneka Tambang were utilized.

a) Block I Paragantritis - Opak River
b) Block II Opak River - Progo River
c) Block III A Progo River - Bugel Village
d) Block III B Bugel Village - Glagah River
e) Block IV Glagah River - Bogowonto River

ii. Basis for the Ore Reserves Calculation

a. Areas of the Ore-Reserve Blocks

The area of each block was calculated by taking both sides of a river, 100 m wide respectively, and the beach 50 m wide along the coastal line.

b. Thickness of Iron Sand Beds

There are three to four ranges of dunes about 5 - 10 meters high with the thickness of the iron sand layers rather varied. However, the calculation was made by taking the average depth along a measuring line representative of each block. A pit on the line was dug down to the water table, and below that a further digging of 2.0 m was made by a hand auger. For the lower portion, this depth was considered to be insufficient, and so 3.8 m was assumed to be the practical mining depth.

c. Specific Gravity

The specific gravity of the iron sand was measured at a site by using a cube container 10 cm across. Next the measured values were compared with those in P. N. Aneka Tambang by the mescylinder method. The discrepancy was only 0.02～0.05. And so the values available at P. N. Aneka Tambang were used.

d. Magnetic Percentage

The magnetic percentages after 7 cleanings at 300 gauss, were adopted, and this was also done by P.N. Aneka Tambang on 1,380 samples.

e. Existing Ratio

Because of the possibility of barren zones insufficient for actual mining, the existing ratio was taken to be 95% for Block III A and III B. Then, for Blocks I and II, for which the exploration was inadequate, and for Block IV, which also contains a military area, the ratio was taken to be 90 %, in order to be on the safe side.

f. Stopping Ratio

In the iron-sand area, there are bags, fields and dwellings, hence mining over the total area is probably impossible. Therefore, a stopping ratio of 95% was adopted.

g. Mixing Ratio of Waste

Where the ore deposit thickness is 3.80 m, a mining depth of 4.00 m was adopted, taking into account waste mixing. That is, the mixing ratio of waste is 10%, and the magnetic percentage of waste is 5%.

h. Fe Grade of Magnetic Ore

The values of Fe grade obtained by P. N. Aneka Tambang were adopted.

iii. Ore Reserve Calculation

Based on the values, etc. given above, the total amount of magnetized ore reserves, at Fe grade 55%, was calculated to be about 25,500,000 tons.

The data obtained in this connection are given in the appended table.

Iron Sand Reserves in Jogjakarta

	Area	Depth	Volume	Specific gravity	Ore reserves	Existing ratio	Stopping ratio	Mixing ratio	Minable ore reserves	Magnetic percentage	Amount of magnetics	Fe	Fe content
	m^2	m	m^2		T				T		T	%	T
I	2,300,000	3.80	8,740,000	1.9	16,606,000	90	95	10	15,617,900	11.3	1,774,100	55	976,100
II	3,060,000	3.80	11,628,000	1.9	22,093,200	90	95	10	20,778,700	15.7	3,305,700	55	1,818,100
III A	4,720,000	3.80	17,936,000	1.9	34,078,400	95	95	10	33,831,300	14.9	5,074,700	55	2,791,100
III B	11,180,000	3.80	42,484,000	1.9	80,719,600	95	95	10	80,134,400	14.1	11,291,700	55	6,210,400
IV	4,580,000	3.80	17,404,000	1.9	33,067,600	90	90	10	31,100,100	13.2	4,099,600	55	2,254,800
Total	25,840,000	3.80	98,192,000	1.9	186,564,800	94	94	10	181,462,400	14.1	25,546,400	55	14,050,500

iv. Chemical Composition

	T.Fe %	FeO %	Fe_2O_3 %	TiO_2 %	P_2O_5 %	V_2O_5 %	Sn %	Cu %	Pb %	Zn %	As %	Al_2O_3 %	SiO_2 %	S %	CaO %	MgO %	Total
Concentrate of Jogjdarkarta iron sand	57.18	23.79	55.32	7.82	0.21	0.50	0.02	<0.01	0.07	0.08	0.02	3.90	3.04	0.09	<0.01	1.57	96.43

Note: The sample is a mixture of the same amount of concentrates, obtained by dry A. C. magnetic separator.

No special problem concerning the impurities of composition.

v. Some Considerations on Ore Reserves

Iron-sand deposits extend over a large area of width 1.0~1.5 km and length 35 km. The magnitude of the ore reserves is very large, and the amount of magnetized ores at Fe 55% is probably about 25,500,000 metric tons. Besides, portions which were not included in the present survey are fairly large, dwellings and fields are also existent and there are the adjoining areas to the area of survey. Therefore, the potentiality of the ore deposit can be considered as very high. The magnetizing Fe grade as observed by Indonesian agencies, which is Fe 55% is low when compared with Fe 57 58% in Tjilatjap. Hence, in order to attain an ore grade such as those in Tjilatjap, studies must be made on the separation treatment from a now angle.

(3) Concentration Tests

i. Purpose

The concentration tests were made mainly to examine the characteristics of the crude sand and its magnetizing degree, and especially to examine the grades of concentrates by different magnetic separators.

ii. Samples Subjected to Test

In the five blocks, I, II, III A, III B and IV near Jogjakarta, seven composite samples (534 samples in total) were taken to Japan for testing.

iii. Characteristics of Iron Sand

The magnetic ore was observed through a microscope. It was found to be angular in shape, in contrast to those near Tjilatjap, and the natural grinding phenomenon is not as marked.

With regard to the nature of iron sand, no separate magnetic particles were observed. It was confirmed that most of the magnetic iron sand is composed of middling and gangue. The texture can be divided in two types: one in which fine magnetic granules are mixed, and the other in which relatively coarse ones are mixed. The Fe grade of iron sand is of course determined by this degree of fineness. However, it seems that the ratio of gangue and magnetic in the ore grain ranges widely. It is interesting that rutile and ilmenite have been observed as liberate particles as a lattice structure -- this was also found in the iron-sand concentrate in Tjilatjap.

(4) Results of the Tests

i. Hand Picking Test by a Magnet

Line Sample No.	Test by the Japanese group		Test by P.N. Aneka Tambang	
	Magnetic percentage (300 G)	T. Fe %	Magnetic percentage (300 G)	T. Fe %
0	-	-	20.8	54.15
1	26.8	55.1	17.75	55.58
6	29.3	51.6	16.70	55.26
11	24.4	49.4	13.80	55.63
15	24.8	47.2	10.28	56.10
21	18.1	50.9	11.92	-
27	16.9	48.8	11.10	-
41	21.5	48.9	-	-
Average	23.8	50.3		

Note: G .... Gauss T. Fe .... Total Fe

Test conditions for separation of the magnetized ore:

Two roughings by a 1200-gauss magnet
Two cleanings by a 600-gauss magnet
Four cleanings by a 300-gauss magnet

The results of these tests are shown in the accompanying table. The average magnetic percentages over all the lines of samples No. 1, 6, 11, 15, 21, 27 and 41 is 23.8% and the average grade of magnetics is Fe 50.3%. When these are compared with those conducted by P. N. Aneka Tambang, the magnetic percentage is rather high, being an average of 23.8%, while the Fe grade is low. The reason for this may be insufficient cleaning as compared with the P. N. Aneka Tambang tests. However, our method is a common one usually employed for the determination of the magnetic percentage of iron sand. Because of the low Fe grade obtained, it seems that the iron sand abounds in middling, with magnetic mixing of gangue. The ore, therefore, would not be eazy to upgrade.

The values by P.N. Aneka Tambang apparently are the result of very thorough cleanings, and so the resulting Fe grade of about 55% may be the upper limit. However, no matter how thorough the cleaning may be, a stationary magnetic separation by a (permanent) magnet middling. Therefore, the Fe 55% by P.N. Aneka Tambang cannot be considered technologically as the upper limit:

ii. Magnetic Percentage Test by an A.C. Magnetic Separator

Since the Fe grade of magnetized ore by hand picking with a magnet is low, tests were made by an A.C. magnetic separator of high separation efficiency to look into the possibility of separation magnetics with Fe grade over 56% and to examine the concentration ratio itself.

A small-size, dry type A.C. magnetic separator was used varying the magnetic-flux intensity. The separation was by ore roughing at 1,000 gauss, one cleaning at 600 gauss and four recleanings at 400 gauss. The results of these tests are given in the following table.

Line sample No.	Magnetic percentage	T.Fe (%)
1	15.7	57.47
11	10.6	58.86
15	9.8	57.41
21	11.9	57.25
27	9.3	57.30
41	7.8	57.30

By the close separation with an A.C. magnetic separator, weak magnetic particles such as the middling could be removed in contrast to the case of the permanent magnet. The grade of concentrate was thus raised to Fe 57%.

When a dry type A.C. Magnetic separator was used, as opposed to the case of a permanent magnet there occurred alternately a magnetic attraction and a repulsion due to the oscillating magnetic field, leading to the exclusion of the gangue mineral and the weakly-magnetized middling, which would otherwise be introduced. This is probably the reason a high grade concentrate was obtained.

iii. Continuous Test by a Drum-type Wet Magnetic Separator

About a six kilogram sample composed of a mixture of six line samples were adjusted into a 20~30% density pulp, then fed into drum-type wet magnetic separator in order to test the extraction percentage and Fe grade. (This type of the drum separator was composed of six drums of 238ϕ x 300m/m. The first drum is for roughing at 1,200 gauss magnet. The second one is for scavenging at 1,000 gauss magnet. The four others are for cleanings at 700, 500, 400 and 400 gauss magnet.)

These tests confirmed that the extraction percentage was 23.2% and Fe grade 52.1% on the average.

It is considered easy to obtain the magnetic concentrate of Fe 57% to 60% with a separator commonly used for normal iron sand. However, the iron sand found near Jogjakarta is of an abnormal type - consisting of middling containing gangue minerals. Hence, it is difficult to upgrade the quality up to over Fe 55%.

iv. Screening Tests

Screening tests were conducted on the magnetic concentrate of line sample 1, 6, 15, 11, 21 and 27. The results are given in the table below.

Line Sample No.	Mesh	Concentrate Grain-size distribution	Grade % T.Fe%	Grade % TiO_3	Line Sample No.	Mesh	Concentrate Grain-size distribution	Grade % T.Fe%	Grade % TiO_3
1	+48	15.6	35.3	5.33	11	+48	11.4	31.5	
	65	32.7	50.8	7.69		65	18.3	43.6	
	111	44.4	54.9	8.29		100	48.6	52.7	
	-115	7.3	56.7	8.83		200	20.6	} 56.0	
						-200	1.1		
	Total	100	55.1	7.67		Total	100	49.4	
6	+48	7.7	34.8		21	+48	9.0	36.3	
	65	16.9	45.5			65	16.9	45.7	
	100	52.4	53.7			100	49.4	53.1	
	200	21.9	} 55.7			200	23.6	} 56.1	
	-200	1.1				-200	1.1		
	Total	100	51.6			Total	100	51.9	
15	+48	14.3	26.9		27	+48	12.1	31.0	
	65	17.7	40.0			65	17.6	42.1	
	100	46.9	51.7			100	47.2	52.0	
	200	20.4	55.5			200	22.0	55.9	
	-200	0.7				-200	1.1		
	Total	100.0	47.2			Total	100.0	48.8	

As seen in the table, the Fe grade for coarse portions, especially plus 48 mesh, are low, in comparison with those of minus 100 mesh, and the existence of a large amount of middling in the coarse portions is indicated. The Fe grade may be increased by rejecting the coarse parts (plus 48 mesh).

The following table gives the sizing analysis on the high-grade concentrates by an A.C. magnetic separator.

Mesh	T. Fe Grade	Distribution	
		Weight %	Fe %
+48	53.8	2.2	2.2
65	55.5	11.9	11.6
100	56.9	52.9	52.6
-100	58.2	33.0	33.6
Total	57.1	100.0	100.0

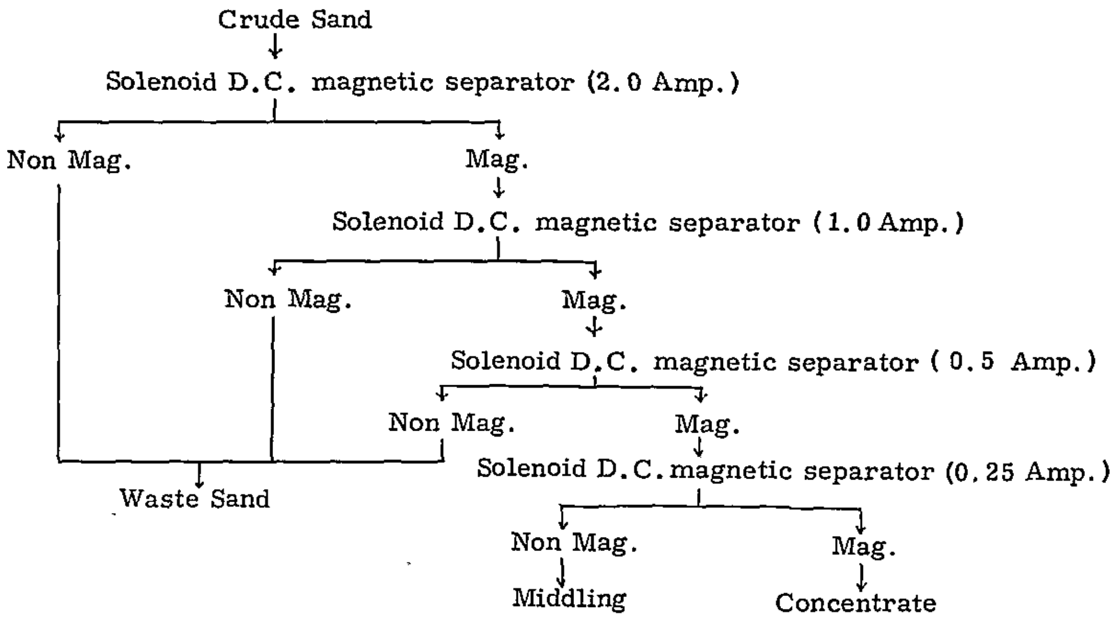
It can be seen from this table that the amount of coarse grains was markedly reduced with a decrease of the middling, and for the fine grains, gangue and middling were completely excluded.

v. Test by a Solenoid-type Wet Magnetic Separator

Another kind of wet magnetic separator is a solenoid-type magnetic separator. Tests were made with a No. 65 rotary type tester.

The iron sand tested was about one kilogram mixed line samples described above. Cleaning was made by varying the current density as follows:

Roughing: 2.0 ampere
Cleanings: 1.0, 0.5, 0.25 ampere



As seen in the table below, both the Fe grade and the recovery were not good.

Product	Fe %	Distribution
Crude Sand	15.9%	100.0%
Mg. Concentrate	54.8	2.9
Middling	47.1	24.4
Waste Sand		72.7

vi. Grinding Test on the Middling with Magnetic Separation

The iron sand near Jogjakarta contains large amounts of middling. Therefore, tests were made on the improvement of the concentrate grade and recovery by grinding the middling. The middling given in the table above (Fe 47.1%, and weight recovery 24.4%).was ground to minus 200 mesh (95.6%) and the separation was made with a Solenoid type magnetic separator.

Item	Fe %	Distribution
Middling	47.1%	24.4%
Mag. Conc. after grinding	57.7	18.6
Waste Sand	6.9	15.8
Secondary Conc.	57.7	18.6
Primary Conc.	54.8	2.9
Final Concentrate	57.3	21.5

That is, the procedure by grinding the middling to minus 200 mesh gave an Fe 57.3% with a high recovery of 21.5%.

vii. Summary of Test Results

The tests conducted by our survey group were done in a brief period, and so the results on limited samples were only of speculative nature. Therefore, further studies in the future are necessary.

The concentrate of the iron sand near Jogjakarta is composed of mostly middling and even in the fine grains liberated magnetite is present only in small quantities. Consequently it may be considered difficult to raise the concentrate grade of this iron sand.

With regard to the magnetic percentage of about Fe 55% obtained by P.N. Aneka Tambang, it should be necessary to try to upgrade it to a point where commercial mining is possible.

In the small-scale tests performed by our survey group, a concentrate of Fe 57% could be obtained. It is therefore very important to select magnetic separators suited to the iron sand near Jogjakarta.

It was found that a wet drum-type magnetic separator extensively employed in Japan is not effective in this concentration since the upgrading is fairly difficult. Nevertheless, if a magnetic separator of extremely high separation efficiency is used together with suitable operating conditions, the upgrading of the magnetic concentrate may be feasible. In any event, a practical feasibility study has to be made.

Other alternatives for upgrading are to remove the coarser pieces of concentrate or to grind the middling for subsequent magnetic separation.

In the removal of coarse grains, it is important in actual operation to employ such screens as the sieve bend.

The grinding of the middling may be combined with a high-efficiency magnetic separator to bring about the desired upgrading. For the possibility of producing pellet feed in connection with the grinding, a further study has to be made.

(5) *Investigation of the Transport Routes*

i. Purpose

For transport of the iron-sand concentrate produced, there are two alternatives. One is transporting it by land (railway) over about 150 km and then shipping it from the existing port at Tjilatjap. The other way is by building a new port near the mining site.

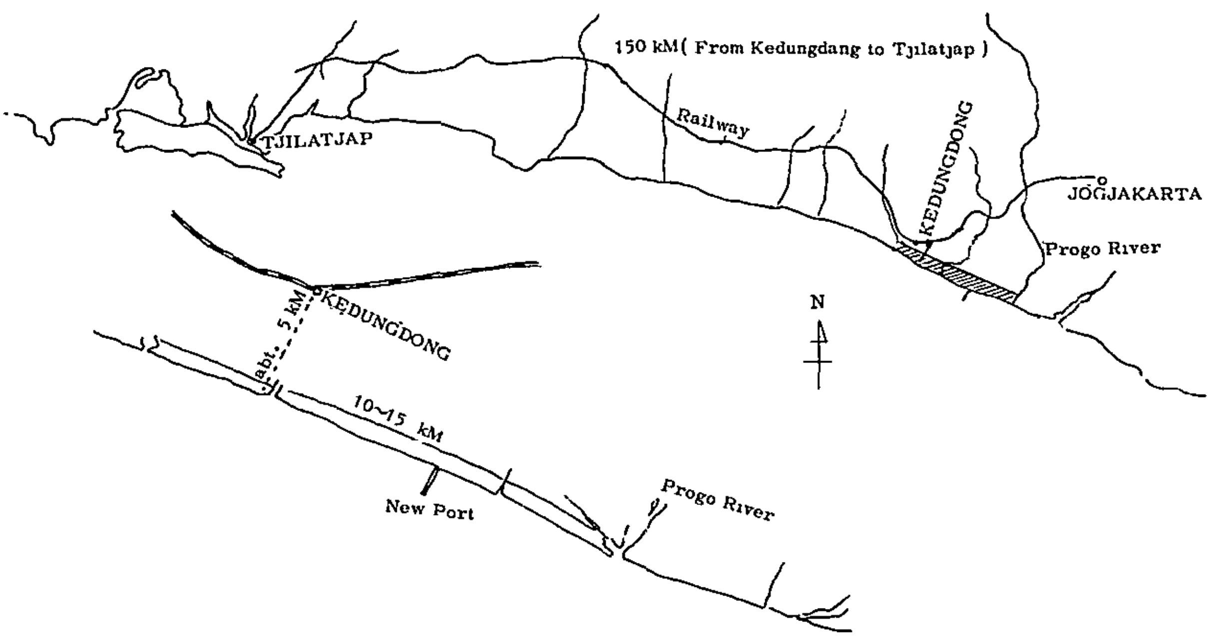
That is,

alternative A: mining site $\xrightarrow[\text{railway (new installation) or truck}]{\text{about 5 km}}$

nearest station (Kedungdang) $\xrightarrow[\text{railway (existing)}]{\text{about 150 km}}$ Tjilatjap Station

$\xrightarrow[\text{truck or belt conveyor}]{\text{about 1 km}}$ Tjilatjap Port → export

alternative B: mining site $\xrightarrow[\text{belt conveyor}]{\text{about 15 km}}$ new port → export



With regard to these two alternatives, a technological survey was made on their feasibility, merits and demerits, assuming one million D. M. T. per year would be transported.

ii. Summary of the Results

a) The Present State of Existing Transport Facilities

At Tjilatjap port, loading facilities (for vessels of 30,000 D/W class) are now under construction to handle iron sand concentrate from Tjilatjap deposits under the guidance of Japanese engineers. Under sufficient maintenance and management, the shipment of the magnetic concentrate of Tjilatjap and Jogjakarta at Tjilatjap port could be made possible.

For this purpose, however, improvements of cargo works, including the assurance of adequate stockyards behind the port will be required. Also, since the fairway in front is narrow, the employment of tug boats will be unavoidable.

At present, this railway services on the average 9~10 runs in both directions of passenger trains each day, 1 run in both directions of freight cars, and one run in both directions of tank lorries. However, in order to transport an additional 83,400 tons of iron sand concentrate per month, an additional 10 runs in both directions must be made along this line, hence some alterations in these facilities may become necessary.

Currently, the railway freight cost for concentrate is 548 Rupiahs (about US$1.50) per ton.

Although there exist some roads, the pavement is either too thin, or they are not paved at all, and in addition the maintenance is insufficient. Besides, some bridges have a maximum load of less than three tons. Furthermore, in some places during the rainy season, the roads are not secure. In short, the road condition, on the whole is not good.

b) Natural Conditions

Along the coast from Tandjung Karang Bata to Patjitan Bay, the natural conditions necessary for the construction of new port facilities are almost non-existent (this takes into account oceanographical, meteorological, topographical and geological conditions).

According to reports at the site, the ocean and weather conditions are the severest from September to October, and the calmest from December to January. The month of March, when the survey was made is also a rather calm month.

However, during observations made at that time, a fair number of breakers could be seen. In addition, according to a book on the hydrographic maps issued in Japan, surges are very high in this area and due also to insufficient data on the topography, it is dangerous for vessels to enter within 4 km from the coast line. In any event, a thorough investigation of the ocean and meteorological conditions may be necessary, considering the situation of the topography of the region. With regard to the sea-bottom slope, it varies widely from one point to another. Even in the same place, the condition of the beach is subjected to constant change, due to waves, current and inflow of rivers.

Therefore, the port must be built at a point with a minimum change in topography and as far away from a river as possible. It is also necessary to carry out studies on the ocean and meteorological conditions as well as the topography at this point.

V. Development Plans

5-1 Production Plans

Since the ore reserves, containing 25,000,000 metric tons of magnetic ore by a permanent magnet can be expected, the production of one million D.M.T. of concentrate per year is possible.

As demonstrated by the separation test with an A.C. magnetic separator, a concentrate of Fe 57% could be obtained. In the initial stage, therefore, the production will be one million D.M.T. with Fe 57% per year, as follows:

Production Plan (per month)

	Amount	Fe %
Crude Sand	695,000	
Magnetic Concentrate	83,400	57

83,400 tons x 12 months ≒ 1,000,000 tons (per year)

(1) Mining Plans

Amount of ore mined:

695,000 D.M.T. per month or 27,800 D.M.T. per day

Depth of mining: 4.00 m (1.60 m below the water table, on average)

Mining is done with light-draft pump barges, each barge operating 20 hours per day; monitoring is partially used.

Mining facility:

Pump Barge 3 sets
Capacity 500 D.M.T. /Hour
with mining and pressure pump

(2) Cencentration Plan

The bases of the plan are as follows:

a) In principle, mining with pump barges, and
b) Intensive concentration

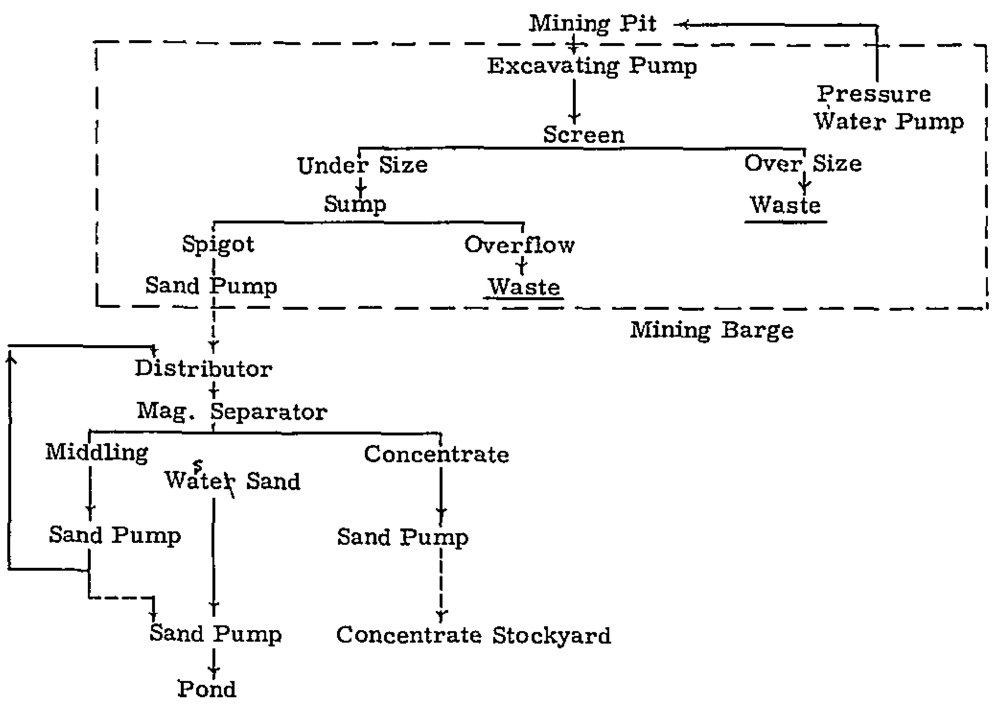
Operation plan

Production of concentrate: 1,000,000 D.M.T. /year
Magnetic percentage of Crude sand: 14%
Recovery percent of concentrate: 90%
Crude sand processed: 695,000 D.M.T. /month
1,000,000 D.M.T. /year ÷ 12 ÷ 14%
÷ 90% ≒ 695,000 D.M.T. (but includes a safety factory of 5%)
695,000 D.M.T. ÷ 50 hrs/month
≒ 1,320 D.M.T. /hr.
\+ concentration facilities

Magnetic separators with capacity 100 D. M. T. /hr:	15 sets
Concentration pump:	6 sets
Waste sand pump:	3 sets
Supplementary feed pump:	3 sets
Pipings:	3 sets
Others	
Dewatering yard:	3 places

Considering the condition of the ore deposits and the uniform production planned, three units of pump barges and separation facilities must be employed. The separation facility is set on land separately from the pump barge, and will be moved at regular time intervals. However, concentrate stockyard must be set for longer use by pipe line extension. A schematic flowsheet of the mining site is shown below.

Three Sets



(3) Transportation at Mine Site

The concentrate will be transported by pipe line to a road built along the north boundary of the ore deposit area. From this road, the following two alternatives are possible (for transport of 83,400 D.M.T. per month).

a) Transport to a stockyard at the newly built port (15 km on average)
b) Transport to a stockyard at the nearest (Kedungdang) station (10 km on average)

In both cases 15-ton dump trucks will be used. In addition, shovel loader, pick-ups, and jeeps for the transportation of workers and patrols are necessary.

(4) Mining Budget

As shown in the table, the construction costs of a mine, with an annual production of 1,000,000 D.M.T., are US$4,619,000, and the civil-engineering costs are Rp. 530,000,000. However, these figures do not contain the expenses for the construction of a new port or the improvement of the railway. In addition, the cost for the installation of shunting tracks are also not included.

Cost of Construction and Expenses for the Production of 1,000,000 D.M.T. per Year.

	Facilities	US$	(000) RP
(1)	Mining	1,600,000	
	Mining Barges	600,000	
	Concentration Plant	1,000,000	
(2)	Power Supply	800,000	
(3)	Transport	735,000	
(4)	Stockyard and Loading	200,000	50,000
(5)	Water Supply		35,000
(6)	Waste Disposal		50,000
(7)	Roads, Bridge etc.		210,000
(8)	Spare Parts	100,000	
(9)	Office and Repair Shop	100,000	40,000
	Laboratory		
	Repair Shop, Garages and Generator		
	Building, Wind Breaks (including machinery)		
(10)	Test, Investigation, Design and Administration	250,000	18,000
(11)	Freight and Insurance	200,000	30,000
(12)	Packing	254,000	
(13)	Starting Expenses		50,000
	Total	4,239,000	483,000
(14)	Contingencies	380,000	48,000
	Grand Total	4,619,000	531,000

5-2 Estimated Profit

It has not yet been determined whether the concentrate produced will be shipped from a new port built at the mining site, or whether it will be transported to the Tjilatjap port via the existing railway. Therefore, for the purpose of reference, the calculation of the profitability was made for the case when the concentrate is shipped from Tjilatjap port.

(1) Basis of the Calculation

i. Railway Freight

The railway freight is US$1. 50 in the current tariff, but taking the discount into consideration, it will be US$1. 25.

ii. Freight

Freight could be calculated by following equation. Freight is equal to the price of magnetic concentrate mines

F. O. B. Price at Tjilatjap Port

The price of magnetic concentrate is assumed to be US$8. 90 and F. O. B. price at Tjilatjap port is said to be US$5. 70 (by P. N. Aneka Tambang). Therefore, freight should be around US$3. 20.

iii. Depreciation

Facilities construction expense:	US$4, 619, 000
Civil-engineering work expense:	US$1, 470, 000 (530 million Rupiahs)
Total	US$6, 089, 000

The depreciation is calculated by ~~a ten~~ nine years declining balance.

iv. Interest to the capital

12% per annum for the construction funds
20% per annum for the working funds

(2) Expected Profit

The expected profit for one D. M. T. of concentrate shipped from Tjilatjap port is shown in the following table.

Item	Sum (US$)	Remarks
Price of ore with Fe 57%	8.84	¢15.5 per Fe 1% for the Fe 57%
The above price minus 10% export duty	0.88 7.96	
(Costs)		
Mining	1.00	Including also the exploration
Railway Fee	1.25	
Transport and Loading	0.40	
General Management	0.10	
Depreciation	0.68	Declining balance over 9 years
Freight	3.20	
Total Production Cost	6.63	
Interest on the capital	0.94	
Interest on the construction costs	0.21	20% per annum for the civil engineering funds
	0.39	12% per annum for the construction funds
Interest on the working funds	0.34	20% per annum
Total Cost	7.57	
Final Profit	0.39	

(3) Considerations on the Profitability

Since it is not yet determined yet whether the ore will be transported by the new port or by the existing railway, a definite conclusion is not possible on the overall profitability. However, if the case of "transport by existing railway followed by shipping from the Tjilatjap port" is taken, the following costs may be expected. That is, the price of ore, grade Fe 57%, minus the export duty, is US$7.96 while the total cost, including depreciation and capital interest, is US$7.57. Therefore, the final profit is at least US$0.39. Expenses for the construction of a new port, or for the improvement of railway facility, are not included in the above figures, so that the overall profitability.is yet impossible to make. If however, the new port is constructed at the mining site, this construction expenses will be added but the railway freight is not required. It is therefore presumed that the proceeds may in this case be raised.

VI. Problems in the Future

6-1 Investigation on the Lower Beds of Iron Sand

It was observed that an iron sand beds are extremely disturbed near the ground surface, especially at the top parts of the dunes due to the force of strong winds. The state of the lower deposits, variation in ore grade, and grain-size distribution are not known at all.

The depth of exploration went as far as 2 m below water table, but no data at lower levels yet exist.

The mineral distribution in the lower levels is also not known due to insufficient exploration, so that adequate data are not available for making detailed mining plans. Furthermore, the magnetic percentage of mixing waste while mining is impossible to calculate. Therefore, it is necessary that studies be made on the magnetic percentage, ore grade and grain-size distribution by sampling at certain strategic intervals (every 50 cm at least).

6-2 Estimation of the Magnetic Percentage

The determination of magnetic percentage was made very laboriously by hand picking with a permanent magnet. The measured value by this method usually contains individual difference, and it is not appropriate as a standard. It is more desirable to measure the magnetic percentage for high grade concentrate by using a tester of A.C. magnetic separator which is both accurate and easy to use.

6-3 Magnetic Ore Reserves

The amount of iron-sand reserves are calculated conventionally by magnetic percentage and the Fe grades are not shown usually.

If magnetic ore with Fe 57~ 59% is indicated by the hand picking test using a parmanent-magnet for an iron-sand deposit, there is no problem. However, in iron sands such as those distributed near Jogjakarta, which abound in middling, the amount of iron-sand reserves varies largely according to the degree of Fe. Hence, the indication of Fe grade is important.

6-4 Mining Methods

The following mining conditions have been decided: the thickness of an iron-sand bed, 3.80 m; the mining depth, 4.00 m; the depth below water table, 1.50 m to 1.80 m; and the mining barge, a light draft pump barge, with partial monitoring. However, since the grade of the lower portion has not been determined, the suitable depth for mining is not yet known. Therefore, further study is necessary on the mining depth and mining procedure.

6-5 Iron Grade of the Concentrate

The iron sand near Jogjakarta is generally coarse in grains and abounds in middling of magnetite. The results from tests indicate that magnetic separators commonly used are not capable of giving the concentrate a sufficiently high grade for export. One of the most important problems in the present project is whether or not a high-grade concentrate can be obtained at high recovery.

For iron sand containing a large quantity of coarse grain middling, the increase in the number of drums in a magnetic separator does not significantly improve the separation efficiency. Therefore, the employment of a magnetic separator may be necessary in which the number of poles and the magnetic-flux distribution are so selected as to give a high agitation effect.

Further the removal of coarse grains from the concentrate, or the application of gravity concentration may be effective for up grading. Therefore above-mentioned problems should be studied, considering also the actual operation.

6-6 Separation Tests

The iron sand in Jogjakarta is generally coarse in grain and contains considerable amount of middling. The grade of concentrate, its grain size, and the concentration ratio seem to vary largely from place to place. Therefore, it is necessary to carry out further studies on samples representing each area with regard to composition as well as other characteristics. After that it is essential to determine the most suitable type of magnetic separator and its design conditions.

It is also necessary to make a feasibility study on the production of concentrate for pellèt feed.

Prior to the dispatch of a survey group for a final feasibility report covering the overall aspects of the project, it is necessary to despach an engineer for gathering typical samples of each calculation block which is kept at the Geological Institute of Bandung, especially grinding tests, so that magnetic separation tests for industrial use may be conducted in Japan.

6-7 Concentration Facilities

In regard to the facilities for mining and concentration, it is important to consider the resulting reduction in production cost which will come about by using a large unit with intensive operation. This can be accomplished by mining with pump barges, the intensive operation of magnetic separation facilities and concentrate stock-yard. In the actual planning and overall layout, however, the actual situation of ore deposits and other site conditions must be understood in detail.

With regard to the magnetic separation, magnetic separators should be selected which have high gradient magnetic circuit suited to the characteristics of the iron sand near Jogjakarta.

6-8 Railway Transport

A number of problems arise in the case of railway transport.

(1) Improvement of the existing railway system may be necessary.

Maintenance and repair are constantly being made at present, but these are insufficient. In order to transport about 83,400 D.M.T. of concentrate per month, the improvement of the tracks may be necessary. Checks and alterations may also be required on the tunnels (a total of 1.5 km) and the bridges.

(2) An increase in the number of locomotivds and freight cars, and the installation of cross tracks may be necessary.

If the present types of locomotives and cars are to be used, 10 runs (in both directions) per day are required. For this purpose, the increase in the number of locomotives and cars, and the installation of the cross tracks and yards are necessary. If locomotives and cars, of higher grade, are to be employed, the railway (tracks) also needs to be re-studied.

(3) A facility is necessary for making a connection between the mining site and the nearest (Kedungdang) station.

(4) The expenses required for the above improvements and installations are not yet known. However, since the railway is operated by P.N. Kereta Api, there is possibility that the tempo of mining project by P.N. Aneka Tambang will not be in step with the renovation by P.N. Kereta Api.

(5) The railway transportation of magnetic concentrate will cause some troubles in maintenance of railway facilities and the reconstruction works following faults and/or accidents which might occur during the course of mining operations.

Difficulties, as described above, might be encountered due to the fact that mining itself is an assignment of P. N. Aneka Tambang while the transportation is under the control of P. N. Kereta Api.

(6) The problem of Transportation Cost

According to the current tariff, the transportation cost per ton of concentrates is US$1.50. However, as mentioned above, P.N. Aneka Tambang will pay US$1.25 because of a discount. In any event, the cost per year is close to 500 million Rupiahs and this figure does not include loading and unloading charges.

(7) It may happen at some future time that the vicinity of the Tjilatjap port will become developed and transportation from station to port will become inefficient.

(8) In the current program to improve Tjilatjap port, vessels of the 30,000 D/W class will be the upper limit.

6-9 Construction of a New Port

In order to construct a new port, the following investigations are necessary.

(1) Investigations for construction of the port and facilities

The natural conditions prevailing are fairly severe. Therefore, considerable difficulties may be encountered in the construction and maintenance of the port and facilities. In order to select an appropriate point and to design of this port, it is necessary to carry out studies on the natural conditions.

(2) Investigation of the port utilization after construction

It seems nearly impossible to secure the constant entry and exit of vessels into and out of the port. Vessels using the port may be those of the 30,000~50,000 D/W class. It is necessary in advance to determine the number of days per year lugging etc. of the vessels is possible and their procedures. For this reason also, a survey is necessary on the natural conditions.

6-10 Profitability

Since it is not yet determined whether a new port at the mining site will be constructed or the existing Tjilatjap port will be used, the profitability of the project cannot be estimated. However, concerning the possible profit already described, the following questions arise.

(1)

(1) Can a rise be expected in the price of US$8.84 for Fe 57% ore (calculated with CIF ¢15.5?%) ?

(2) The depreciation has been taken as a declining balance over 9 years. Is it unnecessary to correct this with respect to Indonesian law on depreciation ?

(3) The freight from Tjilatjap to Japan has been set at US$3.20. However, there is a trend for the tariff of vessel freights to increase.

(4) The interest for a yen loan and for an internal loan, used in the calculation, are 12% and 20% per annum, respectively. These high rates will be an overload.

VII. Feasibility Study for Commercial Mining

As described in the preceding chapter, there remain many problems to be solved, especially in the Fe grade of concentrate. The following tests, therefore, are indispendable prior to the final feasibility report survey.

That is, an expert should be dispatched to the Geological Institute of Bandung to aquire there samples (at least 6.0 tons altogether) for the respective blocks of ore reserve in Jogjakarta. These are to be tested in Japan in a small practical operation to confirm Fe grade and magnetic percentage.

The expenses required for this feasibility study (for commercial mining) are 5,700,000 Rupiahs.

VIII. Feasibility Survey at the Site (for the final feasibility report)

If the result of feasibility studies indicate that commercial mining is possible, as described in Chapter VI, the following overall surveys at the site is necessary: the state in lower ore-beds; the scheme for ore transportation; the methods of mining; the layout of concentration facilities; and so on.

8-1 Investigation of the Ore Deposits

As already described, there is no data on the state of the lower ore deposits. Therefore, it is difficult to estimate the magnetic percentage of mixed-in wastes while mining. In order to deal with this problem, about 50 borings should be made with a Becker drill.to determine the state of the grain sizes and the magnetic percentage of these lower ore beds. In block IIIA, IIIB and IV, borings should be made at 300-m intervals along measuring lines at intervals of about 3 km to obtain the data of the structure, magnetic percentage, etc. of the lower layer. In block I and II, pit borings are made at 20-m intervals along the measuring lines at the intervals of 400 m, to measure the grain size and magnetic percentage.

8-2 Investigations for a New Port

(1) Natural Conditions

a) Winds
b) Waves
c) Sea Currents
d) Depth of Sea
e) Geology of the Sea Bottom

(2) Piers for Vessels

(3) Methods of Loading

8-3 Investigations for the Railway

(1) The Current Facilities

a) Tracks
b) Bridges and tunnels
c) Yards and the cross tracks
d) Locomotivds and Cars

(2) Operation Schedule

(3) Costs of the Transportation

(4) Methods of Loading

8-4 Plant Layout

1. Topography
2. Water Resources
3. Overall Layout for Water Source, Mining, Concentration, Waste-sand Transport, Concentrate Transport, etc.
4. Movement of Plant Facilities
5. Problems in the Disposal of Waste Water and Sand
6. Repair Shops and Other Facilities

IX. Conclusion

The iron sand near Jogjakarta is rather inferior to that in Tjilatjap for the following reasons:((1) the magnetic percentage is low; (2) the upgrading of the concentrate is difficult; and (3) the adverse natural-conditions for ship loading.

However, the ore reserves of Jogjakarta iron sand are large and hence have a high potentiality and so they are an important mineral resource. The problems indicated in the previous chapters should be studied in detail.

The present tests on magnetic separation, mineral characteristics of the iron sand near Jogjakarta could only be superficially studied. To what extent the Fe grade can be raised depends on further studies on the grinding of middling, the selection of suitable magnetic separators, the rejection of coarse grains, and so on. There is also the possibility of producing pellet feed ore. Therefore, prior to the final feasibility report survey, it is necessary to carry out feasibility studies on commercial mining.

With regard to the transport of the produced concentrate, the construction of a new port at the mining site has the following advantages.

(1) The construction of the port, its expansion and maintenance, and its operation can be carried out in step with the mining program.

(2) The initial investment will be higher than using the existing railway and port. But, overall the transportation cost will be reduced.

Therefore, the construction of a new port can be recommended and it is necessary to start as early as possible investigations on the natural conditions.

Following up this pre-feasibility report, we recommend that a feasibility study on the upgrading of the iron sand be carried out as well as making a final feasibility report survey on the whole project.