

№ 32

REGIONAL DEVELOPMENT PLANNING PROJECT
IN CHIQUIMULA
REPUBLIC OF GUATEMALA

MARCH 1982

Japan International Cooperation Agency
Metal Mining Agency of Japan

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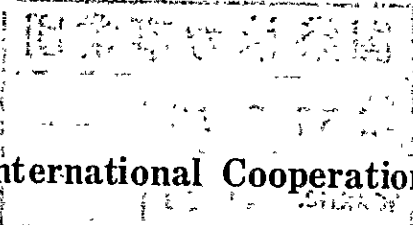
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Japan International Cooperation Agency
Metal Mining Agency of Japan

国際協力事業団

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PREFACE

It is with great pleasure that we present this report entitled Infrastructure Development Planning for the Los Cimientos bentonite deposit to the Government of the Republic of Guatemala.

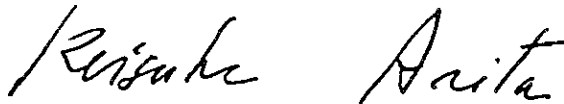
This report embodies the result of a regional development survey which was carried out from October 3 to November 1, 1981 by the Japanese survey team commissioned by the Japan International Cooperation Agency and the Metal Mining Agency of Japan following the request of the Government of the Republic of Guatemala.

The survey team, headed by Mr. Jiro Uchida, had a series of close discussions with the officials concerned of the Government of the Republic of Guatemala and conducted a wide scope of field survey and data analyses.

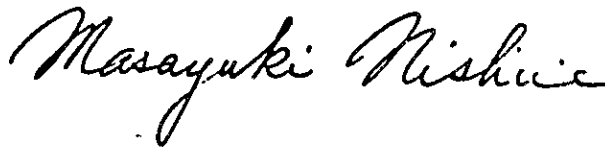
We sincerely hope that this report will be useful as a basic reference for development of the region.

We are particularly pleased to express my appreciation to the officials concerned of the Government of the Republic of Guatemala for their close cooperation extended to the Japanese team.

March, 1982



Keisuke Arita
President
Japan International Cooperation
Agency



Masayuki Nishiiye
President
Metal Mining Agency of Japan

ACKNOWLEDGMENTS

This report summarizes the result of the investigation carried out in fiscal year 1981 by the International Development Center of Japan, entrusted by the Ministry of International Trade and Industry through the Japan International Cooperation Agency and the Metal Mining Agency of Japan.

The objective of the investigation was to formulate a development plan for the bentonite mine, located in Los Cimientos, the east part of the Republic of Guatemala, and to study economic effects related to the mine. It is my sincere wish that this investigation will contribute to the regional development around the mine and further to the economic development of the Republic of Guatemala, and that it will also help strengthening the friendly and cooperative relationships between the Republic of Guatemala and Japan.

A field investigation was conducted for about a month from October 3, 1981 by the mission, consisting of the following members:

Mission Leader	Jiro Uchida International Development Center of Japan
Coordinator	Kazuhiko Uematsu Metal Mining Agency of Japan
Geologist	Hiroshi Miyajima International Development Center of Japan
Geologist	Hiroataka Nishimoto International Development Center of Japan
Economist	Sadayuki Kitamura International Development Center of Japan
Economist	Hisatoshi Matsudaira International Development Center of Japan
Bentonite Engineer	Hiroshi Sakasai International Development Center of Japan

I would like to express my gratitude to government organizations of Guatemala, particularly Direccio General de Minería e Hidrocarburos, for strong supports in all aspects, and also to the Japanese Embassy, trading companies and international organizations who cooperated the survey team in various ways. My deep appreciation is extended also to the Ministry of Foreign Affairs, the Ministry of International Trade and Industry, the Japan International Cooperation Agency, the Metal Mining Agency of Japan, and the Guatemalan Embassy in Japan.

March 1982

A handwritten signature in black ink, appearing to read 'Saburo Kawai', with a large, sweeping flourish at the end.

Saburo Kawai,
President
International Development Center
of Japan

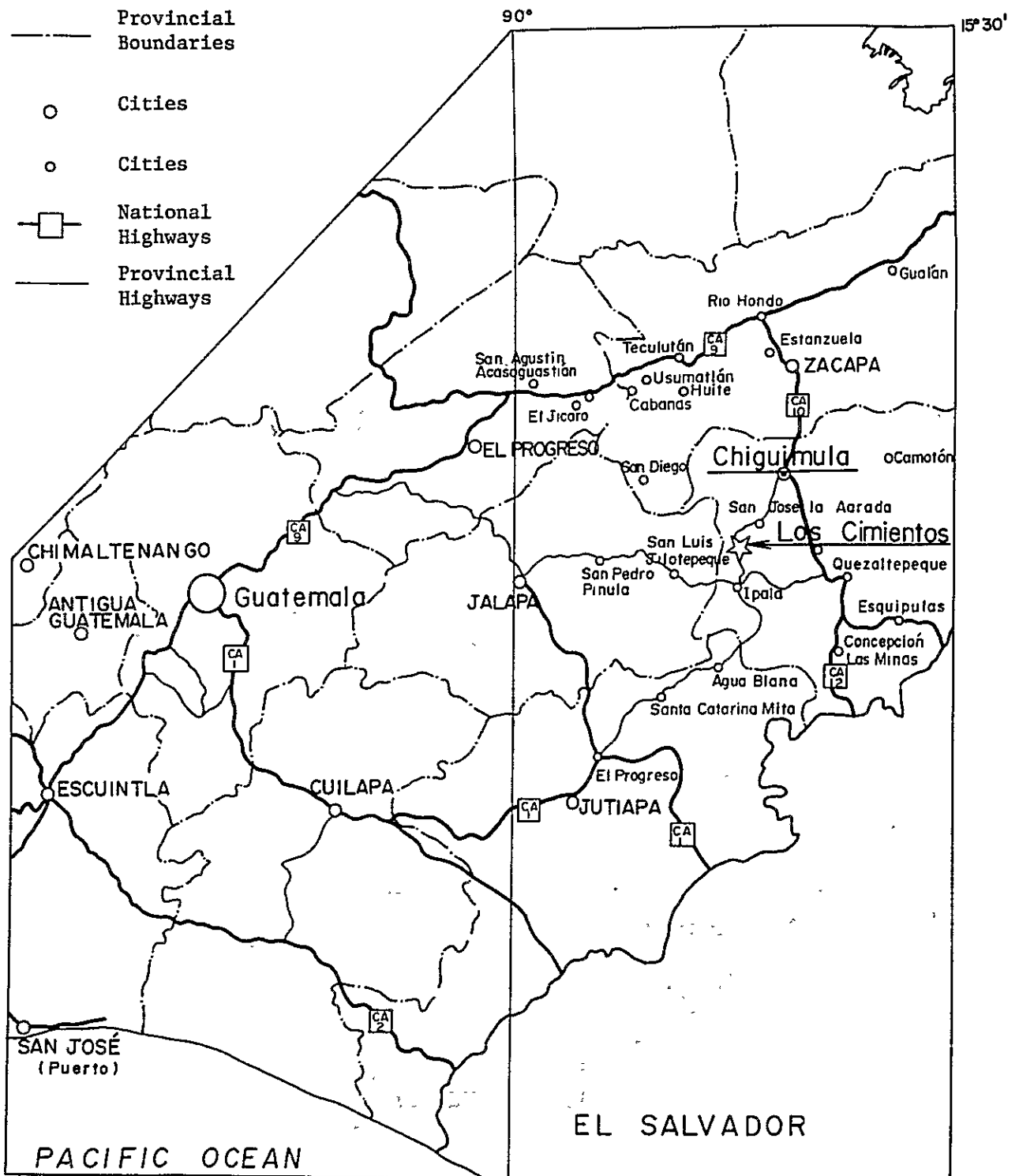
Location Map of Republic of Guatemala

1 : 5,500,000



Guatemala ~ Chiquimula ~ Los. Cimientos

1 : 1,000,000



CONTENTS

CHAPTER 1	SUMMARY	1
1	Premises	3
1-1	Scope of Investigation	3
1-2	Procedure of Project Evaluation	3
2	Outline of Bentonite Project	7
3	Outline of Bentonite	13
3-1	Bentonite Deposit	13
3-2	Properties and Use of Bentonite	13
4	Outline of Construction	14
4-1	Mine	14
4-2	Bentonite Processing Plant	15
4-3	Infrastructure	16
5	Outline of Overall Evaluation	16
5-1	Revenues and Benefits	16
5-2	Financial Analysis	17
5-3	Economic Analysis	17
5-4	Overall Evaluation	19
5-5	Overall Measures and Proposals	19
CHAPTER 2	PLANS UNDER BENTONITE PROJECT	21
1	Basic Points of Project	21
1-1	Identification of Properties of Bentonite and Study of Its Uses	21
1-2	Estimation of Bentonite Ore Reserves	22
1-3	Basic Plan for Bentonite Clay Mining	22
1-4	Basic Plan for Bentonite Production	22
1-5	Study of Infrastructure	23
1-6	Assessment of Economic Feasibility	23
2	Basic Points of Bentonite Production Plan	23
CHAPTER 3	BENTONITE	27
1	Bentonite Deposit	27
1-1	Topography	27
1-2	Geology	27
1-3	Mineral Deposit	32
1-4	Exploration	37
2	Properties of Bentonite	96
2-1	Property Analysis	96
2-2	Analytical Results and Uses	97
3	Bentonite Market	113
3-1	Guatemalan Market	113
3-2	Markets in Countries Around Guatemala	113
3-3	Demand Outlook by Use	118
3-4	Market Estimation	118

CHAPTER 4	MINE DEVELOPMENT	123
	1 General Situation of Los Cimientos	124
	2 Technical Procedure for Mine Development	131
	3 Organization and Personnel Plan for Mine Operation	133
	4 Clay Mining	133
	4-1 Clay Production	136
	4-2 Stripping	137
	4-3 Total Clay Production and Stripping	137
	4-4 Mining Method	138
	4-5 Loading and Transportation	141
	4-6 Mine Machinery	141
	4-7 Mine Operation Cost	144
	5 Mine Facilities	148
	5-1 Mine Facilities	149
	5-2 Construction Cost	151
	6 Clay Transportation	152
CHAPTER 5	BENTONITE PLANT	153
	1 General Situation of Chiquimula	153
	2 Location of Bentonite Plant	160
	2-1 Requirements for Plant Location	160
	2-2 Candidate Sites for Plant Location	161
	3 Bentonite Plant	162
	3-1 Bentonite Plant Facilities	162
	3-2 Production Capacity of Plant	162
	3-3 Incidental Facilities of the Plant	163
	3-4 Construction Cost	164
CHAPTER 6	BENTONITE PRODUCTION	167
	1 Production Plan	167
	2 Production Process	167
	3 Properties and Applications	168
	4 Quality Control	169
	5 Transportation of Products	170
	6 Organization and Personnel Plan for Bentonite Plant	170
	7 Operation Cost of Bentonite Plant	172
CHAPTER 7	HEAD OFFICE FUNCTIONS AND HEAD OFFICE EXPENSES ..	177
	1 Head Office Functions	177
	2 Head Office Expenses	177

CHAPTER 8	INFRASTRUCTURE	179
	1 Roads	179
	2 Transportation	179
	3 Communications	179
	4 Service Water	180
	5 Power Supply	180
CHAPTER 9	OVERALL EVALUATION	181
	1 Viewpoint and Method of Overall Evaluation ...	181
	2 Revenues and Benefits	182
	2-1 Uses and Supplying Policy	182
	2-2 Prices	183
	2-3 Output	183
	3 Financial Analysis	188
	3-1 Financing Plan	188
	3-2 Funds Required	190
	3-3 Cost of Manufacture	194
	3-4 Calculation of Internal Financial Rate of Return	195
	3-5 Analysis of Break-even Point	197
	3-6 Analysis of Value Added	197
	3-7 Summary of Financial Analysis	206
	4 Economic Analysis	206
	4-1 Calculation of Economic Analysis	206
	4-2 Calculation of Internal Economic Rate of Return	217
	4-3 Foreign Exchange Earnings and Savings Effect	218
	4-4 Regional Development and Indirect Effect	218
	4-5 Economic Analysis Round-Up	223
	5 Overall Evaluation	223
	5-1 Validity of Investment in the Mine	223
	5-2 Overall Measures and Proposals	224

LIST OF TABLES AND FIGURES

Table 1-1	Clay Production and Bentonite Production during the Entire Project Period	8
1-2	Personnel Requirements of the Project	9
1-3	Investment for the Project	10
1-4	Operation Cost	11
1-5	Result of Internal Financial Rate of Return Calculations	18
1-6	Analysis of Break-even Point by Production Stage ..	18
1-7	Value Added Rate (%)	18
Table 2-1	Mine Operating Days and Clay Production	25
2-2	Plant Operating Days and Bentonite Production	26
Table 3-1	Mining Area by Levels	36
3-2	Ore Reserves and Oberburden Dimensions by Levels ..	36
3-3	Results of Chemical Analysis	97
3-4	X-ray Diffraction Result (1)	98
	" (2)	99
	" (3)	100
	" (4)	101
	" (5)	102
3-5	Samples with Relatively High Montmorillonite Purity	103
3-6	Test Result of Properties	104
3-7	Relationship of Samples to Uses	109
3-8	Evaluation Criteria - 1	112
3-9	Evaluation Criteria - 2	112
3-10	Bentonite Output in Guatemala	114
3-11	Quantity of Imported Bentonite from USA	114
3-12	Production Situation of Bentonite in USA	115
3-13	Ratios of Bentonite Used for Various Purposes in USA	115
3-14	USA Exports of Bentonite, Including Calcined	116
3-15	Market Estimation	119
3-16	Average Annual Growth Rates of Actual Industrial Output in the Central American Countries	121
Table 4-1	Precipitation (Ipala)	127
4-2	Temperature and Humidity	128
4-3	Mine Machinery and Facilities	142
4-4	Mine Operation Cost (First Stage of Operation - 1st to 6th year)	145
4-5	Mine Operation Cost (Second Stage of Operation - 7th to 12th year)	146
4-6	Mine Operation Cost (Third Stage of Operation - 13th to 23rd year)	147
4-7	Major Mine Facilities	148

Table 5-1	Precipitation (Chiquimula)	155
5-2	Temperature, Humidity (Chiquimula)	157
5-3	Bentonite Plant Machinery and Facilities	165
5-4	Major Items of Facilities for Bentonite Plant	165
Table 6-1	Operation Cost of Bentonite Plant (First Stage of Operation - 1st to 6th year)	173
6-2	Operation Cost of Bentonite Plant (Second Stage of Operation - 7th to 12th year)	174
6-3	Operation Cost of Bentonite Plant (Third Stage of Operation - 13th to 23rd year)	175
Table 7-1	Sales and Management Costs (Head Office Costs)	178
Table 9-1	Bentonite Output and Demand Estimation	184
9-2	Investment Program	191
9-3	Working Fund Program	193
9-4	Classification of Required Investment Fund into Domestic and Foreign Currencies	193
9-5	Fund Procurement Program	193
9-6	Internal Financial Rate of Return Case 1-0 (before tax, \$120/t)	198
9-7	Internal Financial Rate of Return Case 1-1 (after tax, \$120/t, 5% interest)	199
9-8	Internal Financial Rate of Return Case 1-2 (after tax, \$120/t, 10% interest)	200
9-9	Internal Financial Rate of Return Case 2-0 (before tax, \$130/t)	201
9-10	Internal Financial Rate of Return Case 2-1 (after tax, \$130/t, 5% interest)	202
9-11	Internal Financial Rate of Return Case 2-2 (after tax, \$130/t, 10% interest)	203
9-12	Calculation of Fixed and Variable Expenses	204
9-13	Analysis of Break-Even Point of Stage of Production Program	204
9-14	Value Added Rate	204
9-15	Reference Data on Agricultural Productivity	209
9-16	Reference Data on Agricultural Productivity	209
9-17	Reference Data on Agricultural Productivity	210
9-18	Reference Data on Agricultural Productivity	210
9-19	Past Records of Power Supply	211
9-20	Record of Power Supply and Economic Cost	212
9-21	Estimate of Power Supply and Economic Cost	213
9-22	Guatemala's Export-Import and Export-Import Taxes	216
9-23	Guatemala's Shadow Exchange Rates Calculated on the Basis of Simple Equation	216
9-24	Internal Economic Rate of Return Case 2 (\$120/t)	219
9-25	Internal Economic Rate of Return Case 2 (\$130/t)	220
9-26	Foreign Exchange Earnings and Savings Effect	221
9-27	Rate of the Relative Share of Labor	222

Figure 1-1	Sketch of Bentonite Project	1
1-2	Los Cimientos Mine	2
Figure 3-1	Geological Map	41
3-2	Geological Cross Section	43
3-3	Columna Geologica Esquematica, Area De A-3 (Chiquimula)	45
3-4	Location Map of the Bentonite Zone, Out Crops and Bores	47
3-5	Sketches of the Out Cross of the Bentonite	49
3-6	Cross Section of the Deposits (SW-NE)	51
3-7	Cross Sections of the Deposit (NW-SE)	53
3-8	Form of the Open Pit	55
3-9	Maps of the Distribution of the Bentonite Body on Each Level at 5 Meter Internals	56
3-10	Core Sketches of the Borings of DGMH	67
3-11	Geological Profile Through the Drill Holes (SW-NE)	91
3-12	Geological Profile Through the Drill Holes (SW-NE)	92
3-13	Location Map of the Samples	93
3-14	Plan for the Future Prospecting	95
Figure 4-1	Location Map of Chiquimula and Ipala Observatory ..	125
4-2	Organizational Chart of Plant with Number of Personnel	134
Figure 6-1	Typical Flow Sheet for Bentonite Processing Plant	171
6-2	Organizational Chart of Plant with Number of Personnel	171
Figure 7-1	Head Office Organization and Personnel	178
Figure 9-1	Production & Demand Forecast of Bentonite	187
9-2	Analysis of Break-even Point	205
9-3	Sensitivity Analysis for Economic Cost of Electric Power	214

CHAPTER 1.

SUMMARY

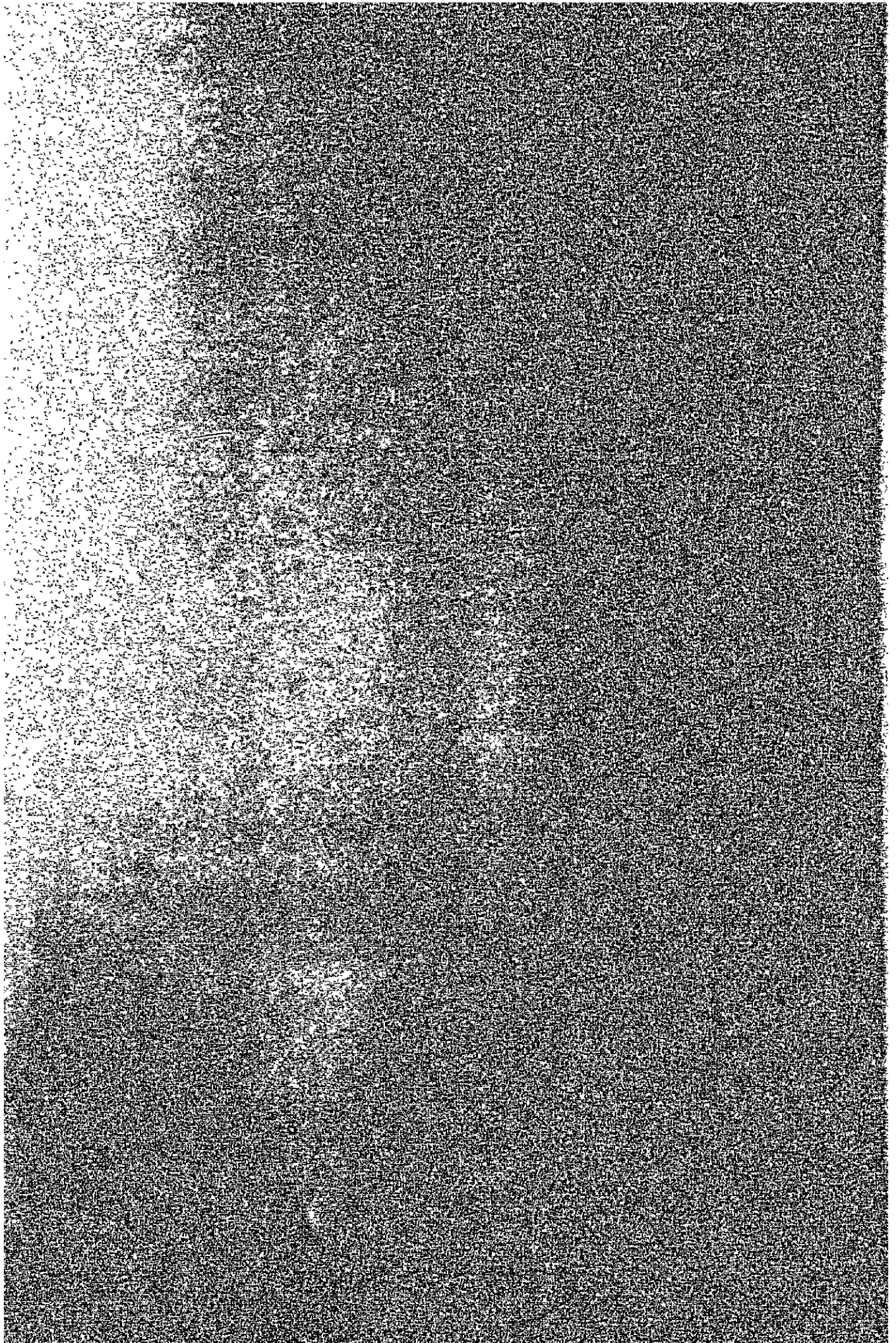
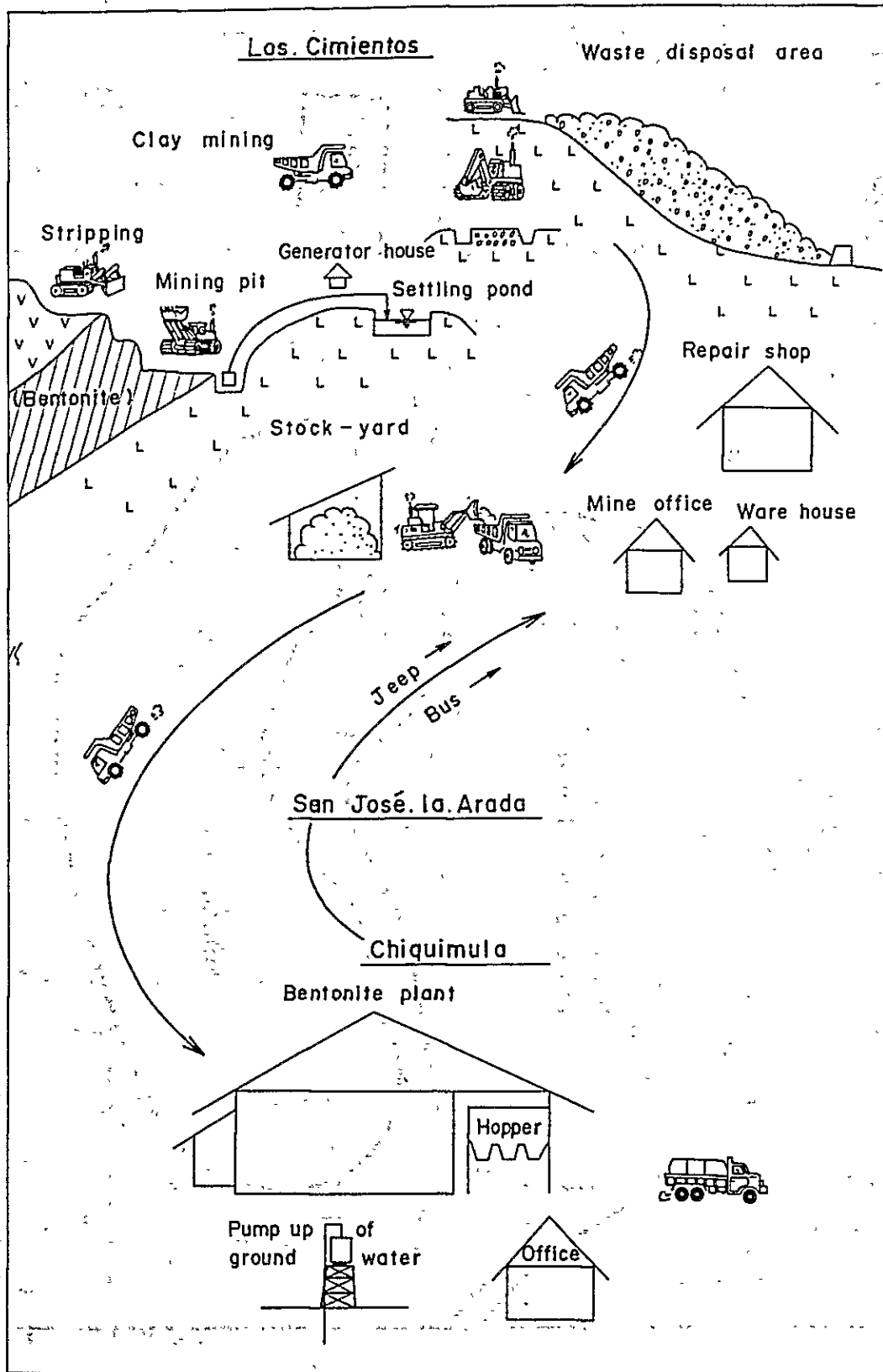
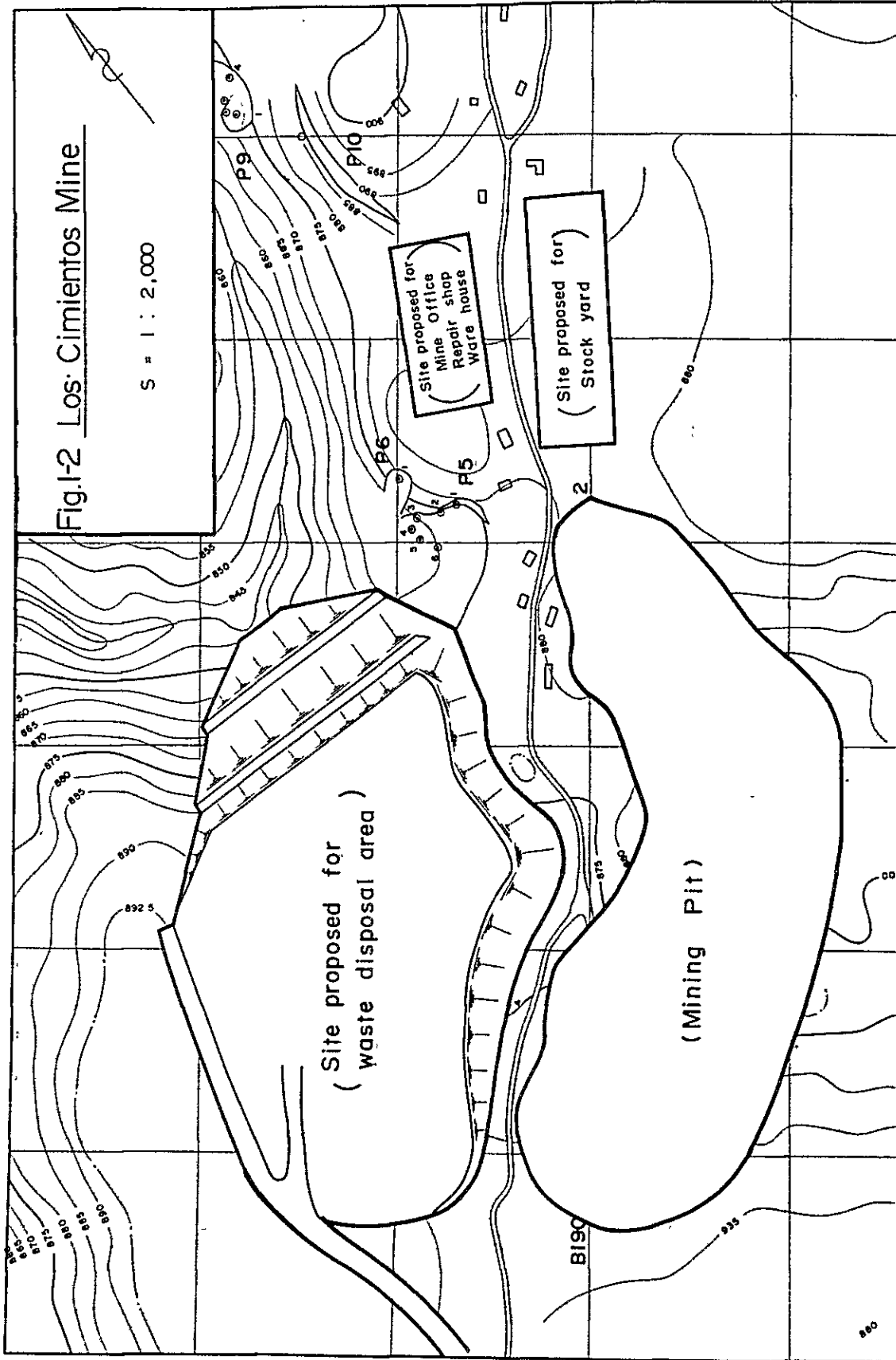


Fig. 1-1 Sketch of Bentonite Project





CHAPTER 1 SUMMARY

1 Premises

1-1 Scope of Investigation

The scope of this investigation shall be as follows:

- 1) Grasping of the potentiality of the resources, such as the bentonite deposits and bentonite properties.
- 2) Basic investigation on technical matters of bentonite mining and manufacturing.
- 3) Feasibility study of the bentonite project.
- 4) Effect of this project on social development.

1-2 Procedure of Project Evaluation

Procedure of the bentonite project evaluation will be presented, divided into technological affairs related to bentonite production and into feasibility of the project.

1) Investigation procedure of the bentonite production techniques.

(1) Bentonite deposit drilling at Los Cimientos (this survey was undertaken by DGMH*).

(2) Survey of topography in the vicinity of the deposit (survey).

Note: * Direccion General de Minería y Hidrocarburos

- (3) Survey of geological conditions and the deposit (geological survey around the deposit area, checking of the drilling core and bentonite sampling).
- (4) Tentative determination of the bentonite mining area.
- (5) Tentative determination of the overburden stripping area corresponding to the bentonite mining area.
- (6) Bentonite property analysis (analysis of chemical and physical properties).
- (7) Drafting of mining area program.
- (8) Calculation of bentonite reserves.
- (9) Calculation of overburden stripping dimensions.
- (10) Meteorological survey of the area around Los Cimientos (general idea of annual precipitation).
- (11) Investigation of the roads, railway and other transport facilities, power supply, communications and general conditions between Los Cimientos and Chiquimula.
- (12) Planning of the mining (overburden stripping and accumulation, bentonite mining and means of transportation, pit draining, etc.).
- (13) Tentative selection of mine equipment and facilities (mining, loading, carrying, draining, power generating and other machines and other facilities such as the stock yard, repair shop, offices and so forth).
- (14) Selection of the location of the bentonite manufacturing plant.

- (15) Investigation of Chiquimula City's meteorological conditions, roads, railway, other traffic conditions, power supply, communications and other general conditions.
- (16) Bentonite manufacturing (crushing, drying, milling, Na activation, etc.).
- (17) Tentative determination of the manufacturing plant capacity.
- (18) Tentative determination of the manufacturing plant machines and facilities (hoppers, crushers, dryers, mills, activation reactors, conveyer belts of various types, bentonite hoppers, other machines, plant buildings, water pumps, offices, assay laboratory and other facilities).
- (19) Investigation of bentonite supply and demand situation in Guatemala and neighboring countries (country-by-country output, demand, uses, import-export, market price and other information).
- (20) Planning of bentonite output.
- (21) Planning of bentonite mining quantity and of the quantity of ore supplied to the plant.
- (22) Planning of mine machinery and facilities.
- (23) Planning of mine operation system.
- (24) Planning of per-hour manufacturing capacity of the plant.
- (25) Planning of the plant machinery and facilities.
- (26) Planning of the manufacturing plant operation system.

- (27) Survey of market prices of mine and manufacturing plant operating materials.
 - (28) Survey of market prices for mine machinery and manufacturing machinery.
 - (29) Investigation into the labor situation and personnel costs in Guatemala.
 - (30) Investigation of laws and regulations connected with mine and manufacturing plant operation (laws related to labor, mining and quarrying laws, laws related to decentralization of industries, etc.).
 - (31) Estimate of mine and manufacturing plant operating organization and head office functions.
 - (32) Plans for initial construction of the mine and manufacturing plant and for additional construction.
 - (33) Plans for initial investment and additional investment of mine and manufacturing plant.
 - (34) Personnel plans for the mine, manufacturing plant and head office.
 - (35) Plans for mine and manufacturing plant operating materials.
 - (36) Plans for operating personnel cost, property costs and running costs of mine and manufacturing plant.
- 2) Investigation procedure of the bentonite project feasibility
- (1) Determination of ore reserves, grade, mine-field, etc.

- (2) On the basis of market research, assumption of bentonite output, uses, price and markets.
- (3) Working out mining and production programs, estimate of investment and operation costs.
- (4) Calculation of annual revenues and expenses, study of the financial feasibility through finding the internal financial rate of return, break-even point and the value added rate.
- (5) Internal economic rate of return and foreign exchange earnings and savings effect are calculated for the purpose of seeing the economic feasibility for the national economy.
- (6) Study of other effects.

2 Outline of Bentonite Project

The bentonite project consists of the bentonite mine and the bentonite manufacturing plant. The bentonite found in Los Cimientos changes, under Na activation treatment, from the H-type bentonite to high grade Na bentonite, which is highly suited for use as bond for molding sand, as drilling mud and as muddy water for the diaphragm wall construction in civil engineering, and so forth. The project aims at obtaining profits by manufacturing and marketing products of high value added, which take advantage of such useful properties of bentonite.

Concretely, basic technical matters related to bentonite mining, transportation and manufacture will be examined, the total cost of manufacture will be estimated while the bentonite market in Guatemala and neighboring countries are simultaneously researched,

sales volumes and revenue will be estimated, thus evaluating the feasibility of the project.

The bentonite ore reserves are estimated at 900,000 T.* Of this total, 890,000 T will be mined in 23 years under the three-stage operation system. From this, 680,000 T of products will be manufactured.

Construction of the mine and the manufacturing plant will consist of three stages, one being initial construction prior to operation and the others being construction to be undertaken at the time of shifting from the first to the second, from the second to the third stage operation periods.

Table 1-1 Clay Production and Bentonite Production during the Entire Project Period

	Clay Production (T)		Bentonite Production (t)	
	Year	Period	Year	Period
1st-stage Operation Period	16,600	99,600	12,600	75,600
2nd-stage Operation Period	33,000	198,000	24,900	149,400
3rd-stage Operation Period	54,000	594,000	41,700	458,700
Total		891,600		683,700

The scope of this basic plan of mine operations will cover from bentonite mining to transport for the manufacturing plant, and manufacturing plant operations will range from bentonite clay

Note: * Only used for clay and overburden as metric ton.

acceptance to manufacture and shipment. Personnel needed for operation is estimated by postulating the practical organization of the bentonite company (Table 1-2). Most of the machines and equipment and key materials needed for construction and operation is imported.

Table 1-2 Personnel Requirements of the Project

Personnel				
	Mine	Mfg. Plant	Head Office	Total
1st-stage Operation Period	11	17	8	36
2nd-stage Operation Period	18	24	8	50
3rd-stage Operation Period	20	35	8	63

Total investment during the 23-year project period is \$15,000,000.

The operating costs under the three-stage production program will gradually drop because of the scale merit, and the operating cost is estimated to range from \$61.40 to \$55.69 per ton.

The bentonite market in Guatemala is estimated at about 7,000 t a year, since 4,000 t are imported to supplement the domestic output of 3,000 t. The domestic product is used as an extending agent in the manufacture of soap and detergent, while the imported product is utilized in drilling.

Table 1-3 Investment for the Project

		Investment (\$1,000)
Mine	Land	12.0
	Pre-stripping waste disposal area	85.6
	Access road improvement	8.5
	Improvement of pit interior and environs	3.4
	Stockyard construction	43.6
	Machines and equipment	647.7
	Rolling stocks	1,721.6
	Buildings	43.9
	Subtotal	2,674.3
Mfg. plant	Land	72.4
	Civil engineering and construction	407.6
	Water drawing pumps	78.0
	Plant equipment and construction	9,252.1
	Rolling stocks	1,801.7
	Subtotal	11,611.8
Contingency		713.9
Grand total:		15,000.0

Table 1-4 Operating Cost

Operating Cost US\$/t				
	Mine	Mfg. Plant	Head Office	Total
1st-stage Operation Period	4.37	53.22	3.81	61.40
2nd-stage Operation Period	4.16	52.54	1.93	58.63
3rd-stage Operation Period	3.62	50.92	1.15	55.69

The bentonite found at Los Cimientos is usable for various purposes after Na activation treatment. For this reason, substitutes for imported bentonite and also exports are conceivable. Development of new markets for such uses is worthy of consideration.

If export destinations are limited to the Central American countries, no market expansion will be conceivable unless the demand for industrial use is stimulated. But the quality of activated sodium-exchange bentonite is high enough to consider South America and Europe as possible export destinations.

Domestically produced bentonite is marketed for 4.0 to 4.5 Q/K* for detergent use. Imported bentonite, however, is estimated to be priced at 130 - 150 \$/t FOB USA, and the retail price in Guatemala tops 400 \$/t.

Judging from these markets, Na activated bentonite mined in Los Cimientos may well be priced at 120 -130 \$/t both for the domestic and export markets.

Note: * Q : quetzal, K : quintal

Financial and economic analyses are undertaken in order to make an overall evaluation of the project. Financial analysis includes analysis of internal financial rate of return, the break-even point and of the value added. In the economic analysis, the internal economic rate of return will be found.

As this project is small in scale, the internal economic rate of return found is considered sufficient for economic evaluation, but since Na activated bentonite is supposed to be used substitutes for the imported products and to be channelled into export, exchange earnings and savings effect is analyzed.

As this study constitutes of a preliminary feasibility study of the bentonite project, the form of management and the means of financing are not mentioned in detail, but a certain postulate of fund procurement and spending was made for financial analysis. The result of internal financial rate of return calculations has proved good.

According to the analysis of the break-even point, profit increases along with the expansion of the production scale. Also, the result of value added analysis showed a high rate of value added. The result of financial analysis, therefore, shows the high profitability of this project.

For undertaking economic analysis, items of expenses for financial analysis are adjusted and the internal economic rate of return is calculated. The result is lower than the figures for the internal financial rate of return, but the effect of foreign exchange earnings and savings is quite high.

While this is a small-scale project, it is financially favorable and promising even from the result of economic analysis. It is considered likely to become a project for promoting decentralization of industries and development of natural resources.

And since this is a preliminary study, a further detailed study will be needed for working out the final plan for implementation of this project.

3-2 Outline of Bentonite

3-1 Bentonite Deposit

The bentonite deposit of Los Cimientos is distributed in the range of about 200 m width and about 1,100 m length. Bentonite is classified to the following three by megascopic observation and touch feeling:

1) White to cream color and cheese-like

2) White color but rough touch

3) Light-brown to light-yellow color and alteration of basalt

As a result of the survey, the original rocks of the first, second and third are perlite, rhyolite and basalt respectively.

The bentonite belonging to the first occurs mainly in the southwest part of the surveyed area and is distributed in the range of 120 m in NW-SE and 360 m in SW-NE centering around P1, P2 and P4. The top and bottom of the deposit are 890 m and 855 m in highest and lowest altitudes respectively and ore reserves are 900,800 T and waste is 790,650 T.

3-2 Properties and Use of Bentonite

The most significant property characterizing the bentonite occurring in Los Cimientos is that it can be refined to Na-type bentonite of extremely high grade by Na activation.

X-ray diffraction and differential thermal analysis were made on 20 pieces of drilling core samples and 64 pieces of outcrop samples. With results of these analyses used as reference, 20 core samples and 37 outcrop samples were selected. After Na activation treatment, these selected samples were subjected to further analyses for swelling property, cation exchange capacity, pH, muddy water quality and green strength.

As a result, it was found that bentonite in Los Cimientos contains good H-type montmorillonite as the essential mineral and can be refined to high-grade Na-type bentonite by Na activation.

Activated bentonite can be used as bonds for molding sand, muddy water for drilling and civil foundation work, carriers for agricultural chemicals and fertilizer, and fillers for paints, ink and cosmetics. Possible applications also include pharmaceutical preparations. Furthermore, it was confirmed that some samples are suited as oil-well drilling muds.

The value added can be increased by producing products for these applications.

4 Outline of Construction

4-1 Mine

The mine will be constructed in three phases according to the project for the first through third stage of operation.

The initial period of construction prior to the start of mining operation will be set at two years. The second phase of construction will be started in the last year of the first stage of operation (the sixth year of operation), and the third phase of construction will begin in the last year of the second stage of operation (the 12th year of operation).

Works to be undertaken in the first phase of construction will include construction of a waste disposal area and stock yard for the first stage of operation, stripping of 100,000 m³ of overburden, construction of a passage to the waste disposal area and a mine access road, and preparation of pits and proximate areas.

The second phase of construction will call for construction of the stock yard covering the second stage of operation, a repair shop, warehouse, generator house, and office building.

The stock yard for the third stage of operation will be constructed in the third phase of construction.

Mine machinery will be delivered to the mine in required quantities at the appropriate timing in each stage of operation.

4-2 Bentonite Processing Plant

The plant will be constructed in three phases according to the first through third operation plans.

The initial construction period that precedes the start of mining operation will be set as two years. The second phase of construction will be undertaken over the fifth and sixth years of operation. The third phase of construction will be carried out over the 11th to 12th year of operation. Construction work for the initial period will involve one unit of processing plant, office building, analysis laboratory, pump-up equipment, etc. One unit of plant will be additionally installed in each of the second and third phases of construction.

4-3 Infrastructure

Infrastructure for this project will include a 1.2 km road from Los Cimientos to the provincial highway, a means of transportation for commuters from either Chiquimula or San José (jeeps or busses), wireless communications between the mine and processing plant, water lorry and water tank, and generators for electric mine machinery and tools.

5 Outline of Overall Evaluation

Financial and economic analyses will be undertaken for an overall evaluation of this project. The financial analysis consists of analysis of the internal financial rate of return, the break-even point and the value added. The economic analysis consists of finding the internal economic rate of return.

5-1 Revenues and Benefits

The bentonite found in Los Cimientos, when Na activated, becomes usable for various purposes, such as bond for molding sand, for drilling, for civil engineering construction work and so forth. As a consequence, manufacture of products of higher value added and of higher national needs is considered to bring higher effect. While bentonite produced in Guatemala for soap and detergent manufacture is marketed for 4.0 to 4.5 Q/K, bentonite for drilling is imported from the USA. This is estimated to be priced at CIF* 300 to 400 dollars per ton. The export price from the USA in this case ranges 130 to 150 dollars per ton.

Using these figures as reference, 130 dollars per ton is used as the revenue in the financial analysis and as benefits corresponding to export portion in the economic analysis, but 350 dollars

Note: * Cost Insurance and Freight

per ton is used for the benefits of import substitution in the economic analysis.

5-2 Financial Analysis

The result of the internal financial rate of return calculations is as given in Table 1-5.

The result of calculations of the break-even point of the price is given in Tables 1-6 and 9-13.

The result of value added calculations is given in Table 1-7.

As presented above, the profitability of this project extremely promising.

5-3 Economic Analysis

The internal economic rate of return is 7.82% in case the product price is set at \$120 per ton, but it is 11.05% if the price is \$130 per ton. The internal economic rate of return showed lower value than the internal financial rate of return.

In the case of this project, the economic cost of electric power accounts for a big portion and it is accompanied by a number of unstable factors. Therefore, further sensitivity analysis was undertaken with respect to the economic cost of power. The result was about the same level as the internal financial rate of return in the case of around \$0.8/kWH of the economic cost of power.

Meanwhile, this project has a high foreign exchange earnings effect. Under a 10% discount per year, the net flow cumulation of foreign exchange will be \$11,143,000 at the product price of \$120 per ton and \$12,402,000 at the product price of \$130 per ton.

Table 1-5 Result of Internal Financial Rate of Return Calculations

Case	Conditions		Result of Calculations
	Sales Price	Others	
Case 1-0	US\$120/t	Profit before tax	15.50%
1-1	120	Profit after tax (5% interest rate)	11.94
1-2	120	Profit after tax (10% interest rate)	13.36
2-0	130	Profit before tax	18.33
2-1	130	Profit after tax (5% interest rate)	13.14
2-2	130	Profit after tax (10% interest)	14.86

Table 1-6 Analysis of Break-even Point by Production Stage

Price (\$/t)	Net Profit (Unit: US\$1,000)		
	1st - 6th Year of Operation	7th - 12th Year of Operation	13th - 23rd Year of Operation
90	Δ 408	Δ 249	Δ 114
100	Δ 282	0	303
110	Δ 156	249	720
120	Δ 30	498	1,137
130	96	747	1,554
140	222	996	1,971

Table 1-7 Value Added Rate (%)

Price	1st - 6th Year of Operation	7th - 12th Year of Operation	13th - 23rd Year of Operation
\$120/t	49	51	54
\$130/t	53	55	57

The level of this project's internal economic rate of return is not necessarily high, but in case the opportunity cost of capital in Guatemala is about 10% or so, this project is judged to be amply adoptable from a comprehensive point of view.

5-4 Overall Evaluation

When Na activation treatment is given, the bentonite mined in Los Cimientos becomes suitable for high value added purposes, since it changes from the H-type to high grade bentonite. This project is very small in scale, and social development accompanying implementation of the project is also very small in scale. But it is financially promising, and it can also be considered promising from the result of economic analysis.

5-5 Overall Measures and Proposals

As a result of undertaking a preliminary feasibility study of the bentonite project, indications that can be considered promising both financially and economically were obtained.

In planning implementation of the project, more practical designs are necessary and detailed surveys for that purpose are also necessary. Surveys that should be undertaken in the future are given below.

- 1) Exploration for deposits
Additional research into the scale and quality of the bentonite deposits.
(Explorations described in Chapter 3, 1, 1-4 1) and 2).)
- 2) Investigation into properties
Analysis of the properties of additional samples.

3) Market research

Detailed survey of bentonite market.

4) Research into investment amounts

Practical designs of the mine and the manufacturing plant,
and actual estimates of equipment and materials procurement
costs.

5) Evaluation of the feasibility study

Financial and economic analyses using the basic data
provided by 1) to 4).