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A Study of the Economic Development  
of  
Minas de Matahambre, S. A.

A Thesis

Submitted to the Faculty of the College of Engineering  
in Candidacy for the Degree of  
Engineer of Mines

by

Dudley D. Homer

1929

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Approved by

Irving Sandorf. Secretary  
Engineering Faculty

Accepted by

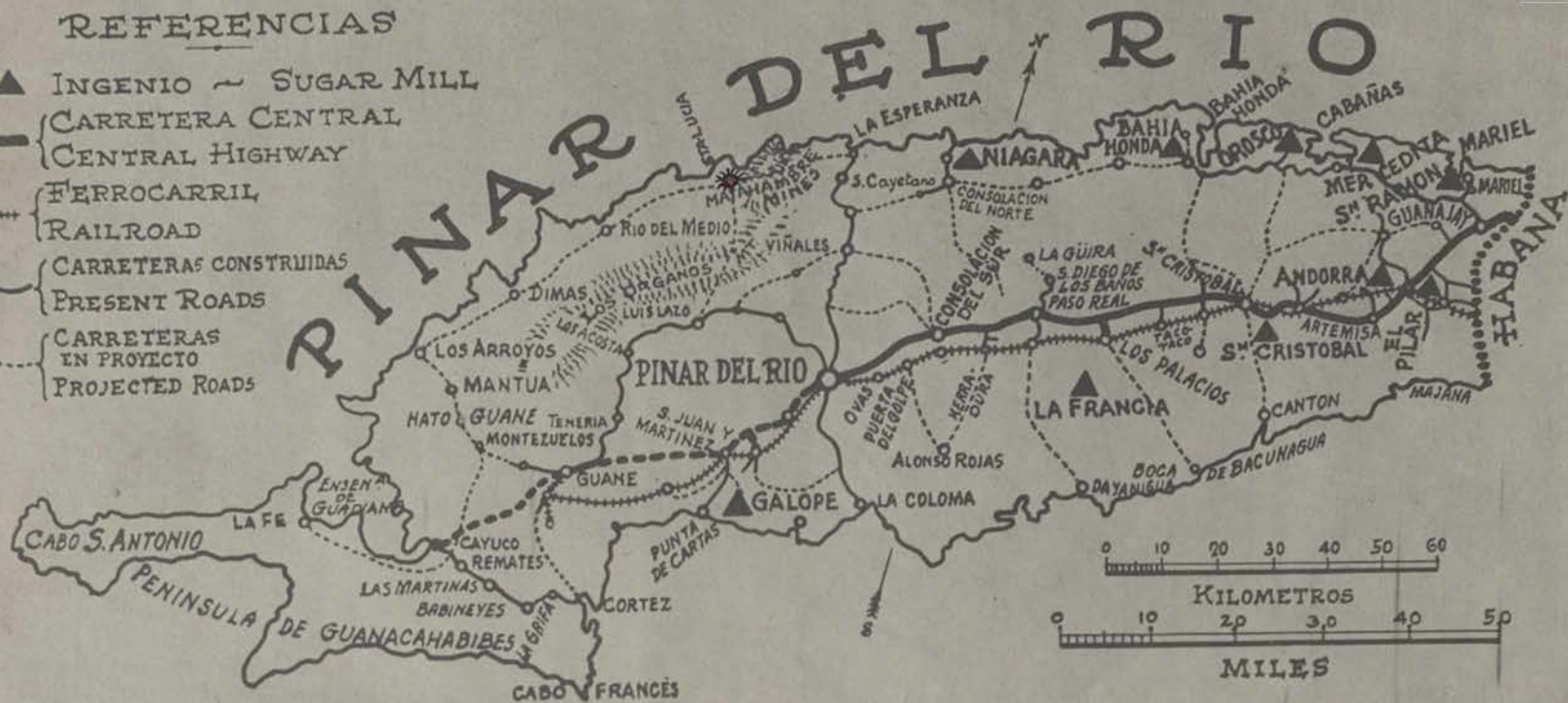
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Graduate Committee

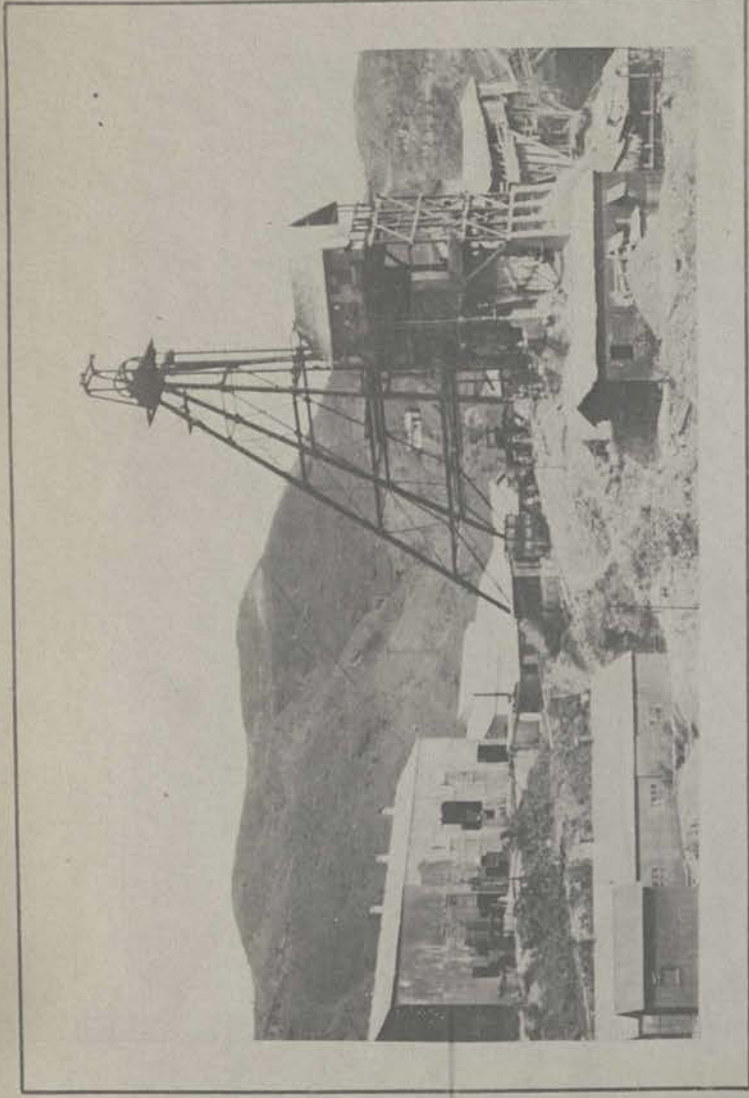
Submitted by

W. D. Homer  
Candidate

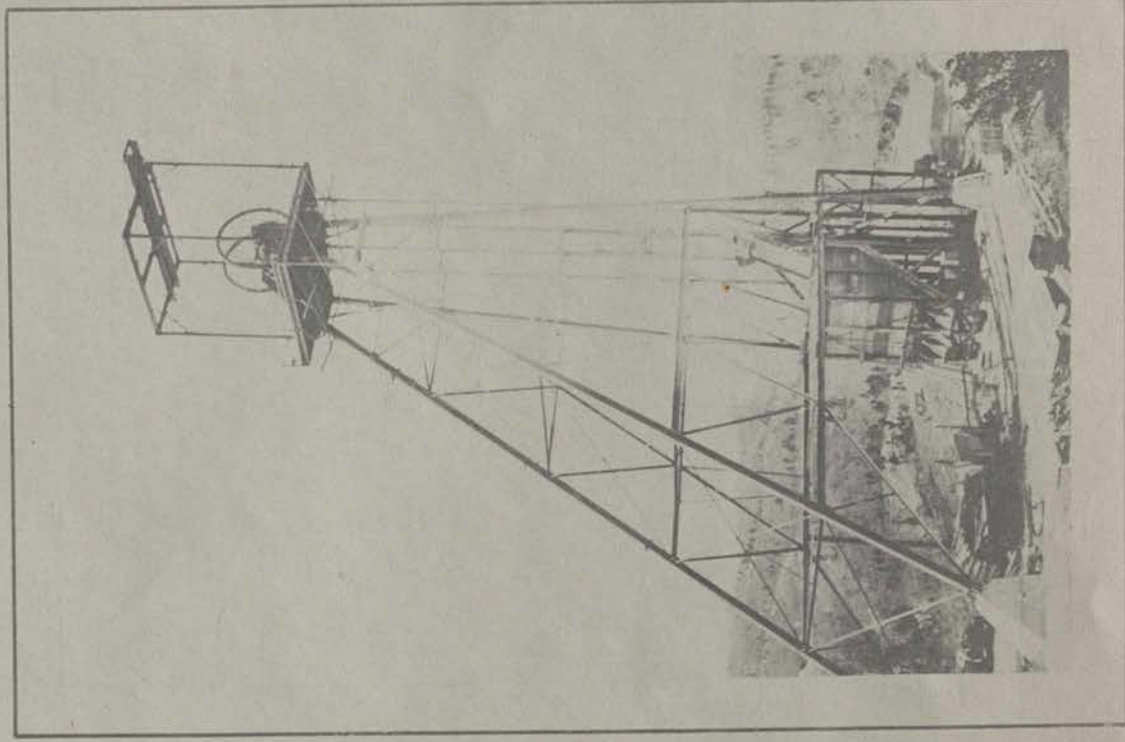
# REFERENCIAS

- ▲ INGENIO ~ SUGAR MILL
- CARRETERA CENTRAL  
CENTRAL HIGHWAY
- FERROCARRIL  
RAILROAD
- CARRETERAS CONSTRUIDAS  
PRESENT ROADS
- - - CARRETERAS EN PROYECTO  
PROJECTED ROADS

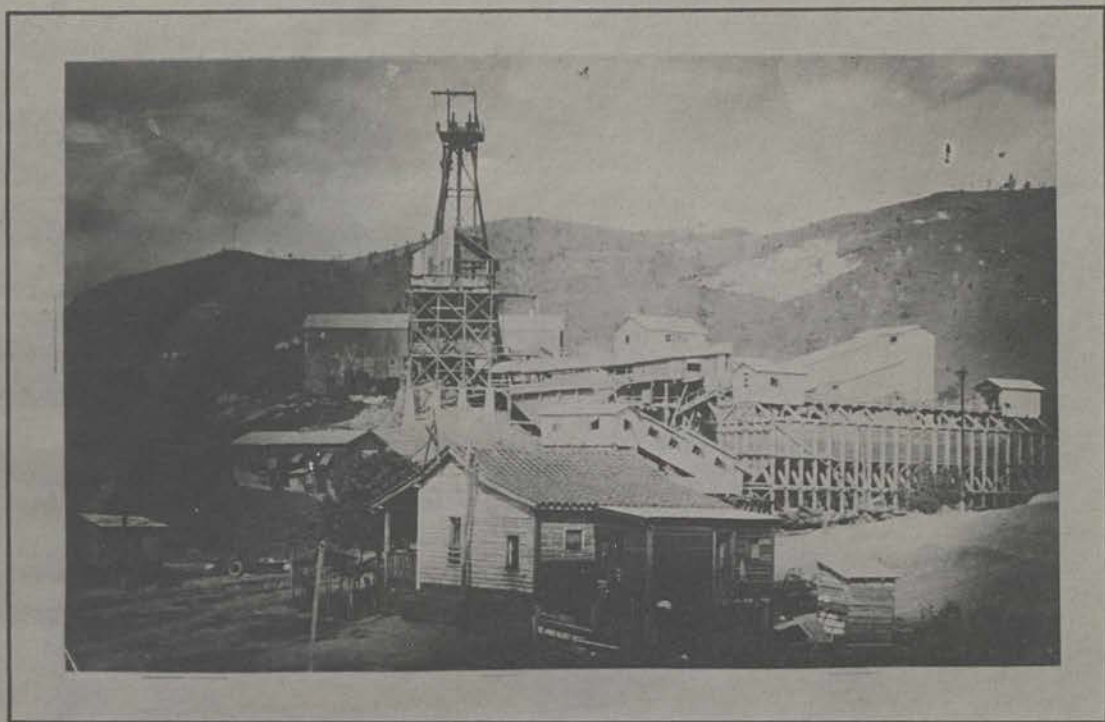




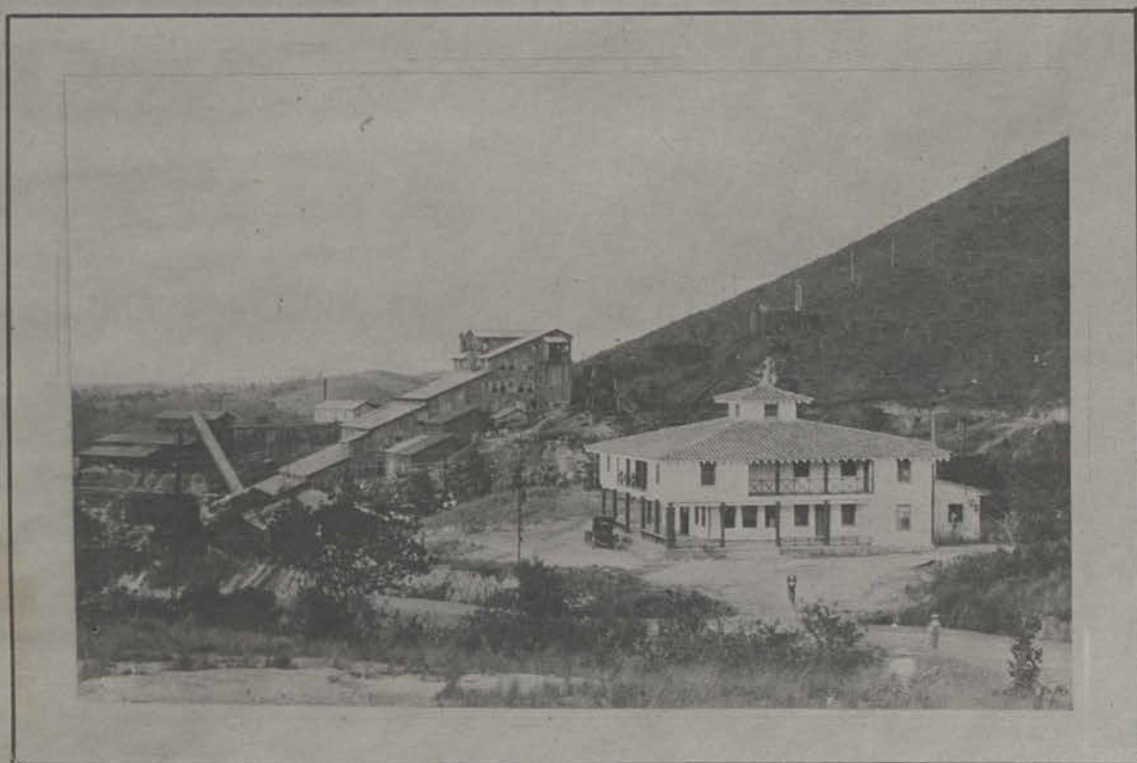
*No. 1 SHAFT AND HOIST HOUSE*



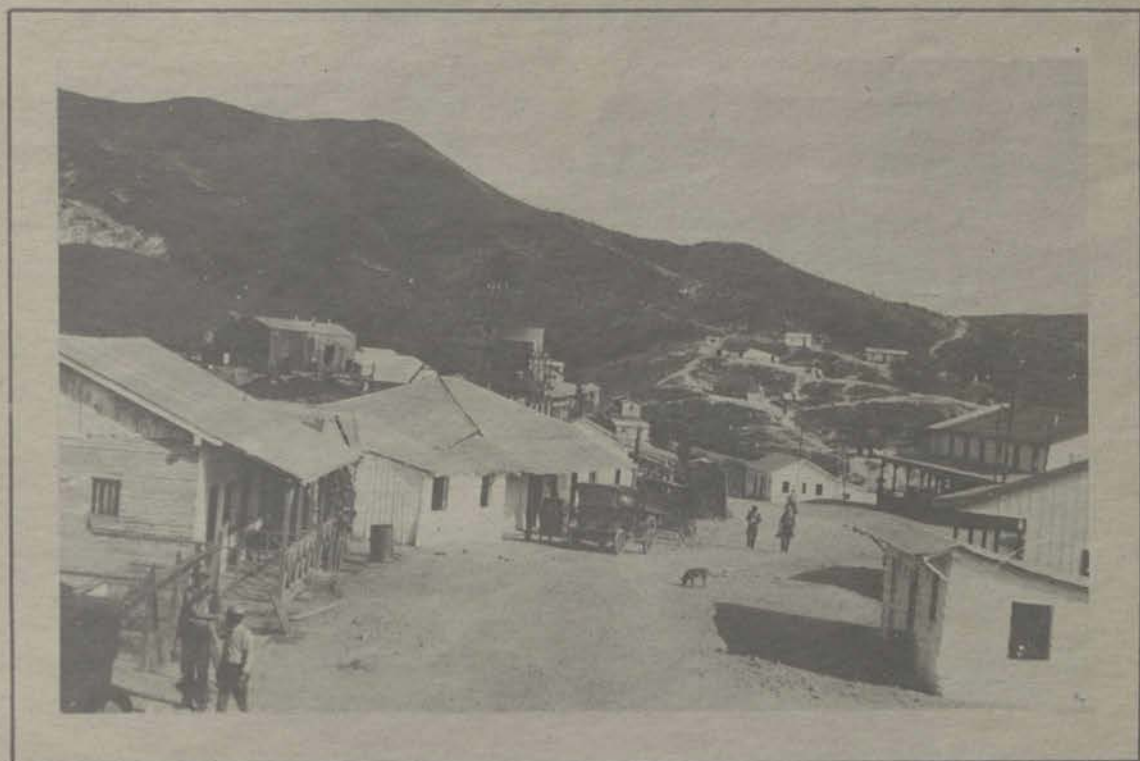
*No. 2 SHAFT - CONTRACTED TO E. J. LONGYEAR AND CO. FOR 2200 FT.*



*NO 1 SHAFT - COARSE CRUSHING PLANT AND 2000 TON ORE BINS*



*CONCENTRATING PLANT - CUBAN CLUB IN FOREGROUND*



*MAIN STREET-MATAHAMBRE-SHOWING TYOI SHAFT IN BACKGROUND*



*PART OF MAIN STREET-MATAHAMBRE*



*POWER PLANT - SANTA LUCIA*



*VIEW OF HARBOR CANAL AT SANTA LUCIA - SHOWING LIGHTERS  
IN FRONT OF CONCENTRATE BINS - BEING LOADED WITH CONCENTRATES*



*MAIN STREET SANTA LUCIA*



*PAITO OIL COMPANY CONCENTRATE BINS AT  
TERAPIWAY SEA PORT TERMINAL SANTA LUCIA*



The Economic Development of Minas de Matahambre

This discussion does not attempt to consider the technical phases of any of the operations except in a very general way, but views the economical results obtained therefrom. Details of the mining, ventilation, drainage, hoisting, ventilation, power plant, and transportation systems are interesting, but are not explained herein.

**The Economic Development**

Minas de Matahambre, S. A., a Cuban Corporation, owns and operates copper mines on the north coast of Cuba, in the Province of Pinar del Rio. The town of Matahambre is located six miles back from the coast. Transportation is effected by means of an aerial tramway from Matahambre to Santa Lucia, Minas de Matahambre, S. A.

**Dudley D. Homer**

**1929**

the coast. Matahambre has a population of 5,000 people, and here are located the mines, concentrating plant, shops, warehouses, and main office. Santa Lucia has a population of 500 people and here are located the power plant, tramway terminal, concentrate bins, docks, and shipping equipment.

The Company operates a steamship under time charter, which makes a round trip each month between Santa Lucia and Carteret, New Jersey, transporting concentrates to the plant of the United States Metals Refining Company, at Carteret, New Jersey, and returning with a cargo of freight and general supplies for the mine.

During the year 1929, Minas de Matahambre mined 335,021 tons of ore and shipped to the miller, 60,500 tons of concentrate and high grade ore from which were recovered 36,500,000 pounds of refined copper.

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The Economic Development of Minas de Matahambre

This discussion does not attempt to consider the technical phases of any of the operations except in a very general way, but views the economical results obtained therefrom. Details of the mining, ventilation, drainage, haulage, metallurgy, power plant, and transportation systems are interesting, but are not emphasized herein.

Minas de Matahambre, S. A., a Cuban Corporation, owns and operates copper mines on the north coast of Cuba, in the Province of Pinar del Rio. The town of Matahambre is located six miles back from the coast. Transportation is effected by means of an aerial tramway from Matahambre to Santa Lucia, the seaport. Matahambre has a population of 3,000 people, and here are located the mines, concentrating plant, shops, warehouses, and main office. Santa Lucia has a population of 500 people and here are located the power plant, tramway terminal, concentrate bins, docks, and shipping equipment.

The Company operates a steamship under time charter, which makes a round trip each month between Santa Lucia and Carteret, New Jersey, transporting concentrates to the plant of the United States Metals Refining Company, at Carteret, New Jersey, and returning with a cargo of freight and general supplies for the mine.

During the year 1928, Minas de Matahambre mined 369,021 tons of ore and shipped to the smelter, 60,362 tons of concentrates and high grade ore from which were recovered 38,940,970 pounds of refined copper.

Minas de Matahambre commenced operations in 1912 and has operated steadily since that time. In 1921, The American Metal Company, Ltd., acquired an interest in the property and took over the management. Later, The American Metal Company, Ltd. purchased the majority of the stock. A program of construction and improvement was started in June, 1922 and has continued until the present time.

In June, 1922 it was realized that production could not be increased to the extent warranted by developments without a considerable capital expenditure. Although new levels in the mine continued to develop satisfactorily, it was not economical to develop more than three years ore reserve ahead. In 1922 the ore reserves were sufficient for two years. The amount of development work was gradually increased from 600 feet monthly to 2400 feet monthly, and the ore reserves were steadily increased and now a three years reserve is maintained.

Matahambre is the only mine with extensive workings in the province, so there has been no guide to indicate possibilities in depth. Studies and favorable reports regarding extensions laterally and in depth have been made by eminent geologists, but regardless of same, the company adopted a policy confining capital expenditures for improvements to those installations which promised to return the capital invested within from two to three years. This has worked out satisfactorily. Necessary construction has, of course, been completed as rapidly as possible.

The equipment in operation in 1922 permitted a production of from 17,000 to 18,000 tons monthly. No department capacity could be increased without a similar increase in the equipment capacity in every other department. Therefore, it was decided to improve the power plant and transportation system first. This work was started in 1923 and completed in 1924. It was then important and possible to increase the capacity of the mine, the mill, and concentrating plant. To increase the capacity of the mine it was necessary to improve ventilation, increase development work, change from hoisting ore in cars on cages, to skip hoisting and to install electric locomotives and additional cars. Ventilation raises to the surface were driven, doors were installed in various drifts and crosscuts on all the levels to regulate the air currents. Three main exhaust fans of suitable capacity were placed in service. A new compressor of adequate capacity for several years was installed, development work was increased; ore passes and skip pockets were cut on five levels, and electric locomotives and additional cars were put in service on the various levels. The use of machine fill was abandoned. While this work was progressing, a new fine crushing plant was installed, consisting of a fine crusher, rolls, and vibrating screens. This new crushing plant reduced the size of the ball mill feed from two inches to three-eighths inches and thereby increased the capacity of the mill from 600 tons per day to 1200 tons per day. This work was carried on without interrupting regular operations and was completed by the end of 1926.

The town has been equipped with a water system, using a chlorine purifying apparatus, sewerage system, light and power system, and two new schools have been built.

By this time, Matahambre was able to mine at the rate of 30,000 tons monthly, except that a suitable means of filling stopes had not been developed. Fill was obtained from surface glory holes and transferred through raises and crosscuts by hand tramming to the stopes. This surface fill is decomposed shale, the consistency of red clay. In transfer to the stopes it becomes wet and sticky. It is difficult and expensive to handle and generally unsatisfactory. It was not possible to obtain more than sufficient to fill the stopes on a production of 18,000 tons of ore monthly and since all of the stopes must be filled, production was limited to this tonnage.

It was decided to experiment with mill tailings for fill. Sand pumps, a bowl classifier, to remove the colloids, and rubber lined pipe from the classifier to the various levels and stopes were installed. The system works satisfactorily, the sand packs hard in the stopes, and the water drains out in a few minutes. The use of surface fill was abandoned, and in 1927 Matahambre commenced production on a 30,000 ton monthly basis.

Additional labor had gradually been employed by the mine until a condition arose where the housing facilities in the town were inadequate. Furthermore, many of the old wooden houses were badly in need of repair, and some were barely habitable. During the past three years, dwellings for two hundred families have been erected.

The town has been equipped with a water system, using a chlorine purifying apparatus, sewerage system, light and power system, and two new schools have been built.

During the period of expansion, it naturally was desirous to effect every economy possible and Matahambre decided to go into the shipping business, to the extent of engaging a suitable ship under time charter to transport concentrates and ore from its port to the smelter and to return with freight and general supplies required in the business. Prior to this time, various shipping companies had sent ships to the port when necessary and the cargoes had been shipped on a per ton basis.

Operating an ore ship on time charter works very satisfactorily and a substantial saving by this method had been made.

In addition to the saving effected in concentrate freight charges, it has also been possible to have general cargoes of freight purchased in the United States delivered alongside the vessel at the smelter dock and shipped direct to the mine port instead of via Havana. Ocean freight charges from Havana to the mine port are practically the same as ocean freight from New York to Havana.

By Governmental Decree, the mine port at Santa Lucia was established, and is one of the few ports in Cuba permitting the entry of explosives.

In order to give a clearer perception of Matahambre operations, a brief description of the property and various departments is necessary.

tried but were not successful.

Pillars are removed by square setting.

- 6 -  
Crushing, Milling and Concentration

The course and The Mine -ing plant is located at No. 3 shaft.

The ore occurs along fractured zones in shale. These fractures cut across the shale bedding planes both in strike and dip. The mine consists of two sections; namely, Matahambre and Ruiseñor. The Matahambre ore is chalcopryite in shale, and the Ruiseñor ore is chalcopryite and iron pyrite in shale. The No. 1 shaft, which is the main hoisting shaft, has been sunk to the 19th level, which is 1600 feet below the collar. The bulk of the ore hoisted is from the 12th and 13th levels. The levels at present are being spaced 150 feet apart. The pumping equipment is at this shaft, and the amount of water handled amounts to 275 gallons per minute. Ore is hoisted from practically every level, but there are skip pockets on five levels only, the ore being transferred from all other levels to these pockets through ore passes.

The ore zone has been explored for a length of 2500 feet. The largest orebody opened has a length of 400 feet and a width of 30 feet. Fourteen different orebodies are being mined along this zone.

The tonnages of mineable ore varies on different levels. The greatest amount blocked out on any one level is about 460,000 tons.

Practically all stoping is of the flat back cut and fill system, and stopes are closely filled with mill tailings.

The ore has a dip of  $42^{\circ}$ . Other forms of stoping have been tried but were not successful. Timber is used whenever necessary. Pillars are removed by square setting.

### Crushing, Milling and Concentration

#### Crushing

The coarse and fine crushing plant is located at No. 1 shaft. The ore is here reduced from 12" size to 3/8 inch, and is discharged into a 2,000 ton bottom discharge storage bin. From this bin the ore is transported to the mill and concentrating plant bins by aerial tramway. The bins at the mill have a capacity of 2,000 tons and feed direct to the coarse mills. By coarse and fine grinding in stages, the ore particles are reduced so that about 15% remains on 48 mesh and 17% on 65 mesh.

In concentration, tables and flotations were formerly used, but due to recent changes in chemicals employed, it has been possible to discard the tables and concentration is now all flotation. Extraction has been improved, and concentrates now average 30% copper and tailings average .18% copper. In view of the fact that the ore is chalcopyrite, this grade of concentrate is rather remarkable.

#### Transportation to Seaport

The concentrates are discharged from the filters with about 8% moisture, on to a conveyor belt and thence to a tramway terminal bin. This tramway is aerial and 30,000 feet long. It connects with terminal bins of 10,000 tons capacity at the seaport of Santa Lucia. These bins are flat bottom and equipped with overhead bridge crane and clamshell buckets. The bin is constructed at the edge of the harbor canal. Lighters are towed to the front of the bins and loaded with concentrates by the crane.



Ocean Freight

At the port of Santa Lucia, Matabanco maintains one steam tug, and two 5,000 ton steamers makes regular runs between the port of Santa Lucia and Carteret, New Jersey. The lighters, loaded with ore, are towed out to the ship by tugs belonging to the company and the concentrates are loaded into the ship by means of clamshell buckets operated by the ship's booms and winches.

Power Plant

The power plant is located at Santa Lucia. Yard space is provided for 7,000 tons of coal, handled by an electric locomotive crane and the fuel oil tanks have a capacity of 400,000 gallons. The boilers are equipped to burn either coal or oil as the market varies. The plant is equipped with coal pulverizers and was the first in Cuba to use pulverized coal.

The power plant has installed 2000 boiler horsepower and 4000 kilowatts in steam turbines and generators. The power plant generates 1,400,000 kilowatt hours monthly at a cost of .8¢ per K.W.H.

When construction on this new plant was started, power was costing 3.5¢ per K.W.H. Most of the old equipment has been discarded. The new plant has effected a saving of 2.7¢ per K.W.H.

The power is transmitted at 11,000 volts over a transmission line 30,000 feet long to Matabanco, where it is stepped down to suitable voltages and transmitted to the various departments. During the construction of the new power plant, the main transmission line was rewired to carry the present load.

Shipping Equipment

At the port of Santa Lucia, Matahambre maintains one steam tug, and two tugs equipped with internal combustion engines; twelve lighters, with a total capacity of 1500 tons, a bucket dredge and small dry dock. About 6000 tons of cargo are handled each month.

With the exception of plans for mining at greater depths, a shaft for which is now being sunk, the original construction program is practically completed.

The construction completed, new installations, and operating improvements made, together with results obtained therefrom are detailed below:

Power Plant

- 2000 Horsepower Boiler Capacity Installed
- 3000 K.W. Steam Turbine and Generator Capacity Installed
- Coal Pulverizing Plant
- New Six Mile Transmission Line
- Six Mile Aerial Tramway - Capacity 30 tons per hour
- Terminal Bins - Capacity 10,000 tons
- Operation of Ocean Freighters on Time Charter.

Crushing, Milling, and Concentrating Plant

- Secondary Crusher Rolls and Vibrating Screens Installed in Crushing Plant.
- Total Costs Per Ton (inclusive of development and prospecting) reduced 30%.
- Grade of Concentrates Increased from 15% to 20% Copper.

Grinding loss was 10% from 25% to 35% Copper

Present Average Recovery of Copper Content obtained in Concentration Plant - 46.3%

Crushing, Milling, and Concentrating Plant  
(Continued)

Change in Reagents in Flotation Plant.

Change from Combination Gravity Concentration and Flotation to All Flotation in Concentrator.

MINE

3600 Cubic Foot Compressor Installed.

Additional Drilling Equipment "

3.5 Ton Skips "

Electric Underground Haulage "

Additional Tramping Equipment "

General

Changed from 10 Hour Day to 8 Hour Day. Average day's pay of all employees increased 20%.

Living Quarters for 200 Families Constructed.

Two New Schoolhouses Constructed.

Town Water System with Filters and Chlorine Pumping Equipment Installed.

Town Lighting and Telephone System Installed

Town Sewage System "

The results obtained from these improvements are as follows:

Tons Mined and Treated Increased 72%

Total Costs Per Ton (exclusive of development and prospecting) reduced 30%.

Grade of Concentrates Increased from 25% to 30% Copper.

Tailing loss reduced from .25% to .18% Copper.

Present Average Recovery of Copper Content effected  
in Concentration Plant - 96.36%

During the period from June 1922 to January 1929,  
approximately \$1,500,000 have been spent on  
Construction and Improvements.

Total combined economies affected based on 1928 tonnage  
amount to over \$2.00 per ton, or about \$750,000 per year.

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No efficiency campaign has been attempted, other than to engage  
competent executives and to maintain a democratic community. Mistakes  
have been made, but the general policy has been successful.

The Board of Directors has been active in its support and unanimous  
in approval of all changes made.

The organization is as follows:

Board of Directors

Otto Sussman	-	President
Claudio G. Mendoza	-	Vice President
César Salaya	-	Vice President
D. D. Homer	-	Treasurer
Ernesto Romagosa		
Fernando Mendoza		
José E. Gorriñ	-	Secretary and Attorney

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D. D. Homer	-	General Manager
R. H. Cromwell	-	Asst. General Manager
G. H. Applegate	-	Chief Accountant
E. B. Butts	-	Mine Superintendent
J. W. Barker	-	Asst. Mine Superintendent
G. L. Richert	-	Chief Engineer
W. S. Holdrum	-	Master Mechanic
J. G. Johnson	-	Power Plant Superintendent
E. F. Bradley	-	Chief Electrician
R. A. Landells	-	Port Superintendent
H. L. Brown	-	Consulting Engineer
A. Kallmeyer	-	Comptroller