REPORT
of the
COMMISSION ON TAXATION AND PRODUCTION OF IRON ORE AND OTHER MINERALS

Submitted to

THE MINNESOTA LEGISLATURE

1969

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State of Minnesota

Members of the Senate
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C. J. BENSON
NORMAN W. HANSON
RUDOLPH HANSON
HAROLD KALINA
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COMMISSION ON TAXATION AND PRODUCTION OF IRON ORE AND OTHER MINERALS

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RICHARD W. O'DEA

TO THE MEMBERS OF THE 1969 LEGISLATURE

Gentlemen:

In accordance with Minnesota Statutes 1967, Section 3.923, the following report is hereby submitted to the members of the Legislature of the State of Minnesota.

Respectfully submitted,

Alfred E. France

ALFRED E. FRANCE
Secretary

AEF:vc

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THOMPSON INSPECTION

In October of 1967, Commission members Salisbury Adams, Ernest A. Anderson, Jack Fena, Alfred E. France, Stanley J. Fudro, Norman Hanson, and Harold Kalina, along with the Commissioner of Conservation and other administrative representatives, flew to Thompson, Manitoba, to inspect the International Nickel Company nickel mine and smelter which the company has constructed.

The Thompson project, located in the remote wilderness of Northeastern Manitoba, was undertaken by International Nickel Co. in 1956 and brought into production in March of 1961. The investment in the plant and related facilities totalled $140 million initially. The company also contracted for the construction of the Thompson townsite which now has a population of more than 18 thousand people.

Currently an expansion project is underway and total investment in the Thompson mine and facilities will amount to $300 million, providing the operation with an annual capacity of 170 million pounds of nickel. The Thompson operation derives its crude material from five separate ore bodies, with some of the sulfides averaging at the high level of 2½% nickel.

The Thompson concentrator can handle 6,500 tons of crude material per day. A nickel concentrate is produced and refined at Thompson while derivative copper and cobalt concentrates are shipped by rail to the company's Copper Cliffs plant in Southeastern Ontario. The nickel concentrate is conveyed to the Thompson smelter and after preheating to eliminate the sulfur, it is moved to electric furnances which melt the nickel concentrate. The molten nickel then goes to a converter which produces a nickel matte which is then reheated in a converter which drives off an iron silicate slag. The slag contains about 39% iron which is not recovered for any commercial purposes, at this time.

The nickel matte is then ready for refining. The matte is taken from a holding furnace and poured into anode ingots. The anode ingots are lowered into electrolytic cells containing a solution which is of a weak acid nature. The cathodes in the electrolytic cells are composed of stainless steel, which

attracts the nickel. Throughout the process there is no attempt made to recover either the iron or the sulfur.

Members of the Commission were particularly interested in the company's efforts to control its plant effluent as it affected water and air quality in the region. In striking contrast to conditions at Sudbury, Ontario, the immediate and adjacent landscape showed no evidence of damage to flora as a result of sulfur deposition. Located within an area of 80 X 88 miles are twenty-one sulfer dioxide testing stations which provide readings of air quality. There have been no reports of any damage resulting from excessive concentrations of sulfur dioxide in the air.

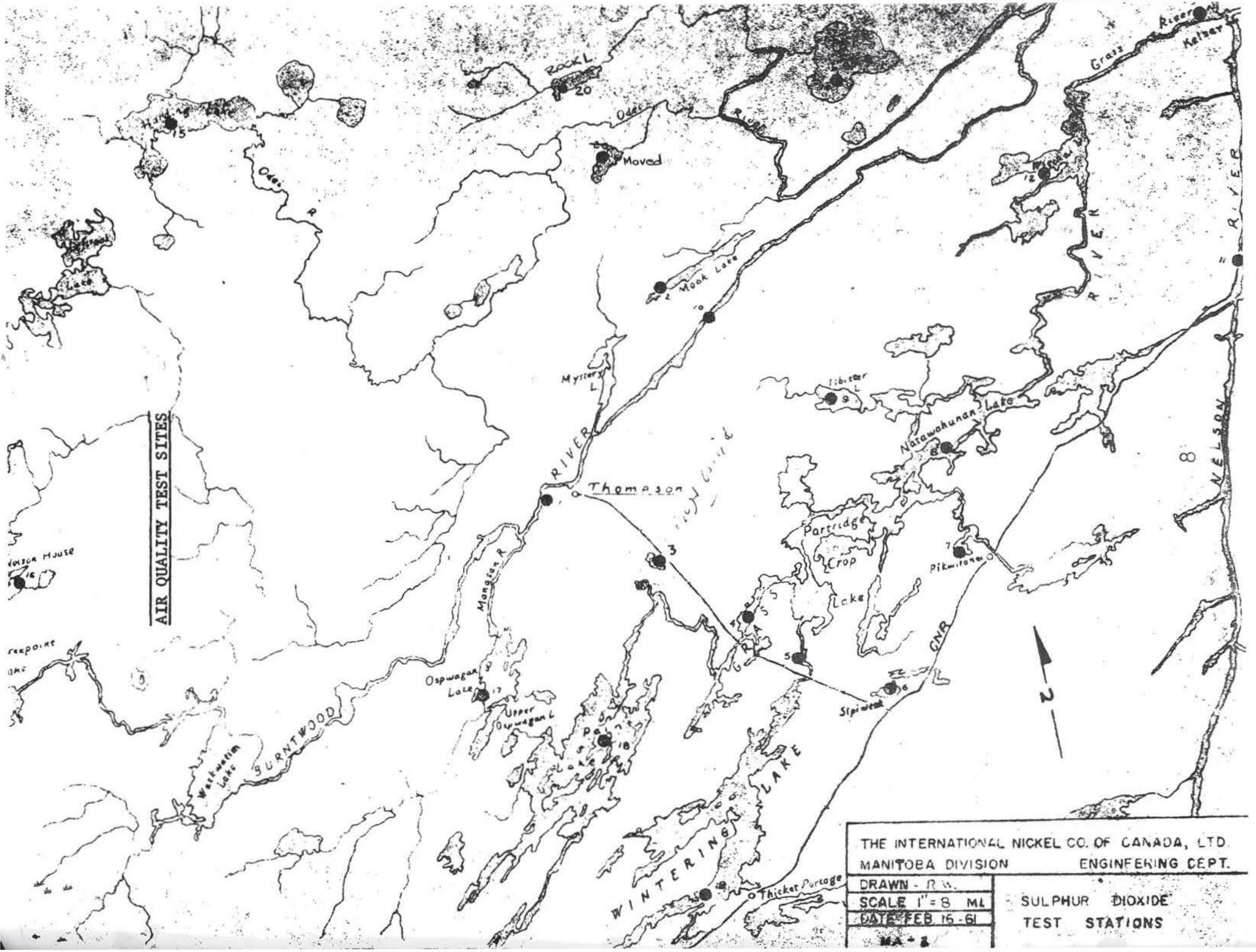
The company also maintains 43 water testing sites in a one hundred mile area centering on the Thompson operation. To date there has been no discernible evidence of water pollution resulting from the mining, smelting or refining operation. In talking with INCO officials it was made clear to the Commission members that the company is highly aware of the need to maintain a high quality environment and to prevent any degree of air and water pollution.

COPPER-NICKEL EXPLORATION ACTIVITIES IN MINNESOTA

Following the granting of exploration leases from the Conservation Department, several mining and resource companies undertook exploration activities in Northeastern Minnesota in the summer of 1967. Prominent among these companies was International Nickel Co., which drove an exploration shaft into a mineralized area south of Ely in the South Kawishiwi River Region. The purpose of this project was to produce sufficient crude material to conduct concentrating tests at the company's research facilities in Canada. The shaft was capped late in 1968 and, to date, research tests are still underway. Preliminary reports indicate that the crude material is of such low grade that it will require new concentrating technology if successful commercial mining and concentrating operation is to be undertaken.

In the meantime, exploration activities conducted by other companies continue and additional exploration leases have been granted by the Conservation Department for exploration work in an area west of International Falls.

While Minnesota does have substantial deposits of low grade copper and nickel in association and while the Duluth Gabbro Mineral Formation has the potential of massive sulfide deposits, there is not yet evidence which points to the likelihood of a significant copper-nickel mining operation in the immediate future.



THE INTERNATIONAL NICKEL CO. OF CANADA, LTD.	
MANITOBA DIVISION — ENGINEERING DEPT.	
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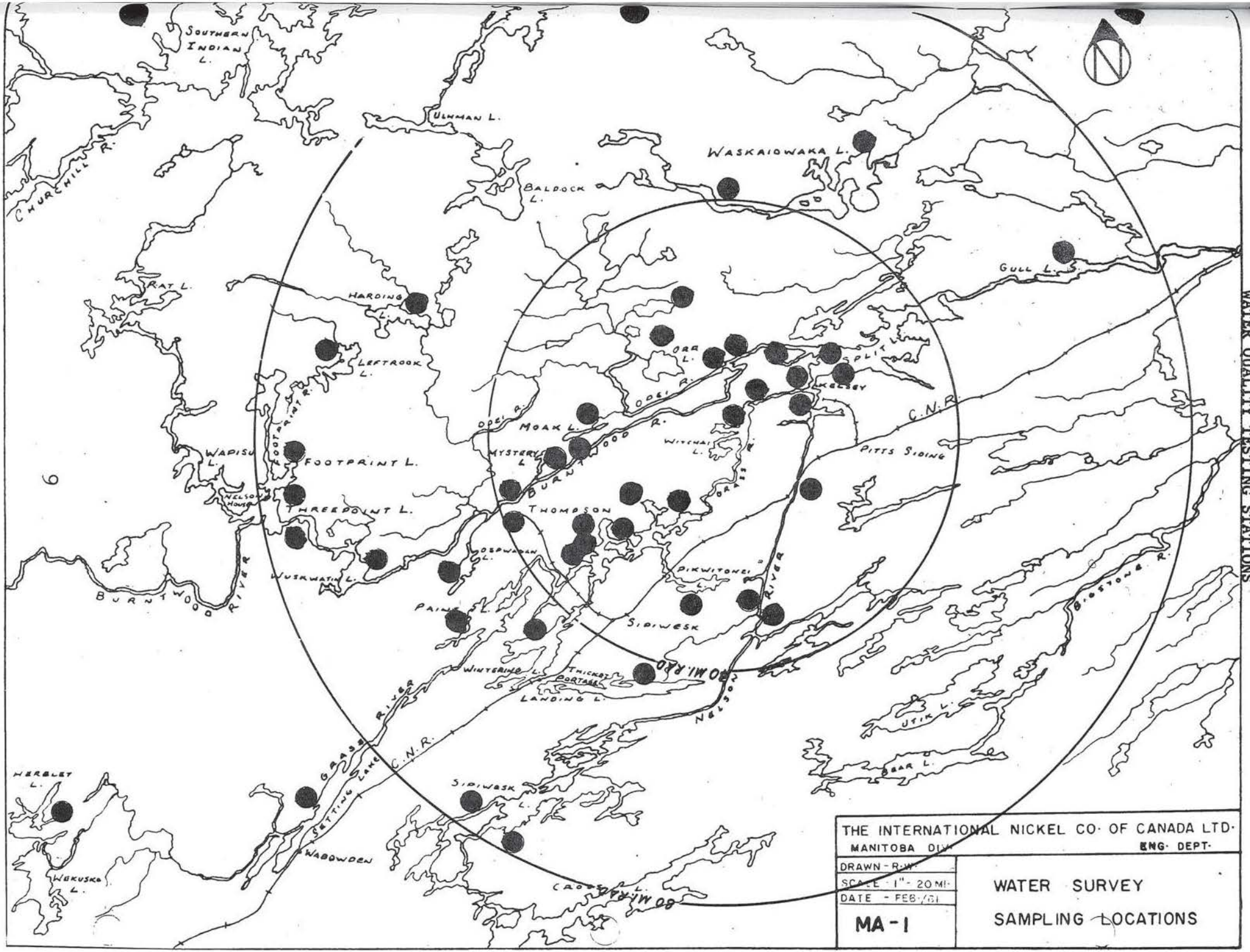

THE INTERNATIONAL NICKEL CO. OF CANADA LTD.
MANITOBA DIV. ENG. DEPT.

DRAWN - R.W.
SCALE - 1" - 20 MI.
DATE - FEB. '61

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WATER SURVEY
SAMPLING LOCATIONS

WATER QUALITY TESTING STATIONS

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Foreward

In January and February of 1968, a four-member subcommittee of the Legislative Commission on Taxation and Production of Iron Ore and Other Minerals embarked on an 18-day fact finding tour to five South American countries: Argentina, Brazil, Chile, Peru and Venezuela.

The purpose of this trip was to obtain first hand information about South American iron ore producers, rates of taxation on mining companies and to study the effect of South American iron ores on markets for Minnesota ores. In each country, Commission members visited with key executives of local mining companies and government officials responsible for regulating mining operations. (The attached bibliography of interviews lists the individuals visited by the Commission members.)

Commission members also visited the production and port facilities of the four largest South American iron ore exporters. These are: Orinoco Mining Company in Venezuela, Cia. Vale do Rio Doce in Brazil, Marcona Mining Company in Peru, and Bethlehem Chile Iron Mines Company in Chile.

In addition, Commission members visited the El Teniente copper mine owned by Sociedad Minera El Teniente S. A. in Chile. With several large companies investigating Minnesota's copper-nickel deposits, the visit to El Teniente - the world's largest underground copper mine - served to acquaint Commission members with some of the problems and operations of the copper mining industry. Chile is rapidly expanding its copper production and will soon be the free world's second largest producer of copper. Thus, the Chilean copper industry plays a major role in determining the future supply and price of copper.

The Commission members were warmly received by business and government officials in the five South American countries and the problems and future of iron ore production were discussed freely.

The following report summarizes the information obtained by the subcommittee during its tour of South American iron ore and copper mines and conversations with businessmen and government officials.

BIBLIOGRAPHY OF INTERVIEWS

PERU

January 29, trip to Marcona Mining Co., San Juan
- N. F. Crossley, Vice President & Resident Manager
- Carlos S. Delta, Public Relations
- Dr. A. W. Ruff, Operations Manager
- R. I. Salberg, Operations Assistant
- D. W. Middleton, General Superintendent-Production

January 30, interviews in Lima
- Clinton Miller, Resident Manager, Compania Minerales Santander, Inc. Subsidiary of St. Josephs Lead Co.
- Alberto Benavides, Presidente, Cerro de Pasco del Peru
- Dr. A. Garcia Sayan, Director, Cerro Corporation, New York and Legal Counsel, Cerro de Pasco del Peru
- Andres Bravo, Director of Mining, Ministry of Development, Peruvian Government
- Victor Salas Melendez, Secretary of Defense, Confederation De Trabajodores del Peru
- Thomas J. Roesch, Second Secretary, United States Embassy

CHILE

February 1, trip to Bethlehem Chile Iron Mines Co., La Serena
- J. D. Kerr, Assistant Vice President, Marine Div. Bethlehem Steel Corp.
- Francisco Alvorez, Legal Counsel
- Edward Stefanic, General Superintendent
- John Johnson, Assistant Manager of Operations
- Alexander Layton, Mine Superintendent
- Carlos Krassa, Maintenance Superintendent
- Archie Henderson, Port Superintendent

February 2, interviews in Santiago
- Hon. Edward M. Korry, United States Ambassador to Chile
- Lester Spielman, Labor Attache, United States Embassy
- Kenneth A. Guenther, Second Secretary, United States Embassy
- Richard C. Sims, Vice President Chile Exploration Co.
  Vice President, Andes Copper Mining Co.
  President, Exotica Mining Co.
- Alejandro J. Hales, Minister of Mines, Chilian Government
- Robert Haldeman, Executive Vice President, Sociedad Minera El Teniente S.A. (formerly Braden Copper Co.)
- Carlos Aracena, Manager, Public Relations
- Edwin Anderson, Deputy Director, U. S. Economic Missions
- Juan Edwardo Correa, Consulting Engineer and Mineral Development

Bibliography, cont.

February 3, trip to El Teniente Mine
Vyron Grant, Vice President, Sociedad Minera El Teniente S.A., Coya
Elbert W. Jeffers, General Superintendent of Operations, Sociedad Minera El Teniente S.A., Sewell

ARGENTINA
February 5, interviews in Buenos Aires
Belmont F. Haydel Jr. Commercial Officer, United States Embassy
Ing. Juan Tibaud, Undersecretary, Secretaria de Energia y Mineria Argentine Government
Dr. Edgardo A. Menoya, Executive Director, Intituto National De Geologia y Mineria
Wing Lew, Executive Vice President, Compania Minera Aguilar S.A., Subsidiary of St. Joseph Lead Co.

BRAZIL
February 7
Max White, Chief of Party, U.S. Geological Survey (attached to U.S. AID Mission)
Dr. H. H. Gusmao, Director, Industria e Comercia de Minerios S.A. (ICOMI)
E. B. Kihl, Companhia Auxiliar de Empresas de Mineracao (CAEMI)
Paulo Amelio Do Nascimento Silva, Sales Superintendent, Mineracoes Braxileiras Reunidas S.A. (MBR)
F. Wiczorek, (MBR)
Dr. B. Litzinger, (MBR)
Dr. M. S. P. Pou, (MBR)
Alfred Leslie Ransome, Minerals Attache, United States Embassy
Emilio Jacques ce Moraes, Cia. Vale do Rio Doce, (CVRD)

February 8, trip to Cia, Vale do Rio Doce at Tubarao
Dr. Duarte F. Aquina, Eng. Assessor
Dr. Luir F. Leitao
Dr. Juberto Daniel
Dr. Tadeu Plazzi
E. F. Norman, Project Manager Arthur G. McKee & Co.
H. W. H. Casperd, Vice President, Foundation of Canada Engineering Corporation Limited.

VENEZUELA
February 10, trip to Orinoco Mining Company, Cerro Bolivar
Carl G. Hogberg, President
Joseph F. McEvoy, Director of Public Relations
Luis H. Viteri, Assistant Director of Public Relations
Ralph J. Denney, General Superintendent of Taxes
Charles W. Morris, Comptroller
Rudy Fimbres, Mines and Petroleum Officer, United States Embassy

P E R U

In Peru members of the Commission visited the mines, plants, port facilities and town developed by Marcona Mining Company at San Juan and San Nicolas. They also called upon the following businessmen, labor leaders, and government officials in Lima;

N. F. Crossley, Vice President & Resident Manager, Marcona Mining Company
Clinton Miller, Managing Director, Compania Minerales Santander, Inc. Subsidiary of St. Josephs Lead Co.
Alberto Benavides, Presidente, Cerro de Pasco del Peru
Dr. A. Garcia Sayan, Director, Cerro Corporation, New York and Legal Counsel, Cerro de Pasco del Peru
Andres Bravo, Director of Mining, Ministry of Development, Peruvian Government
Victor Salas Melendez, Secretary of Defense, Confederation De Trabajodores del Peru
Thomas J. Roesch, Second Secretary, United States Embassy

The information gained in these visits and conversations is presented below.

GENERAL INFORMATION

Agriculture is Peru's primary industry, providing about 37 percent of the Republic's national income. This is followed by natural resources, which provide about 13 percent. Mineral industries generate about $400 million in foreign exchange each year with all other exports creating an additional $400 million. Copper and associated base minerals are the most important segment of Peru's mineral industry. Production and export of iron ore follow.

Two companies produce all of Peru's iron ore. They are Marcona Mining Company and Pan American Commodities S. A. Marcona is the largest of the two, with 1967 shipments of about 7.5 million tons.

MINERAL TAXATION

Land Rents. Under Spanish law, which Peru follows, subsurface rights are owned by the government which grants exploration and mining concessions in return for payments known as "land rents."

An exploration concession runs for five years, during which time the holder may conduct exploration for minerals in return for payments of 1.5 Sol (3.8¢) per hectare (approximately 2.5 acres). If production is not begun within five years the concession may be renewed for additional five year periods. Industry officials felt that exploration concessions were easy to obtain.

When exploration has reached the point where development of a mine is justified, a mining concession requiring a higher land rent is granted. Metallic mining concessions (except gold) require an annual payment of 55 Sol ($1.42) per hectare.

Payment of ground rents and income taxes exempt mining companies from all other taxes or charges (national, regional or local) through 1975.

Income Tax. All corporations pay an income tax at the rate of 35 percent of total net income. All foreign owned corporations engaged in mining pay a complimentary tax of 21 percent on the remaining 65 percent of their net income. This averages out to a total rate of 48.65 percent.

In cases where a mining company must build roads and other facilities that benefit the general public as well, the cost may be allowed as a deduction from corporate income taxes. Other tax incentives are granted to firms investing in undeveloped areas of Peru.

Depreciation allowances range from 3 to 20 years and the rates are viewed as reasonable by local businessmen. Recently, the government modified its views on depreciation and now requires that all funds generated by depreciation be invested in new facilities within Peru.

Depletion is allowed at the rate of 15 percent for metallic minerals, but is limited to one third of net income after depreciation. This provision is similar to the limitation imposed by the United States.

Export Tax. Exporters make advance payments on their income taxes through imposition of an "export tax" of 4 percent on the f.o.b. value of the products exported. The first 800,000 Sol of products exported each year are exempt from this duty. Funds collected under the 4 percent tax will be refunded if the income tax due is less than the payments. One source pointed out, however, that getting the refund was a slow process.

Following devaluation of the Sol, an additional export tax of ten percent was imposed on October 1, 1967 and will run for an 18 month period ending March 31, 1969. This tax is being collected now and may be deducted from future taxes. Beginning in 1969, corporations will be allowed to claim 1/8 of the amount paid under the ten percent tax as a credit against taxes to be paid in each year through 1976. At the current time there is no provision for interest to be paid on this amount, so the tax in effect becomes an interest free loan to the government. One official indicated that the government was considering changing the law and issuing interest-bearing bonds that would be exchangeable in payment of income taxes over the eight year period.

The purpose of the tax is to help finance the current heavy expenditures of the government. The rationale for the tax appears to be to capture from the export industries the "windfall profits" that the government feels they are accruing from the devaluation of the Sol.

Several export products are exempt from the tax: including fish meal, sugar, coffee, and other minor agricultural goods and handicraft products. One businessman estimated that imposition of this tax will delay about $750 million of new investment within Peru during the next two years. The tax is already having a most serious effect on the export industry in Peru. While it is the government's intention that this tax be of short duration (18 months), most businessmen were not optimistic that this would be the case.

This tax is expected to yield about $40 million from mining and a like amount from other exports.

Import Duties. Mining companies may import equipment used in the operations of the mine or to improve operations free of duties if items are not produced locally. If these items are produced locally, a stiff duty is applied to the import.

1950 MINING CODE

All mining in Peru is conducted under the 1950 Mining Code which expires in 1975. The Act grants guarantees of equitable treatment to the mining industry including fair taxation and non-discriminatory conversion of foreign currencies. Revision of the Mining Code is being considered by the government. It was indicated that the new code would continue the present two taxes--land rents and income taxes.

A government official indicated that all future mining operations in Peru would operate under contracts with the government spelling out the terms of operation. These contracts would provide for lower taxes during the period when invested capital is being recovered. One copper company now operates under such a contract which provides for lower taxes than paid by other mining companies.

DEVALUATION

In the summer of 1967, Peru devalued the Sol by 43 percent. The current official rate is 38.70 Sol to the dollar. The former rate (which had held since 1959) was 26.82 Sol to the dollar. Devaluation was caused by the rapid rate of internal inflation Peru has experienced--70 percent since 1959. The government had resisted devaluation for some time and this resulted in a more severe devaluation than if action had been taken sooner.

FOREIGN EXCHANGE CONTROLS

Devaluation also forced the establishment of exchange regulations which affects foreign firms operating in Peru. Sales proceeds from all exports must be returned to Peru and converted to Sol so that the Central Bank can rebuild its reserves. Dollars may be reclaimed from the Central Bank to pay for purchases of capital items from overseas. Under the new regulations, foreign-owned companies are not prohibited from remitting dividends to their parent corporations, but government permission must be obtained first.

EMPLOYMENT

Peru has a population of 12,000,000 people. Approximately 4 million of the population are economically active. Mining employment in Peru totals 80,000. Mining activity is divided into four geographic areas: North, Central, Small South and South.

Tin, Copper and Silver are the principal minerals produced by approximately 3,000 miners in the Northern area.

In the Central area, 60,000 miners are employed producing lead, copper, zinc and gold. Cerro de Pasco del Peru is the largest employer in the area with 14,500 employees. Cerro de Pasco also purchases ore from the smaller mining operations and processes it in their concentrator and smelter.

Marcona Mining Company and Pan American Commodities are the major employers in the Small South. Employment in this area is about 3,000.

In the Southern area, Southern Peru Copper is the primary employer along with two smaller Japanese mining companies and Pima Mining Co., near the Peruvian border. About 10,000 are employed in this area.

WAGES

Average wages for miners in the various areas are as follows:

North	60 Sol ($1.55) per day
Central	99 Sol ($2.55) per day
Small South	145 Sol ($3.74) per day
South	136 Sol ($3.50) per day

Average wages in the North and Central areas are lower because most of the operating mines are older underground properties. Wages in the Small South, where Marcona Mining Co. and South American Commodities are located, appear to be the highest for any miners in Peru.

FRINGE BENEFITS

Mining companies are required by law to provide the following fringe benefits: free housing, education, hospitalization, medical and dental care and work uniforms. Minimum standards for housing have been established by the government. All the larger mining companies have agreed to build a certain number of new homes each year to upgrade employee housing. Three years ago, Marcona Mining agreed to upgrade the quality of its housing. (A Marcona official indicated they are spending two million dollars a year on new housing under this agreement).

After 30 years of service the employee is entitled to retire and receive a pension equal to his salary for the rest of his life. Severence pay equals one month's pay for each year of service with the company. After ten years service an employee cannot be discharged except for acts which are very serious. In effect, after ten years an employee becomes "fire proof."

Marcona Mining Company
San Juan and San Nicolas, Peru

Members of the Commission visited the mine, plants, port and townsites of Marcona Mining on January 29 and were graciously received by company officials. Marcona Mining Company is a wholly-owned subsidiary of Marcona Corporation, which in turn is owned by Utah Construction and Mining Company (50%) and Cyprus Mines Corporation (50%), both of the United States. A description of facilities and operations of Marcona follows:

Location

Marcona's operations are located about 210 miles south of Lima on the coast of Peru in a desert region receiving average rainfall of less than 0.1 inch per year. The mines are located 10 miles inland from the port of San Nicolas on the Marcona Plateau 2,400 feet above sea level. San Juan, the company-built town and site of the initial beneficiation plant and port, is ten miles south of San Nicolas on the coast. The port and plant facilities at San Juan have been closed in favor of a new beneficiation and pelletizing plant and port at San Nicolas.

History of the Marcona Deposit

Iron deposits were first discovered at Marcona in 1906, but all development attempts were unsuccessful until 1952. Much of the initial development work was conducted by the government-owned Peruana del Santa (Santa Corp.) formed to establish a domestic steel industry. In 1952, Santa Corp. signed a contract with Utah Construction and Mining Co. providing that Utah Construction would develop an iron ore mine to provide ore for a steel plant to be built by Santa Corp. at Chimbote in northern Peru. Utah Construction was joined by Cyprus Mines in January, 1953. During a four month period a mine was developed and highways, ore handling facilities and a port were constructed allowing iron ore shipments to begin in May, 1953. Marcona has invested over $110 million dollars in Peru during the first fifteen years of operation. This represents an investment of over $40,000 per employee.

Reserves

The primary ore body is magnetite, thinly covered with sand and located in a zone three miles wide and thirteen miles long. Measured reserves are placed at 343 million tons with additional indicated and inferred reserves of 350 million tons based on development drilling to 500 feet. Exploratory drill holes to a depth of 1200 feet have not pierced the bottoms of the larger ore bodies. Marcona ore varies from 62% Fe, 6% SiO_2 and 0.5% S to 56% Fe, 8% SiO_2 and 2.5% S, dry analysis, but can be up-graded to 68% Fe by beneficiation at San Nicolas.

Mine

Marcona is presently operating five of eleven planned pits, using the most modern and largest equipment viewed by Commission members during the entire trip. Stripping shovels have 15 yd. dippers and production shovels are of 6 yd. capacity. Eighteen 100-ton Lecta Hauls are used primarily for waste removal and nineteen 65-ton Haulpaks are employed in iron production. Marcona has accelerated its stripping programs and will move about 2.5 tons of waste for each ton mined in 1968 compared to 1.05 tons in 1967. Two crusher plants at the mine reduce the ore to minus 4 inches before it is transported to the San Nicolas plant site by a 9.5 mile long conveyor. The final section of this conveyor was placed in operation in June of 1967, eliminating all truck haulage between the mine and the port area. Due to the 1900 ft. drop of the conveyor from the mine to the plant, generator brakes on the downhill sections produce 2300 kw. and the motors in the two level sections consume 1715 kw. leaving a surplus of 585 kw. to be used in other operations.

Plant

Since 1963 a large beneficiation and pelletizing complex has been built at San Nicolas to replace the older facilities at San Juan. Beneficiation processes utilized to upgrade the ore to contract specifications include crushing, screening, jigs, Humphrey spirals, heavy media and magnetic separation. The concentrator contains six grinding lines employing rod and ball mills similar to those used in Minnesota. Two lines are equipped with rod mills measuring 14 x 41 ft., the largest used for iron ore processing in the world. Marcona blends finely ground sand with its iron concentrate to bring the silica content of its pellets to about 4% and reduce iron to about 65.7%. An official explained that this was necessary to eliminate swelling and cracking of the pellets when heated in a blast furnace.

Marcona's pellet plant has an annual capacity of 3.5 million tons and utilizes two pelletizing lines. One is a Lurgi machine, built in 1963, with an annual capacity of 1.25 million tons. The other is a Dravo-Lurgi unit, installed in 1966, with a capacity of 2.25 million tons per year. Bentonite for pelletizing is obtained from a deposit discovered 8 miles east of the mine.

Iron Ore Products

Marcona is currently shipping five different types of products with the following average analysis:

Type of Ore	Size	Iron	Silica
Lump Ore	4" to 8"	65	4
Blast Furnace Ore	¼" to 4"	61-63	4-7
DSO	3/8"	60+	5-7
Sinter Feed	-100 mesh to 3/8"	66-68	2-4
Pellets	3/8 - 5/8"	65.7	4

To meet the requirements of their ore contracts these products are available with differing size, structure and iron content so that about 27 different products are actually shipped. These ores contain some copper and sulfur which detract from the otherwise high quality of the ores. Marcona is planning to install flotation circuits in the near future to remove the iron and copper sulfides from their ores. This will further improve the quality of these ores.

Another future development that will bear watching is Marcona's work with a consuming partner in Japan on shipping iron ore slurry. Present plans call for shipments of a 70 percent iron slurry to begin in 1970. Marcona is working on upgrading its product and a slurry-loading facility is being planned for San Nicolas. The Japanese are designing and building ships to carry the slurry.

Production

Marcona has shipped over 60 million tons of iron ore since production began in 1953. Shipments totaled 7,511,332 tons in 1967 compared with approximately 7,039,000 tons in 1966. Exports in 1967 amounted to 7,411,562 tons, with the remaining 99,770 tons being shipped to Peru's steel plant at Chimbote. Japan is Marcona's largest consumer and purchases are made under long term contracts. Other purchasers, listed in order of importance, include Eastern Germany, United States, Italy, Argentina, France and England. Marcona's U. S. customers are

Bethlehem Steel Corp. at Sparrows Point and Allen Wood Steel Corp. In the past, Marcona has shipped iron ore to the Chicago area and Granite City.

Commission members were informed that Japanese purchasers do not intend to sign any more long term contracts for iron ore. Apparently Japan is going to let the forces of competition determine the price of iron ore. As evidence of this increasing competition, a Marcona official indicated that the price of their pellets had dropped 10 percent during the last 18 months to about 19 cents per unit of iron.

Port

Marcona's 1000 foot pier has a loading capacity of 3,600 tons per hour and the harbor is dredged to 47 feet to allow 100,000 ton vessels to load. Future port improvements will increase loading capacity to 5,000 ton per hour and dredging now underway will deepen harbor channels and berths to accommodate the 200,000 and 250,000 ton vessels that are being designed in Japan. The following table lists the nautical miles from San Nicolas to the principal markets for iron ore:

Table 1

SHIPPING DISTANCES FROM SAN NICOLAS TO

PRINCIPAL MARKETS FOR IRON ORE

Destination	Nautical Miles
Baltimore	3350
Cleveland	5227
Chicago, via Great Lakes	5941
Chicago, via River System*	4282
Mobile	2819
Great Britain--Cardiff	5946
Great Britain--Middlesborough	6575
Northern Europe--Rotterdam	6235
Southern Europe--Genoa	6803
Japan--Moji	9075
Argentina	3800
Peru--Chimbote	500

*Requires trans-shipment at Baton Rouge

Source: American Iron Ore Association

Most of Marcona's ore is carried in ships that are owned or chartered by an affiliate, San Juan Carriers, and it is impossible to obtain accurate costs of transportation to the various iron consuming centers. However, Table 2 contains three freight rates that give an indication of the low costs of ocean transportation.

Table 2

SELECTED FREIGHT RATES FROM SAN NICOLAS FOR IRON ORE

Destination	Rate
Amsterdam	$3.75
U. S. East Coast	1.50
Japan	3.40

Source: Daily Freight Register, June 8, 1967

It costs $1.90 per ton to ship iron ore from Minnesota ports to Chicago or Lake Erie ports, distances of 808 and 850 miles respectively.

Employment

Current employment at Marcona is about 2,700 workers at the mine and plant. Marcona Mining Co. employees are among the highest paid industrial workers in Peru. An electric shovel operator earns about 200 Sol ($5.50) per day, plus fringe benefits. The lowest paid employee earns 139 Sol ($3.60) per day and the average wage is about 155 Sol ($4.00) per day. Employees work six days a week but are paid for seven days work. Fringe benefits include free housing, medical and dental care, hospitalization, education for his children and a 30 day paid vacation. Very few employees, however, take a vacation and instead receive an extra month's pay. Marcona maintains a modern hospital staffed with 19 doctors to care for the workers and their families. San Juan currently has a population of over 14,000. During the past three years, the company has spent $6 million for new employee housing and this year has budgeted an additional $2 million.

Marcona's Contract with Santa Corp.

Marcona does not have a concession to mine iron ore, but operates under terms of a contract with Santa Corp. Santa Corp. -- a government owned corporation -- conducted considerable exploration work in proving the existence of an ore body and, in effect, they are Marcona's fee owner.

Marcona's contract with Santa Corp. expires in 1982 and provides that:

1. Marcona will establish a reserve of 70 million tons of iron ore for Santa Corp.;

2. Marcona will pay a royalty of 25 percent of the difference between production costs and export price, but not less than $.925 per ton; and

3. Marcona will provide iron ore to Santa Corp.'s steel plant at prices equivalent to its production costs.

4. On November 5, 1982, Marcona's iron ore deposits, mining equipment and the facilities at San Juan revert to Santa Corp. In addition, Santa Corp. will acquire a 50 percent interest in the facilities at San Nicolas. Under terms of this contract, Santa Corp. is required to supply a specified amount of iron ore to the San Nicolas plant.

San Juan Carriers, Ltd.

When Marcona began operations in 1953, it was only natural that they should investigate the economies possible through ownership of their own vessels since almost everything used at the plant was brought in by ship and all the iron ore was transported by ship. San Juan Carriers' first vessel, the Harvey S. Mudd (launched in 1956) was the world's largest ore carrier. This ship was followed by more and larger vessels as can be seen by referring to Table 3. At the present time this fleet consists of nine ships with a total dead weight capacity of 549,800 tons. The San Juan Exporter (placed in service early in 1968) is the largest ore carrier afloat, but is to be followed by three 127,500 dwt. vessels designed to carry ore or oil now on order from a Japanese shipyard. In addition, San Juan Carriers charters eleven vessels with total capacity of 621,000 dwt. and it appears that its charter fleet will continue to expand.

Table 3

DEAD WEIGHT TONNAGE OF VESSELS OWNED AND CHARTERED
BY SAN JUAN CARRIERS, LTD., 1968

Owned Vessels		Chartered Vessels	
Name	Tons	Name	Tons
San Juan Exporter	106,000	Shobu Maru	63,000
San Juan Prospector	71,000	Essi Gina	55,000
San Juan Pathfinder	71,000	Shozan Maru	55,000
San Juan Pioneer	71,000	Onomichi Maru	55,000
San Juan Trader	63,000	San Martin Maru	55,000
San Juan Merchant	49,000	Bolivar Maru	55,000
San Juan Traveller	49,000	Theodore	53,000
Harvey S. Mudd	31,400	Barbo	35,000
Allen D. Christensen	31,400	Barvik	35,000
		Phillips Kansas	80,000
		Phillips Louisiana	80,000
	549,800		621,000
TOTAL			

Several of these ships are dual purpose carriers built to carry ore or oil so that back hauls from Asia or Europe can be arranged. The tremendous size of these ships plus their versatility gives Marcona a sizeable advantage in marketing its iron ore.

C H I L E

In Chile members of the commission visited the mine, plant, port and townsite of Bethlehem Chile Iron Mines Co. at La Serena; traveled into the Andes Mountains to vist the mine, concentrator and smelter of the El Teniente Mine now owned by Sociedad Minera El Tenienta S. A.; and called on the following businessmen and government officials in Santiago:

Hon. Edward M. Korry, United States Ambassador to Chile
Lester Spielman, Labor Attache, United States Embassy
Kenneth A. Guenther, Second Secretary, United States Embassy
Richard C. Sims, Vice President, Chile Exploration Company; Vice President, Andes Copper Mining Company; and President, Cia Minera Exotica S. A.
Alejandro J. Hales, Minister of Mines, Clilean Government
Robert Haldeman, Executive Vice President, Sociedad Minera El Teniente S. A. (formerly Braden Copper Company)
Vyron Grant, Vice President Sociedad Minera El Teniente S. A.
Carlos Aracena, Manager, Public Relations
Edwin Anderson, Deputy Director, U. S. Economic Missions
Juan Eduardo Correa, Consulting Engineer and Mineral Development
J. D. Kerr, Assistant Vice President, Marine Division, Bethlehem Steel Corporation
Francisco Alvorez, Legal Counsel, Bethlehem Chile Iron Mines Company

The information gained in these visits and conversations is presented below.

GENERAL INFORMATION

The Republic of Chile lies between the Andes Mountains on the east and the Pacific Ocean on the west. It extends more than 2,600 miles from north to south, but has an average width of only 100 miles. Sixty percent of the nation's 8 million people live in urban areas.

Mining and agriculture are Chile's major economic pursuits, but manufacturing is growing in importance. Almost one-third of Chile's work force of two million is engaged in agriculture, forestry, hunting or fishing, while 17 percent are employed in manufacturing.

Minerals comprise 75 percent of Chile's exports -- the United States being the largest customer. Forty percent of its exports go to the United States while 45 percent of its imports come from the United States. Exports consist of copper, iron ore, nitrate and

agricultural products. Imports consist of machinery, transportation equipment, petroleum products and some food items. Notwithstanding Chile's large agricultural population, the nation is unable to produce enough food to feed its people.

MINERAL TAXATION

Mining Concessions. The Chilean Mining Code reserves to the government the ownership of all minerals regardless of surface ownership. Exploration and development concessions are granted to individuals and corporations in return for payment of a small registration fee equivalent to about ½ cent per hectare per year. Every five years these concessions can be renewed, but at a slightly higher fee. (Alejandre Hales, Minister of Mines, indicated that concession fees should be escalated at a faster rate to force the holders to develop the property or relinquish control).

Corporate Income Tax. Corporations engaged in the business of mining pay a corporate income tax of 25 percent (a base rate of 20 percent, plus a surtax of 25 percent). Chile also imposes a 30 percent tax on dividend remittances. Since almost all after-tax income is remitted in dividends, the effective tax rate is 47.5 percent. In addition, there are various other surcharges ranging from 7½ percent to 25 percent that may be levied at the discretion of the President of the Republic which increase the effective tax rate.

There are also special schedules that apply only to copper mining companies (based on the price of copper) that can boost tax rates as high as 90 percent. However, this can be reduced by credits for increasing copper production.

These provisions give the government a great deal of flexibility in negotiating tax rates with mining companies operating in Chile.

The Chilean corporate tax law makes no provision for depletion on mineral properties. However, depreciation is allowed on fixed assets at the following rates:

Real Estate and Fixed Machinery	1 to 2%
Machinery & Fixtures	5%
Automobiles	10%
Tools & Instruments	15 to 30%
Organizational Expenses	20%

Due to the rapid rate of inflation in Chile (over 20 percent per year) business firms are allowed to increase the value of their assets to help offset the depreciating effect of inflation. Mining officials indicated this revaluation was not large enough to offset all of the loss.

Property Tax. Chile completed a reassessment of real property in 1964 and classified property as either agricultural or non-agricultural. Tax rates vary depending on the location, but range from 2 to 2.5 percent of the property's value.

Import Duties and Taxes. Chile regulates the flow of imports into the country by means of a complex system of tariffs, import surcharges, deposits, and exchange regulations. All but a few necessities pay an ad valorem duty of 30 percent. In addition, machinery for mining is subject to a 1 percent duty if like items are not produced in Chile. Items similar to those produced in Chile may be imported, but are subject to duties that may be as high as 300 percent.

FOREIGN EXCHANGE CONTROLS

Chile's foreign investment law guarantees the corporation's right to remit profits and interest income overseas; and, furthermore, includes the right to repatriate capital in accordance with the provisions of the Supreme Decree approving the investment.

Chile operates under what is known as the "return system", where foreign companies operating in Chile and selling their products abroad are required to return only enough money to cover costs and taxes in Chile. The government guarantees that foreign companies will not be charged discriminatory exchange rates in converting capital to and from local currency.

The Chilean Central Bank follows a regular practice of devaluating the Escudo to offset the effects of rapid internal inflation. During the first two months of 1968, there were four such devaluations.

GOVERNMENT MINING REGULATIONS

Every large mining company in Chile now operates under a contract with the government. This contract spells out the terms for all elements of the mining operation, including tax rates, housing for employees and other important components of the operation. No new mine may be opened or existing mine expanded without such a contract. This system appears to make capital expansion a cumbersome process, but gives the government a great deal of flexibility in guiding mining development.

COPPER INDUSTRY

Copper is Chile's major industry and accounts for 70% of the country's foreign exchange income, provides 15% of all government revenues, and copper mining companies pay 75 to 85% of all corporate taxes. The primary tax on copper companies is the corporate income tax. Thus, the fiscal planning of the government is deeply affected by the price of copper. A sharp rise in copper prices will increase government revenues while, conversely, a decline will cause government revenues to slide.

These factors make copper prices, production and tax rates the concern of almost every Chilean. As a result, the nation's copper resources frequently become major elements of national political campaigns.

Current tax policies in Chile are interwoven with the Chileanization Program instituted by President Eduardo Frei following his election in 1964. During his campaign, Frei was strongly opposed by a candidate supported by a coalition of Communists and Socialists that advocated nationalization of all copper companies in Chile. To counter this challenge, Frei followed a middle-of-the-road policy and advocated Chileanization--a program whereby the government was to take equity interests in the copper company and become stockholders.

This program was instrumental in Frei's election and when he took office the program began to take shape. Negotiations between the two major copper producers--the Anaconda Company and Kennecott Copper Corporation--produced differing results because of the peculiar situations facing each company in Chile. These negotiations led to the Chilean government taking equity interests in two mining companies within the country. In addition, the copper industry agreed to invest over $500 million in new facilities to boost copper production.

Anaconda's negotiations with the Chilean government climaxed in the government acquiring a 25 percent interest in the Cia Minera Exotica S. A. This new mine--adjacent to the Chuquicamata Mine--(presently under development) will represent an investment of $38 million, and is scheduled to be in production by 1971. Anaconda retained its ownership of both Chile Exploration Company (El Salvador Mine) and Andes Copper Mining Company (Chuguicamata Mine), but agreed to plant expansions of 10 percent and 40 percent respectively to increase copper production. Altogether, Anaconda agreed to invest over 200 million dollars in Chile between 1967 and 1972.

Under current agreements with the government, taxes on Anaconda's subsidiaries will drop from about 82 percent to 60 percent for Chile Exploration Company and 50 percent for Andes Copper Mining Company. Following completion of current expansion programs corporate taxes on Chile Exploration Company will be about 52 percent, Andes Copper Mining Company will remain at 50 percent, and Cia Minera Exotica S. A. is expected to pay at rates between 41 and 45 percent.

Kennecott Copper Corp. which owned Braden Copper Company, operator of the El Teniente Mine, was faced with a different situation than Anaconda. Only about 11 percent of Kennecott's total earnings were derived from Chilean copper; whereas it was reported that over 75 percent of Anaconda's profits were derived from Chilean copper. Thus, Kennecott was not as dependent on Chilean earnings as Anaconda.

After considering all the factors involved, Kennecott offered to sell 51 percent of Braden Copper Company to the government for $100 million. A purchase price of $80 million was subsequently agreed upon and Kennecott was issued 15 year bonds in payment for the equity interest. Under the terms of the agreement, the government agreed to reduce the taxes on El Teniente profits from 87 percent to about 60 percent. Thus, Kennecott was able to increase its after-tax earnings from Chile by selling 51 percent of its equity.

When the Chilean government took over, the name of the company was changed to Sociedad Minera El Teniente S. A. and Kennecott Copper Corp. was given contracts to operate the mine and sell its production.

In 1967, as part of the agreement, Sociedad Minera El Teniente embarked on a $230 million expansion program to increase production from 180,000 tons of copper annually to 280,000 tons.

Cerro Corp. and Corporacion del Cobro (Codelco), a government agency, signed an agreement in 1966 for development of the Rio Blanco Mine. Cerro Corp. will own 75 percent of this project and Codelco will own 25 percent. In 1966, total costs of this project were estimated at $89 million. However, Commission members were informed that inflation had pushed costs above estimates and refinancing would be required and had delayed completion of the project.*

*Recent news releases indicate that total costs of the Rio Blanco project have risen to $157 million. Under new financing plans Cerro's interest is reduced to 70 percent and Codelco's increased to 30 percent.

Taxes on this property are expected to be 42 percent, the lowest rate for any mine. This lower tax rate was granted because Rio Blanco is located in a remote area 10,000 feet in the Andes and will have to build its own roads and power facilities.

IRON ORE INDUSTRY

Chile's iron ore industry produced over 12 million tons in 1967. There are 56 mines and deposits in Chile, located in the western part of the Coquimbo and Atacama provinces in the northern part of the country. Many companies and individuals produce iron ore in Chile, but the most important are listed below:

Compania Minera Santa Fe
Compania Acero del Pacifico
Bethlehem Chile Iron Mines Co.
Companie Minera Santa Barbara
Cia. Minera de Atacama

Reserves. Official reserve estimates for Chile are placed at 1.1 billion tons; however, officials indicate that this figure could probably be raised by 30 to 50 percent. The iron content of Chilean ores ranges from 61 to 66 percent with an average of 63.8 percent. The silica content ranges from 3.5 percent in lump ore to a high of 8 percent in fines.

EMPLOYMENT

Wages. As in Peru, Chilean mine workers are among the highest paid employees in the nation. This was strongly emphasized when the Chilean Minister of Mines, Alexandre Hales, pointed out that the average copper miner earns more per year than he himself was paid. A blue-collar mine worker earns monthly take-home pay of about 700 Escudo's ($100) per month. Employees work six days a week. Commission members were informed that fringe benefits amount to about 150 percent of take home pay.

Fringe Benefits. Chilean regulations identify two types of employees, "workers" and "employees." The "worker" corresponds closely to what we know as a blue-collar worker in the United States, and the "employee" to what we call a white-collar worker. Mining companies are required to provide their employees with free housing and subsidize the education of their children. Medical, dental and hospitilization services are provided by the Social Security Service.

Social Security Service contributions amount to 38.25 percent of wages for the employer and 8.85 percent of the wages for employees--a total of 47.1 percent. Private Employees Welfare Fund contributions amount to 41.77 percent for the employer and 12.9 percent for employees--a total of 54.67 percent. A maximum of four months of sick leave must be paid during illness for "employees" and "workers" who have served the same employer for at least one year. Twelve weeks with full pay are allowed for pre-natal and post-natal leave for female workers and employees.

Employees with less than one year of service are granted one week of paid vacation, employees with more than one year of service are granted a two-week paid vacation. As the length of service increases, the amount of vacation increases. For example, an employee with 24 years of service would be eligible for four weeks of paid vacation.

Mining companies are required to contribute 10 percent of their profits for bonuses to "workers" and 20 percent of their profits for bonuses to "employees." The amount of the bonus is based on the wage scale and years of service.

New Housing Policy. Housing accommodations for workers are spelled out in the general development plans for a mining property. Chile will no longer allow mining companies to build camps next to the mine, and several existing camps are being evacuated and new housing built in or near existing communities. Experience has shown that workers that live in established towns are more likely to take an active part in community affairs. As an example, the workers at Chuguicamata are being moved to a new city 35 miles from the mine and will be transported to work on a road in company buses. El Teniente is also abandoning its towns of Sewell and Caletones near the mine and will build a new housing area on the plains near Rancagua.

Labor Movement. All the large mining companies are unionized and the various locals engage in collective bargaining. In other industries, each local must bargain for itself. Chilean labor leaders are not full-time and must take time off from their regular work to conduct union business. As in Peru, the labor unions are action arms of political parties. Commission members were told that politics has an effect on union members, but they will not strike on the basis of politics alone; there must be economic issues attached to make them walk out. Union contracts run for 15 months and strikes are frequent. In the mining unions, retroactive wage settlements are common, and a strike bonus of 100 Escudos is paid at the end of the strike.

MINE INSPECTION TOUR

Bethlehem Chile Iron Mines, Romeral Division
La Serena and Guayacan, Chile

Members of the Commission visited the mine, plant, port and town-site of Bethlehem Chile Iron Mines Co., Romeral Division, on February 1, and were escorted on an extensive tour by company officials. Bethlehem Chile Iron Mines Company is a wholly-owned subsidiary of Bethlehem Steel Corporation. (The company also operates the El Tofo Mine which is considerably smaller than the El Romeral Mine).

Location

The El Romeral mine is 10 miles north of La Serena, which is about 250 miles north of Santiago. The mine and plant are located inland about 10 miles from the ocean and the pit is carved from the side of a small mountain. The port is about 17 miles to the south at Guayacan.

Reserves

El Romeral's reserves are placed at about 112 million tons of magnetite ore. Exploratory drill holes of 700 feet depth have failed to pierce the bottom of the ore body.

Mine and Plant

This property was opened in 1956 with an annual capacity of 3 million tons. In the mine, 6-yard electric shovels load trucks of 65-ton capacity in stripping and 35-ton capacity in iron ore production. Ore from the mine averages 57 percent iron.

The ore is processed in a plant at the mine utilizing crushing, screening, and wet and dry magnetic separation to produce an iron product with the following dry analysis: 63.8% iron; 5.5% silica; and .190-.200% phos. El Romeral ships one product averaging plus ¼ inch to minus 4 inches with an allowable percentage of fines containing about 2.5 percent moisture. The ore is carried to the port by company-owned railroad equipment over a short branch line owned by the company and the national railroad main line.

Port

Iron ore from the railroad cars is conveyed to a stockyard with a capacity of 300,000 tons. The ore is removed from the stockpile by means of a conveyor gallery below the stockpile, transported to the dock and loaded into ships at 4,000 tons per hour. The harbor is dredged to a depth of 47 feet and can accommodate ships of 60,000 ton capacity.

During 1967 El Romeral shipped 2,912,809 tons of iron ore to the following countries:

Japan	1,622,116 tons
Cia. De Acero Del Pacifico (CAP)	737,435 tons
United States	553,186 tons

El Romeral provides iron ore to CAP -- the government owned steel company -- at its cost of production under a contract with the Chilean government.

The following table lists the nautical miles from Guayacan to the principal markets for iron ore.

Table 4

SHIPPING DISTANCES FROM GUAYACAN TO PRINCIPLE MARKETS FOR IRON ORE

Destination	Nautical Miles
Baltimore	4395
Cleveland	6272
Chicago, via Great Lakes	6986
Chicago, via River System*	5152
Mobile	3864
Great Britain--Cardiff	6991
Great Britain--Middlesborough	7444
Northern Europe--Rotterdam	7280
Southern Europe--Genoa	7720
Japan--Moji	9682

*Requires trans-shipment at Baton Rouge.

Source: American Iron Ore Association.

The competitive position of El Romeral's ores has been helped by the increasing size of modern ore carriers. This is illustrated by the following table:

Table 5

SELECTED FREIGHT RATES FROM CHILE
FOR IRON ORE 1954 and 1964

Destination	1954	1964
United States	$ 8.00	$ 3.25
Japan	$16.00	$ 6.25
Europe	$12.00	$ 5.40

Source: American Iron Ore Association

More up-to-date comparisons of freight rates are not available, but one company official indicated that the freight rate from Guayacan to Baltimore was in the area of $2.25 to $2.50 a ton at the present time.

Employment

The El Romeral Mine employs about 1,000 men. The average wage at El Romeral is 15 Escudos ($2.10) per day plus fringe benefits. Commission members were informed fringe benefits average about 70 percent of direct labor costs. The company is required to furnish its employees free housing and have provided three and four bedroom homes for the employees. Employees in company homes get a 30 Escudo allowance per year to maintain the yard and flowers. Those employees not able to live in company homes are given a housing allowance of 120 Escudos per month to cover the cost of renting housing.

Free medical care, hospitilization and drugs are provided for "employees." "Workers" are covered by the National Health Plan.

The Chilean government provides free education through Junior High School, although the company is required to pay a fee of $15 per pupil for the school. High school is not free and the company is required to pay the high school tuition for children of "employees" and "workers."

Expansion Plans

Bethlehem Chile Iron Mine is planning to invest 20 million dollars to expand production at El Romeral to 5 million tons over the next five years. The company is presently negotiating with the Chilean government over the contract terms under which this expansion will take place. At the present time, Bethlehem Chile is operating under

three different contracts and is attempting to get all these contracts combined into one covering existing operations and the expansion. The first contract specified a tax rate of 50 percent on that portion of the investment, the second contract specified a tax rate of 51 percent on that portion of the investment, the third contract specified a tax rate of 57 percent on that portion of the investment. Bethlehem is now attempting to consolidate the various tax rates into one tax rate for the entire property under the new contract.

MINE INSPECTION TOUR

Sociedad Minera El Teniente
Rancagua, Coya, Caletones, and Sewell, Chile

On February 3, members of the Commission visited the mine, plants, and townsites of Sociedad Minera El Tenienta S. A. and were accorded an extensive tour of the company's facilities. Sociedad Minera El Teniente S. A. is owned 51% by the Chilean government and 49% by Braden Copper Company, which is a subsidiary of Kennecott Copper Corporation of the United States. The description of the facilities and operations of El Teniente follow:

History

As a copper producer, El Teniente is older than the Republic of Chile itself. The area encompassing El Teniente has been worked sporadically since 1771 but it was not until 1903 when William Braden, an American mining consultant, took an interest in the property, that it was brought under serious commercial development. Equipment for the first 250 ton per day concentrator was hauled to 7,000 feet in the mountains by ox carts. It was not until 1911 that a narrow gauge railroad was completed from Rancagua -- 46 miles away. In 1909, Guggenheim brothers took control of Braden Copper Company and William Braden retired. Seven years later, control of the company was transferred to Kennecott Copper Corporation which has operated El Teniente since that date.

Mine and Plant

To reach the mine and plant of El Teniente, Commission members rode the company's narrow gauge railroad 46 miles to an elevation of 7,000 feet in the Andes. The railroad is the only form of transportation between the mine and Rancagua. In the mine, block caving is employed in mining and the copper ore is carried from below the mining area to the concentrator through a horizontal drift. El Teniente is the world's largest underground copper mine and contains over 600 miles of shaft, galleries, and ore chutes.

El Teniente's concentrator sprawls across the steep sides of the Andes Mountains and receives copper ore from a haulage drift located below the mining area. The concentrator plant is old and consists of sections that have been added over the years. The concentrating process itself is quite similar to that of taconite, consisting of primary and secondary crushers and ball mills. Copper separation is accomplished by several stages of floatation. Minor amounts of molybdenite concentrate is produced from the ore. The copper concentrate is transported 2,000 feet down the mountain by an aerial tramway to the smelter at Caletones.

At the smelter the concentrate is first passed through a multiple hearth roaster to remove all moisture and then to a reverberatory furnace where it is heated at 1500°C. This operation separates some of the iron and waste material into a slag which is drawn off and discarded. From the reverberatory furnaces the copper is carried in ladles to converters where air is blown through the molten mass and the remaining impurities are oxidized. This stage of the process produces what is known as blister copper which is 99.43 percent pure. The balance of the copper is transferred to another furnace where it is processed to remove the last of the impurities in a process called fire refining. Fire-refined copper is 99.92% pure. A portion of El Teniente's copper is shipped abroad in 320 lbs. slabs as blister copper. In 1967, El Teniente produced a record 203,800 tons of copper.

Near the smelter is a plant capable of manufacturing 85 tons of sulphuric acid daily using sulphur dioxide waste gases from the converters. This plant supplies all of the acid requirements for the mill at Sewell.

The concentrator creates 33,000 tons tailings each day which are transported in water 37 miles down the valley in a flume to the disposal area near Parron. Construction of the flume required building 18 steel and 330 wood bridges. A new precipitation plant has been built at Las Rosas and is now treating the water overflow from the tailings area with carbonate of lime and filtering out 9 tons of copper daily. After treatment by the plant, the water is pure enough to be returned to the river. Water from the river is used for irrigation of crops.

Employment

El Teniente employs almost 9,000 people in its Chilean operations. Of these, less than 100 are foreigners. Free housing is provided for workmen and their families, as are hospital and medical facilities. The company operates nine private schools, while ten government schools and one industrial school also function on the company property.

Thirteen percent of El Teniente's employees have over 20 years of service with the Company.

Company Towns

Sewell, largest of the El Teniente communities, clings to the steep mountainside where stairways replace streets and there are few vehicles. Of its 13,000 inhabitants, about one third are company employees; the remainder are families and the staffs of various stores needed in a complete community.

Another company town is Caletones, site of the smelter. Caletones has a total population of 3,000 of which 900 work at the smelter. The company also has a small community at Coya where El Teniente's hydro-electric facilities are located.

Plant Expansion

Because of the topography at Sewell, the present concentrator cannot be expanded. Therefore, a new mill will be constructed at Colon which will receive ore directly from the mine over a new section of railroad. The expansion will increase El Teniente's annual copper capacity from 180,000 tons to 280,000 tons and will cost $230 million.

As part of the expansion program, the communities of Sewell and Caletones will be abandoned and their residents will be moved to a new residential area on the plains near Rancagua. The workers will be transported to the mine at Colon by buses over a new highway that is now under construction. From Colon an electric railroad will carry the mine workers directly into the mine and to the plant.

A R G E N T I N A

Argentina has no significant iron mining industry and no inspection trips were scneduled, but Commission members did call on the following businessmen and government officials in Buenos Aires:

Ing. Juan Tibaud, Undersecretary, Secretaria de Energia y Mineria, Argentine Government
Dr. Edgardo A. Menoya, Executive Director, Instituto Nacional De Geologia y Mineria
Wing Lew, Executive Vice President, Companie Minera Aguilar S. A., Subsidiary of St. Joseph Lead Co.
Belmont F. Haydel Jr. Commercial Officer, United States Embassy

The information gained in these visits and conversations is presented below.

General Information

South America's second largest country, Argentina, is poorly endowed with minerals but is well known for its production of beef and grain. Although less than 40 percent of Argentina's 20,000,000 people live in farm areas, it exports more beef than any other nation.

Argentina is the leading manufacturing and processing country in South America, but has little heavy industry because it presently lacks adequate supplies of raw materials. Of the mineral resources that it has, few are able to supply all of the country's requirements. Thus, Argentina must import some portion of all its mineral requirements. Salt is the only mineral that is found in large deposits, although Argentina does have small deposits of tungsten, lead, zinc, tin, antimony, copper, silver, gold, iron ore, coal, uranium and petroleum. Although Argentina has small deposits of iron ore, it must import a portion of its requirements for its government owned steel mill.

MINERAL TAXATION

Mineral Concessions. Under the Argentine Code of Mines, minerals belong exclusively to the state. The government grants exploration rights in return for a minimal payment. If mining is to be undertaken, a formal concession must be obtained. Minerals on private properties cannot be mined without a permit.

Income Tax. Argentina's corporate income tax on domestic corporations is 35.31 percent (33 percent flat tax plus a 7 percent emergency tax) and branches of foreign corporations pay a tax of 41.045 percent (a flat tax of 38.36 percent plus a 7 percent emergency tax). In addition, there is an 8 percent tax on all dividend distributions. The emergency tax fluctuates from year to year as is shown by the tax rates for the last few years:

1965	10%
1966	20%
1967	15%
1968	7%

Normal depreciation allowances range from 5 to 20 percent on building, machinery and equipment. New mining investments are encouraged by allowing companies a deduction equal to 10 percent of sales for 15 years from the beginning of extraction. However, the deduction is limited to 50 percent of the net profits.

Argentina has adopted provisions similar to our investment credit and allows mining and manufacturing companies to deduct up to 100 percent of the cost of new investments in machinery, equipment, and from their income. However, the amount of the deduction is limited to 60 percent of the taxable income. Any unused portion may be carried forward for two years. All investments between June 1, 1967 and December 31, 1968 qualify for this deduction.

Additional tax incentives are granted to industries locating in eight northwestern Argentina provinces and in the promotional zones outside of Buenos Aires, Entrerios and San Luis.

Inflation is a perennial problem in Argentina. It was reported that over the last 19 years, inflation has averaged 25 percent per year compounded. As a result of this inflation, the Peso was devalued by 40 percent in March 1967.

Because of this rapid inflation, taxpayers are permitted to write up the value of all assets including land, buildings, machinery and equipment for tax and accounting purposes. The Banco Central de La Republica establishes the amount of the write-up based on price indexes. The amount of the revaluation may be depreciated over a future period of ten years for most equipment and 25 years for buildings. However, companies that revalue must pay a 1.5 percent substitute inheritance tax on the new value of the assets. In addition, a tax is levied on 50 percent of the upward revaluation as follows:

3% up to A$5,000 ($1,430)
5% between A$5,000 and A$1,000,000 ($2,860)
7% between A$1,000,000 and $1,500,000 ($4,290) and
10% over A$1,500,000

This tax is deductible from the income tax and is payable in four annual installments. A 15 percent discount is allowed if the tax is paid in cash immediately.

Sales Tax. Argentina imposes a 10 percent sales tax on the value of a company's mineral production. However, the mining companies have the option of paying the 10 percent tax in cash or giving the government 10 percent of their production in payment of the sales tax. The tax is considered an expense and is deductible in computing the corporate income tax. This tax was 5 percent before it was raised to 10 percent in 1958.

Import Duties

In March 1967, the government reduced import duties on most capital goods from 220 percent to 95 percent. This is expected to encourage new investments in Argentina.

MINERAL INDUSTRY

Argentina is not a wealthy country in terms of mineral resources and, as a result, mining is not well developed. The mining industry represents less than 1½ percent of the country's Gross National Product. With few exceptions, mining and beneficiation activities are carried out by small firms, two national government agencies (Fabricaciones Militares and the Instituto Nacional de Geologia y Mineria) and several provincial government agencies. The only big mine is the Aguilar, operated by a subsidiary of St. Joseph's lead company. By 1970, this mine is scheduled to be expanded by 70 percent.

Iron Mining Industry. There is only one iron mine at the present time -- the Sierra Grande -- located 30 kilometers from the ocean. This property has estimated reserves of 65,000,000 tons of iron ore averaging 57.5% iron, 5.5% silica, and 1.43% phos. This ore could be concentrated and pelletized to produce a 67 to 68 percent pellet with low phos. Eventual production is estimated at about 1,000,000 tons per year. However, the ore body is deep and would have to be mined by underground methods.

A large iron ore deposit, averaging about 35 percent iron, has been discovered in the northwest part of the country. Recently, another reserve averaging about 30 percent iron was discovered in northern Argentina. Both of these reserves are too far inland to be economic at the current time.

Only about 13 percent of Argentina's annual iron ore requirements are produced locally. The rest must be imported. Annual iron ore consumption is about 1.5 million tons. It is estimated, however, that Argentina will consume 5 million tons of iron ore annually by 1974. To fill part of this demand, the government is working to develop the Sierra Grande property.

Argentina has 3 steel plants but only one, Sociedad Mixta Siderurgica Argentina, (Somisa) is of sufficient capacity to be noteworthy -- 850,000,000 tons. This plant is currently being expanded to 1.1 million tons. The complete expansion program including new facilities will involve an investment of $200,000,000 and is expected to be completed by 1973.

Labor

Mining companies are required to provide townsites with free housing, electricity, medical, dental and hospitalization. In addition, they are required to subsidize schools and accept other social obligations. In the last few years, the government has taken a strong posture toward labor and everyone is expected to work an eight-hour day. This is somewhat new in Argentina in that under Peron the government employees used to work 4 or 5 hours a day.

Social Security payments amount to 26 percent of wages (11 percent is deducted from employee wages and the employer contributes 15 percent). In an attempt to control inflation the government is trying to freeze wages. However, a 14 percent increase in wages was allowed in July, 1967. In December, the government reduced the employee old-age contribution from 11 percent to 5 percent.

B R A Z I L

In Brazil members of the Commission visited the plant and port facilities of Cia. Vale do Rio Doce (CVRD) at Tubarao. They also called upon the following businessmen and government officials in Rio de Janeiro:

Max White, Chief of Party, U.S. Geological Survey (attached to U.S. AID Mission)
Dr. H. H. Gusmao, Director, Industria e Comercia de Minerios S.A. (ICOMI)
E. B. Kihl, Companhia Auxiliar de Empresas de Mineracao (CAEMI)
Paulo Amelio Do Nascimento Silva, Sales Superintendent, Mineracoes Braxileiras Reunidas S. A. (MBR)
F. Wiczorek, (MBR)
Dr. B. Litzinger, (MBR)
Dr. M. S. P. Pou, (MBR)
Alfred Leslie Ransome, Minerals Attache, United States Embassy
Emilio Jacques ce Moraes, Cia. Vale do Rio Doce, (CVRD)
Dr. Duarte F. Aquina, Eng. Assessor, (CVRD)
Dr. Luir F. Leitao, (CVRD)
Dr. Juberto Daniel, (CVRD)
Dr. Tadeu Plazzi, (CVRD)
E. F. Norman, Project Manager Arthur G. McKee & Co.
H. W. H. Casperd, Vice President, Foundation of Canada Engineering Corporation Limited.

The information gained in these visits and conversations is presented below:

GENERAL INFORMATION

Brazil is South America's largest country. It has a population of over 60 million people. This represents about half of the entire continent's population. Agriculture and related industries emp y approximately half of Brazil's work force. The country produces half of the world's coffee, ranks third in cocoa production and fourth in cotton production.

Brazil is well endowed with natural resources and in addition to its vast reserves of iron ore, has extensive forests and probably the world's largest reserves of manganese. Other significant mineral reserves include: diamonds, gold, quartz, aluminum, manganesium, tungsten, cobalt, tantalum, columbium, chrome, uranium, mica, zirconium, berylium and some high sulphur coal.

MINERAL TAXATION

Income Taxes. The basic income tax on commercial profits, including those of foreign corporations, is 33 percent (30 percent base tax plus a 10 percent surtax). A five percent tax is levied against all income distributions which increase the total tax rate to 36.35 percent if all income is distributed to shareholders. Taxes on public utilities, other public services and concessionaires is 17 percent, while qualifying professional firms are taxed at 11 percent.

Non-residents and branches of foreign corporations are required to pay a 25 percent withholding tax on all retained profits -- increasing the effective corporate tax rate to 52.5 percent.

A tax of 15 percent is levied on all undistributed corporate profits or retained earnings. However, this tax can be used as a credit against the 25 percent withholding tax if the Brazilian subsidiary subsequently distributes the excess reserves in cash, stock dividends, cash bonuses or other allowable distributions.

Depreciation is allowed for capital equipment at 10 percent and 20 percent for vehicles. Generally no depreciation is allowed on buildings. The depreciation rate on machinery may be increased to 15 percent if the company operates two 8-hour shifts per day, and 20 percent for 24-hour operation. Mining companies are allowed a depletion allowance amounting to 15 percent of the sales price of the iron ore.

In 1963, Brazil imposed a "Supplemental Tax" on dividends remitted abroad. This tax is 40 percent if the transfer is between 12 to 15 percent of registered capital and reinvested profits; 50 percent between 15 and 25 percent; and 60 percent over 25 percent of capital and reinvested profits. In effect, the supplemental tax is an excess profits tax.

Investment Incentives. Brazil offers several incentives to encourage investment in undeveloped regions. These incentives range from tax credits of 50 percent against all corporate income taxes to complete exemption from corporate taxation, depending on the location of the investment.

Sole Tax. The new Federal Constitution provides for consolidating several different taxes on mining into one tax--the "Sole Tax." This tax is currently set at 8 percent and is levied against the total production of a mine. The tax is computed in the following manner: Semi-annually the government establishes the F.O.B. value of all iron ore to be exported and determines the average value per ton for the ore (currently about $5.00 per ton). No expense deductions are allowed: however, the F.O.B. value may be reduced by 40 percent to offset costs of transportation, loading, insurance, etc. Based on this rate, the current tax is .24¢ per ton. Mining company officials pointed out that the 40 percent reduction did not cover all transportation charges. They also admitted that the $5.00 per ton export value was less than the actual sales price of the iron ore.

Payroll Taxes. Companies operating in Brazil are required to pay several payroll taxes. Social Security taxes are 16 percent (8 percent for employer and 8 percent for employee). All companies are required to create a Fund for Labor, representing 37 percent of employee remuneration. The law requires that the proceeds of this tax be invested in government bonds. Four percent of a company's payroll is to be placed in the National Indemnity Fund for use by the National Housing Bank to finance construction of condeminium housing.

MINERAL CONCESSIONS

Mineral exploration and mining is controlled by the Brazilian government, even when the mineral is located on private lands. Individuals may own minerals in Brazil if they owned the land before the 1934 Constitution became effective. However, if they are not interested in developing the mineral, the government can issue another company a mining concession. The Brazilian Mining Code reserves to the landowner a royalty equal to 10 percent of the Sole Tax.

An Authorization to Prospect may be obtained from the Minister of Mines after payment of a fee equal to three times the highest minimum wage in the country.

Following successful exploration, a Mining Concession is issued by decree of the President of the Republic after payment of a fee equal to five times the highest minimum wage in the country. Obtaining a mining concession entails long negotiations with the government concerning plans for development. One mining company official pointed out that 114 different licenses are required before mining can proceed.

If the property is not developed within the time schedule and in the manner outlined in the plan filed with the government, the mining concession may be revoked.

MINERAL DEVELOPMENT

Brazil is richly endowed with mineral resources and has received considerable assistance from the United States in developing its mineral industry. Members of the U. S. Geological Survey have been in Brazil since 1942, when there was a great urgency to develop new sources of iron ore during World War II. The nation has also taken advantage of United Nations assistance programs in mineral development. Brazil has just recently received a $8.4 million AID loan to finance a five-year survey of surface and ground water resources in two remote areas.

Mineral activity is expanding under a recent change in philosophy concerning natural resources. In the past, Brazil discouraged foreign investments because it felt that foreign interests were only interested in "stealing" the nation's resources. Now that the immense size of those resources has been more clearly defined a more favorable attitude toward foreign investment has developed. The government now realizes the importance of the nation's resources in financing the development of Brazil and is encouraging mineral production. As a result, they have become very aggressive in developing markets for their mineral resources, particularly iron ore.

Base metal production is not growing as fast as iron ore and could be developed more rapidly. A large reserve of nickel was discovered recently -- averaging 1.5 to 2 percent. Transportation and power problems are presently retarding development, but solutions to those problems can be expected in the future.

Commission members were informed that foreign corporations representing several countries--Japan, Belgium, Netherlands, Germany and the United States--have indicated serious interest in developing Brazilian natural resources. In fact, Japanese interests are considering building a steel plant in the Minas Gerais area to produce steel for export.

NEW DEVELOPMENTS

Cia. Siderurgica da Guanabara (COSIGUA) has announced plans for a new port and steel plant complex at Sepetiba Bay near Rio de Janeiro. COSIGUA will be an integrated steel plant using iron ore produced in its company owned mines near Belo Horizonte in Minas Gerais. The port will have a capacity of 15 million tons of iron ore per year and will be designed to load 100,000 ton ore carriers. This port, when completed, will greatly increase Brazil's export capability.

During their visit to Brazil, Commission members were informed of a new aluminum complex to be built in the province of Minas Gerais. The new company, Cia. Mineira de Aluminio, is to be a joint venture between Hanna Mining Company, Aluminum Co. of America and Brazilian interests. The facility will include a bauxite mine, 50,000 ton refinery and a 25,000 ton smelter.

IRON MINING INDUSTRY

Reserves. Nearly all of Brazil's iron ore production comes from the "Iron Quadrangle" -- a 7,000 square kilometer area -- in the Minas Gerais state. Iron ore reserves in this area are primarily hematite and itabirites. They have been estimated to total approximately 30 billion tons, divided as shown in Table 6.

Table 6

MINAS GERAIS IRON ORE RESERVES

Billions of tons	Percent Iron
4.5	64 to 69%
1.1	60 to 64%
24.2	35 to 65%

The large reserves of lower grade ores are easily concentrated to 65 to 69 percent iron products. Quartz is the only significant impurity found in Brazilian iron ores and is easily removed by beneficiation. These estimates are conservative and do not represent Brazil's total reserves. There are other deposits in Minas Gerais that have not as yet been explored. Also a large reserve of high grade iron ore was recently discovered in the Amazon region by Companhia Meridional de Mineracao (CMA) a subsidiary of U.S. Steel Corp. This deposit could be the largest discovery in Brazil's history.

Location. The iron deposits of Minas Gerais are located inland and require relatively long-rail hauls to the coast. The rail distance from Belo Horizonte to Rio de Janeiro is about 390 miles. The distance to the ports at Vitoria and Tubarao is approximately 310 miles. Commission members were informed that the rail rate to Rio de Janeiro was $3.00 per ton and that the rate to Vitoria-Tubarao was about $2.75 per ton.

The Central do Brasil Railroad has a present capacity of 3 million tons of iron ore and currently carries about 2.5 million tons. With minor improvements and additional equipment, capacity of this railroad can be expanded to 30 million tons. The Vitoria-Minas Railroad has an excellent route with moderate grades and a total capacity of 30 million tons of iron ore. It is presently carrying about 13.5 million tons.

Iron Ore Production. There are several companies producing and shipping iron ore in Brazil. The most important of those companies are listed below:

Cia. Vale do Rio Doce (CVRD)
Mineracoes Brasileiras Reunidas S. A. (MBR)
Cia. Siderugica Nacional
S. A. Mineracao do Trindade
Fertico S. A.

MBR is a new company formed by the merger of Compania Auxiliar de Empresas de Mineracao (CAEMI) and Companhia de Mineracao Novalimense. CAEMI owns 51 percent of MBR and is controlled by Augusto Antunes. Companhia de Mineracao Novalimense owns 49 percent of MBR and is a subsidiary of St. John del Rey Mining Company which is controlled by Hanna Mining Company.

Most of the iron ore produced in Brazil is exported. An estimated 21 million tons was produced in 1966, a 16 percent increase over 1965. Of this total, 12.9 million tons was exported (CVRD alone exported 11 million tons). The remainder was either used by domestic steel industry or represents "fines" stockpiled for future use in pelletizing plants. In 1967, exports increased 12 percent to 14.3 million tons (CVRD exports amounted to 11.6 million tons).

Much of the exported iron ore is high-grade sized ore. Table 7 below contains the various types ore shipped and the iron content:

Table 7

TYPES OF IRON ORE PRODUCED IN BRAZIL

Type of Ore	Size	Iron Content
Lump	2" to 8"	67 to 68.7%
Blast Furnace	½" to 3"	66 to 68.2%
Fines	Minus ½"	65 to 66.2%

Brazilian iron ores have few impurities. Silica is usually less than one percent, Alumina can run as high as 2 percent and Phos. ranges from .01 to .08 percent.

The high quality of these iron ores has enabled Brazil to increase its exports from 6.2 million tons in 1961 to 14.3 million tons in 1967 as shown in Table 8:

Table 8

BRAZILIAN IRON ORE EXPORTS, 1961 TO 1966
(Millions of Metric Tons)

Year	Tons
1961	7.0
1962	7.6
1963	8.3
1964	9.7
1965	12.7
1966	12.9
1967	14.3

Source: United States Bureau of Mines.

In 1967, Brazil advanced its European sales campaign by adding two more nations -- the Netherlands and East Germany-- to its list of customers. Presently, Brazil exports iron ore to 17 countries.

Table 9

BRAZILIAN IRON ORE EXPORTS, 1966 & 1967
(Thousand of Metric Tons)

Country	1966	1967
Argentina	796	557
France	676	1,025
West Germany	2,976	4,550
Italy	771	1,020
Japan	1,839	2,368
Netherlands	99	1,066
United Kingdom	733	755
United States	3,025	1,385
Others	1,995	1,553

Source: United States Bureau of Mines

Exports to West Germany increased from 2,976,000 tons to 4,550,000 tons in 1967. In addition, purchases by France, Italy, the Netherlands and Japan showed significant increases. Those countries purchasing more than 500,000 tons of Brazilian iron ore are listed in Table 9.

Information obtained by Commission members indicated that Japanese purchases of iron ore will continue to expand, and that Brazilian iron ore producers are committed to expanding their sales in Europe.

EMPLOYMENT

Miners in the Belo Horizonte area of Minas Gerais receive an average wage of $90 per month plus fringe benefits. Commission members were informed that fringe benefits amount to 48 percent of direct employee compensation. Mine employees are paid for 13 months work each year. Minimum wages in Brazil are established by region and equal $37 per month in the Belo Horizonte area.

As in other South American countries, mining companies in Brazil are obligated by law to provide certain benefits to their employees, such as free housing, medical and dental care, and hospitalization. In addition, they must provide schools or subsidize the public schools in the area.

After ten years of service with one company, a worker cannot be fired except for very serious reasons. Severance pay amounts to one month's salary for each year of service.

MINE INSPECTION TOUR

Cia. Vale do Rio Doce
Tubarao, Brazil

Members of the Commission visited the plant and port of Cia. Vale do Rio Doce (CVRD) on February 8 and were accorded a warm reception by company officials. The Brazilian government owns 85 percent of CVRD's capital stock. A description of the facilities and operations of CVRD follows:

Location

CVRD's three mines are located 225 miles north of Rio de Janeiro at Itabira in the state of Minas Gerais. The company operates two ports; one at Vitoria and a new facility at Tubarao. These ports are located on the Atlantic Ocean about 300 miles northeast of Rio de Janeiro.

History of Cia. Vale do Rio Doce

CVRD was formed in 1942 as a result of the Washington agreements between Brazil, Great Britain and the United States. The purpose was to export iron ore to be used in the war effort. Between 1942 and 1950 iron ore shipments were less than one million tons per year. Since that time, CVRD has rapidly increased its iron ore production to over 13 million tons in 1967.

Reserves

CVRD's iron ore reserves are estimated at over 1.9 billion tons and consist of 300 million tons of hard hematite, 100 million tons of soft hematite and over 1.5 billion tons of itabirite--a taconite-like formation averaging 40 to 45 percent iron. While itabirite is lower grade than other Brazilian ores, it is easily concentrated to a high-grade product amenable to pelletizing. In addition, the company has large reserves of "blue dust" -- fine iron ore averaging 66 to 69.5 percent iron. CVRD is conducting an exploration program at its Timbopeba and Picarrao deposits to expand futher its iron ore reserves.

Mines

The company operates three mines in the area near Itabira. In these mines--the Caue, Conceicao, and Dois Corregos--high capacity equipment and modern mining methods are utilized in producing iron ore. CVRD's largest mine, the Caue, has a capacity of 13 to 14 million tons per year. The other properties are being expanded to provide additional ore.

Ore is hauled to the crushing and screening plants by truck, and is then conveyed to the railroad loading area. Iron ore is transported to the company's ports in 150-car trains over the 350 mile company operated railroad.

Ports

CVRD operates two ports: one at Vitoria and the other at Tubarao. Vitoria, the older of the two ports, has 36 foot channels which limit its use to ships of less than 35,000 tons. In spite of this limitation, the port of Vitoria has a loading capacity of 10 million tons per year.

Tubarao, CVRD's newest port, resulted from a $600 million contract with Japanese steel producers for the purchase of 50 million tons of iron ore over a fifteen year period. The new port was necessary to load the large carriers that would be used to transport the ore. Construction began in 1963 and the first cargo was loaded in April, 1966.

The harbor channels are dredged to 56 feet in order to accommodate 100,000 ton ore carriers. Commission members were informed that Japanese steel producers had requested that the harbor channels be dredged further to accommodate 200,000 ton ore carriers by 1970.

Iron ore is unloaded by a two-car rotary dumper and conveyed to either the crushing and screening plant for processing or to the stockpile area. The stockpile yard has a capacity of one million tons. The ship loading system is designed to load 6,000 tons per hour -- or about 10 million tons per year.

The port is designed so that it can be expanded to 20 million tons by adding a second loading dock. Tubarao's largest cargo was loaded in June, 1967, when the MV Sig Silver -- a British ship -- took on 96,000 tons of iron ore.

Tubarao's location in South America requires relatively long ocean voyages to principal steel consuming centers. As shown in Table 10, Baltimore is the nearest destination followed by Cardiff, Mobile, Rotterdam and Genoa. Japan requires the longest voyage -- 11,687 nautical miles. While Commission members were at Tubarao, the Tsukushi Maru was loaded with 70,900 tons of iron ore bound for Japan. At the same time, a smaller British vessel, the Dukesgarth was waiting to take on an iron ore cargo on the other side of the dock.

Table 10

SHIPPING DISTANCES FROM TUBARAO TO PRINCIPLE MARKETS FOR IRON ORE

Destination	Nautical Miles
Baltimore	4,581
Cleveland	5,693
Chicago, via Great Lakes	6,407
Chicago, via River System*	6,108
Mobile	4,876
Great Britain--Cardiff	4,766
Great Britain--Middlesborough	5,160
Northern Europe--Rotterdam	5,055
Southern Europe--Genoa	5,060
Japan--Moji	11,687

*Requires trans-shipment at Baton Rouge

Source: American Iron Ore Association

The impact of large ore carriers on shipping costs is illustrated by the difference in transportation rates for iron ore from Tubarao and Rio de Janeiro to consuming centers.

	Tubarao	Rio de Janeiro
Baltimore	2.50	3.75
Western Europe	2.75	4.20

Rio de Janeiro is only 300 miles further than Tubarao, but its 33 foot channels limit use of the terminal to ships of 30,000 tons or less. Thus, the difference in the rates represents not so much the variation in distance, but the larger vessels that can be loaded at Tubarao.

Recent negotiations between CVRD and Japanese steel producers indicate the magnitude of cost reduction available by using 90,000, 105,000 and 125,000 ton vessels. CVRD's first contract with the Japanese established a rate of $7.34 cents per ton between Tubarao and Japan for shipments in 50,000 ton vessels. Current negotiations indicate the following rates for shipment to Japan.

Table 11

SHIPPING FROM TUBARAO TO JAPAN

Vessel Size	Rate
50,000 tons	$7.34
90,000 tons	5.70
105,000 tons	5.28
125,000 tons	4.30

Source: United States Bureau of Mines

As the vessel size increases there is a substanial reduction in shipping costs. The $4.30 rate for 11,687 mile shipments to Japan in 125,000 ton vessels compares unfavorably with a rate of $1.90 per ton for 850 mile shipments from Duluth to Cleveland.

Iron Ore Production

CVRD has pursued a successful program to expand iron ore production and exports. In 1952, exports totaled 1.5 million tons, rising to 3.2 million tons in 1959 and are estimated at over 13 million tons for 1968.

Table 12

TYPES OF IRON ORE PRODUCED BY CVRD

Type	Size
Lump Ore	½" to 8"
Special Lump Ore	3" to 8"
Blast Furnace Ore	½" to 3"
Blast Furnace Ore	½" to 2"
Gravel Ore	0 to 3"
Fines	Minus ½"
Pellets	¼" to ½"

As Table 12 demonstrates, CVRD produces a broad range of iron ore products to meet consumer requirements. This broad range combined with the extremely high quality (65 to 68.5% Fe) of the iron ore are helping the company expand its production.

Commission members were told that prices for CVRD's natural ores average about $5.65 per ton F.O.B. Tubarao. Pellets with 68% iron ore are expected to sell for $11.80 per ton or 17.3 cents per iron unit F.O.B. Tubarao. (In comparison, Minnesota pellets are priced at about 21.7 cents per unit F.O.B. Duluth)

Employment

Total employment at CVRD is about 10,000. Of this total, about 2,300 are employed in the Mining Department at Itabira, 7,000 work for the railroad and about 700 staff the port facilities.

In addition to compulsory social welfare contributions, CVRD provides hospitals and elementary and technical schools for its employees.

CVRD also invests a portion of its profits in a fund to be used for development of the areas in which the company operates. This fund is apportioned 70 percent to the Minas Gerais area and 30 percent to the Tubarao - Vitoria area.

Expansion Program

During their visit Commission members inspected the construction site of CVRD's two million ton pellet plant. This plant, costing $22 million, is to be completed in 1969, and will be followed by a second two million ton plant in 1971. Eventually, CVRD plans to have a total pellet capacity of 9 million tons.

Included in future expansion plans is a new dock to berth 200,000 ton vessels which will expand loading capacity to 12,000 tons per hour. The new dock, plus the existing docks at Tubarao and Vitoria, will give CVRD a total loading capacity of 30 million tons per year.

Recently, CVRD and Companhia Meridonal de Mineracao (CMA), a United States Steel Corp. subsidiary, agreed to jointly develop a large iron ore deposit in the Amazon region. CVRD will own 51 percent of the new company and CMA, 49 percent.

Preliminary exploration indicates that reserves of this deposit may exceed 50 billion tons. CVRD and CMA are planning to invest $300 million for construction of ports, plants, mines, etc., to develop the reserve which averages 64 to 66 percent iron.

Vale Do Rio Doce Navegacao S. A. (Docenave)

Docenave was organized as a trading company to enable CVRD to reduce freight rates on iron ore by utilizing larger ships and utilizing more back-hauls. At the present time, Docenave has time-chartered three ships -- Texas Getty, Tubarao Maru and Carsten Russ. In addition, they have a contract of affreightment for 1.2 million tons with Bergesen and Gotaas Larsen.

CVRD has ordered two 104,000 ton ore-oil carriers from Japanese shipbuilders. These ships, to be delivered in 1971, will be 846 ft. long, 128 ft. wide and a draft of 52 ft. These ships will be used to carry iron ore to Japan with a back-haul of oil from Kuwait to Tubarao.

Itabira International Co. Ltd.

Recently, CVRD formed a subsidiary, Itabira International Co. Ltd., to handle sales of iron ore in the United States, Canada and Europe. Itabira International plans to open offices in New York and Zurich, Switzerland.

V E N E Z U E L A

In Venezuela members of the Commission visited the mine, plant and port facilities and towns developed by Orinoco Mining Company. They also called upon the following businessmen and government officials:

Rudy Fimbres, Mines and Petroleum Officer, United States Embassy
Carl G. Hogberg, President, Orinoco Mining Company
Joseph F. McEvoy, Director of Public Relations
Luis H. Viteri, Assistant Director of Public Relations
Ralph J. Denney, General Superintendent of Taxes
Charles W. Morris, Comptroller

The information gathered during these visits and conversations is presented below.

GENERAL INFORMATION

Venezuela, the sixth largest country in South America, is better known for its oil production than iron ore. Petroleum shipments account for about 90% of Venezuela's exports followed by iron ore, which is second in importance.

The nation is also rich in other minerals including bauxite, manganese, gold, asbestos, gypsum salt, sulphur, phosphate, asonium, titanium, nickel, lead, mica, copper , mercury, chrome ore, and antimony. Both United States Steel Corporation and Bethlehem Steel Corporation have developed iron ore mines in the Guayana region in eastern Venezuela. In spite of Venezuela's rapid industrialization, 45% of the population still live an agricultural or rural life.

MINERAL TAXATION

Real Property Taxes: Property taxes are levied by "municipalities" -- a unit of government roughly equivalent to counties in the United States. The tax rate on unimproved land is 0.9% of the value. Other types of property are taxed at 6½% of the annual income received or imputed.

The law contains an unusual feature in that the taxpayer is allowed to estimate the value of the property or its imputed income. However, if local authorities believe that the property's evaluation exceeds that determined by the taxpayer by more than 20 percent, they may require an appraisal. The cost of this appraisal is paid by the taxpayer unless it sustains his valuation. Tax exemptions are offered by some, but not all, municipalities for varying lengths of time to attract new industry.

Exploitation Tax: In Venezuela all the minerals are owned by the government. Mining and drilling concessions are sold to private companies and are subject to a surface tax of Bs. 1.00 (22¢) per hectare. Once production is begun, an Exploration tax of 1% of the gross value of iron ore at the mouth of the mine is also imposed.

Municipal License Tax: Each municipality has a business license tax which is assessed annually -- usually as a percent of gross receipts. The rate of the tax varies from area to area and ranges from .1 percent to 1.0 percent. The Mines Tax Law specifically exempts mining companies from this tax in lieu of the exploitation and surface taxes.

Corporate Income Taxes: In 1967, Venezuela's revised corporate income tax went into effect. The result was a slight increase in the level of taxation on mining companies.

Companies engaged in mining and oil activities are taxed on a graduated scale beginning at 20 percent on income up to Bs.100,000 ($22,222) ranging to 52 percent on all income over Bs.28,000,000 ($6,221,600). The rates applied to other corporations are 15 percent graduating to 50 percent. An additional tax of 5 percent is levied on the amount of net income received by any taxpayer from mining or petroleum industries if the earnings from these sources are greater than the taxes paid after deducting residual income. This tax is not applicable if the excess net taxable income is less than 10 percent of the net assets used to produce the income. The additional tax only applies to one-half of the income if the net taxable income is greater than 10 percent, but less than 15 percent of the value of the net assets.

Venezuela has an investment credit similar to the United States whereby 8 percent of the cost of new investments, if in the form of fixed assets used for the production of income, can be deducted from income taxes to be paid by mining and oil companies. An additional 4 percent of the total cost may be deducted if the new investment is for exploration and research. Corporations engaged in other businesses receive an investment credit of 15 percent.

Depreciation is allowed on plants, equipment and other fixed assets at reasonable rates. Depreciation may be taken only on assets located within the country and no specific depreciation rates are proscribed. Any system of depreciation recognized by established accounting practices is permissible and must be followed consistently.

Venezuela does not allow "percentage depletion." Mining and oil companies are allowed to claim "cost depletion" on a per unit basis to recover the cost of acquiring concessions from the government as well as development and exploration expenses. Amortization of these costs is based on the ratio of production to estimated reserves. Only those costs related to a productive concession can be amortized.

Dividend Tax: A foreign corporation and branches of U. S. corporations operating in Venezuela are subject to a 15 percent dividend tax on net profits remaining after the regular corporate tax has been paid. Dividends declared by mining and hydrocarbon companies are exempted from the dividend tax. Dividends paid on bearer shares are taxed at 30 percent, unless the owner of the shares has his name registered with the corporation.

Import Duties: Venezuela, like other South American countries, imposes duties on imports. Some duties are intentionally high to protect domestic industries or agricultural production, and some are intended primarily to raise revenue. Items such as machinery, other equipment, tools and certain raw materials are assessed a nominal duty or no duty at all, to encourage the development of new industries.

IRON MINING

Cerro Bolivar and El Pao are the main iron ore producing mines in Venezuela. Commission members visited Cerro Bolivar, operated by Orinoco Mining Company. El Pao, operated by Iron Mines Co. of Venezuela (a subsidiary of Bethlehem Steel Corp.), is located about 30 miles south of Palua and Puerto Ordaz on the Orinoco River. Iron ore from the El Pao Mine is transported by a company owned railroad to the port at Palua on the Orinoco River for loading into ocean going ships. In 1967, El Pao shipped 3,287,351 tons

of iron ore, an increase of about 500,000 tons from the 2,789,307 tons shipped in 1966. The iron ore produced by Iron Mines Co. averages 61.7% Fe; 1.95% silica; 4.6% alumina; 0.051% Phos. and 0.02% Sulphur based on dry analysis. The ore is crushed to minus 3 inches and shipped as run of the mine ore containing about 4.7% moisture.

RESERVES

Iron ore reserves of Venezuela are estimated as follows:

Table 13

IRON ORE RESERVES OF VENEZUELA
(In Millions of Metric Tons)

Reserve	Measured	Indicated	Total
El Pao	97	--	97
Cerro Bolivar	367	8	375
Other Orinoco Mining Company Reserves	492	25	517
National Reserves	677	475	1,152
	1,633	508	2,141

The national reserve is located about 30 miles south of Cerro Bolivar and has not been opened for development. This reserve represents a source of high quality ore for the future and insures Venezuela a continuing position as a major South American iron ore producer in the years to come.

NEW DEVELOPMENTS

In July, the Ministry of Mines and Hydro-carbons signed an agreement with a private consortium to study exploitation of the San Isidro iron ore deposits. This consortium is composed of Wells Overseas Ltd. of Canada; Phillip Brothers Corp. of the United States; and Schneider-Creusot of France.

The proposal (which will require 18 months to complete) contemplates an investment of $70 to $90 million to develop a mine; and construct a railroad, beneficiation plant and port facilities on the Orinoco River. This project is expected to have an annual capacity of 4.5 million tons of iron ore pellets and direct shipping ore.

Orinoco Mining Company
Ciudad Piar and Puerto Ordaz, Venezuela

Members of the Commission visited the mine, plant, port and townsites of Orinoco Mining Company on February 10, and were accorded a most extensive tour by company officials. Orinoco Mining Company is a wholly owned subsidiary of United States Steel Corporation. A description of facilities and operations of Orinoco Mining Co. follows:

Location

Orinoco's operations are located about 310 miles south of Caracas in Bolivar State in the Guayana Region. Cerro Bolivar was discovered on April 4, 1947, by a prospecting party from Oliver Mining Company, a U. S. Steel subsidiary. Orinoco Mining Company was formed in 1949, construction began in 1952, and the first iron ore shipments were made in 1954. Cerro Bolivar consists of a mountain of iron ore rising 1,800 feet above the surrounding plains to an elevation of 2,605 feet above sea level. The mountainous ore body is 7½ miles long and 2½ miles wide. Orinoco Mining Company constructed Ciudad Piar near the mine to house company employees and constructed a port and townsite at the confluence of the Orinoco and Caroni rivers. The mine and port are connected by a 90 mile company-owned railroad.

Reserves

The ore body is primarily hematite and limonite with small percentages of magnetite. Measured reserves of the Cerro Bolivar mine are about 375 million metric tons. One company official indicated that total reserves in all of Orinoco's concessions are in excess of one billion metric tons. The ore averages about 58% iron, 1.5 percent silica, 1.5% alumina with moisture of 6.5 to 7% depending on the season.

Mine

Mining operations are conducted by standard methods using modern high capacity equipment. Nine inch rotary drills are used for drilling blast holes. Sixty-five ton Haul Paks are used for stripping while 45-ton Mack trucks are used for production. Eight yard shovels load either directly into 90-ton railroad cars or into 45-ton trucks which then dump the iron ore into railroad cars from loading ramps. The iron ore is hauled 90 miles to Puerto Ordaz daily by four trains consisting of 107 to 125 ninety-ton ore cars.

Plant

After arriving at Puerto Ordaz, the railroad cars are unloaded at the crushing plant by two rotary car dumpers. Through the use of primary and secondary crushers, the ore is reduced to minus 4 inches and conveyed to the stockpile. The plant is basically a crushing plant with scalping screens to facilitate the crushing operation and has no washing or screening facilities to upgrade the product or produce sized ore. The stockpile has a capacity of 1.3 million metric tons and is equipped with facilities for blending the ore. Iron ore is reclaimed from the stockpile through tunnels for movement to the dock.

Loading Facilities

The mechanical shiploader has a capacity of 3,000 tons per hour and can move the length of the 1,885 foot dock. The Orinoco River at the dock site has a draft in excess of 39½ feet during the rainy season, but drops to 32 feet during the dry season. When the river is high, 60,000 ton ships can be fully loaded. During the dry season when the river is low, these ships can be only partially loaded. During the Commission's visit to Puerto Ordaz, a 50,000 ton ship was being loaded to only 36,000 tons because of low water.

Production

Orinoco Mining Company ships "run of mine" ore that is crushed to minus 4 inches and contains about 60% minus ½ inch material. The average dry chemical analysis is 63% iron, .1% Phos., 1.5% silica, 1.5% alumina, 0.01% sulphur with 5.5% loss on ignition. The ore contains about 7% moisture in its natural state.

During 1967, Orinoco Mining Company shipped a total of 14,129,000 metric tons of iron ore from the Cerro Boliver mine. Of this amount 322,000 tons were sold for domestic consumption and the remainder was exported. 1967 production was 409,000 tons lower than the 14,548,000 tons shipped during 1966.

Orinoco's iron ore was exported to the following countries:

Table 14

ORINOCO'S MINING COMPANY EXPORTS, 1967
(In thousands of Metric tons)

	Tons	Percent
United States	10,317	74.7%
England	1,308	9.4%
Germany	1,103	8.1%
Italy	1,079	7.8%
Total Exports	13,807	100.0%

In 1967, 75 percent of Orinoco's production was shipped to the United States. England, Germany and Italy received the remainder. A company official indicated that Orinoco planned to ship about 13.5 million tons during 1968. Thus, Orinoco Mining Company is feeling the effects of increased competition from Brazilian iron ore particularly in European markets.

River Dredging

With its port facility being located on a river, Orinoco Mining Company is faced with the task of keeping a channel open. Constant dredging is necessary to maintain the 184 mile navigation channel from Puerto Ordaz to the Atlantic Ocean. Under terms of a contract with the government, Orinoco operates a 16,700 ton dredge to maintain the river channel. In return, Orinoco receives 90% of a 45¢ toll collected by the government to cover the cost of dredging and channel maintenance. This toll is included in the FOB price of the iron ore at Puerto Ordaz.

The depth of the river channel presents special problems to both Orinoco and Iron Mines Corp. in that it limits the size of vessels that can be used to transport iron ore. The large ocean transports now in operation and under construction will not have access to Orinoco River ports. Thus, these mining companies will not be able to enjoy the reduced transportation costs made possible by these large ships. This will almost certainly have negative effects on the ability of Venezuelan iron ore to compete in world markets.

Table 3 below contains the shipping distances from Puerto Ordaz to the principal world steel centers. As can be seen, Baltimore and Mobile represent the shortest distances, while Cleveland and Chicago are slightly closer than the European steel centers. Shipping into the Great Lakes is limited by the size vessel that can navigate the St. Lawrence Seaway or the extra expense of trans-shipping the iron ore to barges on the Mississippi River.

Table 15

SHIPPING DISTANCES FROM PUERTO ORDAZ TO PRINCIPLE MARKETS FOR IRON ORE

Destination	Nautical Miles
Baltimore	2132
Cleveland	3761
Chicago, via Great Lakes	4385
Chicago, via River System*	3500
Mobile	2218
Great Britain--Cardiff	3981
Great Britain--Middlesborough	4433
Northern Europe--Rotterdam	4270
Southern Europe--Genoa	4416
Japan--Moji	9626

*Requires trans-shipment at Baton Rouge

Source: American Iron Ore Association

Japan is about 9,600 miles away and the voyage includes a passage through the Panama Canal. North America and Europe therefore appear to be the prime markets for Venezuelan iron ore.

Very little information is available on transportation rates from Puerto Ordaz to various steel centers. One source published in 1962 by the Department of Mines and Technical Studies, Ottawa, Canada reports shipping rates of $2.75 to Baltimore and $5.00 to Rotterdam from Puerto Ordaz. One official indicated that the current rate to Baltimore was $1.50 per ton. This again demonstrates the impact of larger ships on transportation rates.

An aluminum plant is being built at Ciudad Guayana to take advantage of the low cost power to be produced by the new Guri hydroelectric dam now under construction on the Caroni River. This dam will have an initial output of 525,000 kw when the first phase is completed in 1969. Future expansions will bring total output to 6 million kw.

The aluminum plant will smelt alumina carried as a back haul from Texas on ships that are used to transport iron ore to Mobile and other Gulf Coast ports. Thus, the alumina cargo will enable Venezuelan iron ore producers to reduce further the cost of transporting iron ore to the Gulf Coast.

Employment

Orinoco Mining Company employs about 2,500 workers, 1,000 of whom work at the mine and live in Ciudad Piar, a company-built town with a population of about 5,000. The remainder of the employees live at Ciudad Guayana, a growing industrial center near Puerto Ordaz.

Company employees work five days a week, but are paid for a seven-day week. An electric shovel operator earns about 54B$ ($12.00) per day or about $84.00 per week. The average wage at Orinoco is about 31B$ ($7.00) per day or about $49.00 per week. The minimum wage for that area is 24B$ ($5.35) per day or about $37.40 per week.

Like other mining companies in South America, Orinoco is required to provide its employees with free housing, medical and dental care, hospitalization and education for the children. Ten percent of Orinoco's profits are placed in a profit sharing fund and distributed once a year. These distributions may not be less than one week's pay nor more than two months pay.

Venezuela has no unemployment compensation, but does require a system for severance pay. If an employee is layed off or fired, he is eligible for 1½ months' pay for each year of service. If an employee quits, he is eligible for one month's pay for a year of service.

A company official indicated that fringe benefits received by each employee equaled total payroll costs.

New Developments

While the Commission was at Puerto Ordaz, they were informed that Orinoco Mining Company was planning to build a plant that would produce pre-reduced iron ore briquettes. Puerto Ordaz was chosen for this new type of plant because of its proximity to a low cost source of electric power and cheap natural gas from an oil field 125 miles to the north.

A government release, quoted below, indicates a third fa

> "The plant of high iron briquettes for the Venezuelan iron ore industry, the first of its type in the world, will manufacture a super-mineral with an iron content of 86.5% that will fortify its competitive position in the world market. Our direct shipping ore with a content of 58% has been the victim of keen competition caused by the exploitation of new mines and the increasing production of pellets."

The plant is expected to cost $50 million, have an annual capacity of one million tons of 86.5% iron briquettes and employ 200 people. About 1,500 workers will be employed during the two-year construction period.

This plant, if successful, will certainly improve the competitive position of Venezuelan iron ore in world markets.

S U M M A R Y

SOUTH AMERICAN MINE INSPECTION TRIP

+ + + +

The subcommittee's visit to the principal iron ore producers in South America clearly points out that these countries have both the reserves and the desire to stimulate iron ore production.

While South American iron ore producers are located far from their major markets, the high quality iron ore deposits permit lower production costs. The growing use of large ocean transports enables them to sell their ores competitively at steel-producing centers almost everywhere in the world.

This section will summarize the information contained in the body of the report, combine it with other developments affecting the world iron ore market and relate them to the Minnesota iron ore industry.

BUSINESS CLIMATE

Large, high quality reserves located close to tidewater do not automatically guarantee the establishment of an iron ore industry. The nation's business climate is one of several important factors that will govern the pace at which reserves are developed.

Each of the countries visited by the Commission indicated (through government representatives) a willingness to expand mineral production. These countries recognized that they must export their natural resources to provide foreign exchange. This enables them to purchase from the industrial world the products necessary to stimulate their economic growth. Brazil certainly represents the most dramatic change of policy. Within the last few years, they have reversed their policy of extreme protectionism and have begun to encourage expansion of mineral exports -- particularly iron ore.

While favoring expanded mineral production, it was clear that these governments were not going to allow mineral development unfettered by government regulation. In almost all cases, mining is carried out under specific plans approved in advance by the government. Negotiations concerning these plans can easily extend over five years before permission to begin development is granted.

Exploration concessions are easy to obtain and may be held for long periods at relatively low costs. Conversations with government officials in Peru and Chile indicated that this policy may be altered in those countries. Mining concessions are not expensive, but can require long negotiations with the government before they are granted.

The negotiations necessary to begin an iron mining operation are indicative of the growing interest and desire of South American governments to participate in mineral development. This trend will undoubtedly increase in the future.

Recent trends in Brazil, Chile and Peru point toward increased government participation in future iron ore production.

The threat of nationalization is always present. However recent events, such as the Chileanization program, have provided a feasible and more acceptable alternative.

In Brazil, the government currently owns 85 percent of Cia. Vale do Rio Doce (CVRD), the country's largest and most rapidly expanding iron ore company. CVRD is one of five major iron ore producers in Brazil, but it is the only one that is able to obtain government approval for large expansion plans. The other privately owned companies have announced plans for development, but they never seem to come to fruition. This, in itself, seems to indicate that the Brazilian government is going to control the major part of the iron mining industry. United States Steel Corporation's recent discovery of a large iron ore deposit in the Amazon region provides an excellent example of this trend. They recently announced a joint venture with CVRD for the development of those reserves. This joint venture is certainly calculated to speed development plans.

In Peru, Marcona's present contract with Santa Corp. (a government owned company) provides that the mines and plant facilities at San Juan will revert to Santa Corp. in 1982. Also, Santa Corp. will obtain a 50 percent interest in the beneficiation and port facilities at San Nicolas.

Investing in South America contains certain elements of risk. Those best qualified to analyze these risks are the companies that are considering investments in South America. In every country visited by the Commission, American owned companies were planning expansions or new developments. Apparently they analyzed the possible risks and the profit potential and have decided to proceed. This is probably the best indicator of the overall business climate in the five countries.

MINERAL TAXATION

In most of the countries visited by Commission members the fluctuations in levels of taxation and associated government regulations seemed to be a roughly coincident barometer of the current business climate. Conversations with local mining executives in South America indicated that taxes are lower now than in the past -- the exception being Peru. This easing of tax rates is undoubtedly a reflection of governmental efforts to stimulate foreign investment.

Each of the five countries levies a corporate income tax. Aside from that, any similarity to the combined federal, state and local tax structure in the United States disappears.

Income Taxes. In all countries (except Venezuela) the tax rates on foreign corporations were higher than the rates imposed on domestic corporations owned by the country's nationals. In Chile and Venezuela mining companies pay higher taxes than other corporations within the country. However, corporate income taxes on mining in Peru are lower than those paid by other corporations. The effective income tax on profits of foreign corporations is shown in Table 16.

Table 16

EFFECTIVE INCOME TAX RATES ON FOREIGN CORPORATIONS ENGAGED IN MINING, 1968

Country	Rate
Argentina	45.76%
Brazil	52.50
Chile*	47.50
Peru	48.65
Venezuela	52.00

* Statutory rate. Actual rates are negotiated with the government and range up to 55 percent on iron mining.

The rate shown assumes that all after-tax profits are paid out in dividends. (All of the countries, except Venezuela, levies what amounts to a dividend withholding tax on foreign corporations.) The withholding tax on dividends can be avoided in Argentina, Chile and Peru if retained profits are invested in new production facilities and mine development within the country. Brazil encourages the payment of dividends by imposing a 15 percent tax on retained earnings.

Argentina, Brazil and Venezuela have adopted investment incentives similar to the investment credit used in the United States. Argentina, Brazil and Peru also offer lower tax rates for investments in underdeveloped regions of their countries. This incentive is particularly important to mining companies because many mineral deposits are founds in remote and underdeveloped areas.

Property Tax. Only Chile and Venezuela impose property taxes; however, Brazil imposes an 8 percent "sole tax" on all mining operations in lieu of other local taxes, and Argentina levies a 10 percent sales tax on all mineral production.

Mineral Concessions. In each of the countries visited, all iron mining is controlled by the government. Exploration or mining may be carried out only after concessions have been obtained from the government. Exploration concessions require an annual payment of a few cents per hectare (approx. 2.5 acres.) In some countries when the mineral is located on private land, a royalty must be paid to the owner if he is not the developer. (No royalty is required when the government owns the mineral reserve.)

Exchange Regulations. Almost all South American countries impose exchange regulations to control the flow of funds to and from the country. Mining companies have been guaranteed against discriminatory exchange rates, although in some cases government approval to repatriate funds may take months.

Import Duties. Each of the five countries visited by the Commission levies duties of one kind or another on imports. These duties range from 10 to 30 percent of the value of the item if similar items are not produced within the country. If a similar item is manufactured locally and can be substituted for the imported item, the duties range from 80 to 200 percent of the item's value.

The tax structure for mining companies in South America differs significantly from that of the United States and Minnesota. This fact makes it impossible to accurately compare the level of taxes on mining companies in South America with those in Minnesota. However, it appears that corporate income tax rates on foreign corporations are designed to roughly equal the United States corporate income tax.

In some countries mining companies do not pay local taxes, but they must provide all employees with free housing, medical and dental care, hospitalization, education for the employees' children, and other assorted fringe benefits. In other words, the mining company is required to provide many services normally provided by local government.

IRON ORE RESERVES

The Latin American Iron and Steel Institute estimates that South American iron ore resources exceed 81.6 billion tons. Not all of these resources are economical at the present time, but there is no question that the four principal South American iron ore producers -- Brazil, Chile, Peru and Venezuela -- have sufficient iron ore reserves for the forseeable future.

Estimates of these reserves total 9.8 billion tons and are listed by country in Table 17.

Table 17

IRON ORE RESERVES OF SOUTH AMERICA
(In millions of tons)

Country	Tons
Brazil	4,547
Chile	2,462
Peru	622
Venezuela	2,141
Total	9,772

These extimates are considered conservative. Brazil's iron ore reserves are shown at 2.5 billion tons in Table 16. However, knowledgeable experts estimate that Brazil's iron ore resources range from 25 to 50 billion tons using a cut-off of 40 percent iron. As an example, iron ore reserves of the Minas Gerais area are estimated at between 25 and 30 billion tons.

A recent iron ore discovery in the Amazon region is reportedly larger than the reserves of the Minas Gerais region. If these two estimates are even nearly accurate, they would push Brazil's iron resources well above the 50 billion ton mark.

Only small portions of South America have been explored using sophisticated mineral detection devices. Therefore, as the search for minerals expands and these countries become more settled, it is reasonable to expect that their mineral reserves will continue to be discovered.

However, abundant reserves do not guarantee development. Many other factors including location, quality and transportation costs will affect any development plans. Reserves that are located far inland will not be economic without low cost transportation such as inland waterways. CVRD ships its iron ore 350 miles by rail at an indicated cost of 2.75 per ton. This is the longest rail haul for iron ore found in South America.

South American iron ore reserves are not only abundant, but they are of higher quality than those found in Minnesota. Table 18 contains the average iron content for reserves held by the four largest iron ore exporters in South America.

Table 18

AVERAGE IRON CONTENT OF SOUTH AMERICAN IRON DEPOSITS

Company	Iron Content
Cia Vale do Rio Doce (CVRD)	67%
Bethlehem Chile Iron Mines Co.	60%
Marcona Mining Company	62%
Orinoco Mining Company	63%

CVRD in Brazil has the highest quality iron reserves with an average iron content of 67 percent. Some of CVRD's reserves exceed 69 percent iron. Bethlehem Chile Iron Mines Co. and Marcona Mining Company both beneficiate their ores to improve iron ore content to 64 and 66 percent respectively. CVRD and Orinoco Mining Company limit processing to screening and crushing. Each of these companies is capable of producing a high-grade iron ore product to meet the higher standards demanded by world iron ore consumers.

South America is well endowed with high quality iron ore reserves that can easily support increased production. Brazil, particularly, is in an excellent position to greatly expand exports of its high quality iron ore.

ECONOMICS OF IRON ORE PRODUCTION

There are probably two key factors responsible for the rapid growth of South American iron ore production: (1) large high quality reserves near tidewater; and, (2) the growing use of large ocean transports to carry iron ore. These two factors are primarily responsible for increasing sales of South American iron ores in world markets today.

Despite the fact that wages are lower in South America than in Minnesota, fringe benefits may exceed direct wage costs. In all five countries mining companies are required to provide generous fringe benefits and, in some cases, pay high social welfare taxes. All of the companies visited by the Commission employed modern technology in mining and processing iron ore and were as modern as the facilities found in Minnesota.

While some operating costs may be lower in South America, capital equipment is more expensive than in the United States. Virtually all of the sophisticated mining equipment used in these operations--ranging from trucks and electric shovels to crushers, rod mills and magnetic separators--must be imported. Considering freight costs and import duties, this equipment costs roughly 30 to 40 percent more than in the United States.

Accurate estimates of production costs in South America are impossible to calculate; however, some information on iron ore prices is available. Actually, the price at which the iron ore is sold in world markets is more important than its cost of production.

For the most part, little information is available on iron ore prices. However, the terms of iron ore contracts signed by Japanese steel producers are published in trade journals. Table 19 was compiled from these published reports and compares the price of Minnesota natural ores and pellets with other prices around the world.

Iron ore and pellets from Minnesota are sold under a formula-pricing system known as the "Lake Erie" price. This price does not represent actual sales but is accepted as the industry standard Japanese steel producers base all their iron ore purchases on dry analysis. Since Minnesota iron ore sales are based on natural analysis--which includes moisture content--the Lake Erie price was adjusted to reflect dry analysis prices.

Recently, only the higher quality Minnesota natural ores have been readily marketable. A natural ore averaging about 55 percent iron is representative of these higher quality ores. A 55 percent iron corresponds to an average dry iron content of about 59 percent.

Table 19

IRON ORE PRICES, 1968

Country	Average Iron Content (Dry Analysis)	Price Per Ton (FOB Port)	Price Per Unit of Iron (FOB Port)
Natural Ores			
Minnesota -- Coarse*	59%	$9.94	16.8¢
Fines*	59	8.61	14.6
Brazil -- CVRD	68	5.65	8.3
Australia - Goldsworthy Lump	64	9.37	14.6
Fines	64	7.68	11.6
Australia-Robe River Fines	64	5.76	9.0
India -- Bailadila Lump	64	9.85	15.4
Sweden -- Grangesberg**	63	8.95	14.2
California -- Kaiser	56	9.85	17.6
Chile -- Canadian Foreign Ore Development	63	7.80	12.4
Iron Ore Pellets			
Minnesota*	63%	$15.88	21.7¢
Peru-Marcona	66	12.54	19.
Brazil -- CVRD	68	10.75	15.8
Australia -- Robe River	64	11.84	18.5
Australia -- Hamersley	64	11.71	18.3

* Minnesota prices are based on the Lake Erie price after deducting transportation and unloading charges to arrive at a FOB Duluth value. The value per unit of iron is adjusted to reflect an average dry analysis value.

** Based on a spot sale contract

Technical note: Information for this table was compiled from published reports in iron and steel trade publications. Most of the prices are those negotiated for long term contracts.

Source: U. S. Bureau of Mines, Engineering and Mining Journal and American Iron Ore Association

Comparisons of iron ore prices cannot be made on price per ton alone because of the variation in iron content. Therefore, the price per unit of iron (price per ton divided by percent iron content) is a more accurate reflection of the iron ore's value.

As can be seen by referring to Table 19, the price for coarse Minnesota ore averaging 59 percent dry is 16.8¢ per unit. For fines, the price is 14.6¢ per unit of iron. These are the highest prices shown in the table for iron ore with similar structure, with the exception of Kaiser's price of 17.6¢ per unit f.o.b. Long Beach

Sixty-eight percent iron content ore from CVRD is priced at 8.3¢ per unit. In pricing iron ore, coarse or lump ore is more valuable than fine ore which accounts for the difference in price even though the iron content is the same. In Chile, Canádian Foreign Ore Development offered 63 percent iron ore to Japan at 12.4¢ per unit which is almost 50 percent higher than CVRD's price.

South American iron ore pellets are also lower in cost than Minnesota pellets. Marcona indicated that the price of their 66 percent iron pellets was 19¢ per unit. CVRD in Brazil indicated a price of 15.8¢ per unit for 68 percent iron pellets.

Japan represents the largest single purchaser of iron ore in the world market today and has had a tremendous impact on iron ore prices. Almost every season for the last five years, world iron ore prices have dropped and Japan is responsible for most of the reduction.

This pressure on prices is getting so intense that six iron ore exporting nations, with Venezuela in the forefront, gathered in Geneva to study some form of coordinated action to stabilize iron ore prices. Other countries attending this meeting were: Brazil, Chile, India, Liberia and Peru. It is apparent that these countries feel that the Japanese pressure on prices threatens their iron ore industries.

Table 19 also indicates a strong competitive edge for Australian ores in the world market. Mt. Goldsworthy fines are offered at 11.6¢ per unit of iron while Robe River fines ore are offered at 9¢ per unit of iron. Pellet prices are fairly close, with Robe River pellets being offered at 18.5¢ per unit while Hamersley pellets are offered at 18.3¢ per unit. CVRD is the lowest, with a reported price of 15.8¢ per unit. These prices are much lower than the price of 21.7¢ per unit for Minnesota pellets.

South American producers have the advantage of being able to employ large bulk carriers to transport their iron ore to consuming centers.

A revolution in ocean shipping technology has occurred in the last 15 years. In 1953 a 30,000 ton iron ore carrier was a giant in the trade. There are now 106,000 ton ships in service and 125,000 ton ships under construction. The Japanese are reportedly planning to launch 150,000 and 200,000 ton ships in the near future. Ships this size will have a tremendous impact on ocean transportation costs for iron ore. At the present time, there are no harbors in the United States deep enough to accommodate these ships.

Transportation costs are extremely important to South American and Australian iron ore producers as can be seen by referring to Table 20. These producers are located far from iron ore consuming centers and are dependent upon low cost ocean transportation to competitively market their iron ores.

The closest iron ore markets for Peru and Chile are Mobile and Baltimore in the United States. Japan is the most distant consumer. At the present time, Japan purchases most of Marcona's production while United States and European purchases are declining. One reason for this may be that Marcona cannot use its large ore carriers in the European or American trade because Panama Canal passage is limited to ships of 60,000 tons or less. In addition, Panama Canal tolls add 90¢ per ton to transportation costs.

Principal markets for Brazilian iron ore -- the United States and European ports -- are between 4,500 and 5,100 miles distant. Japan represents a 11,867 mile voyage.

Venezuela is in an excellent position to ship iron ore to the United States with the tidewater ports of Baltimore and Mobile only 2,132 and 2,218 miles away. European customers are between 4,000 and 4,100 miles away. Japan is 9,200 miles from Puerto Ordaz and shipping is limited to 60,000 ton vessels by the depth of the Orinoco River and the Panama Canal.

Transportation is most important to Australian iron ore producers. Port Hedland is 3,500 miles from Japan and with the exception of Genoa, Italy, every other consuming port is over 11,000 miles distant. Baltimore is over 12,000 miles from Australia, but an American steel official reported an offer of Australian iron ore delivered to Baltimore with a transportation cost of $3.00 per ton.

Table 20

SHIPPING DISTANCES TO PRINCIPAL MARKETS FOR IRON ORE
(Nautical Miles)

Destination	Duluth	Peru San Nicolas	Chile Guayacan	Brazil Tubarao	Venezuela Puerto Ordaz	Australia Port Hedland
Baltimore	--	3350	4395	4581	2132	12,268
Cleveland	833	5227	6272	5693	3761	13,000
Chicago, via Great Lakes	808	5941	6986	6407	4385	13,724
Chicago, via River System	--	4282	5152	6108	3500	13,735
Mobile	--	2819	3864	4876	2218	12,282
Great Britian--Cardiff	--	5946	6991	4766	3981	11,310
Great Britian--Middlesborough	--	6575	7444	5160	4433	11,704
Northern Europe--Rotterdam	--	6235	7280	5055	4270	11,534
Southern Europe--Genoa	--	6803	7720	5060	4416	7,230
Japan--Moji	--	9075	9682	11,687	9626	3,505

Source: American Iron Ore Association.

Minnesota iron ore producers have the shortest shipping distances, 806 miles to Chicago and 835 miles to Cleveland. The rate is $1.90 per ton. This represents a much higher per ton mile cost than exists in ocean transportation. For example, the ocean rate from Puerto Ordaz to Baltimore, a distance of 2,132 miles, is $1.50 per ton.

In the past, the size of ore carriers on the Great Lakes has been limited by the depth of the connecting channels between the Great Lakes and the size of the locks at Sault Ste. Marie. Presently, the largest Great Lakes ore carriers have a capacity of 25,000 tons. A new lock will soon open at Sault Ste. Marie that will permit passage of larger ships.

Consequently, both Bethlehem Steel Corp and United States Steel Corp. have new ore carriers under construction. Bethlehem's ship will have a capacity of 51,500 tons and U. S. Steel's ship will have a capacity of 45,000 tons. Ships of this size should be able to achieve significant economies in Great Lakes shipping and help reduce the delivered cost of Minnesota iron ores.

The use of large iron ore carriers was pioneered by the Japanese. The economies afforded by large ships, coupled with tough price negotiation, have resulted in a significant reduction in the delivered cost of iron ore. Recently Japan reported that the average imported price of iron ore was $12.65 per ton for the year ended March 31, 1968. Table 21 contains the average price of iron ore imported into Japan from Australia, Brazil, India, Peru and South Africa.

Table 21

AVERAGE PRICE OF IRON ORE DELIVERED TO JAPAN, 1968

Producing Country	Price Per Ton	Estimated Ave. Iron	Price Per Iron Unit
Australia	$11.50	63%	18.2¢
Brazil	12.60	67	18.8
India	12.40	64	19.4
Peru	12.20	65	18.8
South Africa	13.50	64	21.1
Average	$12.65	N.A.	N.A.

N.A. Not Available

Source: Engineering and Mining Journal

A per unit value of the iron ore can be obtained by applying an estimated iron content to the delivered cost of iron ore. Australia has the lowest per unit price with 18.2¢ per unit. Peru and Brazil are second, both with per unit prices of 18.8¢.

The average cost of Australian, Indian, Brazilian, and Peruvian iron ore delivered to Japan does not compare very well with the 20.1¢ per unit cost for 59 percent iron ore from Minnesota delivered to lower lake ports. Japanese steel producers can buy iron ore and ship it almost halfway around the world at lower prices than Minnesota ores can be delivered to Chicago or Cleveland.

It appears that Japanese purchase policies have been designed to create intense competition in the world iron ore market. This competition is responsible for significant reduction in iron ore prices over the last five years.

The result of this competition is that Minnesota can no longer consider the U. S. inland steel centers as their exclusive market. For example, 59 percent iron Minnesota ore delivered in Pittsburgh has a cost of about 25¢ per unit based on the Lake Erie price. At the same rate, Brazil can deliver 67 percent iron ore to the Pittsburgh area at a cost of 21¢ per unit of iron. This includes a relatively expensive ($3.86 per ton) rail shipment from east coast ports to Pittsburgh.

Other South American iron ore producers can ship as far inland as Pittsburgh at competitive prices. It also appears that Australian iron ore producers could be very competitive in the Pittsburgh market if they decided to make the effort. Thus, the intense competitive pressures of the world iron market have effectively reduced the market for Minnesota iron ores to those steel centers located on the Great Lakes. Even the Chicago market is not completely secure in that iron ore can be barged up the Mississippi River and the river system in Illinois to Chicago at prices competitive with Minnesota ores.

Minnesota's iron ore industry grew and achieved dominance during a period of iron ore scarcity. Since that time, iron ore has become a world-wide commodity. The growing use of large ocean transports is primarily responsible for this change. As a result, delivered prices of iron ore in the world market have declined sharply.

Minnesotan's must recognize that these fundamental changes in the iron ore industry have created serious challenges for our iron ore industry.

MINNESOTA IRON RANGE INSPECTION

Other Commission activities during the interim included the organization of a series of inspection tours of Minnesota taconite facilities for members of the Minnesota Legislature. In all, 93 members of the Legislature visited and studied iron ore and taconite facilities including the Eveleth Taconite Company, the U.S. Steel Mintac operation, the Butler pellet plant near Keewatin, the Erie Mining Company and some open pit mining operations.

Members were able to inspect the new pellet loading facilities which had been built by the Duluth Missabe and Iron Range Railway Co. at Duluth.

Since 1964, direct investments in new taconite facilities are in an amount exceeding $400 million, with additional investments being made in collateral and supporting facilities. As of the end of 1968 the year around average employment in taconite facilities totalled over 9,000 persons.

SUMMARY

CONCLUSION

In its 1959 Report, the Legislative Commission on Taxation of Iron Ore stated:

> "Today competition for iron ore markets has created an indisputable need for improvement in grade and texture of practically all ore mined in and shipped from Minnesota. Need for such changes has been developing in the iron ore mining industry during recent years as our reports have pointed out."

In reality, from the end of World War II to the present time there have been revolutionary changes in three directions: (1) foreign deposits of high grade natural ore; (2) development of processes to make use of the vast domestic reserves of lower grade ores; and more recently (3) development of processes to make use of the vast foreign reserves of ores amenable to concentration and pellitizing. The summary sheet of "Operating Pellet Plants" illustrates these latter two developments.

The existence of these plants verifies the many advantages of high grade iron ore pellets. In 1955 the North American mining industry produced a little over one million tons of pellets. By 1960 the total was 13 million tons. In 1967 the industry produced 59 million tons of pellets in the United States and Canada. Present industry capacity is in excess of 80 million tons per year.

Undoubtedly this pellet capacity will continue to increase, and how fast and where continues to be one of the major concerns of this Commission.

RECOMMENDATION

It is recommended that this Commission continue to investigate and consider the appropriate level of all phases of taconite taxation, to the end that the industry remains competitive with iron ore producers in the area, while at the same time bearing a fair and equitable tax burden.

CONCLUSION

Since this Commission's last report to the Legislature, numerous problems relating to local taxation and its relation to school, municipal, and county expenditures have been brought

to our attention. The relationships of these problems in mining areas to other phases of iron ore and taconite taxation call for a comprehensive and thorough analysis.

RECOMMENDATION

It is recommended that this Commission in whatever manner deemed appropriate assist in any studies or investigations relating to attempts to solve the problems in these areas, particularly in Northeastern Minnesota.

CONCLUSION

The recent announcement of the acquisition of areas for exploration within the Duluth-Gabbro Complex by various mining firms has called attention to the economic potential of Minnesota's copper-nickel deposits. The Minnesota Legislature, acting on a 1959 recommendation of this Commission, in 1967 enacted Laws 1967, Chapter 671. This statute develops a framework of mineral taxation somewhat similar to that covering taconite taxation. We conclude that the ultimate potential of Minnesota as a source of copper and nickel is promising, but not without overcoming various technological and economic problems.

RECOMMENDATION

It is recommended that this Commission continue to survey this potentially great source of economic security for the areas involved.

EXHIBIT A

Minnesota's Greenstone Belts--A New Exploration Target

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THE EXPLORATION BEGUN RECENTLY in Minnesota's greenstone belts has added new emphasis to the search for base metal deposits in the state. The greenstone belts are similar geologically to many of those in Canada that contain valuable massive sulfide or lode gold deposits. It is useful to compare the geology across the international boundary and to evaluate the possibilities for worthwhile deposits in Minnesota.

CANADIAN GREENSTONE BELTS

Greenstone belts are widely distributed in the Canadian Shield, and are particularly abundant in the Superior Province in Ontario and Quebec. The volcanic complexes that make up the belts consist of mafic volcanics—dominantly pillowed basalt or andesite flows—lesser felsic and intermediate volcanics, and sedimentary rocks of graywacke affinity. Thicknesses of the volcanic complexes vary considerably, but are dominantly in the range of 20,000 to 60,000 ft. (Moorhouse, 1965, p. 948). The volcanic and associated sedimentary strata typically are surrounded by granitic rocks, which have an average composition of granodiorite (Goodwin, 1968 b) and are about 2500 million years old. The volcanic complexes and the intrusive granitic rocks are assigned to the Archean (Lower Precambrian) (Stockwell, 1965).

The greenstone belts of the Canadian Shield have certain patterns of rock distribution, structural style and mineral occurrence that are common to one another. As summarized by Goodwin (1965; 1968 a), the volcanic complexes that constitute the belts have similar generalized stratigraphic successions that grade from (1) thick sequences

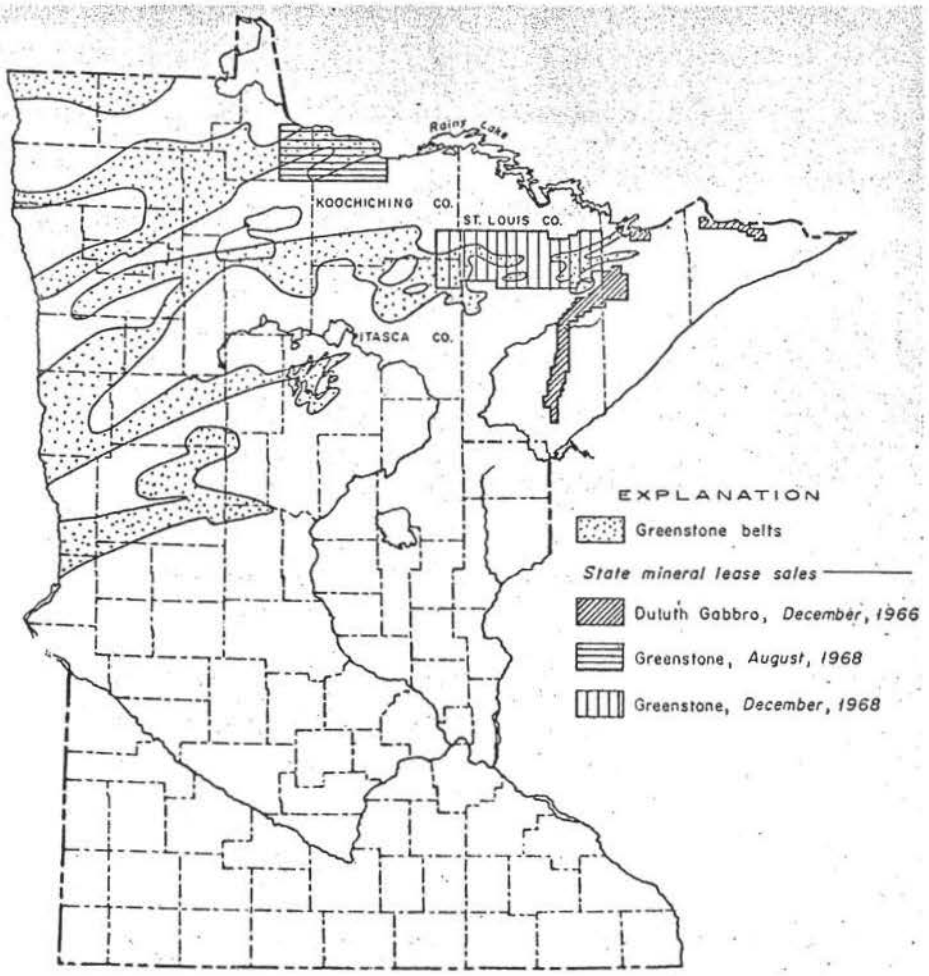

Figure 1—Map of northern Minnesota, showing the distribution of known and inferred volcanic rocks of Lower Precambrian age.

Exploration of Minnesota's Greenstone Belts

(Continued from front cover)

of mafic flows upward through (2) increasing proportions of intermediate flows and fragmental rocks, to (3) thick piles of felsic pyroclastics intercalated with, and overlain by, (4) clastic sediments. There are local variations, reversals and omissions to this idealized sequence, but the broad trend is from early mafic vulcanism to late felsic pyroclastic discharge.

MAJOR ORE DEPOSITS IN GREENSTONE

Valuable mineral deposits within the greenstone belts occur mainly at volcanic eruptive centers, which generally are marked by concentrations of fragmental rocks of intermediate and felsic compositions and may contain intrusive rocks of gabbroic composition. Among the many significant deposits in this environment are those in the Porcupine-Kirkland Lake-Noranda region, the fabulous Kidd Creek mine near Timmins, and the Geco mine in the Manitouwadge area.

The deposits are dominantly of two types: (1) strata-bound sulfides and (2) fissure veins and lodes. The strata-bound sulfide deposits, which are mainly massive copper-zinc-silver bodies, most commonly occur in the upper stratigraphic parts of the complexes, associated with mixed volcanic or fragmental rocks (Goodwin, 1965, p. 957). They tend to occur either within definite stratigraphic units or marginal to small intrusive stocks. The vein-type deposits are mostly valuable for gold; they may be present in any part of the volcanic pile or even in granite. A third type of deposit containing nickel and copper occurs in local ultramafic and mafic bodies that intrude rocks of the volcanic piles.

Most Canadian writers believe that the ore-forming solutions that yielded the deposits in the volcanic sequences were derived from the volcanic pile itself. That is, both the metals and host rocks represent consanguineous products of common magmatic derivation. Many of the ideas concerning the origin of the ores have been reviewed recently by Wilson (1967).

Considering the known mineral deposits in the several volcanic complexes in the Canadian Shield, there seems to be at least two common denominators of the mineralized sequences: (1) the presence of substantial thicknesses of felsic and intermediate lavas, pyroclastics and intrusive porphyries or equigranular rocks, that is, the upper stratigraphic part of the volcanic pile, and (2) the presence of faults and other structural discordances that have visible alteration, especially silicification. However, the differences in the patterns of mineralization from one Canadian district to another are so great that it is dangerous at this stage of our knowledge to evaluate the potential of the greenstone belts in Minnesota on these factors alone.

MINNESOTA GREENSTONE BELTS

The geology of the Lower Precambrian rocks of northern Minnesota is similar in most essential respects to that of the Archean terrane of Ontario and Quebec. Volcanic rocks of diverse composition and associated sedimentary rocks are intruded and generally surrounded by granitic rocks of granodiorite to granite composition. The granitic intrusive rocks are considered from present data to be 2400 to 2750 million years old (Goldich, 1968). The distribution of the volcanic complexes that constitute the greenstone belts is shown in figure 1 on the front cover. Delineation of the greenstone belts in the northwestern part of the state that is mantled by unconsolidated glacial deposits is based mainly on aeromagnetic and gravity data and extrapolation of the known geology in northeastern Minnesota. Accordingly, the outlines of the belts in this part of the state are imperfectly known. For a specific comparison with Canadian greenstone belts, the geology of the rather well exposed volcanic-sedimentary sequence in the western part of the Vermilion district, recently mapped by the Minnesota Geological Survey (Sims and others, 1968), will be reviewed.

VERMILION DISTRICT

The Vermilion district, famed as a major source of premium grade natural iron ores in past years, consists of a relatively narrow belt of volcanic rocks and associated porphyries, banded iron-formations, graywacke, slate, and conglomerate that is bounded on the north by granitic rocks of the Vermilion batholith and on the south by rocks of the Giants Range batholith (Sims and others, 1968; Goldich and others, 1961; Gruner, 1941). The rocks are metamorphosed to the relatively low grade greenschist facies except adjacent to the granitic masses where they are changed to the higher grade amphibolite facies.

The general geologic features of the western part of the Vermilion district can be discussed with reference to figure 2. The dominant structural feature of this area is an inverted anticline cored by a body of Ely Greenstone that plunges steeply eastward.* The Ely Greenstone consists dominantly of pillowed basalt and contains local lenses of banded iron formation, the largest of which are distinguished separately on figure 2. The maximum thickness of the unit in the map area is estimated to be about 10,000 ft.; eastward, toward Ely, the unit thickens to an estimated 25,000 ft.

Overlying the Ely Greenstone stratigraphically on the north limb of the fold is the Soudan iron formation, a well defined unit that can be traced continuously from the vicinity of Soudan to Twin Lakes, south of Ely, a distance of 15 miles. Stratigraphically above the Soudan iron formation, and locally resting directly on the older Ely Greenstone, is the Knife Lake Group. The Knife Lake consists of several rock units that interfinger and intertongue. On the north limb of the fold, east of Pike Bay and on the several islands in the eastern part of Vermilion Lake, it consists mainly of interbedded volcaniclastic and clastic rocks.

The dominant volcaniclastic rock is a quartz tuff, which is intercal-

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Modified from a paper presented orally at the University of Minnesota Mining Symposium held at Duluth, Minn., Jan. 14, 1969.

*Existing formal stratigraphic nomenclature is used in this report, although it is known now that rocks characteristic of these units intertongue and, on a regional basis, do not have a specific stratigraphic position in the volcanic-sedimentary sequence, as was assumed previously.

ated with quartz-feldspar porphyry, chloritic graywacke, and conglomerate composed mainly of pebbles of porphyry and iron formation in a felsic matrix. The felsic tuff and associated rock types grade westward along strike into chloritic graywacke and eastward into pyroclastic rocks and flows of intermediate-mafic composition. Similar volcanic, volcaniclastic, and clastic rocks overlie the Ely Greenstone stratigraphically on the south limb of the fold. A unit within this succession contains some felsic flows. The succession on the south limb interfingers to the west with biotitic graywacke. A feldspathic quartzite unit abuts the Ely Greenstone along the fold crest to the west of Tower. Tower is three miles southwest of Soudan, figure 2.

SIMILARITY TO CANADIAN BELTS

Accordingly, the stratigraphy of the volcanic succession in the western part of the Vermilion district is similar to the idealized succession that Goodwin (1965) has described for Canadian greenstone belts. A thick sequence of mafic flows grades upward into intermediate and felsic pyroclastics and flows that are intercalated with and overlain by clastic rocks. The thickness of the felsic volcanic increment in the Vermilion district is not as great as in some productive Canadian volcanic sequences, as for example at Noranda (Goodwin, 1965, p. 460), but nevertheless exceeds a few thousand feet.

With respect to the second factor mentioned above, the Vermilion district is cut by an intricate system of faults, some of which are major structural breaks. A major high angle fault, previously named the Vermilion fault (Sims and others, 1968), lies along the northern margin of the district and separates the district proper from the Vermilion batholith and associated biotite schists and amphibolites to the north. A marked discontinuity of rock units on either side of the fault and an abrupt transition in metamorphic grade at the fault indicate a large displacement along the fault, both horizontally and vertically. The amount of displacement is not known, but could be on the order of several miles in the horizontal component and about a mile in the vertical component. Other subsidiary faults branch southward from the Vermilion fault. In addition to these faults, a northeast-trending set, mainly having left lateral movements, cuts all rock types in the area. The maximum horizontal displacement inferred on faults of this set is about four miles.

Silicification, milky quartz, and pyrite occur locally along most of the faults. Silicification is common at many places along the Vermilion fault, particularly near the east end of Vermilion Lake. Farther to west, in NW¼ sec. 36, T. 63 N., R. 16 W., strands of the fault contain quartz-pyrite veins as much as several inches thick. The schist wall rock adjacent to the veins is bleached and altered.

COMMON ACCESSORY MINERALS

Considering the volcanic sequence as a whole in the western part of the Vermilion district, pyrite and pyrrhotite are common accessory minerals. At places these minerals are accompanied by chalcopyrite and lesser sphalerite. For the most part the sulfides are disseminated through the rocks, but locally they occur in tiny veinlets. Massive sulfide pods have not been observed.

To judge from the gross similarities in the stratigraphy and structure of the volcanic sequence in the Vermilion district to productive greenstone belts in Canada, the Vermilion district warrants exploration for strata-bound massive sulfide deposits and vein-type gold deposits. The most favorable areas for exploration probably are the upper

(Continued on page 18)

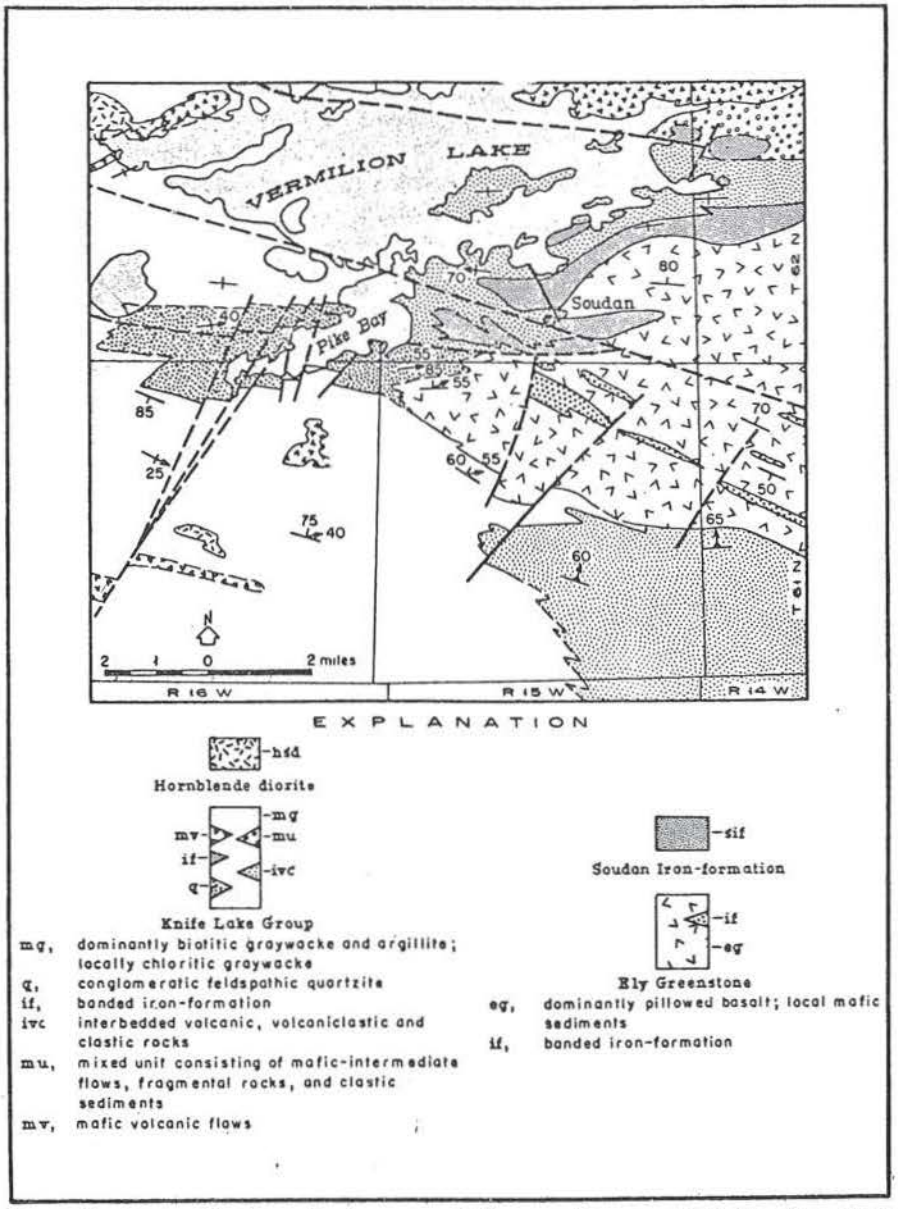

Figure 2—Generalized geologic map of the western part of the Vermilion district, Minnesota.

stratigraphic parts of the volcanic pile, in zones containing interbedded and intertonguing units of pyroclastics and felsic-intermediate flows and associated rock types.

The other greenstone belts in Minnesota are poorly exposed as compared with the Vermilion district, but can be expected to be generally comparable in stratigraphy and structure to it. One greenstone belt, a relatively narrow one that trends east-northeastward along the south shore of Rainy Lake in the vicinity of International Falls, has yielded a small production of gold. The gold was mined from the Little America mine in the 1890s (Grout, 1937).

ULTRAMAFIC BODIES

A few bodies of ultramafic rocks are known to be present in the greenstone belts of Minnesota. Except for a single occurrence at Rainy Lake, the known bodies are restricted to a mafic volcanic unit that extends from the vicinity of Burntside Lake, west of Ely in northeastern St. Louis county, northeastward to Basswood Lake, on the international boundary. The ultramafic bodies are dominantly serpentinized peridotites. They are small and somewhat elongated parallel to the strike of the country rocks. The country rocks are dominantly basaltic flows or metadiabase.

Analysis of nine selected samples of ultramafic bodies indicate the following ranges in metal content: chromium, 3000 to 5000 ppm; nickel, 30 to 900 ppm; copper, as much as 300 ppm; zinc, as much as 60 ppm; boron, 20 to 200 ppm; and silver, 0.2 to 1 ppm.

EXPLORATION ACTIVITIES

Currently, several major mining companies are investigating the mineral potential of greenstone belts in Minnesota. The most active interest is in the Vermilion district in St. Louis county and the belts of volcanic rocks that lie to the west of it (see figure 1). The latter belts extend from Vermilion Lake through the western part of St. Louis county into Itasca and Koochiching counties and areas still farther west. Substantial activity also is being carried out in a greenstone belt adjacent to the international boundary in Koochiching and Lake of the Woods counties. In this area, one private company has begun exploration drilling. Unquestionably, adverse weather this winter has delayed some exploration programs in the state.

Both geologic mapping and geophysical surveying are being used to delineate the geology and to determine exploration targets. Combined aeromagnetic and gravity data are useful in distinguishing the volcanic belts from the sedimentary and intrusive granitic rocks in areas of poor exposures. Airborne surveys that employ electromagnetic methods followed by ground geophysical surveys are being used widely by the private companies as a direct guide to exploration targets.

STATE ACTIVITIES

Since 1963 the Minnesota Geological Survey has had an active program of geologic mapping in the older Precambrian terranes of northeastern Minnesota as well as in the younger Duluth Complex. Systematic gravity surveying, to aid geologic mapping, was begun in 1965. Because of the possibility of significant base metal deposits in the greenstone belts, considerable attention has been given to geologic studies of the Vermilion district and adjacent areas. Geologic maps of the western part of the Vermilion district (scale: 1-125,000) (Sims and others, 1968) and of the Gabbro Lake quadrangle (scale: 1-31,-680) (Green, Phinney, and Weiblen, 1966), which includes much of the central part of the district, have been published. In addition, a simple Bouguer gravity map (scale: 1-250,000) of the Hibbing two-degree sheet (Ikola, 1968) has been published. Regional combined aeromagnetic and geologic maps were published earlier (Bath, Schwartz, and Gilbert, 1964; 1965). Detailed geologic mapping of selected areas and both regional geologic mapping and gravity surveying are continuing.

The state has encouraged exploration in the greenstone belts by leasing state lands in two separate areas. These areas are shown in figure 1. In Aug. 1968, a total of 50,000 acres in northwestern Koochiching county and 8,000 acres in adjacent Lake of the Woods county were leased to two companies: Humble Oil & Refining Co. and Texas Gulf Sulphur Co. In Dec. 1968, a total 60,000 acres in north-central and northeastern St. Louis county, 21,000 acres in northeastern Itasca county, and 7,000 acres in southeastern Koochiching county were leased to six mining companies: Bear Creek Mining Co., The Hanna Mining Co., Humble Oil, The New Jersey Zinc Co., U. S. Steel Corp. and Warren S. Moore Co.

Previously (1966), the state of Minnesota leased about 86,000 acres within the Duluth Complex for the mining of copper-nickel and related minerals. The sites of these leases are shown also in figure 1. A brief discussion of the nature of the leases has been published (Sims, 1968).

CONCLUSIONS

The current active interest of the mining industry in the greenstone belts of Minnesota adds substantially to the already high level of exploration for copper-nickel deposits in the Duluth Complex (Sims, 1968). To judge from the favorable geology, the greenstone belts warrant intensive exploration as a potential source of massive sulfide ores and possibly gold ores. A sustained program of exploration will add a new dimension to the search for commercial sulfide deposits in Minnesota.

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EXHIBIT B

Operating Pellet Plants*

Project	Location	Annual capacity, tons	Initial operation (year)
United States			
Erie Mining Co. (Bethlehem) (Youngstown) (Interlake) (Stelco)	Hoyt Lakes, Minn.	7,500,000 2,800,000	1955 1967
Republic Mine of Marquette Iron (Cleveland Cliffs) (Jones & Laughlin) (International Harvester) (Wheeling)	Republic, Mich.	2,000,000	1956
Reserve Mining Co. (Armco) (Republic)	Babbitt and Silver Bay, Minn.	9,000,000 1,700,000	1957 1966
Eagle Mills (Cleveland Cliffs)	Eagle Mills, Mich.	800,000	1957
Cornwall (Bethlehem)	Cornwall, Pa.	700,000	1959
Humboldt Mine (Cleveland Cliffs) (Ford)	Humboldt, Mich.	800,000	1960
Grace Mine (Bethlehem)	Reading, Pa.	1,500,000	1961
Empire Iron (Cleveland Cliffs) (Inland) (McLouth) (International Harvester)	Palmer, Mich.	1,400,000 1,800,000	1963 1966
Atlantic City (U. S. Steel)	Atlantic City, Wyo.	1,500,000	1963
The Hanna Mining Co. (Hanna)	Groveland, Mich.	1,600,000 500,000	1963 1967
Meramec Mining Co. (Bethlehem) (St. Joseph Lead)	Pea Ridge, Mo.	2,000,000	1964
Eveleth Taconite Co. (Ford) (Oglebay Norton)	Eveleth, Minn.	1,600,000	1965
Pioneer Pellet Plant (Cleveland Cliffs) (Republic) (Bethlehem) (McLouth)	Eagle Mills, Mich.	1,200,000	1965
Eagle Mountain (Kaiser)	Eagle Mountain, Calif.	2,000,000	1965
Keewatin (National Steel) (Hanna)	Keewatin, Minn.	2,400,000	1967
Minntac (U. S. Steel)	Mountain Iron, Minn.	4,500,000	1967
Butler Taconite (Hanna) (Inland) (Wheeling)	Nashwauk, Minn.	2,000,000	1967
Pilot Knob (Hanna) (Granite City)	Pilot Knob, Mo.	1,000,000	1968
	Total	50,300,000	

Project	Location	Annual capacity, tons	Initial operation (year)
Canada			
Sudbury Mine (International Nickel)	Copper Cliff, Ont.	750,000 250,000	1956 1967
Marmoraton (Bethlehem)	Marmora, Ont.	500,000	1957
Hilton Mines, Ltd. (Stelco) (Jones & Laughlin) (Others)	Shawville, Que.	900,000	1957
Carol Pellet Co. (Bethlehem) (National Steel) (Hanna) (Armco) (Republic Steel) (Youngstown) (Wheeling)	Labrador City, Newfoundland	5,500,000 4,500,000	1963 1968
National Steel Corp. of Canada (formerly Lowphos Ore Ltd.) (National Steel) (Hanna)	Capreol, Ont. (Moose Mountain)	625,000	1963
Adams (Jones & Laughlin)	Kirkland Lake, Ont.	1,250,000	1964
Wabush Mines (formerly Arnaud Pellets) (Stelco) (Dominion) (Youngstown) (Inland) (Interlake) (Pittsburgh) (Others)	Pointe Noire, Que.	6,000,000	1965 1968
Caland Ore Co. Ltd. (Inland)	Atikokan, Ont.	1,000,000	1966
Steep Rock Iron Mines Ltd. (Algoma) (Detroit)	Steep Rock Lake, Ont.	1,350,000	1967
Sherman Mine (Dofasco) (Cleveland Cliffs)	Temagami, Ont.	1,000,000	1968
Griffith (Stelco)	Iron Bay, Ont.	1,500,000	1968
	Total	25,125,000	

Project	Location	Annual capacity, tons
Other Countries		
Otanmaki Oy	Finland	250,000
Mines De Fer De Segre	France	50,000
Salzgitter AG	Germany	250,000
Montecatini	Italy	330,000
Kawasaki Steel Corp.	Japan	1,600,000
Kobe Steel Works, Ltd.	Japan	1,200,000
Norsk Jernverk	Norway	600,000
Marcona Corp.	Peru	3,600,000
Hellefors Bruk	Hallefors, Sweden	40,000
Svenska Kullagerfabriken	Hofors, Sweden	60,000
L.K.A.B.	Kiruna, Sweden	1,600,000
	Malmberget, Sweden	1,000,000
Uddeholms A.B.	Persberg, Sweden	60,000
Stora Kopparbergs	Soderfors, Sweden	30,000
The Grangesberg Co.	Strassa, Sweden	500,000
Krivoi-Rog	USSR	(est.) 900,000
Zelezara Skopje	Yugoslavia	150,000
Chowgule and Co.	Pale, Goa, India	550,000
Hamersley Iron Pty. Ltd.	Australia	2,000,000
Kawasaki (Take over of Philippine Iron Mines)	Philippines	750,000
Broken Hill Pty. Ltd.	Whyalla, Australia	1,500,000
Savage River Mines	Tasmania, Australia	2,000,000
Liberia-American Cooperative (LAMCO) (Bethlehem)	Liberia, Africa	2,000,000
	Total	21,020,000

* As of January 1, 1969.
Source: American Iron Ore Association.