Report
on
the Investigation of Ore Deposits
in Argentina

May 1965

Overseas Technical Cooperation Agency

Government of Japan

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P R E F A C E

The Government of Japan had accepted the request by the Government of Argentine to make fundamental investigation of mineral resources of the country and entrusted the work to the Overseas Technical Cooperation Agency.

The survey mission consisted of six experts with Mr. Yoshikazu Horikoshi as chief, and investigated for approximately two months from 15 October 1964, the potential of copper, lead, alunite and laterite as well as the possibilities of the establishment of aluminum production plant in the country.

The present report contains the results of the survey.

Thanks to the special assistance and cooperation by the Government of Argentine, the survey was performed smoothly.

Ever since the Agency was established in June 1962 as an executive organ of the Government in connection with Japan's overseas technical cooperation, it has made steady achievement in various fields, and dispatching experts to developing countries, receiving their trainees into Japan, offering of consulting service and so on.

Nothing would be more gratifying to the Agency if the present report could be of any use for the development programmes of mineral resources and contribute to the promotion of amicable relations as well as economic interchange between both countries.

In conclusion the Agency takes this opportunity to express its deepest gratitude for the assistance extended to the investigation works on the spot to the authorities concerned of the Argentine Government.

May 1965

SHINICHI SHIBUSAWA
Director General
Overseas Technical Cooperation Agency

C O N T E N T S

(25 figures and 8 photos)

(I) SUMMARY

(1) The "Japanese Mining Mission to Argentine, 1964" was dispatched by the Japanese Government to Argentine at the invitation of the Argentine Government from the 16th of October to the 28th of December, 1964 for mutual cooperation in the Argentine mining development consultation.

(2) The mission was composed of six members headed by Dr. Y. HORIKOSHI.

(3) The mission was able to investigate about 40 mines most of which are described in this report.

(4) Mining in Argentine is still undeveloped, not due to the lack of mineral resources but due mainly to the economic and political conditions of the country. The mission has ascertained that Argentine has a large number of useful mineral resources which have not been developed as yet. Therefore, the mining industry of the country has a bright future, if provided with appropriate political control and technical, as well as financial, aids.

(5) The mission recommends the following six items:

(A) Development of the Jujuy area.

(B) Development of the "Capillitas" and "Farallon Negro" areas.

(C) Development of the Mendoza and Neuquen Provinces.

(D) On the problem of aluminum industry.

(E) Development of kaolin deposits.

(F) Problem of supporting small mines.

(6) The most important point of this report is that a large mine cannot come into existence without the efforts for supporting small mines which are operated economically.

(II) INTRODUCTION

(1) CIRCUMSTANCES OF THE DISPATCH OF THE MISSION

It was 1963 when the Japanese Government was consulted by the Argentine Government about construction of aluminum plants in Argentine. At that time, however, the Japanese Government was unable to give effect to any practical plans. In 1964, in response to the request from the Argentine Government for the second time, the Japanese Government decided to dispatch a consultant mission to Argentine, to carry out basic investigations for exploitation of not only aluminum but also other useful minerals in the country. Thus, the dispatch of a Japanese technical mission was materialized and the mission, consisting of three mining geologists, two mining engineers and one specialist in aluminium plant, left Japan in October 1964.

(2) PURPOSES OF THE MISSION

The aims of the mission were; (1) basic investigation of mineral deposits from the standpoint of economic geology, and study of possibility of exploitation of the deposits from the standpoint of mining engineering, and (2) feasibility study for construction of aluminum plants. The results are reported herein. As to the feasibility study for aluminum plant constructions, Dr. S. Sonoda, one of the members of the mission and specialist in aluminum plant, has written a separate paper which is presented as Chapter V of this report.

(3) MEMBERS OF THE MISSION (Dates of stay in Argentine, abbreviations of names for the convenience of the succeeding descriptions and the names of organizations they belonged are appended.)

Chief:	Yoshikazu HORIKOSHI YH	(D. Sc.) (Mining geologist) (October 16, 1964 - December 28, 1964), (Director, Overseas Mineral Resources Development Co., Ltd.)
	Susumu SONODA SS	(D. Sc.) (Aluminum plant specialist) (November 20, 1964 - December 8, 1964), (Director, Showa Denko K.K. Co., Ltd.)
	Toru KIKUCHI TK	(D. Sc.) (Mining geologist) (October 16, 1964 - December 26, 1964), (Overseas Mineral Resources Development Co., Ltd.)
	Tsuguo NAKAMURA TN	(Mining engineer) (October 16, 1964 - December 28, 1964), (Nippon Mining Co., Ltd.)
	Yoichi TAKEBAYASHI YT	(Mining engineer) (November 1964 - December 26, 1964), (Ministry of International Trade & Industry)
	Yutaka KIKUCHI YK	(Mining geologist) (October 16, 1964 - December 28, 1964), (Sumitomo Metal Mine Co., Ltd.)

(4) ITINERARY OF THE MISSION

The mission worked in Argentine for 73 days from October 16 to December 28, 1964. The six members of the mission worked often separately under the command of the chief (Dr. Y. HORIKOSHI) of the mission. They made the field trips as follows:

(1) Oct. 28 - Nov. 4. YH and YK; to Chubut Province, for aluminum, kaolin and nonferrous minerals.

(2) Oct. 28 - Nov. 22. TK and TN; to Jujuy, Salta, Catamarca, La Rioja. San Juan, and Mendoza Provinces mainly for nonferrous minerals.

(3) Nov. 9 - Nov. 12. YH and YK; to Misiones Province, for aluminum.

(4) Nov. 28 - Dec. 5. YH; } to Rio Negro, Chubut and Santa
Nov. 30 - Dec. 5. SS and YT; }
Crus Provinces, for aluminum, kaolin and nonferrous minerals.

(5) Nov. 28 - Dec. 17. TK; } to Jujuy, Salta, Tucuman and Catamarca
Dec. 7 - Dec. 17. YH; } Provinces, mainly for nonferrous
Dec. 9 - Dec. 16. YT; } minerals.

(6) Nov. 29 - Dec. 15. TN and YK; to Cordoba, San Luis, Mendoza and Neuquen Provinces, for nonmetal and nonferrous minerals.

(5) ACKNOWLEDGEMENTS

The mission expresses profound gratitude for the assistance rendered by the Argentine Government and all the persons concerned. The Argentine Government, through the Consejo Nacional de Desarrollo, provided the mission every convenience without which the mission would have been unable to accomplish its duty that covered the extensive and unfamiliar districts.

Listed below are the persons and organizations who gave the mission valuable assistance and to whom the mission owes a great deal.

(Not in order)

Ing. Roque Carranza;	Secretario, Consejo Nacional de Desarrollo, Presidencia de la Nación Argentina
Dr. Rúben H. Lopez;	Asesor Responsable Sector Minería, C.N.D., P.N.A.
Ing. Hertzog Enrique;	Sector Mineria, C.N.D., P.N.A.
Dr. Guillermo J. Cano;	Embajador, Embajada de la República Argentina Japón

Dr. Rodolfo E. Barbagelata;	Consejero Economico, E.R.A.J.
Dr. Luciano Catalano;	Subsecretario de Mineria, Ministerio de Economica
Ing. General Carlos Guido Blanco;	Direction General de Fabricaciones Militares
Coronel Carlos Vidueira;	Director, Direccion de Movilizacion Industrial, D.G.F.M.
Dr. Edgardo Menoyo;	D.M.I., D.G.F.M.
Dr. Kitaro Hayase;	D.M.I., D.G.F.M.
Sr. Victor Carretero;	D.M.I., D.G.F.M.
Teniente Coronel Miguel Munoz;	Director de Officina Salta, D.G.F.M.
Dr. Relix Gonzales Bonorino;	Presidente, Instituto Nacional de Geologia y Mineria
Dr. Robert V. Tezón;	I.N.G.M.
Sr. Luis N. Salodo;	I.N.G.M.
Sr. Fernand Lima;	I.N.G.M.
Ing. Floy A. Gandulfo;	Director Ejectivo, Dirección Nacional de Industrias del Estado
Sr. Emillo S. Nicolini;	Petroquimica E.N., D.N.I.E.
Dr. Guillermo del Corro;	Director, Museo Argentino de Cincias Naturales
Sr. Armando Navarro;	Gobernador de Catamarca, Provincia Catamarca
Ing. Adolfo Factor;	Director, Dirección de Minas, Provincia Catamarca
Ing. Osmar Edmundo Marchetti;	Jefe, División Inspección, P. Catamarca
Ing. Juan Carlos Perucca;	Departamento de minas, provincia San Juan
Ing. Francisco J. Gabrielli;	Gobernador de Mendoza, Provincia Mendoza

Dr. Mendez;	Director, Direccion de Geologia y Mineria, Provincia de Jujuy
Dr. John Carman;	Project Manager from United Nations, Plan Corillerano
Sr. Donald P. Robertson;	from U.N., Plan Corillerano
Sr. Paul I. Eimon;	from U.N., Plan Corillerano
Teniente Coronel H. Enrique Yaurequi;	from D.G.F.M., Plan C.
Ing. Julio R. Millan;	President, Yacimientos Mineros de Agua de Dionisio
Ing. Domingo N. Carrion;	en Mina Farrallon Negro, Y.M.A.D.
Dr. Raul G. Sister;	en Mina Farrallon Negro, Y.M.A.D.
Ing. Dr. Ramon Ruiz Bates;	Facultad de Ingenieria, Universidad Cuyo
Ing. Carbs G. Rudolph;	F.I., Univ. Cuyo
Dr. Luis Alberto Gonzáles;	Gerente General de Petroquimica E.N. Comodoro Rivadavia, Chubut.
Dr. Pedro M. Racaguni;	Presidente del H. Directorio, Dirección Provincial de Mineria, Prov. Cordoba
Dr. Ricardo B. Rister;	Dirección Provincial de Mineria, Cordoba
Dr. Walter Spillmann;	Dirección Provincial de Mineria, Cordoba
Dr. Luis Vullo;	Dirección Provincial de Mineria, Cordoba
Dr. Hugo E. Moni;	Dirección Provincial de Mineria, Prov. San Luis
Sr. Tomas Gonzalez;	President de Cia. Mineria de Togan
Dr. Pedro A. Muzzio;	President de Mina Rio Diamante
Sr. Alfredo R. Insua;	President, Cia. Cuprifera Argentina S.A.
Sr. Jorge M. Gamundi;	Vice President, C.C.A.
Ing. Ramon Palou;	Director, Jefe, Planta de Jujuy, C.C.A.
Sr. Jorge A. Insua;	C.C.A.
Ing. Robert P. Steele;	Superintendent, Cia Minera Aguilar S.A.

Ing. Milani;	Vice Superintendent, Mina Aguilar
Dr. Wallace J. Cropper;	Chief Geologist, Mina Aguilar
Ing. Carlos Roberto Eichert;	Cia. Minero los Marayes S.R.L.

E R R A T A

Page	Line	Errors as appeared in the report	Correction
7	23th	Togan	Togon
20	6th	FARALION	FALALLON
21	5th	Pegmatities	Pegmatites
44	15th	wich	winch
56	2nd	remaind	remained
56	16th	expoitation	exploitation
80	2nd from the bottom	¥ 204,000	¥ 204,307
80	1st from the bottom	¥ 186,000	¥ 187,840
85	9th	48,878	48,087
87	7th from the bottom	¥ 33 million	¥ 33.1 million
89	5th	203,364	204,307
89	5th	179,539	199,356
89	5th	23,728	4,951
89	6th	186,612	187,840
89	6th	162,968	176,482
89	6th	23,644	11,358
89	7th	16,755	16,467
89	7th	16,571	22,874
95	4th from the bottom	if view	of view
Photo	Photo 4	asidic	acidic

(III) GENERAL VIEW OF MINING IN ARGENTINE

The name "Argentina" originates in "Argentum", a Latin term meaning "land of silver", and the name of the famous river "Rio de la Plata" means "silver river". In spite of such good names, mining production of the country has not been very noticeable, and the total amount of minerals produced in 1960 counts about 7,700 million pesos, which is only several percents of the total production of the nation.

Petroleum and natural-gas are the leading products, followed by zinc, lead, iron, tin, tungsten, silver, manganese, beryl, antimony, mica, kaolin, etc. Production of copper is very small, 3,000 tons (as metal) per year. These minerals are found throughout the country, but the western mountainous area is most important from the viewpoint of mining.

The following reasons may account for the belated mining industry of this country;

(1) Agriculture and cattle-breeding have been developed well to suffice the national economy and the people's livelihood in Argentine.

(2) Inhabitants are very few in the mine areas, whereas nearly one-third of the total population is concentrated in Buenos Aires.

(3) In the past the mining business was seldom successful, hence few people took interest in investing in mining.

However, numerous mineral resources have been known to exist and discovery of many more is geologically possible. In other words, the underdeveloped mining in Argentine is not due to scarcity of mineral resources, but due mainly to the economic and political conditions of the country. It will be, therefore, possible to promote mineral industry in Argentine by appropriate political control, if provided with satisfactory technical and financial aids.

(IV) INDIVIDUAL DESCRIPTIONS OF THE MINES INVESTIGATED BY THE MISSION

The mission visited various parts of the country and investigated about 40 mines and other related places. The principal 30 mines (including one plant) are as follows: (see Fig. 1)

Jujuy Province:

(1) Mina Los Chorillos (Cu) .... (TK & TN, Oct. 30) & (TK, Nov. 30)

(2) Electrolytic Plant (Cu) .... (TK & TN, Oct. 30) & (TK, Nov. 30)

Salta Province:

(3) Mina La Colorada (Cu, Fe) .... (TK, Dec. 3)

(4) Mina El Zorrito (Cu) .... (TK & TN, Oct. 31)

Catamarca Province:

(5) Mina Farallon Negro (Mn, Au, Ag) .... (TK & TN, Nov. 5 & 6) & (YH, TK & YT, Dec. 13 & 14)

(6) Mina Capillitas (Cu, Pb, Zn, Mn) .... (TK & TN, Nov. 4 & 5) & (YH, TK & YT, Dec. 15)

(7) Mina Cerro Rico (Cu) .... (TK, Dec. 9 & 10)

(8) Mina Los Ratones (Pb, Zn) .... (TK & TN, Nov. 11)

(9) Mina Cebila (Sb) .... (YH, Dec. 8)

Misiones Province:

(10) Laterite deposits .... (YH & YK, Nov. 11 & 12)

San Juan Province:

(11) Mina Caledonia (Au, Ag, Cu, Pb, Zn) .... (TK & TN, Nov. 17)

Cordoba Province:

(12) Mina Distrito S. Esteban (Au) .... (TN & YK, Nov. 30)

(13) Mina Cerro Blanco (Quartz) .... (TN & YK, Nov. 30)

(14) Mina Mogote de la Picaza (W) .... (TN & YK, Dec. 1)

(15) Mina Distrito Cabalango (Fluorite) .... (TN & YK, Nov. 30)

(16) Mina Maria Ines (Mica) .... (TN & YK, Dec. 2)

San Luis Province:

(17) Mina Los Condores (W) .... (TN & YK, Dec. 5)

(18) Tungsten Mines at C? Blanco Area .... (TN & YK, Dec. 4)

Mendoza Province:

(19) Mina Rio Diamonte (Pb, Zn) .... (TN & YK, Dec. 9 & 10)

Neuquen Province:

(20) Mina Achaley and Mina Rio Aurio
(Barite, Gypsum, Pb) .... (TN & YK, Dec. 13)

(21) Mina Chita (Kaolin) .... (TN & YK, Dec. 12)

(22) Mina C? Colorado (Cu) .... (TN & YK, Dec. 12)

Rio Negro Province:

(23) Mina Maria Teresa (Pb) and others
(W, Fluorite, Pb, Mn) .... (YH, Nov. 29)

Chubut Province:

(24) Mina Lago Fontana (Zn, Pb, Cu) .... (YH & YK, Nov. 2)

(25) Mina Cerro Bayos (Kaolin) .... (YH & YK, Nov. 1)

(26) Alunite deposits at Camarones .... (YH & YK, Oct. 30)

Santa Cruz Province:

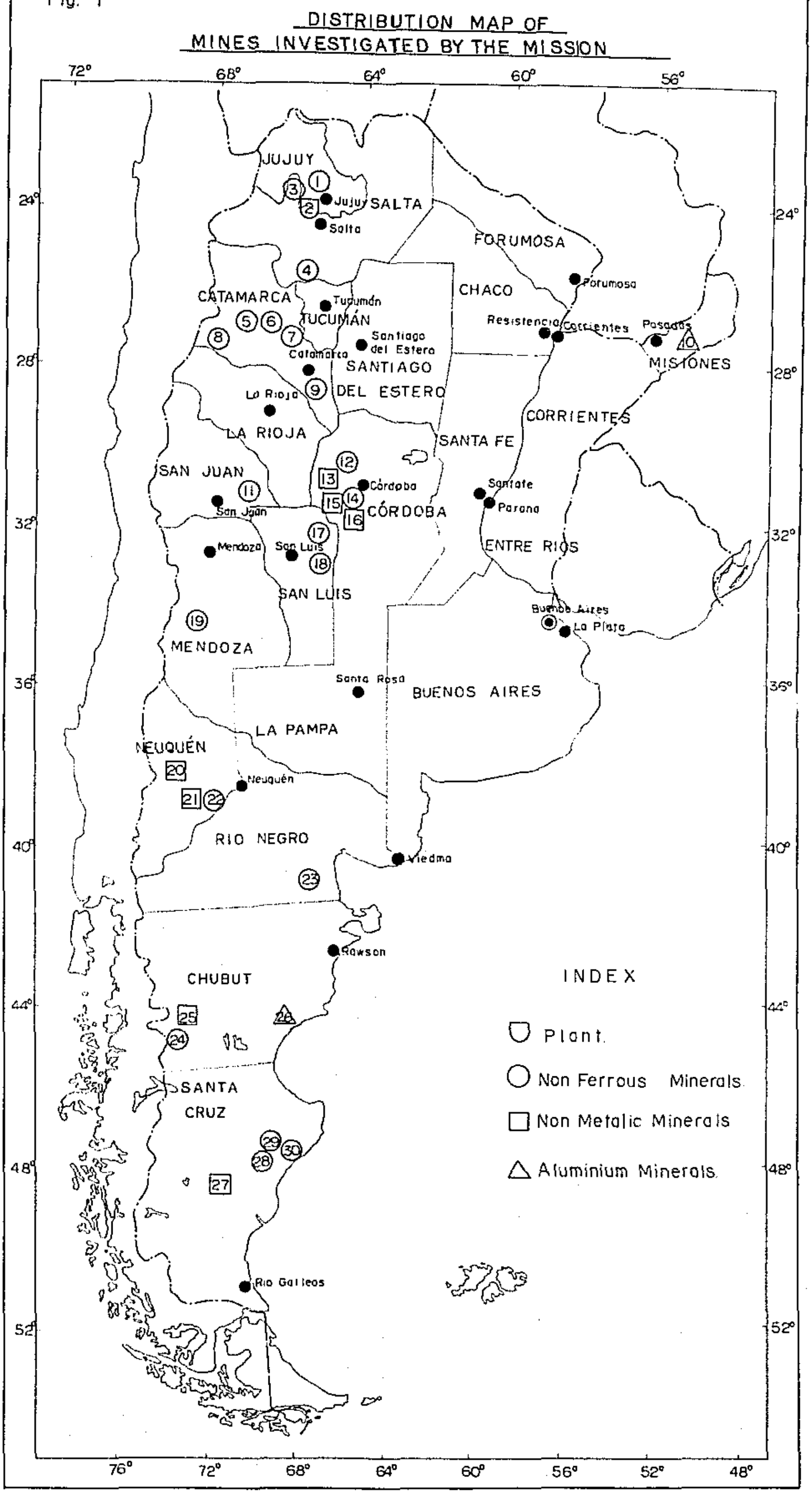
(27) Kaolin deposits .... (YH & YT, Dec. 3)

(28) Mina Los Leones (Cu) .... (YH & YK, Oct. 29) & (YH & YT, Dec. 2)

(29) Mina Tres Cerros (Cu) .... (YH & YK, Oct. 29)

(30) Mina La Angerita (Pb) .... (YH & YK, Oct. 29)

Fig. I


DISTRIBUTION MAP OF
MINES INVESTIGATED BY THE MISSION
JUJUY
SALTA
FORUMOSA
CHACO
CATAMARCA
TUCUMÁN
SANTIAGO DEL ESTERO
MISIONES
CORRIENTES
LA RIOJA
SANTA FE
SAN JUAN
CÓRDOBA
ENTRE RIOS
SAN LUIS
MENDOZA
BUENOS AIRES
LA PAMPA
NEUQUÉN
RIO NEGRO
CHUBUT
SANTA CRUZ
Jujuy
Salta
Tucumán
Santiago del Estero
Catamarca
La Rioja
Córdoba
San Juan
Mendoza
San Luis
Santafe
Parana
Resistencia
Corrientes
Posadas
Forumosa
Buenos Aires
La Plata
Santa Rosa
Neuquén
Viedma
Rawson
Rio Galleos
INDEX
Plant.
Non Ferrous Minerals.
Non Metalic Minerals
Aluminium Minerals.

(1) MINA LOS CHORILLOS (Cu)

Location: The mine is located at Chorillos, Tumbaya in the Province of Jujuy, 30 km northwest of San Salvador de Jujuy, and is reached after 22 km by the national highway from Jujuy and another 8 km by the mine road crossing a bridgeless river near Barcena railway station (see Fig. 2). The mine site is 2,000 m above sea level.

Owner: The mine is owned by the Cia. Minera Santa Cruz S.A.L., invested by the Cia. Cuprifera Argentina (50%) and others (50%).

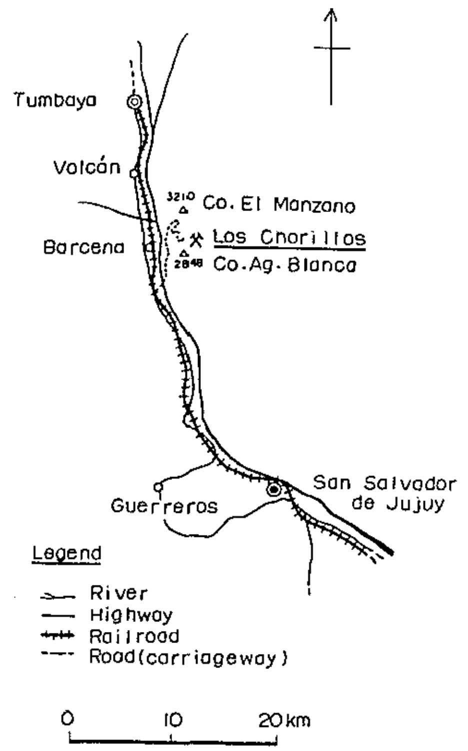
Geology and ore deposits: The mine area is composed of quartz schist and limestone of supposedly Mesozoic age. Ore occurs in quartz veins that are partially brecciated. The principal vein is 1,000 m long, 200 m deep, with an average width of 1 m, accompanied by many minor branched veins. Ore minerals are native copper, cuprite, chalcocite, chrysocolla, azurite, malachite, etc.

Production: The mine produces 80 tons per month of crude ore (10% Cu). All products are transported by small trucks for a distance of 30 km to the plant of Cuprifera Argentina at Jujuy.

Workers: There are four workers, with a wage of about 350 pesos a day.

Recommendation: Further exploration along the strike of the principal vein is desired.

Fig.2 Location of Los Chorillos



(2) ELECTROLYTIC PLANT (Cu)

Location: The plant is located at Guerreros, 9 km west of San Salvador de Jujuy. (See Fig. 3)

Owner: It is owned by the Cia. Cuprifera Argentina S.A., headed by Sr. Alfredo R. Insua.

Ore supply: The plant gets about 120 - 140 tons of ore from "La Colorada" mine (Salta Prov.) and 80 - 100 tons from "Los Chorillos" mine (Jujuy Prov.

Productions: The plant produces 7 - 9 tons/month of electrolytic copper.

Workers: There are 11 workers under the chief of the plant.

Fig. 3 Location of the plant

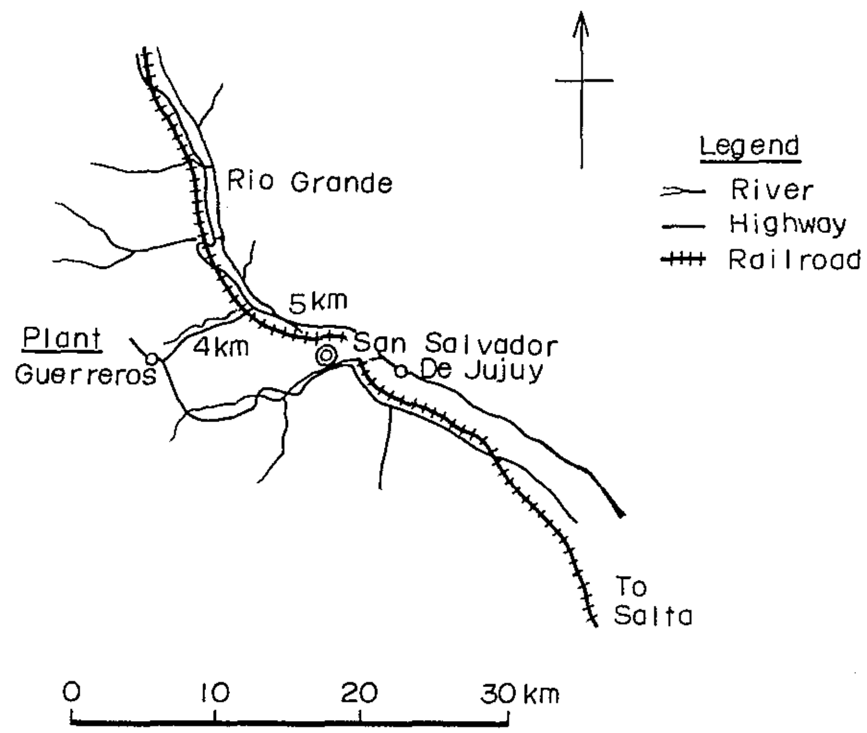
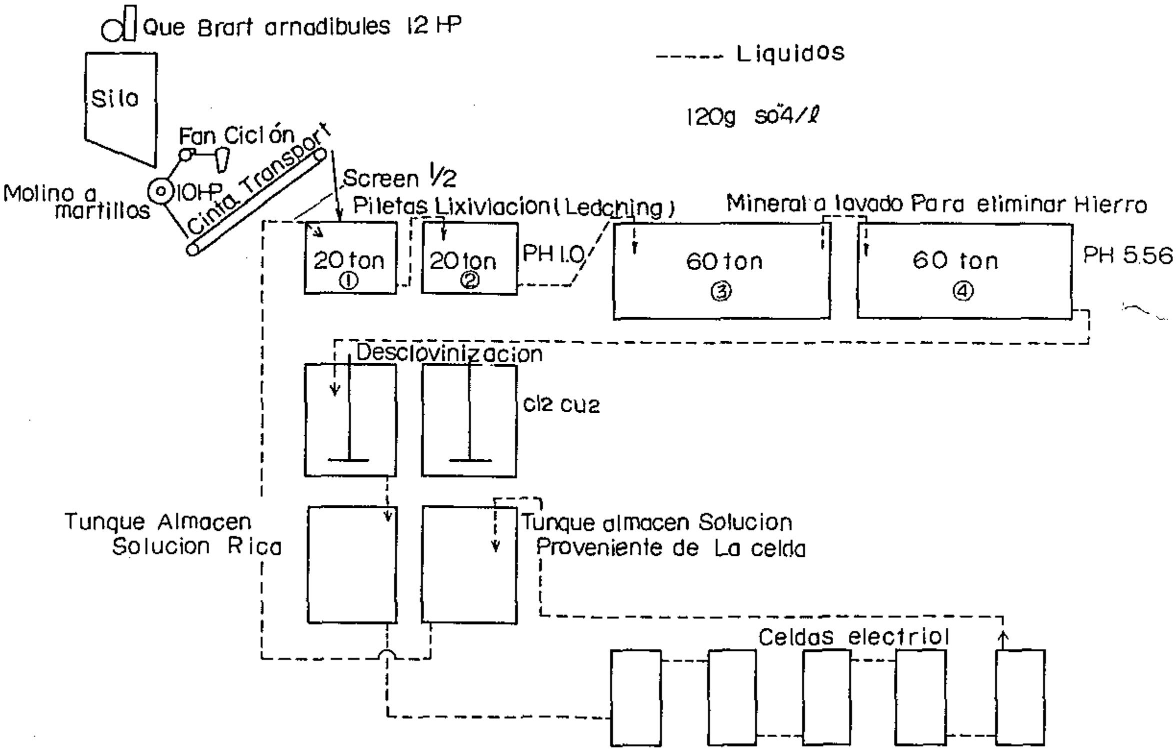


Fig 4



<u>Eliminacion del hierro</u>

El mineral entra con 10 % de Cobre. La solución que atacó a Pileta.

① Desolvio hierro 8 gr/l pasa a pileta.

② Donde el hierro aumenta a 10 gr/l en pileta.

③ Donde el mineral es recien cargado elimina el hierro que queda en el mineral en forma de sulfato basico y Carbonato basico de hierro, luego de 5 dias ese mineral de pileta. ③ se "lava" con agua que arrastra el coloide. El mineral lava do se carga en pileta ① La ley del mineral de bajado a 6% de cobre, Alli se deja basta gue las colas dan 0.4 % de Cu.

(3) MINA LA COLORADA (Cu, Fe)

Location: The mine is located at Cobres, 65 km north of San Antonio de Los Cobres, Salta Prov., and is 3,500 m above sea level.

Owner: It is owned by Sr. Luiz Witte.

History: The mine has been known since old days, as far back as 100 years, as a copper and iron mine. The present owner obtained it 11 years ago, and mined iron first and copper later. He has produced about 4,000 tons of iron ore (Fe 51-52%), and 1,500 tons of copper ore (Cu 10%) up to now.

Ceology and ore deposits: Schists, phyllites and granite are the main rocks of the mine area. It is uncertain whether or not the intrusion of the granite has any connection with the mineralization.
The mineralization comprises two types, primary and secondary.
The primary mineralization is represented by impregnation of pyrrhotite and pyrite, accompanied by small amounts of chalcopyrite, galena and sphalerite in the silicified phyllitic rocks. The areal extension of the impregnation has not been estimated, but it seems to be broader than 500 m^2. The secondary mineralization (oxidation and secondary enrichment) is recognized in the upper part of the hills. Oxidation of sulphides has produced thick gossans of limonite, 10 m to 30 m thick, with Fe content up to 50% in assay. Within or under the limonite gossans there are nodules, seams and layers of the secondarily enriched copper minerals, such as azurite, malachite and a small amount of chalcocite, containing 10 - 30% Cu.

Ore reserves and grade: No precise estimate has been made either for ore reserves or grade. It is reported, however, that the Aguilar mine made the following estimate in 1957 on the basis of core samples obtained from several drillings:

Limonite:	300,000 tons with 45% Fe
Secondary copper:	2,500 tons with 20% Cu
	10,000 tons with 5% Cu
Primary sulphides:	4,000,000 tons with 0.53% Cu, 33% Fe and 21% S

These values are considered reliable and they may become larger.

Activities: The mine produces about 70 ton/month of copper ore (8.5% Cu) which is sold to the Jujuy Plant of the Cia. Cuprifera Argentina. The mine has 16 workers and one compressor (53 HP). (There are about 50 inhabitants at Cobres with a school and a police station.)

Conclusion: The deposit of primary mineralization is not small but is of low grade. The secondary copper enriched portion may be mined economically.

(4) MINA EL ZORRITO (Cu)

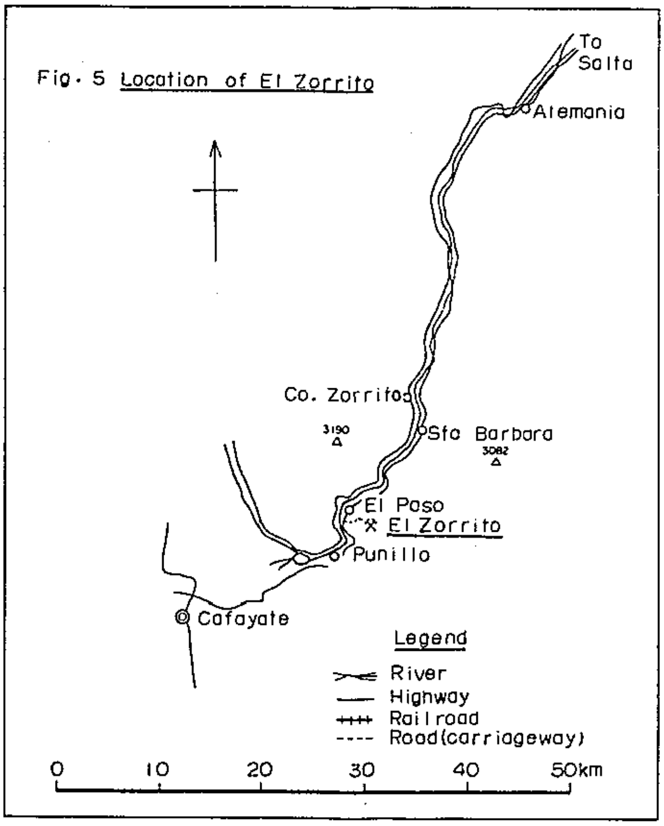
Location: The mine is located at La Yesera, Cafayate, in the Province of Salta. It is 50 km SSW of Alemania or 30 km NNE of Cafayate, and about 1 km walk from the highway (Ruta 68). The mine site is 1,700 m above sea level. (See Fig. 5)

Owner: The mine is owned by Sr. Ricardo Liendro.

Geology and ore deposits: Precambrian slate is the principal rock of this area. Granite is known to occur at 3 km south of the mine. Several copper-bearing quartz veins are found in the Precambrian formation. The veins strike N-S to N40°W and dip 70° to 90°W. The width of these veins is 0.5 to 1.5 meters. Malachite, azurite, atacamite, chrysocolla, cuprite, tennorite and chalcocite are recognized in the veins as copper minerals. Some black spots and veinlets of chalcocite can be seen in copper-rich portions.

Activities: The owner of the mine has attempted prospecting by one inclined shaft, about 30 m long, but no more.

Recommendation: Further exploration is needed.



(5) MINA FARALION NEGRO (Mn, Au, Ag)

Location: The mine is in the Hualfin district, Belen department, Province of Catamarca. It is about 30 km west of the Capillitas mine (See Fig. 6), or 40 km from Nacimiento de Abajo on the road between Cafajate and Belen. Although situated at an elevation of 2,700 m above sea level, the mine can be reached by car.

Owner: The mine is owned by the Yacimientos Mineros de Agua Dionisio (Y.M.A.D.) which is under the joint management of Tucuman University, the Catamarca Provincial Government and the Central Government of Argentine.

History: The deposits are well known from old times and various geologic studies with mining explorations have been carried out since 1938 by

Tucuman University and others. The Y.M.A.D. is now making geologic survey and exploration, but with no actual exploitation as yet.

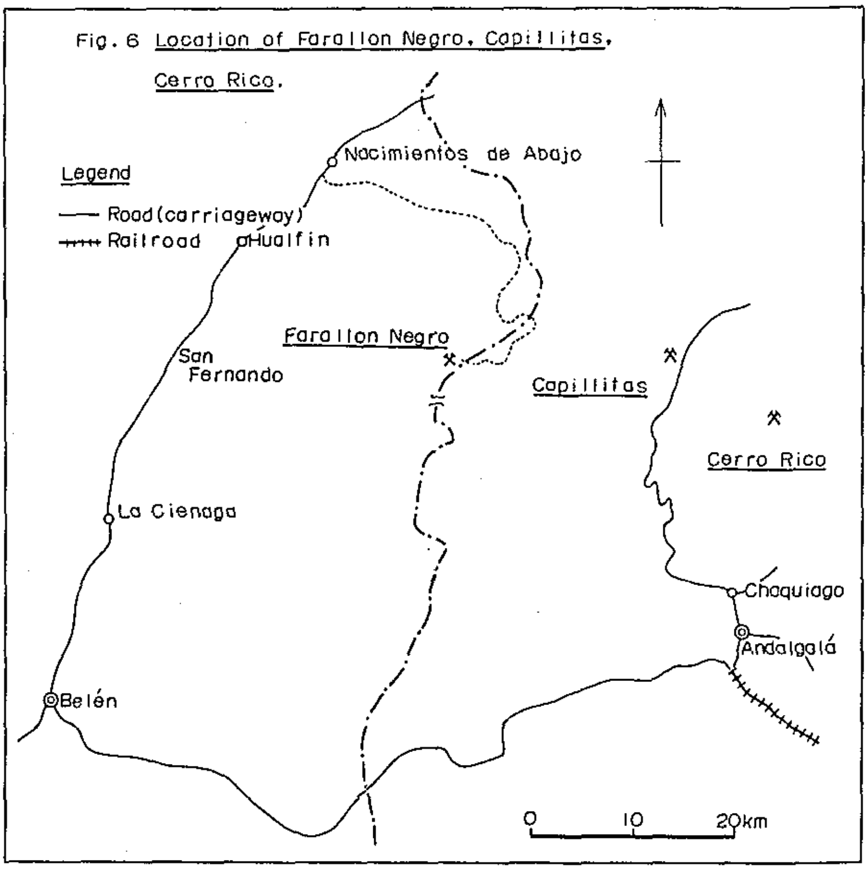


Fig. 6 Location of Farallon Negro, Capillitas, Cerro Rico.

Geology and ore deposits: The dominant rocks of this area are phyllitic slates, quartzites, micaceous schists and limestones, penetrated by granites, granodiorites and pegmatities. Over these base rocks, light reddish sandstones of upper Tertiary are distributed unconformably. The sandstones are covered by a series of volcanic rocks (andesitic, basaltic and dacitic lavas, tuffs and breccias). Quaternary gravel deposits are also found in some places. Some andesitic and monzonitic intrusives are found in the area of the ore deposit.

Several veins have been known in the area. The leading ones are Veta Farallon Negro and Veta Alto de la Blenda. The Farallon Negro vein is about 12 km long, striking N 50° - 60°W and dipping 65° - 85° NE; it is known to show no variation of mineralization down to the depth of 173 m. The mineralization is simple; manganese (pyrolusite, psilomelane, hausmannite, wad, ankerite, rhodochrosite, etc.), with gold and silver. Gold occurs in minute flakes or splinters, hardly visible (0.015 to 0.020 mm). Silver is traced only by chemical means, as it is not recognizable in its natural state. Pyrite, chalcopyrite, galena and zincblende are also found. The gangue minerals are quartz, jasperoid, calcite, aragonite, barite, chalcedony, etc.

Another leading vein is the Alto de la Blenda which is situated some 800 meters northwest of the central zone of the Farallon Negro. The vein is 3,500 m long, 1-8 m wide, striking N 30° - 50°W and dipping 70°NE. Structurally, this vein is similar to the Farallon Negro, but differs from the latter in the appearance of mineralization. Zincblende, galena, pyrite, chalcopyrite, bornite, ankerite, calcite, quartz and gypsum are predominant.

Ore reserves and grade: Underground prospecting has been carried out in the Farallon Negro vein since 1948, and in the Alto de la Blenda vein since 1962. Ore reserves of the Farallon Negro vein have been estimated, and those of the Alto de la Blenda vein are being estimated now. Beside the above two deposits, in this area are found some other prospective veins which remain unexplored.

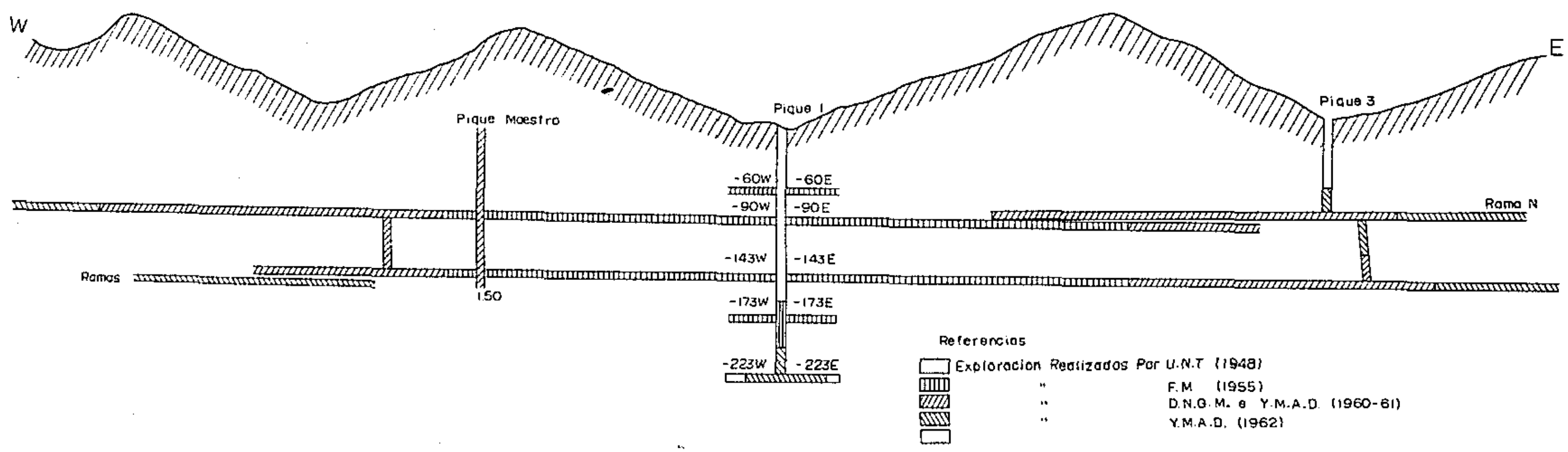
The ore reserves of the Farallon Negro vein estimated on the basis of excellent and reliable geologic studies are 865,971 tons (containing 6.7 g/t of Au, 124.3 g/t of Ag and 14.34% of Mn).

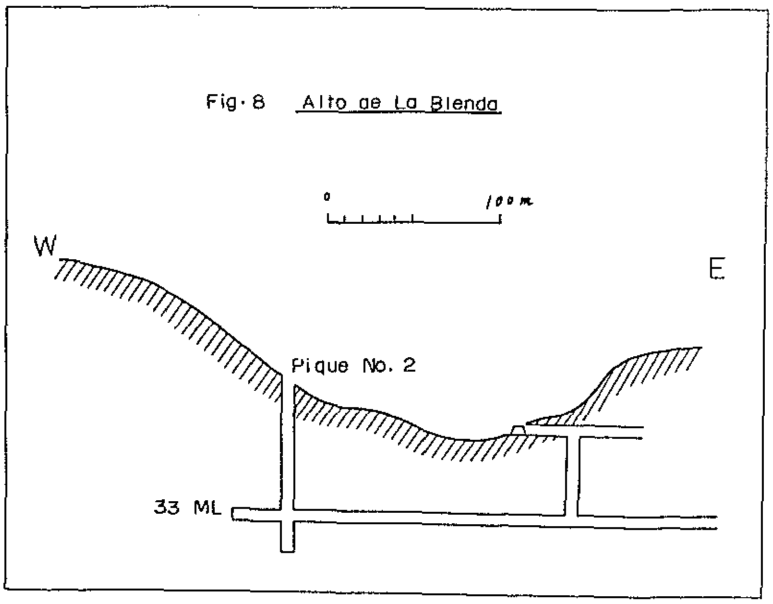
Explorations:

(1) Tunnels: (See Figs. 7 and 8)

Inclined shaft: No. 1 230 m Inc. 70° Farallon Negro vein
No. 2 40 m Inc. 70° Alto de la Blenda vein
No. 3 123 m Inc. 70° Farallon Negro vein

Fig. 7 Trabajos de Exploración Realizados En la Zona Central de Farallon Negro
Proyeccion Longitudinal-Vertical





Vertical shaft: 150 m Farallon Negro vein

(Notes: No. 1 and No. 2 shafts are now in use.

No. 3 is used for ventilation. The vertical shaft awaits future use.)

Total length of the tunnels:

Inclined and vertical shafts: 543 m

Horizontal tunnels: 4,500 m

(2) Machines:

5 compressors (75 HP), 5 rock drills (including 2 stoppers), 2 winches (25 HP), 4 generators (one 100 KVA, two 50 KVA, one 25 KVA), 7 cars, and others.

(3) Workers: 60 (including 10 staffs)

(4) Water:

No water is found in the neighborhood of the mine either on the surface or in the underground tunnels. Water is transported twice a day from a place 25 km away by a truck with a capacity of 5,000 liters.

Recommendation: This mine is one of the best-known mines in Argentine and has already been studied very well. Although it has been considered a manganese mine, the contents of precious metals should be estimated. It is recommended that exploitation should be commenced immediately starting from the part where the contents of precious metals are highest.

(6) MINA CAPILLITAS (Cu, Zn, Pb, Au, Ag and Mn)

Location: The mine is located at Capillita, Andalgala, Province of Catamarca. It is 56 km north of Andalgala by an unpaved road, and is 3,000 - 3,500 m above sea level. (See Fig. 6)

Owner: The mine is owned by the Dirección General de Fabricacines Militares.

History: The mine is known from olden days. In 1942 - 1945 the Fabrications Militares acquired the mining right and constructed one dressing plant and one roasting kiln. After a half year, however, operation was stopped, for the reason that the mine was not payable. All machines have been transferred to the sulphur mine in the Sarta Province and to the iron mine in the Jujuy Province, both belonging to the D.G.F.M., and only the constructions still remain there.

Geology and ore deposits: Granite is widely distributed in the area. Younger Tertiary volcanics, such as liparite, dacite, brecciated-tuff, etc., are also found as the main country of the ore deposits.

Many outcrops of oxide copper ore were found and mined already in the old times. Three main veins named "Veta Restauradora-1" (or "capillitas"), "Veta Calmeritas" and "Veta 9" were found under the ground. They are nearly parallel to each other, having an E-W to

N80°W strike and an almost vertical dip. Each of these veins is about 400 - 500m long, 50 - 60 m deep, and 0.5 - 0.8 m wide.

The veins consist of the following minerals:

Copper minerals; enargite, tetrahedrite, tennantite, chalcopyrite, bornite, digenite, etc.

Lead and zinc minerals; galena, zincblende, zinc-rhodochrosite, etc.

Iron-sulphide minerals; pyrite, marcasite, etc.

Manganese minerals; rhodochrosite, etc.

Gangue; quartz, barite, etc.

Ore reserves and grade: Fabricaciones Militares has already estimated the reserves and the grade on the basis of the excellent geological study, and the results, tabulated below, seem to be reliable.

Name of vein	Ore reserves ton	Width m	Cu %	Pb %	Zn %	Au g/t	Ag g/t
Carmelita	72,690	0.56	4.12	4.65	8.80	2.96	267
Capillitas	97,840	0.55	4.66	1.27	2.50	6.32	142
Veta 9	65,212	0.53	3.30	2.57	5.23	2.50	156
Total	235,743	-	-	-	-	-	-
Average		0.547	4.12	2.67	5.20	4.20	184

Dressing problem: The D.G.F.M., as mentioned above, gave up the flotation operation for the difficulties involved. The ores of the mine are of a rather complex nature, and it is very difficult to separate minerals of various kinds by a simple method of differential flotation. Dr. Kitaro HAYASE has already recommended in his report (June 1, 1960) that application of fluosolid roasting process or chlorination roasting process should be considered.

Mining possibility: This mine is one of the best-known mines in Argentine and has already been studied well. It is rather difficult to separate minerals of various kinds but copper content of the ore is high enough for exploitation.

(7) MINA CERRO RICO (Cu)

Location: The mine is located on the west side of Mt. Yutuyako (4,220 m), 28 km north of Potorero, Andalgala, Catamarca Province (See Fig. 6), and is accesible on horseback.

Owner: The mine is owned by Sr. Francisco Vera.

History: The mine is known from old times and was mined by a Frenchman until 1900. The present owner obtained the mine in 1948 but has not fully surveyed the area.

Geology and ore deposit: Granite is distributed in the southern part of the area, and schist and shale occur near the deposits. The country rock of the deposits is either quartz-porphyry or silicified liparite.

The mineralized area is not small, and indication of alteration (silicification, argillization, etc.) can be seen throughout the area. The center of the mineralizations is represented by impregnation of chrysocolla, atacamite, and rarely chalcocite and cuprite in quartz-porphyry. The central body is as large as 100 m × 100 m.

Ore reserves and grade: No estimate has been made, but the reserves seem to be no less than several hundred thousand tons. The result of chemical analysis (on the specimens collected by the mission and analyzed by the Nippon Mining Co., Japan) is as follows:

Sample No.	Total Cu. %	Sol. Cu %
1	9.69	9.56
2	0.97	0.95
3	4.31	4.20
4	4.58	4.52

Sample 1 was taken by the systematic sampling (one meter each) from the stock pile of about 350 tons. Sample 2 was taken by the horizontal channel sampling for a length of 8 m at the point about 15 m north of the mouth of the tunnel. Sample 3 is by the horizontal channel sampling for 7 m at the outside of the entrance of the tunnel. Sample 4 is by the horizontal channel sampling for 12 m along the southern wall of the tunnel.

According to the above, the grade of the stock pile (350 tons) seems to exceed 9% Cu, and the average grade of the central part of the impregnation is over 4% Cu. The oxide copper minerals are almost completely soluble.

Water: Water is obtained from the river 100 m below the central part of the mine.

Recommendation: The deposit seems to be of a porphyry copper type and the mineralization is strong. A systematic exploration is desired.

(8) MINA LOS RATONES (Pb, Zn)

Location: The mine is located at Fiambala, 51 km north of Tinogasta, Catamarca Province. To reach the mine, we take the national highway (Ruta 60) up to Fiambala, then go for 14 km by jeep, and 4 km more on foot or on muleback. The mine site is 2,350 m above sea level.

History: The mine was closed after a little work at the outcrops and underground.

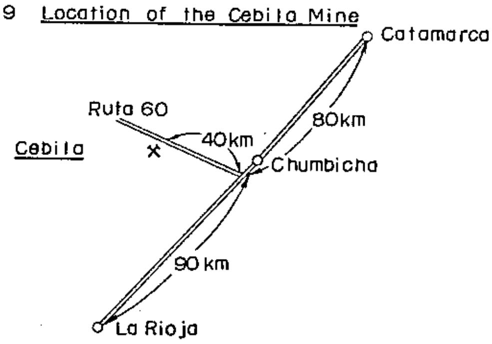
Geology and ore deposits: Leading rocks of the area are schists (mainly chlorite-sericite-quartz schist). Impregnation of galena and zinc-blende along the schistosity of the country rock makes the ore deposits of this mine.

Mining possibility: Possibility is small because the mineralization seems to be weak.

(9) MINA CEBILA (Sb)

Location: The mine is located at Chumbicha, Catamarca Province near the border of the La Rioja Province (See Fig. 9).

Fig. 9 Location of the Cebila Mine



This is one of the famous antimony mines in the area named "Grupo Minero Rumasupay" where numerous antimony mines are known. The mine site is about 1,000 m above seal level. Ore deposits are found on both sides of the road (Ruta 60).

Geology and ore deposit:

(I) There is an old mine office on the west side of the road, and an old shaft on the east side 50 m from the road. The rocks of this area are sandstones and quartzites, either sericitized or silicified, containing a small amount of pyrite impregnation which is brown in color, strike N-S and dips 20^{o} - 40^{o}W.

The outcrops reveal that the deposit occurs as a vein, 3 m wide, striking N 35°E, dipping vertically, highly sericitized and contains some stibnite (fine grain) and quartz. The old shaft which was sunk along the outcrop has collapsed. It is reported that the shaft was 30 m in depth with some horizontal tunnels but was abandoned because of much water and poor ore. There is a stockpile of about 5 tons (about 5% in Sb) at the mouth of the shaft. Some smaller veins and irregular lenticular nests with stibnite and quartz are found in the sandstone, but the amount is not very large.

(II) Another outcrop, 300 m northwest of the above-mentioned outcrop, shows network of quartz veinlets with fine grains of stibnite. It has a 10 m^2 extent but has no center of strong mineralization, hence there is no possibility of mining.

(III) There is another vein, 100 m northwest from the above-mentioned deposit, and has been prospected by open cut but the shaft is old and damaged now. The depth of the shaft was, it is reported, about 40 m, with an horizontal tunnel about 5 m long, but the ore was very poor. The rock here is dacite, different from the others. It seems that there were some rich ores here because some blocks of pure stibnite ore and yellow antimony oxide are found here.

Recommendation: As a characteristic of this type of deposit, occurrence of ore is very irregular. Therefore, it would be unwise to sink shafts or to furnish facilities only for one good occurrence of ore. Moreover, the ore would require some mechanical dressing which will be difficult for a small enterprise. There was no place worthwhile economical mining in the area surveyed this time. However, it may be better to consider to construct a central dressing plant or establish an ore purchasing center, in order to accelerate exploration and exploitation of the small mines of this area.

(10) LATERITE DEPOSITS IN MISIONES PROVINCE

Location and geography: Almost the whole area of the Misiones Province is covered with laterite, especially so in the western half of the province (100 km × 150 km). All roads in this area are unpaved but are fairly good except for some parts.

The area is situated between two rivers, Rio Parana and Rio Uruguay, and borders on Brazil in the southeast and Paraguay in the northwest. It is a vast plain with a small relief. Being situated in the subtropical region, this area has the precipitation about 1,600 mm/year (the amount is larger in summer than in winter).

The chief industry of the area is agriculture, growing "Tung" (to manufacture machine oil), tea-plants, corns, potatoes and oranges. Mining is performed only for limonite and building stones.

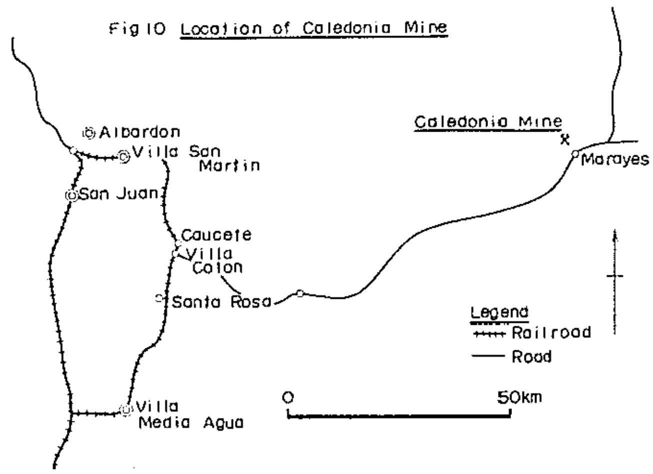
Geology and ore deposits: The surface of vastly distributed basalt has been lateritized due to the subtropical climate. However, the lateritization is not very intense. The thickness of the reddish soil bed is about 1 m (at Posadas) to 20 m (at Capiovi, about 200 km east of Posadas). The soil grades downward into greyish decomposed basalt. Occurrence of some bauxite was reported from a well at Capiovi. According to an old record, the Al_2O_3 content of the laterite ranges from 8 to 35%.

Conclusion: Generally speaking, laterite deposits of this area cannot be considered good aluminium resources because of the weak laterization. In the future, however, it is possible to find other deposits of better quality by geologic survey. At any rate, as far as the laterite deposits are concerned, this vast area is still in the stage of basic geologic investigations.

(11) MINA CALEDONIA (MARAYES) (Au, Ag, Cu, Pb, Zn)

Location: The mine is located at about 10 km north of Marayes, Caucete, San Juan Province. Marayes is 147 km east of San Juan city and can be reached by Ruta 20 or by the railroad. The mine has a dressing plant 4 km southeast of Marayes. The mine site is 700 - 800 m above sea level. (See Fig. 10)

Fig 10 Location of Caledonia Mine



Owner: The mine is owned by the Cia. Minero Los Marayes S.R.L., directed by Ing. Jose N. Sueyro.

History: The mine worked gold since 1855 but only for a short period. Later the mine was operated by D.G.F.M. for gold and zinc. In 1954, D.G.F.M. reopened the mine to work gold and zinc, but the present owner is operating it as a zinc mine.

Geology and ore deposits: Pre-Cambrian schists and limestones are the predominant rocks of the area. There are also some aplitic dikes seemingly related to the ore deposits. Several ore veins are known at the contact of the limestone and the aplite.

The ore veins strike generally N - S, and dip 60° - 70°E. The Veta Blanca, one of the leading veins is known to have a depth as large as 150 m. Other leading ones are Veta Azufre, Veta Calefornia, Veta San Rosa, Veta Crista, and Veta Blenda (See Fig. 11). The width of the veins is very variable, attaining to 5 m in maximum.

Ore reserves: At least 50,000 tons of ore are estimated for the veins investigated.

Activities: The present daily output is 10 tons from Veta Azufre and 20 - 25 tons from Veta Blanca, totalling 800 tons per month. The average grade of hand-picked ore is as follows: Zn 15%, Pb 2.8%, Cu 3.0%, Ag 300 g/t and Au 6 g/t. The mine is furnished with 6 rockdrills, 4 portable compressors (3 being 30 HP, one 70 HP), 3 air-hoists (10 HP) and others.

Dressing: A flotation plant is now being operated (See Fig. 12). Water is pumped up at a place 300 m from the plant. The concentrate is transported to Cordoba by trucks.

Generators: There are two generators, one is 100 KVA with 220 HP and the other is 50 KVA with 120 HP.

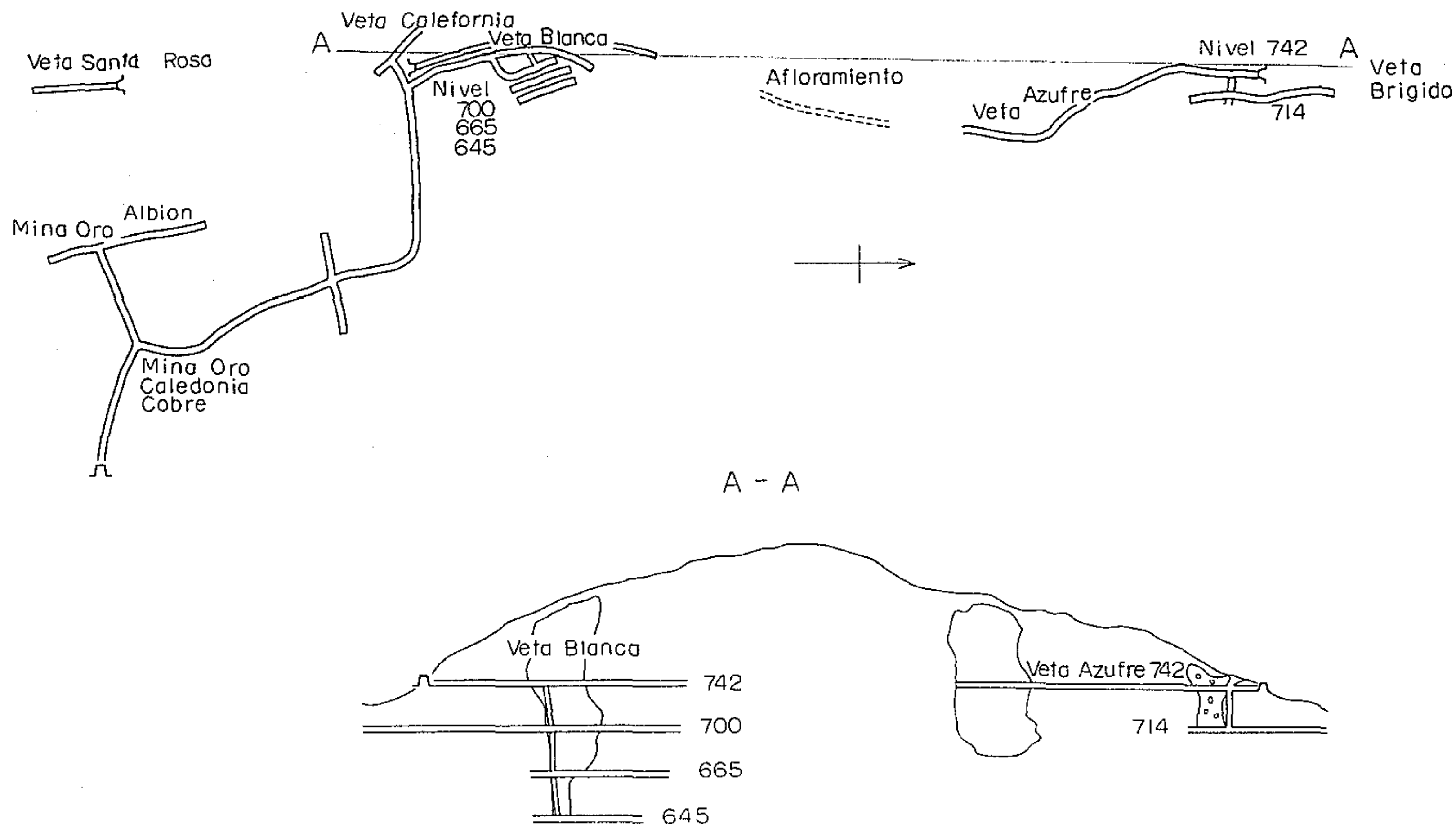
Workers: About 45 men in the mine and about 25 in the plant are working under a superintendent.

(12) MINA DISTRITO S. ESTEBAN (Au)

Location: It is 18 km west of La Farda on Ruta 38 from Cordoba. (See Fig. 13)

Geology and others: The deposit is an epithermal quartz vein in black schist near granite. The vein is 200 - 250 m long and 10 - 70 cm

Fig. 11



Veta Santa Rosa
A
Veta Calefornia
Veta Blanca
Nivel
700
665
645
Albion
Mina Oro
Mina Oro
Caledonia
Cobre
Afloramiento
Veta
Azufre
Nivel 742
A
Veta
Brigido
714
A - A
Veta Blanca
742
700
665
645
Veta Azufre 742
714

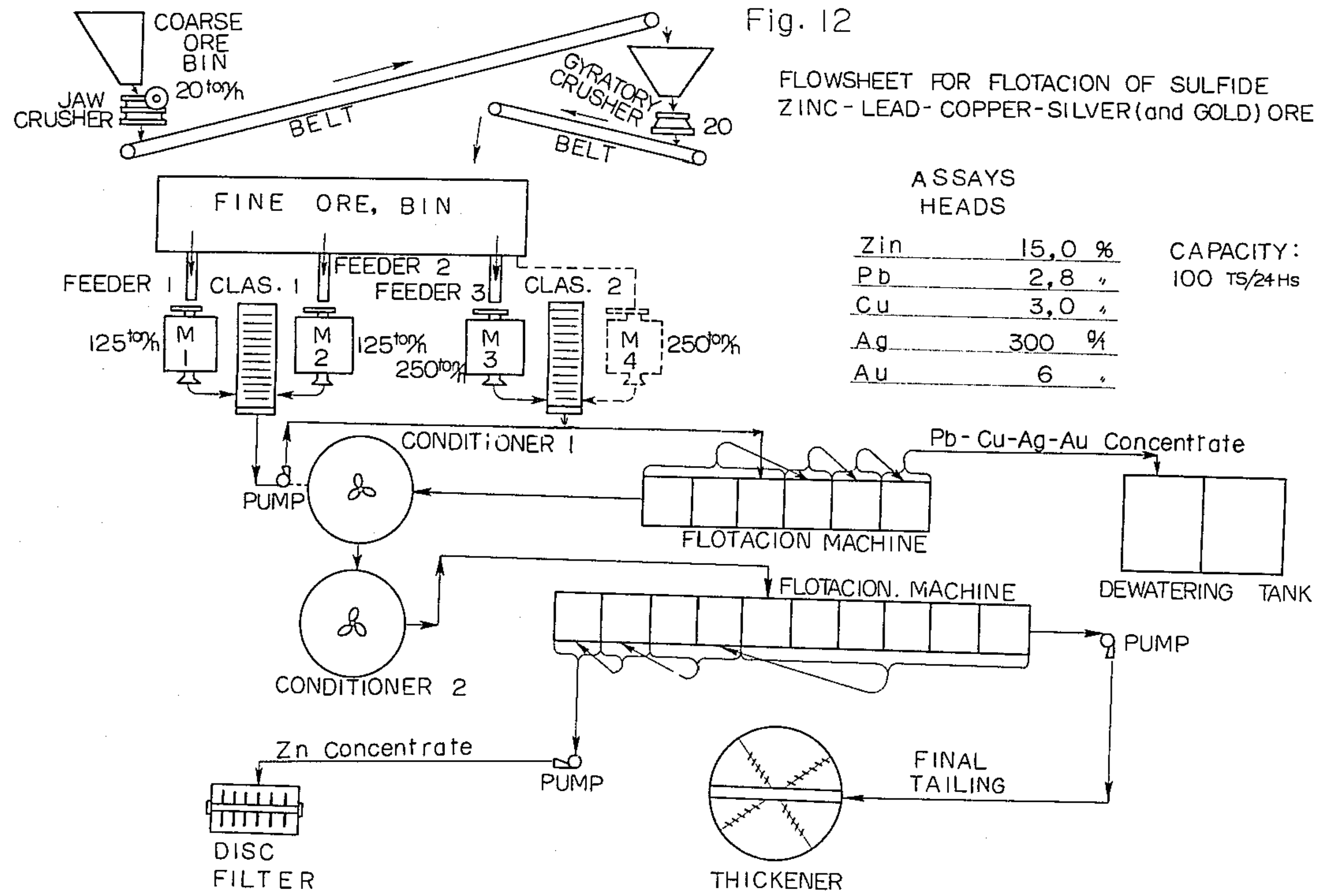
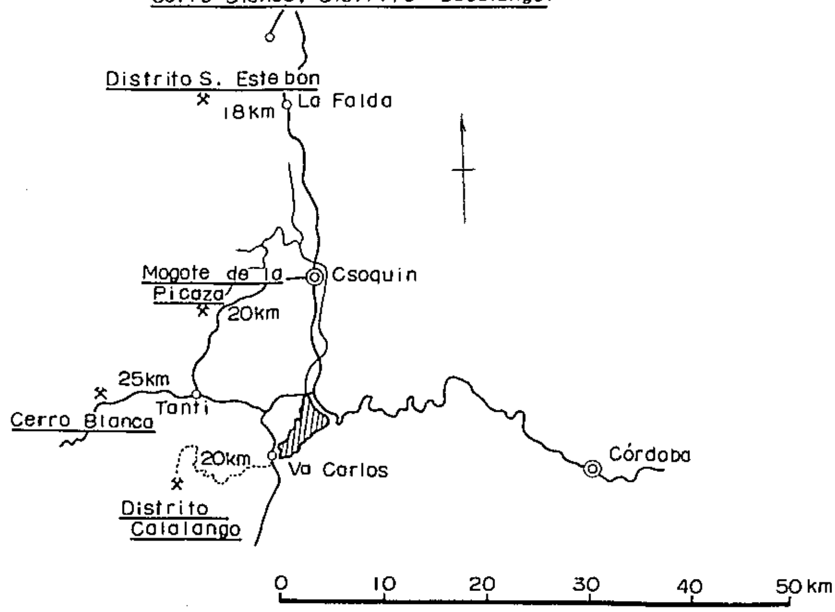


Fig. 12

FLOWSHEET FOR FLOTACION OF SULFIDE ZINC-LEAD-COPPER-SILVER (and GOLD) ORE wide, striking N 25° - 30°E and dipping nearly vertical. The grade of gold is low.

Fig. 13 Location of Distrito S. Esteban, Mogote de la Picaza, Cerro Blanco, Distrito Cabalango.



(13) MINA CERRO BLANCO (QUARTZ)

Location: It is 25 km northwest of Tanti, about 55 km west of Cordoba city, Cordoba Province. (See Fig. 13)

Geology and ore deposit: The main rock is granite, penetrated by some pegmatite dikes. The pegmatite dikes are 50 - 200 m long, 5 - 20 m wide, striking N 40° - 45°E and dipping 30° - 50° NW. These dikes are arranged at intervals of 200 - 500 m.

It is reported that the mine worked beryl in 3 or 4 places, but it is now working quartz.

(14) MINA MOGOTE DE LA PICAZA (W)

Location: The mine is located at Panpa de Olaen, 20 km west of Cosquin on Ruta 38 from Cordoba city, Cordoba Province. (See Fig. 13)

Geology and others: Paleozoic limestone (marble) and a batholith of granite are the leading rocks of this area. The deposit is of a contact type, occurring between the two rocks. At the contact, quartz, calcite, garnet, hedenbergite, epidote, and tourmaline are found. Scheelite for tungsten occurs rarely and in a very small amount, unrecognizable by the naked eye.

The size of the contact ore deposit is 20 m long, 3 m wide and 7 - 8 m deep. There may be 2 or 3 more deposits as large as this.

History and activity: The deposit was worked until 4 years ago, but the mining is now suspended. There is one washing plant having a capacity about 20 ton/day, with one crasher, tables and others.

(15) MINA DISTRITO CABALANGO (FLUORITE)

Location: It is 20 km southwest of Va. Carlos on Ruta 20 from Cordoba city (See Fig. 13), Cordoba Province.

Owner: It is owned by Dr. Chioti.

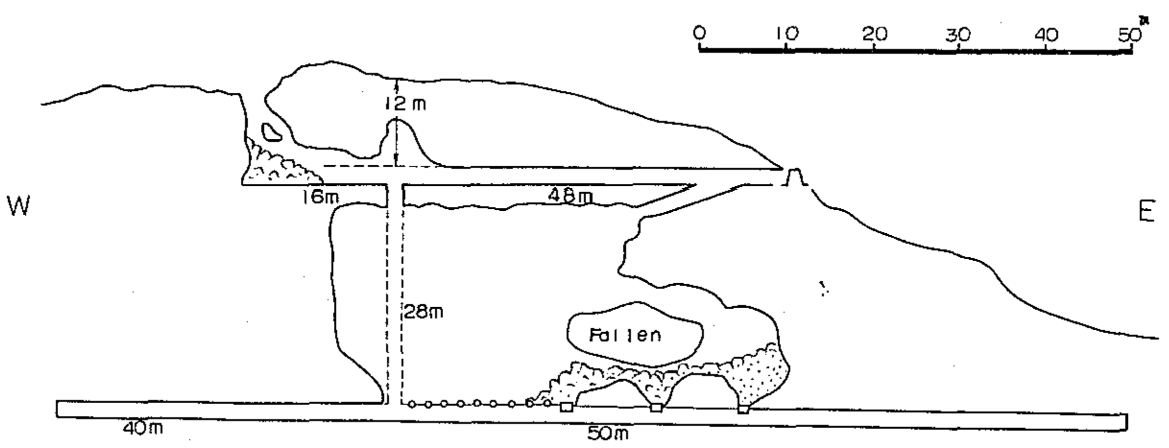
Geology and ore deposit: The deposit is a fluorite-calcite-quartz vein penetrating quartz-graphite-biotite schist. It is E-W in strike, 80° - 75°N in dip, 200 m in length of the outcrop, 130 m in length of the exploited part. 50 cm in average width, 2 m in maximum width. The main constituent of the vein is purple fluorite, accompanied by white (partially transparent), light-green, and bluish-violet fluorite, and small amounts of quartz and calcite.

The bonanza is 15 m in length, 1.2 m in average width and over 30 m in depth.

Ore reserves and grade: The reserves of the bases 100 m - 200 m in length, 50 m - 60 m in depth, 0.5 m - 0.7 m in width, and 2.5 - 2.7 in specific gravity, will amount to as much as several thousand tons.

Activity: The output of fluorite is 200 ton/month (65 - 70% in CaF_2), after concentrated by hand-picking from crude ore of 500 ton/month. It is mined by an underground tunnel (See Fig. 14).

Fig. 14

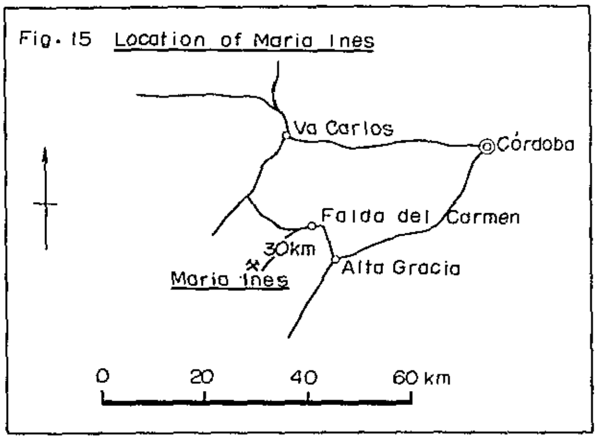


The machinery comprises one compressor (30 HP), one winch (electric, 15 HP), two rock hammers, and one generator (380 KVA). There are 15 workers. The price of ore is 8,000 - 8,500 pesos per ton in Buenos Aires. Transportation by truck from the mine to Buenos Aires costs 1,500 pesos per ton.

Mining possibility: The mine is not bad as a fluorite producer, although the area has not been fully surveyed as yet. Further geologic investigations are required.

(16) MINA MARIA INES (MICA)

Location: It is 30 km southwest of Falda del Carmen, Cordoba Province (See Fig. 15).



Geology and ore deposit: Precambrian sericite-graphite-quartz schist and pegmatite dikes are the leading rocks of the area. The schist strikes N-S - N 20°E and dips 45° - 60°W, similar to the general strike and dip of the metamorphic rocks of this district.

The general strike and dip of the pegmatites are N 70°W and 70°N respectively. The size of the pegmatite body which has been mined is 20 m in length, 50 m in depth and 5 - 7 m in width. Constituent minerals are quartz, feldspar and muscovite, with a small amount of beryl.

Muscovite is abundant in the outer part of the pegmatite and decreases toward the center. Mica is of very good quality. Another pegmatite body of this area has been explored for a mica deposit.

Activity: Output of selected muscovite is about 30 tons per month. Muscovite is exported to the U.S.A. The mine has 13 workers, with two rock drills and one compressor (30 HP).

Mining Possibility: Future prospect is good and further exploration is required.

(17) <u>MINA LOS CONDORES (W)</u>

Location: It is 10 km west of Concaran which is about 150 km northeast of San Luis, San Luis Province (See Fig. 16).

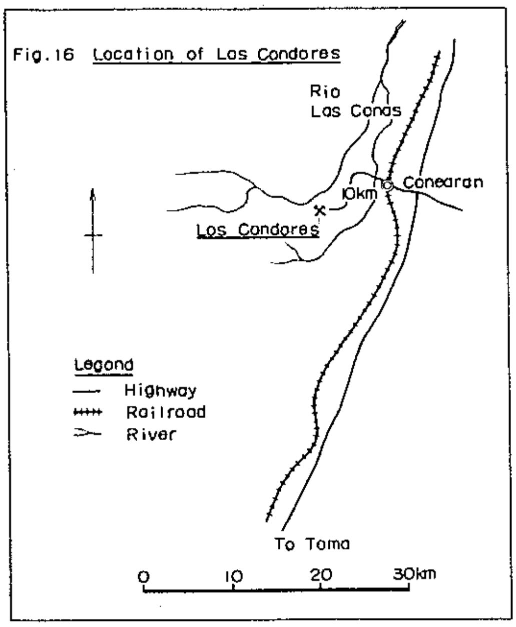


Fig.16 Location of Los Condores

Owner: The mine is owned by the Western Machinery Company (San Francisco, U.S.A).

Geology and ore deposits: Granodiorite and some metamorphic rocks are the leading ones of this area. The ore deposits are quartz veins in the sediments near the granitic rock. The veins, striking N 60°W, and dipping 55°S or vertical, are 2.5 km in length, 425 m in depth and 0.7 m in average width. The vein-forming minerals are wolframite, scheelite, chalcopyrite, pyrite and bismuthinite, with gangue minerals such as quartz and calcite. There is one main vein and others are smaller.

History and activity: The mine has been operated since 1937 and the largest production was recorded between 1952 and 1956, amounting to 9,000 ton/month of crude ore (0.7% WO_3). The operation has been suspended in 1962 due to ore shortage and grade lowering. There were about 80 workers at the mine site.

Underground mining has been performed by overhand stopping in the levels of 30 m each. There is one shaft at the center of the deposit.

The dressing plant has jiggers, tables, flotation systems, magnetic separation systems and other machineries, all being preserved in a state of perfection.

Mining possibility: As the mine area has been explored well, ore reserves and grade can be estimated. The mine is ready to reopen any time.

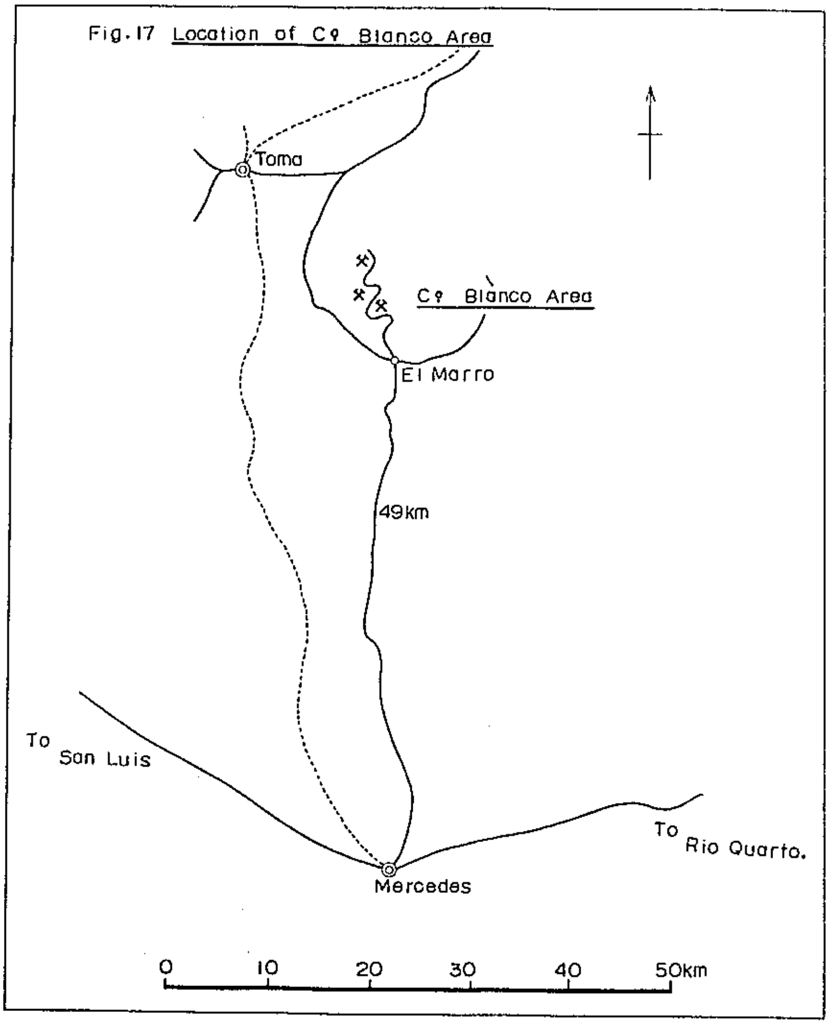
(18) TUNGSTEN MINES AT Cº BLANCO AREA

Location and others: The mines are located at about 100 km east of San

Luis city, San Luis Province or 4 km north of El Marro which is 49 km north of Mercedes on Ruta 7 (See Fig. 17).

There are several small tungsten mines which are being worked either by open-cut or underground mining.

General geology of the area: Rather strongly metamorphosed schists (sericite-chlorite-epidote-quartz schist, sericite-calcite-quartz schist, etc.) and granites (granite and granodiorite) are the leading rocks of this area. The schists, striking N-S or N 20°E and dipping to the west, are intruded by granites. There are some other tungsten-bearing quartz veins intruding these two rocks.



Geologic features of the mines: (1) Mina C° Blanco, owned by Mr. Mario Guernia. A scheelite-bearing quartz vein, intruding black schist, strikes N 65° - 70°E and dips 25° - 30°S. It is 2.5 m in maximum width, averaging 1.5 m, 15 m in length and 40 m in depth. The boundary of the vein is not sharp, especially at both ends.

Ore reserves may amount to about 10,000 tons. The ore grade is not high, probably about 0.5% WO_3 on an average, in spite of some rich parts as high as about 20% WO_3.

(2) A mine, name unknown. A scheelite-bearing quartz vein, intruding the schist near the granite, strikes N 60°E and dips 40°S.

The boundary of the deposit is not clear in its upper part where low-grade are occurs in network. At about 60 m down the dip, the deposit looks as if banded quartz veins have replaced the wall rock of the schist, where WO_3 is rich (probably 25% WO_3) with a width of 2 m. The length of the outcrop is about 300 m.

The reserves are not small but the grade does not seem very high, averaging 0.2 - 0.5% WO_3.

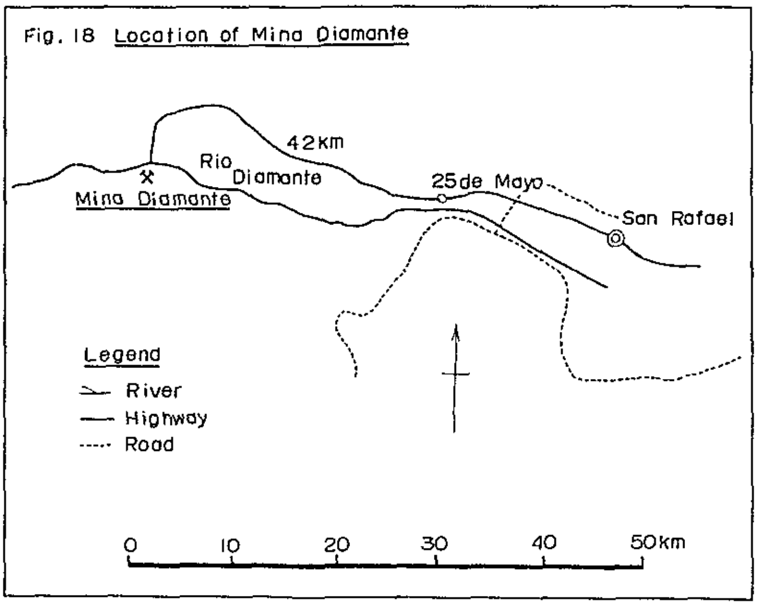
(3) A mine owned by the director of the Mining Bureau, San Luis Province. A tungsten-bearing quartz vein, similar to the one described in (2), is intruding the schist. The vein is 30 m in length, 30 m in depth, 2.5 m (maximum) and 1.5 m (average) in width. No estimate of the reserves has been made, but the value may be similar to that of (2).

Activity: The Mina Co. Blanco has a production of 150 ton/month of crude ore (0.5% WO_3). The machinery comprises two compressors (70 HP), one wich (10 HP), three rock drills and others. There are 20 workers, The mine has its dressing plant with a 3 ton/hour capacity, producing 3 - 5 ton/month of concentrates (65% WO_3) from the crude ore which is mined by the mine itself or bought from other mines in the area.

Mining possibility: This area is very hopeful as a tungsten producer. Construction of a central dressing plant is advisable. Further geologic exploration and study of mining methods are required.

(19) MINA RIO DIAMANTE (Pb, Zn)

Location: It is 52 km west of San Rafael, Mendoza Province, and 42 km west of the railroad station "25 de Mayo" (See Fig. 18).



Owner: The mine is owned by Pedro A. Muzzio.

Geology and ore deposit: The leading rocks of this area are metamorphic rocks and granites. The metamorphic rocks are mainly sericite-quartz-chlorite schist (weakly metamorphozed) and massive green schist of indistinct schistosity grading into the other schist mentioned above. The granite intrudes the schists, and is abundant in the eastern part of the area.

The ore deposits are fissure-filling quartz veins intruding these rocks. They are N 70°W in general strike, almost vertical in dip, 0.5 m in average width, 2.5 m in maximum width and 4,000 m in length. No record is available for the depth, but it seems to be more than 50 m. The width of the mineralized zone is about 15 m.

Ore-forming minerals of the oxidized zone (4 - 10 m) are mainly cerussite, a small amount of malachite, unoxidized galena, arsenopyrite and pyrite. In the sulphide zone under the oxidized zone, galena, spharelite, arsenopyrite and pyrite can be recognized.

There are two principal veins on the outer sides of the mineralized zone (15 m in width at the center) in which some small veins, 1 - 5 cm wide, can be seen. These two champion veins join into one vein at both ends which are about 300 m apart from each other. The north-eastern elongation of the vein is in the granite but is not very remarkable.

Ore reserves and grade: On the basis of an exploration with 12 test drillings in the lower central part, the reserves have been estimated at 100,000 tons. Since the area has not been fully explored, it is possible that the reserves would be larger.

The average grade of the oxidized zone is 5 - 7% Pb, 300 g/t Ag and 0.5% As.

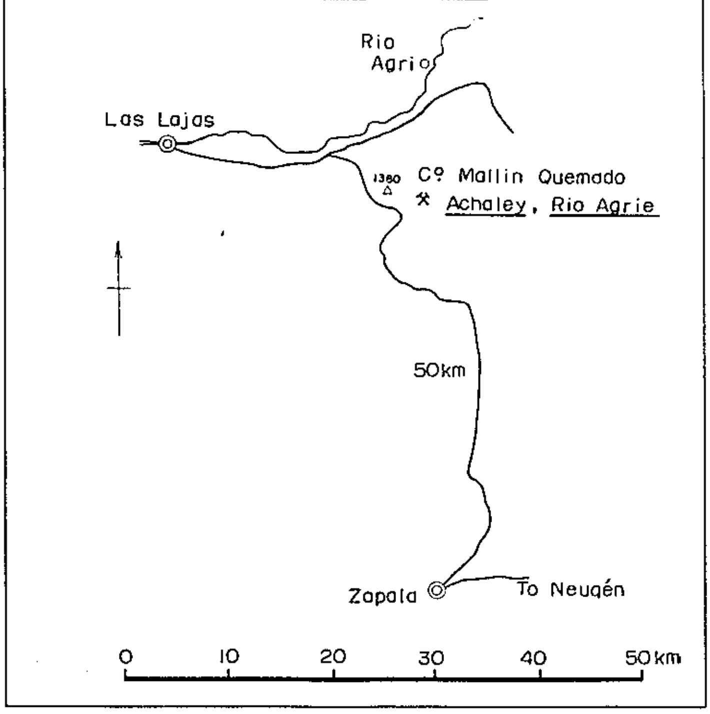
History and activity: The mine was formerly called Mina La Picaza. It has been mined since 1934 for cerussite at the outcrops by a gravity concentration system. In 1959, the operation was stopped because of increasing sulphides (galena, arsenopyrite and pyrite) in the ore. The plant is still preserved.

Mining possibility: Further exploration by drilling is recommended because sulphides in the lower parts are promising. The reserves will be increased to over 500,000 tons. A flotation system will be required when the mine is reopened.

(20) MINA ACHALEY AND MINA RIO AGRIO (BARITE, GYPSUM, Pb)

Location: Mina Achaley is located at Cerro Mallin Qurmado, 50 km north of Zapala, Neuquen Province (See Fig. 19). Mina Rio Agrio is situated at about 2.5 km north of Mina Achaley.

Fig. 19 Location of Achaley, Rio Agrio



Owner: The mines are owned by Togon Compania Minera Industrial (Tomas Gonzalez).

General geology: (1) Mina Achaley: The mine area is composed of an alternation of Tertiary tuff, sandstone, conglomerate and tuff-breccia. The alternation strikes generally N 50°E and dips 12°NW. Hydrothermal alterations (silicification, argillization and chloritization) are rather strong.

(2) Mina Rio Agrio: The leading rocks of the mine area are similar to those of Mina Achaley, but some limestones are found. General strike and dip are almost horizontal, and the mine is situated on the axis of an anticline.

Geologic features of the mines: (1) Mina Achaley: The ore deposit is of a complex type, consisting of barite-galena veins and massive barite-gypsum-galena replacement deposit. The champion vein (4 m in width, N 45°E in strike, 72°SE in dip) which is rich in barite occurs in the uppermost part of the deposit. About 30 m below, however, the deposit seems to become a massive body, several tens of meters in diameter, containing barite in the lower part and gypsum in the upper part. The barite deposit is very large (2,300 m in length, 5 m in average width, 120 m in depth) with a high grade (50% $BaSO_4$). The mine is now working this barite. Some lumps of aggregated galena are found occasionally in the barite mass. The gypsum deposit also seems to be large (150 m × 120 m × 50 m, according to the owner) and of a high grade. The gypsum ore contains much alabaster and its grade will be about 70% in $CaSO_4 \cdot 2H_2O$, i.e., about 30% in SO_3.

(2) Mina Rio Agrio: The ore deposit is a barite-quartz vein intruding the above-mentioned sedimentary rocks. The vein strikes N 20°E and dips 80°NW. Its width is generally 0.5 - 2 m, 6 m in maximum. The quality is lower than that of (1) because of quartz. The length along the strike is about 200 m. There are some accessory parallel small veins.

Ore reserves and grade: (1) Mina Achaley has its reserves about 2,400,000 tons in barite, (1,500 m × 5 m × 120 m × 4 × 2/3), and 600,000 tons in gypsum, (150 m × 120 m × 50 m × 2 × 1/3).

(2) Mina Rio Agrio has about 14,000 tons of reserves (200 m × 1 m × 20 m × 3.5).

Activity: Both mines are working chiefly on barite.

(1) Mina Achaley: The deposit 2,400 m long along the strike at the outcrop has already been known. Only the good parts are now being mined at the levels of 15 m each. Galena which is abundant in the lower part is hand-picked.

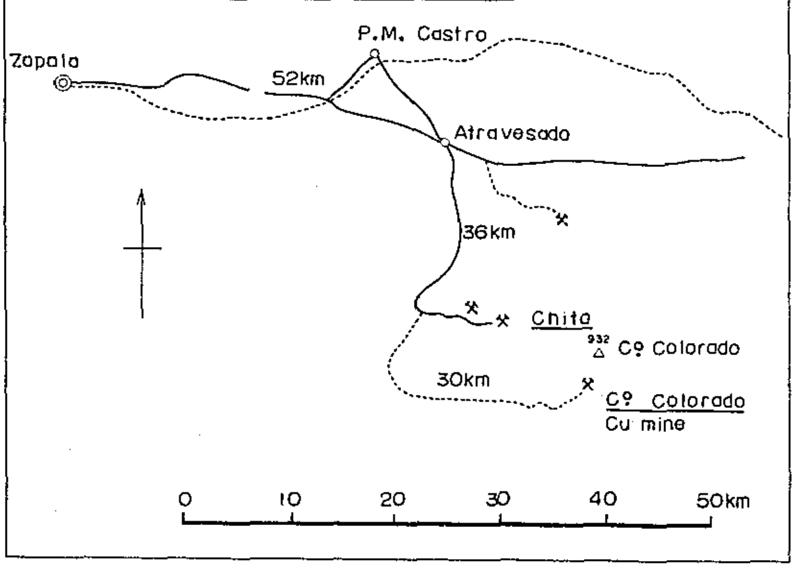
(2) Mina Rio Agrio: Overhand stopping is employed at 4 levels of 30 - 40 m.

Mining possibility: The deposits are large, good, and promising. For Mina Achaley which is now working underground, an open-cut mining is advisable.

(21) MINA CHITA (KAOLIN AND CLAY)

Location: The mine is located at Atravesado, Zapala, Neuquen Province (See Fig. 20).

Fig. 20 Location of Chita, C° Colorado



Owner: It is owned by Fulio C. Lopez Osornio and Fuan M. Galparsoro.

Geology and ore deposit: The mine area is composed of almost horizontally alternating Tertiary sandstone, tuff and conglomerate. The rocks are generally acidic and especially the tuff is liparitic. The clay deposit is an alteration product of the tuff.

The clay deposit shows three different colors, white, black and red. The white clay, consisting mainly of kaolin, constitutes the uppermost part of the deposit; it is 10 - 70 cm wide and pinchs out toward the north. The reserves of the white clay in the area seem to be about 25,000 tons.

The black clay bed which lies below the white one is about 2 m in width and is characterized by a grayish black color. It contains a considerable amount of iron and is useful only for brick manufacture. The part richest in iron is the red clay which contains over 5% Fe. The reserves of the black and red clays seem to be about 500,000 tons, 1/5 of which is of the latter.

Activity: Mina Chita is the only mine working in the area, producing 2,000 - 3,000 tons of clays per month. The clays are being used in Buenos Aires as ceramic materials.

Mining possibility: The white clay is the most important, but its amount is not large. Further prospecting for the white one is recommended.

(22) MINA Cº COLORADO (Cu).

Location: The mine is located at the foot of Mt. Colorado (982 m), Atravesado, Zapala, Neuquen Province (See Fig. 20).

Geology and ore deposit: The rocks of this area are almost horizontally alternating Tertiary sandstone and conglomerate.

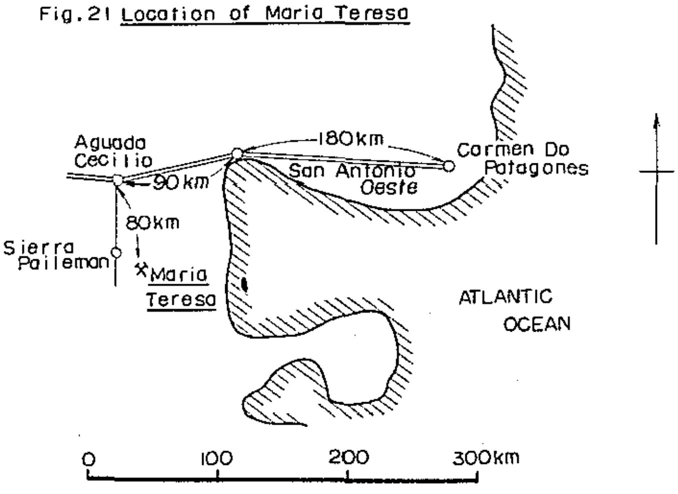
The deposit consists of copper oxides (malachite, azurite, etc.). The deposit is about 30 m × 20 m, with a width 10 - 15 cm, and the grade seems to be about 3% Cu. There are several places like this in the area of 200 m × 300 m.

The reserves are no more than 10,000 tons, with 3% Cu.

(23) AREA OF MINA MARIA TERESA (Pb) AND OTHER DEPOSITS (WO_3, FLUORITE, Pb, Mn)

Location: The area is on the boundary between San Antonio Department and Valcheta Department, Rio Negro Province (See Fig. 21). The eastern part, which is called Sierra Colorada or Sierra Paileman, with Mina Maria Teresa and other deposits, is a hilly land extending from east to west in an area of about 20 km N-S and 10 km E-W. This area, belonging to the northern part of the Patagonia Plain (Highland), is conveniently situated, but does not have sufficient water.

Fig.21 Location of Maria Teresa



Geology and ore deposits: This area is occupied mostly by older rocks such as granite gneiss, biotite schist, calcareous schist, etc. which lie almost horizontally.

Many small quartz veins cut these rocks along a large number of small faults. The veins, striking N-S or NE-SW and dipping almost vertically, have been found by test boring and trenching in the grassland. The mineralization does not seem very strong, and each of these veins contains different ores, such as lead, fluorite, tungsten, manganese, iron, etc.

The largest and most famous vein is known as Mina Maria Teresa (Pb), occurring in the crushed zone of the gneiss. The vein is 1 m wide, striking N-S with an almost vertical dip. The ore minerals are galena (partly accompanied by lead oxides and cerussite) and fluorite. The part rich in galena seems to form a rod-like bonanza. Fluorite is greenish white or pinkish, but its amount is small. The vein was explored by an open-cut 50 m long and 18 m deep.

The same vein has been explored at a point 100 m north of the above-mentioned locality, but the 20 m long cut has disclosed no good ore. There are some other veins named Mina Winca, 100 - 200 m west of the above vein, but the ore is poorer.

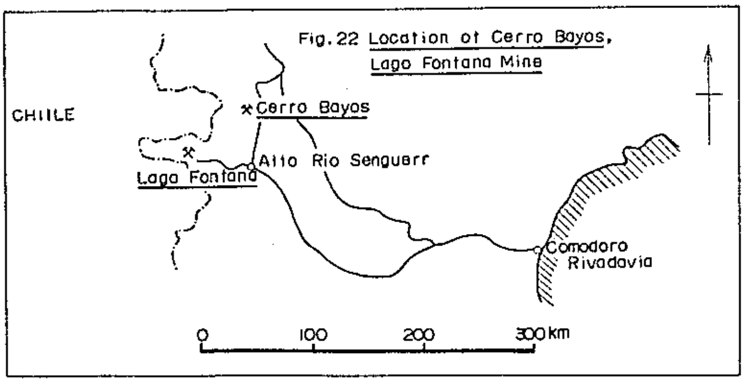
Many old prospecting pits are found in an area of about 5 km^2 centering on Mina Maria Teresa. Don Lalo and Don Clemente have small amounts of Mn, Fe and WO_3, Maria Reyna, Don Tito and Don Mario have pure fluorite, but the ore bodies are small.

Recommendation: The fluorite deposit in these areas is worthy of note although no good places have been found in the investigation this time. In order to promote exploration and exploitation of many small deposits, it is advisable to build a center washing plant where water can be obtained.

Other metalic minerals do not seem to be promising.

(24) MINA LAGO FONTANA (Zn, Pb and Cu)

Location: It is in the western part of Chubut Province, near the Chilean border (See Fig. 22).



To reach the mine site, we travel on the national and provincial roads for a distance about 350 km (only 50 km of which is paved) from Comodoro Rivadavia to Alto Rio Senguerr, then on a narrow road (passable by car) to Lago Fontana for about 55 km, and take a poor road, which is occasionally closed, to the mine camp 30 km away. The mine is 1 km from the mine camp, but the mine road is now impassable by car as abundance of fallen trees are blocking the passage. The trip from Alto Rio Sengueer to the mine camp takes 2.5 to 3.5 hours by car.

As the mine is about 1,200 - 1,500 m above the sea level, it is covered with snow, 40 - 50 cm thick, in winter when the temperature lowers down to about -5°C.

History and activities: The mine was explored a little with an English capital in 1942 - 1943 without success, and the mine camp (one house and one store) is still there. Many tunnels also remain in good condition except that water has accumulated at the mouths.

The mine area has no inhabitants but a few frontier guards.

Owner: The mine is owned by the Petroquimica Empressa Nacional.

Geology and ore deposit: The rocks of the area are andesite and andesitic tuff which are probably Tertiary in age, striking N 50°E and dipping 45° - 50°S.

There are two silicified zones, about 200 m apart from each other, trending N 60° - 65°E. The southern zone contains a network of Zn-Pb-Cu-bearing quartz veins which strike N 65° - 80°E with an almost vertical dip, and intersect other quartz veins.

Bonanzas rich in galena and spharelite are only about 30 cm in average width (1 m in maximum) and several meters in length. However, the mineralized area seems to be as large as 2 km in length and 2 m in average width (5 m in maximum). The extension of this mineralization reaches Chile.

In the northern part (lowermost part) of the tunnel, the ore deposit becomes poor, containing only barren quartz in network. However, at about 30 m above this place, there is the richest bonanza containing sphalerite, galena and a small amount of chalcopyrite. Some chlorite-bearing banded quartz is also found, but chemical analysis has detected no gold or silver. Many other places with small amounts of Pb and Zn are of less importance than the above.

(25) MINA CERRO BAYOS (KAOLIN)

Location: It is in the western part of Chubut Province, near the Chilean frontier (See Fig. 22).

The location is about 40 km west from a place 40 km north on Ruta 40 from Alto Rio Senguerr, and is about 1,200 m in elevation. The road to the mine is poor.

The mine area has no inhabitants.

History: In 1943, it was mined with an English capital, but the operation is suspended at present.

Geology and ore deposit: Conglomerate, sandstone and tuff-breccia are intruded by some dikes of liparite. Silicification and kaolinization are recognized in the sediments and in the liparite itself. The silicified zone is as large as 200 m × 300 m, but kaolinization is not very remarkable. A small amount of alunite is found but its economic value is negligible.

(26) ALUNITE DEPOSIT AT CAMARONES

Location: The alunite deposit is located at 270 km northeast of Comodoro Rivadavia which is 10 km west of Camarones, Chubut Province. The area is a plateau 300 - 400 m above sea level and is about 160 km^2. No large rivers drain the area but water is available in some low places.

Mine lots: The mine lots are Raya Corta, Bambi, Libertad, Tob., and Arazu group (Lucero, Vasija, and Victorio).

Owner: The lots belong to P.E.N. (Petroquimica Empressa Nacional).

Geology and ore deposit: Alunite occurs in the horizontally lying Jurassic beds. The ore-bearing part is a terrigenous deposit named "Porphyritica" bed, consisting of acidic tuff, tuff-breccia and brecciated quartz porphyry, in ascending order. The lower-most tuffaceous part is lead-colored, with silicification being noticed only in the pebbles. The silicification becomes stronger upward and the uppermost porphyritic part is hard and yellowish. This part is the so-called alunite ore, locally containing white powdery kaolin. The mineralized zone consists of aggregated boulders, accompanied by some limonite in the lowermost portion which is a 2 - 3 m thick reddish bed.

The genesis of the ore deposit may be interpreted as follows:

(1) First, tuff and tuff breccia were silicified and kaolinized.

(2) Aluminium altered to alunite, and silica formed hard rocks.

(3) The kaolinized portion was weathered and eroded away after peneplanation, and the deposit remaind in situ as a boulder-rich bed at the top of the hills.

(4) Iron went down and formed the Fe-bearing bed.

Ore reserves and grade: The reserves have not yet been estimated, but the amount seems to exceed several million tons.

According to the past record the grade of the ore is not very high (20% Al_2O_3, partially over 30%). It seems to be very difficult to mine selectively or to carry out dressing. The microscopical observation reveals that the ore also seems to be too hard to mill because the alunite has silica crust.

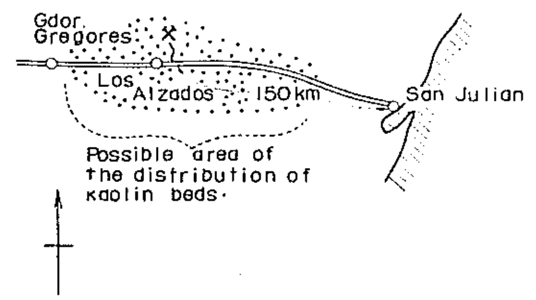
Recommendation: The alunite deposit is very large and its location is convenient for transportation. However, since the ore grade is not high and the ore is not easy to treat, it will be difficult to be economically exploited as aluminium resources.

Nevertheless, should the national policy requires its expoitation regardless of economy, it is advisable to prepare ore distribution maps immediately and to estimate ore reserves and grade. For this purpose, test pits and shallow drillings as many as possible, two mining geologists with several assistants, and a period of one year will be necessary.

(27) KAOLIN DEPOSITS IN SANTA CRUZ PROVINCE

Location and other: Kaolin deposits are distributed between San Julian and Gregores along the highway, Ruta 521, on the Patagonia highland in the central part of Santa Cruz Province (See Fig. 23).

Fig. 23 Location of the kaolin deposits



Some kaolin deposits which were investigated by the present mission are situated near "Estancia Esmeralda" about 30 km north of Los Alzados (150 km west of San Julian). The road to the mines from San Julian is not paved but good. The area is in the southern part of the Patagonia highland where the climate is cold all the year round. However, the area is relatively dry with occasional rain and snow, and is not too cold to do mining.

Geology and ore deposits: It is reported that the kaolin-bearing beds are Neogene Tertiary continental deposits. Details are not known because the area is covered with grass.

Activity: The mine area (about 500 m × 1,000 m) is a basin having a small relief of about 10 m. Mining is going on at two places, one of which is called "Camp 2".

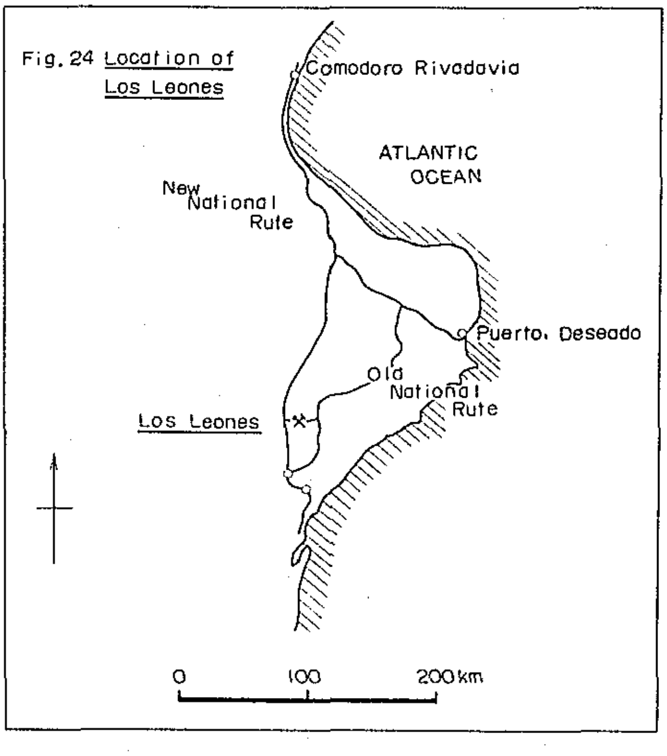
The Camp 2 deposit is being worked at a cliff for a length of 150 m making a 10 m high wall. The area of the old mine pits is about 150 m × 50 m. Good kaolin ore is found just beneath the ground surface or locally below the 3 m thick crossbedded sandstone. Open pits, trenches and tunnels are in operation. The thickness of the kaolin bed ranges from 1 m to 14 m or more. The ore is classified into 14 classes, and 100 tons of the best ore is yearly exported to Brazil, whereas ores of other classes are transported to Buenos Aires. The ore deposit, owned by a man in San Julian, is being mined by three workers.

Recommendation: The reserves of kaolin of this area seem to be very large, and the quality also is considered good, although no precise analysis has been made as yet. It is reported that water is available at a distance of 15 km from the mine. Thus, the area is worthy to be taken into consideration for exploration and exploitation. Further studies of geology and mining feasibility are recommended.

(28) MINA LOS LEONES (Cu)

Location: The mine is located between the old road and the new road (Ruta 3) near the east coast of the Santa Cruz Province, and is about 400 km south of Comodoro Rivadavia (5 hours by car) (See Fig. 24).

Fig. 24 Location of Los Leones



The area has little water, but the amount of rainfall is about 150 mm/year.

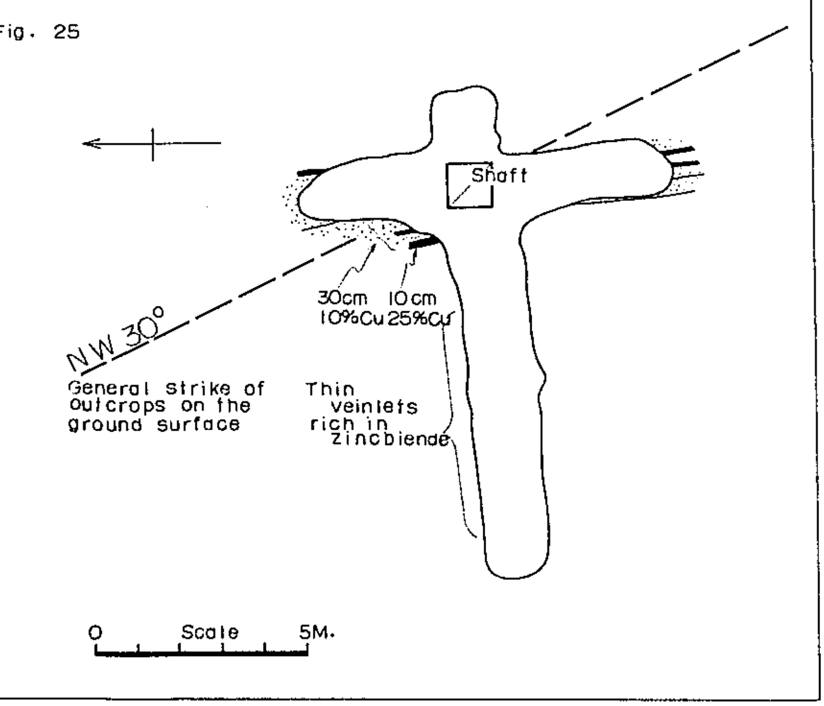
Owner: The mine is owned by the Petroquimica Empressa Nacional.

History and activity: The mine as explored about 20 years ago. In 1964, P.E.N. re-explored it with 21 trenches and one shaft which is 31.8 m deep and has a 20 m horizontal tunnel. One engineer and 4 workers are now staying at the mine sites, but the area has no inhabitants.

Geology and ore deposits: The leading rocks of this area are Precambrian granite and Jurassic porphyrite. Silicification is recognized near the ore deposits which are fissure-filling copper-bearing quartz veins. About 10 ore veins, 2 - 50 cm wide, occur as networks or parallel veins in the mineralized zone which extends 2,500 m in length (in N 50^{o}W direction) and 7 - 15 m in width.

On the surface, chalcocite, malachite and chrysocolla are found in the veins. In the shaft, about 30 m below the surface, the wall rock of soft granite contains much tetrahedrite and chalcopyrite, accompanied by some chalcocite and bornite, but copper oxides are smaller in amount. Pyrite is also common but not much. Some spharelite occurs in several accessory veins (See Fig. 25).

Fig. 25



Ore reserves and grade: The ore reserves estimated from the deposit 2,000 m in length, 50 m in depth, 2.0 m in width, 2.5 in specific gravity, and 1/3 in minable ratio, are as follows:

$$2,000 \times 50 \times 2 \times 2.5 \times 1/3 = \text{about } 167,000 \text{ tons}$$

Average grade seems to be 2.5 - 3.0% Cu.

Mining possibility: Outcrops of the deposit occur continuously in a row for a distance of about 2 km in the desert, but the oxide ore is small in amount and low in grade. However, at the bottom of the shaft, there is a rich ore with tetrahedrite, which must be an upper part of the deposit.

To determine the mining possibility of this deposit, it is advisable that the bottom of the existing shaft is explored further in the direction of the veins, and another shaft is sunk to prospect the other end of the veins. An extensive exploration by means of test boring is also desirable.

(29) MINA TRES CERROS (Cu)

The mine is located at 2.5 km west of the Mina Los Leones. Ore deposit is a fissure-filling quartz vein 15 cm wide, striking N 50°E with an almost vertical dip, containing small amounts of chalcocite, malachite and azurite.

Mining is not prospective as the scale of ore deposit is small (See Fig. 24).

(30) MINA LA ANGELITA (Pb)

It is located at 15 km (8 km in direct distance) west of the Mina Las Leones. Only a small indication of galena is found in a quartz vein intruding granite (or porphyrite). Not prospective (See Fig. 24).

(V) PRELIMINARY FEASIBILITY STUDY ON CONSTRUCTION OF ALUMINUM MANUFACTURING PLANT

(1) PREFACE

The present chapter deals with the calculation of capital investment in an enterprise in which alumina is first manufactured from alunite found in Chubut Province of Argentina, and then refined into aluminum by means of electrolysis.

Several preconditions are necessary for the existence of an aluminum industry. There must be, for instance, a background of supporting industries nearby, particularly the chemical industry.

In this connection Argentina is making strenuous efforts under its five-year plan to carry out development in various fields of industry.

We have made a tentative cost calculation as agreed in our discussions with CONADE, of the machinery and equipment for the various materials involved on the basis of Tokyo prices, which, we expect, will be converted by CONADE into that which would exist in Argentina at the time of realization of the project.

In this trial calculation, the unit cost of power is the factor which exerts a particularly strong effect. While CONADE indicated a unit cost of 1 peso (¥2.16) per KWH for power generation by means of natural gas, we have adopted ¥3.50, the current power rate in Japan. If the unit cost of ¥2.16 is applied, the cost of aluminum will be considerably reduced from that which is shown in this cost calculation to a level which can be deemed promising.

However, this estimate is not based on experiments with alunite ores of Argentina origin. Therefore, if further study is necessary, it will be advisable to conduct bench scale process experiments and, in the event the results obtained approximate the above premise, to study not only engineering problems but also commercial plant operation by pilot plant tests, before a final decision is made.

This report also contains an estimate of the pilot plant cost.

It would be advisable to survey the alunite deposits after the usability of the ore has been determined by tests.

While the cost estimate is made on the basis of 20,000 tons per year of aluminum, it also allows for scaling up to 30,000 tons.

(2) ALUMINA SECTION

The description of the results of the study on the manufacture of aluminum from alunite is divided into two cases: the Kali Process and the Ammonia Soda Process.

A. Kali Process for manufacturing alumina from alunite

a) Premises re material balance taken as cost calculation basis

(1) Ore composition

Al_2O_3	T-SiO_2	R-SiO_2	K_2O	Na_2O
24.0%	26.0	5.2	6.0	1.5
T-SO_3	F-SO_3	R_2O_3	Organic matter and combined H_2O	
25.0	18.0	3	14.5	

The above composition is based on the results obtained from samples collected by the study team sent to Argentina in 1964. The percentages of SO_3 and other components whose contents are unknown have been inferred from analytical values previously obtained.

Particularly important premises in the material balance are as follows:

(a) 20% of the total SiO is reactive SiO_2, and this is associated with the formation of zeolite.

(b) The portion of SO_3 other than that stoichiometrically combined with K_2O and Na_2O is taken as free SO_3, the whole quantity of which reacts with KOH.

(2) Taking into account Al_2O_3 loss during the manufacturing process and the grade of available ore, the requirements of said ore are calculated to be 5,850 kg/t Al_2O_3.

(3) Considering KOH loss due to zeolite formation and also during the manufacturing process and the amounts of KOH reacting with F-SO_3, the consumption of KOH is calculated at 1,950 kg/t Al_2O_3.

Taking the yield as 100% on the basis of purity, the yield of K_2SO_4 as a by-product is calculated at 2,929 kg/t Al_2O_3.

b) Premises re equipment

(1) Plant capacity is 40,000 tons per year of Al_2O_3 and the stream factor is 90%, making the standard production rate 5 tons of Al_2O_3 per hour.

(2) The cost of manufacturing equipment, including the plant, utility facilities, other necessary apparatuses and piping and wiring, cover only those parts which fall within the battery limits. It is made a condition that the ores be procured which have been crushed to adequate sizes for manufacture.

(3) There are spares for the main facilities, and operation, as a rule, will be on a continuous basis.

(4) Unknown local conditions and characteristics which have a bearing on plant construction have been inferred from the experience of the mission.

c) Premises for cost calculation

(1) The KOH electrolysis equipment, boilers, generators and potassium sulfate manufacturing equipment are listed as equipment cost items and included in the cost calculation. (However, the generator capacity is estimated at about 3,000 KW.)

(2) The prices are all based on those currently prevailing in Japan.

(3) The prices of by-products are credited in the cost calculation, on the basis of Japanese market prices less direct selling expenses.

(4) The entire quantity of the chlorine obtained as a by-product is sold, 45% as liquid chlorine and 55% as hydrochloric acid, and the proceeds are credited in the cost calculation.

(5) The price of purified K_2SO_4 is credited in the cost calculation, on the basis of Japanese market prices less direct selling expenses.

(6) The amount arrived at by adding the engineering and know-how fees to pure equipment costs is deemed as the total plant cost, and depreciation is carried on said total.

(7) Depreciation is carried for 12 years by the straight line method, with the scrap value taken as 10%.

(8) The repair cost is taken as 3% of the pure equipment costs.

(9) The engineering and know-how fees are estimated to total ¥650 million.

(10) Interest, taxes and dues are excluded.

d) Cost of required equipment

(1) These equipment costs are calculated on the basis of general estimates of the costs of the machinery involved, with the

addition of the costs of the following equipment:

Instrumentation	17%	of cost of machinery
Electricals	15%	"
Construction and civil engineering	40%	"

(2) In respect to the electrolytic plant, the cost is calculated from separate data.

(3) Cost of required equipment broken down into:

Process	Machinery	Instrumentation	Electricals	Construction & civil engineering	Total
Ore storage Crushing & digestion Separation of crude potassium sulfate Purification of potassium sulfate Precipitation & white mud separation Filtration and calcination Alumina silo Evaporation of mother liquor Boiler & utilities Plant office, repair shop, etc. KOH electrolysis plant	¥4,896-million	¥591.2-million	¥1,288.8-million	¥2,374-million	¥9,150-million

(4) Engineering and know-how fees

(5) Total plant cost

Equipment	¥9,150-million
Engineering and know-how	650-million
Total	¥9,800-million

e) Required personnel

(1) Alumina department
(2) Potassium sulphate department
(3) Caustic potash department
(4) Auxiliary departments
(5) Office personnel and administrative staff

Total: 550 men

f) Table 1. Cost calculation per ton of alumina by Kali Process

Item		Unit Consumption	Unit Price (¥)	Amount (¥)	Remarks
Raw Materials	Alunite	5.85 t	2,300	13,400	
	KCl	2.95 t	16,000	47,200	
	Power	5,200 kwh	3.50	18,200	KOH electrolysis, etc.
	Heavy oil (B)	0.72 kl	6,000	4,300	Boiler
	Heavy oil (A)	0.2 kl	6,000	1,200	Alumina baking
	Others			4,400	
Sub-total				88,700	
Labor	Personnel			9,900	550 × 60,000 ¥/man month
Sub-total				9,900	
Expenses	Depreciation			18,375	To be carried for 12 years with scrap value as 10%
	Repairs			6,870	3% of total plant cost
	Others			5,000	
Sub-total				30,245	
Total				128,845	
Less Prices of by-products	Liquid chlorine	0.56 t	26,300	-14,700	
	Hydrochloric acid (35%)	2.0 t	11,200	-22,400	
	K_2SO_4	2.5 t	11,800	-29,500	
	Power	600 kwh	3.50	-2,100	Private generation
Sub-total				-68,700	
Manufacturing cost				60,145	

B. Ammonia Soda Process for manufacturing alumina from alunite

a) Premises re material balance

(1) Ore composition

Same as in the Kali Process. Particularly important premises in the material balance are as follows:

(a) 20% of T-SiO_2 is R-SiO_2, and the R-SiO_2 becomes a component in the formation of zeolite.

(b) SO_3 other than those in which SO_3 is stoichiometrically combined with K_2O and Na_2O are F-SO_3.

(c) 80% of F-SO_3 reacts with NH , and the remainder is transferred with the residue to the soda process to react with NaOH.

(2) Al_2O_3

Taking into account Al_2O_3 loss during the manufacturing process and the grade of available ore, the requirements of said ore are calculated to be 5,850 kg/t Al_2O_3.

(3) NH_3

Considering the quantity of NH_3 which reacts with SO_3 and the NH_3 loss during the manufacturing process, the consumption of NH_3 is calculated at 430 kg/t Al_2O_3.

(4) NaOH

Taking into account NaOH loss due to zeolite formation and also during the manufacturing process and the amount of NaOH which reacts with F-SO_3, the consumption of NaOH is calculated at 540 kg/t Al_2O_3.

b) Premises re equipment

Same as those described in respect to the Kali Process

c) Premises for cost calculation

(1) Facilities such as NaOH electrolysis, boilers, generators and potassium ammonium sulphate manufacturing equipment are listed as equipment cost items and included in the cost calculation.

(2) The ammonia synthesis plant is outside the cost calculation and not included in the equipment cost, but ammonia synthesis is supplied at production cost.

(3) The price of potassium ammonium sulphate obtained as a by-product represents the weighted average of the price of ammonium sulphate and that of potassium sulphate; and the amount arrived at by deducting direct selling expenses from said weighted average is credited in the cost calculation.

(4) The cost items involved, prices of by-products, percentages of products from by-product chlorine in sales; the objects and methods of depreciation, repair costs, engineering and know-how fees, interest, taxes and dues are all the same as stated for the Kali Process.

d) Cost of required equipment

The conditions involved in the cost calculation are the same as described in the Kali Process.

(1) Cost of required equipment broken down into:

Process	Machinery	Instru-mentation	Electricals	Construc-tion & civil engineering	Total
Ore storage Roasting Crushing and treatment with ammonia Manufacture of potassium ammonium sulfate Digestion Separation of red mud Vacuum cooling Precipitation & white mud separation Filtration and calcination Alumina silo Evaporation of mother liquor Boiler & utilities Plant office, repair shop, etc. Electrolytic plant	¥5,173-million	¥706-million	¥1,070-million	¥2,500-million	¥9,449-million

(2) Engineering and know-how fees

(3) Total plant cost

Equipment	¥9,449-million
Engineering and know-how fees	650-million
Total	¥10,099-million

e) Required personnel

(1) Alumina department

(2) Potassium ammonium

(3) Caustic soda department

(4) Auxiliary departments

(5) Office personnel and administrative stall

Total: 550 men

f) Table 2. Cost Calculation per ton of alumina by Ammonia Soda Process

Item		Unit Consumption	Unit Price (¥)	Amount (¥)	Remarks
Raw Materials	Alunite	5.85 t	2,300	13,400	
	NaCl	0.87 t	4,300	3,741	
	NH_3	0.43 t	30,000	12,900	
	Power	2,300 kwh	3.50	8,050	NaOH electrolysis, etc. and other uses
	Heavy oil (B)	0.72 kl	6,0000	4,300	Boiler
	Heavy oil (A)	0.70 kl	6,000	4,200	Ore roasting and alumina baking
	Others			2,700	
Sub-total				49,291	
Labor	Personnel			9,900	550 m3n × 60,000 ¥/man·month
Sub-total				9,900	
Expenses	Depreciation			18,936	To be carried for 12 years with scrap value as 10%
	Repair			7,087	3% of total plant cost
	Others			5,000	
Sub-total				31,023	
Total				90,214	
Less Prices of by-products	Liquid chlorine	0.215 t	26,300	-5,656	
	Hydrochloric acid (35%)	0.776 t	11,200	-8,580	
	$(NH_4)_2SO_4$	1.26 t	15,000	-18,900	
	K_2SO_4	0.585 t	11,800	-6,900	
	Power	600 kwh	3.50	-2,100	
Sub-total				-42,136	
Manufacturing cost				48,078	

C. Comparison of Kali Process and Ammonia Soda Process

The major points of these two processes are compared below:

Item	Kali Process	Ammonia Soda Process
Manufacturing cost per ton of alumina	¥60,145	¥48,078
Plant cost	¥9,800-million	¥10,099- million
Required personnel	550 men	550 men
Production of by-product fertilizer	90,000-100,000 tons per year	90,000-100,000 tons per year
Kinds of by-product fertilizer	Potassium sulphate (K 40-45%)	Potassium ammonium sulphate (N and K around 13% respectively)
By-product chlorine	About 50,000 tons per year	About 20,000 tons per year
Power	26,000 kwh	13,000 kwh
Others		In addition, ammonia source of about 20,000 tons per year is required

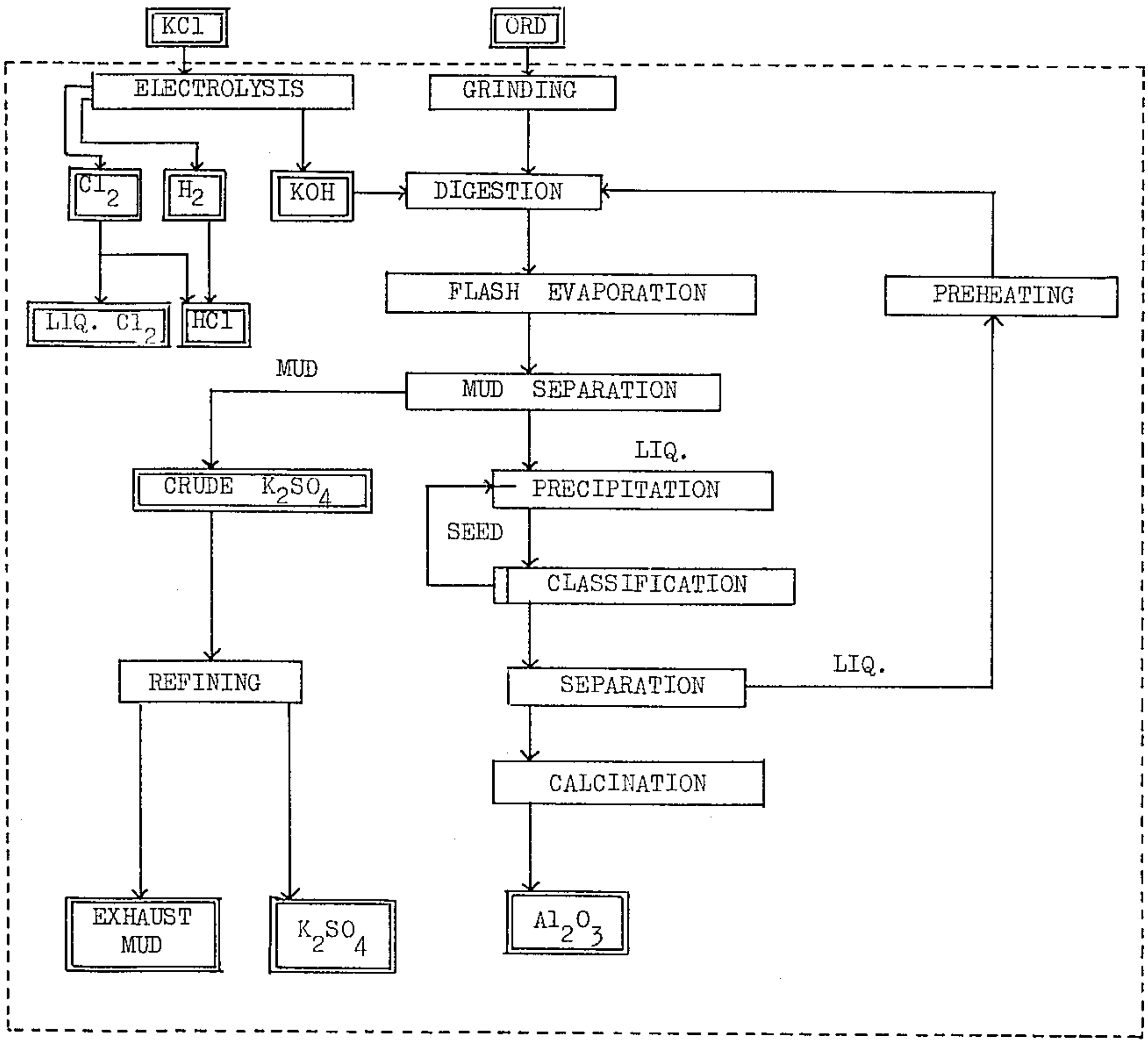
From the above comparison and the aforementioned different premises of the two processes, the Ammonia Soda Process is deemed more advantageous than the Kali Process in manufacturing alumina from alunite. Attached are the process flow sheets for the manufacture of Al_2O_3 by the Kali Process and the Ammonia Soda Process.

Process flow sheet 1 Kali Process

Process flow sheet 2 Ammonia Soda Process

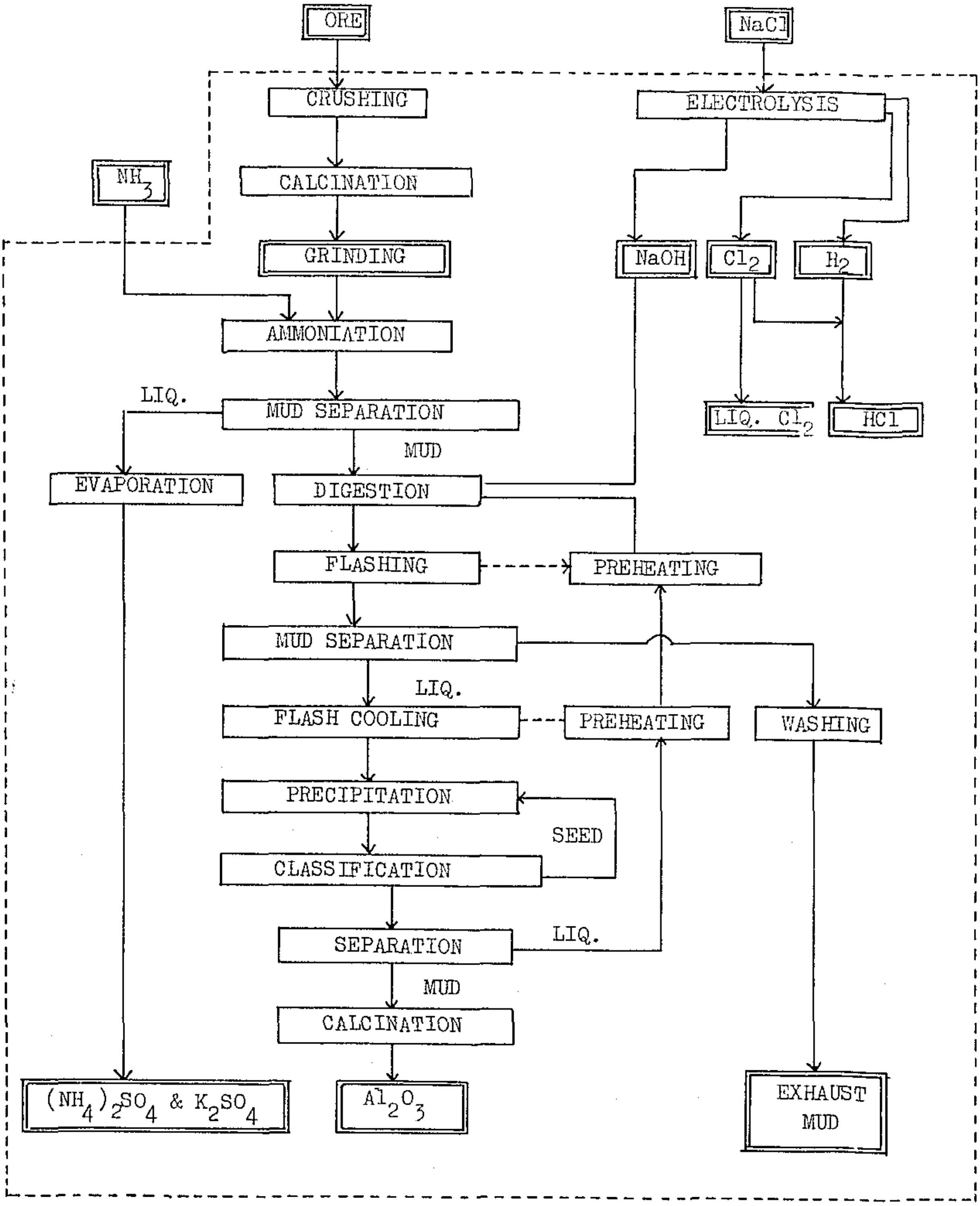
Process Flow Sheet 1

KALI PROCESS



Process Flow Sheet 2

AMMONIA SODA PROCESS



(3) ALUMINUM SECTION

Described below is the manufacture of aluminum from the aforementioned alumina by fused electrolysis.

A. Cost of alumina electrolysis equipment and aluminum produced thereby

a) Premises re equipment

(1) The plant capacity is on the basis of 20,000 tons per year of aluminum.

(2) The alumina used is manufactured from alunite by the Kali Process or the Ammonia Soda electrolysis and then cast into ingot.

(3) The equipment costs including the manufacturing equipment, utility facilities, other necessary apparatuses and piping and wiring cover only those parts which fall within the battery limits.

(4) Operation of the main equipment is on a continuous basis.

(5) With regard to electrical equipment, it is necessary to provide power receiving equipment with a capacity of more than 50,000 KW. However, a flat power supply must be obtained at all times due to the specific nature of fused electrolysis operations.

(6) The aluminum reduction plant is constructed adjacent to the alumina plant.

b) Premises for cost calculation

(1) The prices are all based on those currently prevailing in Japan.

(2) Depreciation is carried for 12 years, with the scrap value taken as 10%.

(3) Repair costs are taken as 3% of the equipment costs.

(4) Interest, taxes and dues are excluded.

(5) The per unit consumption of raw materials is estimated from the experience and records of the study team.

c) Cost of required equipment

The general estimates of the required equipment are based on experience and records relative to the construction of an aluminum reduction plant.

Equipment	Total (in ¥1-million)
Handling and transportation	200
Receiving and distribution of power	300
Convertor	1,080
Electrolysis	2,740
Gas disposal	250
Casting	220
Electrode manufacture	300
Others	200
Total	5,290

d) Required personnel 280 men in total

e) Table of cost calculation for aluminum castings

Following is a comparison of the cost of manufacturing aluminum castings, using Al_2O_3 produced from alunite by the Kali Process and the Ammonia Soda Process.

Cost item		From Al_2O_3 produced by Kali Process			From Al_2O_3 produced by Ammonia Soda Process			Remarks
		Unit requirement	Unit price (¥)	Total (¥)	Unit requirement	Unit price (¥)	Total (¥)	
Raw materials	Alumina	1,915 t	60,145	115,178	1,915 t	48,078	92,070	
	Cryolite	0.03 t	87,000	2,610	0.03 t	87,000	2,610	
	Aluminum fluoride	0.03 t	125,000	3,750	0.03 t	125,000	3,750	
	Anode paste	0.56 t	25,000	14,000	0.56 t	25,000	14,000	
	Power	17,500 kwh	3.50	61,250	17,500 kwh	3.50	61,250	
Sub-total				196,788			175,680	
Labor	Personnel			10,000			10,000	About 280 men at 60,000 ¥/month
Sub-total				10,000			10,000	
Expenses	Depreciation			19,838			19,838	Carried for 12 years by straight line method, with scrap value at 10%.
	Repairs			7,935			7,935	3% of equipment cost.
	Casting			2,500			2,500	
	Others			2,500			2,500	
Sub-total				32,773			32,773	
Manufacturing cost				239,561			216,453	

Note: If the power rate is estimated at ¥2.16 per KWH and the resultant reduction in the alumina cost is taken into account, the aluminum cost will be about ¥204,000 with the Kali Process and about ¥186,000 with the Ammonia Soda Process.

B. Conclusion

As a result of the foregoing studies it is concluded:

(1) The manufacture of aluminum using Al_2O_3 produced from alunite by the Ammonia Soda Process, is more advantageous than that manufactured by the Kali Process.

(2) The cost of manufacturing 20,000 tons per year of aluminum ingot by the Ammonia Soda Process is estimated at ¥216,453 (power rate: ¥3.50).

(3) The selling price of aluminum ingot should be determined by adding direct and indirect selling expenses and profit to the manufacturing cost.

(4) Comparison with the international price of aluminum .

The current international price of aluminum is about ¥200,000 per ton. If the aluminum market price in Argentina could allow for a 20% increase over the international level, the final selling price would be ¥240,000 per ton.

Since, as a result of study, the aluminum manufacturing cost is calculated to be ¥216,453 ton as above described, it is necessary that all direct and indirect selling expenses and profit be absorbed in amounts within the range of

240,000 ¥/T - 216,453 ¥/T = 23,547 ¥/T

The direct and indirect selling expenses are estimated from its records, to be about ¥10,000 per ton. On this basis, the profit per ton of aluminum would be ¥13,547.

Since the projected production is 20,000 tons per year, the total profit would be ¥270-million per year.

However, if experiments should be actually made in aluminum production starting with alunite of Argentine origin, there might be change in the premises for the material balance. Moreover, the cost calculation herein given does not include interest, taxes and dues. If there should be a change in the methods or factors of depreciation, the cost of said depreciation would vary accordingly. With regard to the conditions of Argentina related to the plant construction, there are a large number of unknown factors. Therefore further study should be made in full consideration of the fact that all the foregoing elements will combine to affect the manufacturing cost.

APPENDIX

Comparison of the costs of manufacturing 60,000 tons per year of Al_2O_3 in Argentina from alunite by the Kali Process and the Ammonia Soda Process

a) Increase in personnel requirements

(1) An additional 50 men are required, bringing the total to 600 men.

b) Cost of manufacturing Al_2O_3 by the Kali Process

Cost item		Amount (¥)	Remarks
Balance arrived at by deducting selling prices of by-products from raw material costs		20,000	Refer to previously given cost calculation table on basis of producing 40,000 tons per year of alumina
Sub-total		20,000	
Labor	Personnel	7,200	600 men at 60,000 ¥/man month
Sub-total		7,200	
Expenses	Depreciation	15,900	Carried on total equipment cost of ¥1,270-million by straight line method for 12 years with scrap value taken as 10%.
	Repairs	5,950	3% of equipment cost
	Others	5,000	
Sub-total		26,920	
Manufacturing cost		54,050	

c) Cost of manufacturing Al_2O_3 by the Ammonia Soda Process

Cost item		Amount (¥)	Remarks
Balance arrived at by deducting selling prices of by-products from raw material costs		7,155	Refer to previously given cost calculation table on basis of producing 40,000 tons per year of alumina
Sub-total		7,155	
Labor	Personnel	7,200	600 men at 60,000 ¥/man month
Sub-total		7,200	
Expenses	Depreciation	16,600	Carried on total equipment cost of ¥1,330-million by straight line method for 12 years with scrap value taken as 10%.
	Repairs	6,150	3% of equipment cost
	Others	5,000	
Total		27,750	
Manufacturing cost		42,105	

d) Comparison of the costs of manufacturing 40,000 tons and 60,000 tons per year of Al_2O_3

	Al_2O_3 Production		Balance (¥)
	40,000 tons per year	60,000 tons per year	
Manufacturing cost by the Kali Process	60,145	54,050	6,095
Manufacturing cost by the Ammonia Soda Process	48,878	42,105	5,973
Difference between manufacturing costs by Kali Process and Ammonia Soda Process	12,067	11,945	

e) Comparison of costs of manufacturing 20,000 tons and 30,000 tons per year of aluminum

	20,000 tons	30,000 tons	Difference due to amounts of production
From Al_2O_3 by the Kali Process	239,561 ¥/T	222,806 ¥/T	16,755 ¥/T
From Al_2O_3 by the Ammonia Soda Process	216,453 ¥/T	199,932 ¥/T	16,521 ¥/T
Difference due to the types of process	23,108 ¥/T	22,874 ¥/T	

Data relative to construction in Argentina of pilot plant for manufacture of Al_2O_3 from alunite

a) Premises re pilot plant

(1) The Al_2O_3 capacity of the pilot plant is taken as 1.0 ton per day.

(2) Al_2O_3 is manufactured from alunite of Argentine origin by the Ammonia Soda Process.

(3) The basic conditions of operating said process are the same as the premises re material balance in sub-paragraph a) under the heading of B relative to the manufacture of alumina from alunite by the ammonia soda process as described in the separate data: "Preliminary Feasibility Report on Construction of Aluminum Plant in Argentina."

(4) Facilities for manufacturing ammonia and caustic soda are not provided. These materials are purchased.

(5) Equipment such as heat exchangers, which are intended simply to ensure good economics, are not installed.

b) Premises for pilot plant cost

(1) Machinery and equipment required in the manufacture of Al_2O_3 are priced on an FOB basis.

(2) Consequently the cost of assembling and erecting such machinery and equipment at the site as well as the cost of constructing piping, foundation and buildings are excluded.

(3) Amounts are indicated in Japanese yen.

The costs of machinery and equipment to be imported are taken as totalling ¥147.1 million, including:

1) Equipment for crushing and roasting ores

2) Equipment for treatment ammonia

3) Equipment for dissolution

4) Equipment for filtering red mud

5) Equipment for precipitating white mud

6) Equipment for digestion and control

7) Equipment for calcining alumina

8) Utility equipment

9) Boiler equipment

10) Instrumentation equipment

Additional costs required in the completion of the pilot plant at the site, are roughly estimated at ¥43 million, bringing the total estimate of the pilot plant cost to ¥190.1 million.

In the following cases, however, some savings may be made on the machinery and equipment to be imported.

(i) In case dust collecting equipment related to ore handling and the digestion of mother liquor is eliminated.

Amount saved: ¥9 million, thus reducing the cost of imported equipment to ¥138.1 million.

(ii) In case equipment for calcining alumina and digesting and crystallizing ammonium sulphate solution is omitted, which elimination presents no technical problems as viewed from the principal purpose of the pilot plant.

Amount saved: ¥33 million, thus reducing the final cost of imported equipment to ¥105 million.

In addition, an amount of ¥19 million is required as engineering and know-how fees for the pilot plant.

Other matters:

Manufacture and delivery time of pilot plant machinery and equipment to be imported.

Prior to the design and manufacture of the pilot plant machinery and equipment, it is necessary to make basic bench-scale experiments using alunite of Argentine origin to study the various conditions which were taken as premises. A period of about six months is scheduled for the purpose.

Then the design and manufacture of the pilot plant machinery and equipment is undertaken in accordance with these basic experimental data. This requires another six-month period.

Consequently the pilot plant machinery and equipment will be completed and shipped in about one year after Argentina has made its formal decision on the installation of said equipment.

Remarks:

(1) Based on Al_2O_3 manufactured from alunite by the Kali Process, the cost of producing aluminum from said Al_2O_3 is calculated as follows:

Aluminum cost by the Kali Process (20,000 T/Y; power rate 3.50 ¥/kwh)		239,561 ¥/T
Final sales price of aluminum in Argentina		240,000 ¥/T
Direct and indirect selling expenses	about	10,000 ¥/T

Loss incurred per ton of aluminum sold

¥240,000 - 239,561 = ¥439

¥439 - ¥10,000 = -¥9,561

Therefore the total losses on the sale of 20,000 tons

-¥9,561 × 20,000 = -¥191,220,000

Thus the total losses amount to more than ¥191-million per year.

(2) Aluminum cost calculated with the power rate taken as 2.16 ¥/kwh

	20,000 t/y (¥/T)	30,000 t/y (¥/T)	Difference due to amount of production (¥/T)
Kali Process	203,367	179,539	23,728
Ammonia Soda Process	186,612	162,968	23,644
Difference due to the types of process	16,755	16,571	

Comparison of costs of manufacturing 30,000 tons per year of aluminum by different processes

Cost item		From Al_2O_3 manufactured by Kali Process			From Al_2O_3 manufactured by Ammonia Soda Process			Remarks
		Unit requirement (T)	Unit cost (¥)	Total (¥)	Unit requirement (T)	Unit cost (¥)	Total (¥)	
Raw materials	Alumina	1,915	54,050	103,506	1,915	42,105	80,632	
	Cryolite	0.03	87,000	2,610	0.03	87,000	2,610	
	Aluminum fluoride	0.03	125,000	3,750	0.03	125,000	3,750	
	Paste	0.56	25,000	14,000	0.56	25,000	14,000	
	Power	17,500 kwh	3.50	61,250	17,500 kwh	3.50	61,250	
Sub-total				185,116			162,242	
Labor	Personnel			8,064			8,064	About 336 at 60,000 ¥/month
Sub-total				8,064			8,064	
Expenses	Depreciation			17,590			17,590	Carried by the straight line method for 12 years with scrap value at 10%.
	Repairs			7,036			7,036	3% of equipment cost
	Casting			2,500			2,500	
	Others			2,500			2,500	
Sub-total				29,626			29,626	
Manufacturing cost				222,806			199,932	

Note:

(1) The aluminum reduction plant cost for the manufacture of 30,000 tons per year of aluminum is estimated by applying a multication power of 0.7 (commonly used in Japan) with the aluminum reduction plant cost for 20,000 tons taken as the base.

Thus,

20,000 T/Y aluminum plant cost × $(\frac{3}{2})^{0.7}$

¥5,290-million × $1.5^{0.7}$ = ¥5,290-million × 1.33 = ¥7,035.7-million

(2) The labor required for 30,000 tons per year of aluminum is taken as about 336 men, namely, the number of personnel about 20% over 280 men for 20,000 tons.

(VI) CONCLUSION AND RECOMMENDATIONS

The mission visited the mines described above and gained important knowledge on the mining in Argentine in spite of the limited time. Without the kind and active cooperation rendered by the Argentine Government and persons concerned, it would have been impossible for the mission to obtain the results as reported here within the period of only 75 days.

As mentioned in the chapter entitled "GENERAL VIEW OF THE MINING IN ARGENTINE", the mission ascertained that the country has a large potentiality of abundant mineral resources although most of them are still unexplored. The possible reason for this inactivity in mining have been given in this report. It is natural that the government of Argentine keenly feels the necessity of development of mines to meet the pressing national demand. It is our belief that the mining industry of this country will be promoted remarkably if supported by an appropriate policy of the government.

However, mining itself is a very difficult and risky industry as it requires a large capital and constant efforts in maintaining, as well as operating, mines for a long period of time. A big mine, especially, cannot be operated if these requirements are not satisfied. It is, furthermore, very important to keep in mind that a big mine is developed from a small mine, that is a small mine is also important as a bud of a big mine. In other words, development of small mines in Argentine has to be considered first.

Mentioned below are the mission's recommendations to the Argentine Government pertaining to the development of the mining industry in the country. The recommendations are based on the geological, technical and economical points of view. The mission will be glad to cooperate with the Argentine Government by doing whatever necessary and possible.

(A) Development of the small copper and other nonferrous mineral mines in the northwestern part of the country centering on San Salvador de Jujuy: -- This area, from the geological point of view, seems to have a large potentiality of copper and other nonferrous mineral resources although most of mines remain still undeveloped except for the "Mina Aguilar". The area will become one of the most important mining areas in Argentine in future as it is geologically continuous with the Bolivian mining area in the north and with that of Chile in the south.

The activity of the Cia. Cuprifera Argentina S.A. in San Salvador de Jujuy, producing some electrolytic copper, is small but important, as the company is the sole buyer of copper ore in this country. Therefore, the company can play a role of the center of development of minor mines, when the market of ore is the most important problem for small mines. In this respect, more attention should be paid to the company with its services to the nation, although the company is still very small and its location is unfavourable.

Here the mission recommends that the Argentine Government assists the company financially and technically in order to increase production, which will enable development of not only this company but also many other small mines in the country.

(B) Development of the area of "Capillitas" and "Farallon Negro", and other mines in Catamarca Province: -- The area of the two mines has been well known since old times as a promising area, the mission has ascertained that the mines are quite hopeful. As a matter of fact, it is hardy understandable why these two mines are not operated as yet, because any mine which has already been explored like these mines would be ready for exploitation and operation. Geological and mineralogical studies should be constantly carried out, keeping a close connection with production of ores. Besides, these two mines seem to be able to operate economically, one with copper and the other with gold. Manganese will be the next important product of both mines.

The mission is fully aware of the difficulty in dressing the ore of this kind. However, such complex ore as this is not rare in the world. Complex ores are found in Japan, too. In Japan such ores have been studied step by step for the past 80 years, keeping a economical production, and the study is still continued. Therefore, the mission recommends that the two mines should start exploitation as soon as possible, and the problem of dressing should be continuously studied along with the mining operation.

Moreover, it will be better to operate the mines, even if the operation is not economical, than to leave them as they are. Because, by operating the mines the nation can get supply of such minerals as gold, silver, copper and manganese, and also the mines will become the active center of this mineral province. The above-mentioned two mines, at least, should start operation immediately.

(C) Development of lead and other mineral deposits in Mendoza and Neuquen Provinces: -- The mission had a chance to visit the interesting mines of lead, gold, barite and gypsum near San Rafael, Mendoza Province and Zapla, Neuquen Provinces. (Refer to (19) and (20) in INDIVIDUAL DESCRIPTIONS OF THE MINES INVESTIGATED BY THE MISSION of this report.) These mines are highly prospective for development when provided with appropriate geologic studies.

The mission did not have enough time to study these mines and the surrounding area, but as far as our present knowledge goes, this area seems to have a large possibility of much more ore deposits of this kind. Therefore, a sufficient geologic survey will be required from the economic point of view.

(D) Problem of aluminium industry: -- The mission surveyed the alunite deposit in the Chubut Province and the laterite deposit in the Misiones Province, and obtained data necessary for a feasibility study on plant establishment, which was one of the important purposes of the present mission.

Both of the above-mentioned deposits are unsuitable as materials of aluminium industry. The mission recommended that, if possible, Argentine imports good bauxite to promote aluminium industry, and preserves alunite and laterite deposits in the country as future resources.

However, should the Argentine Government intend to use the domestic resources from the political necessity, the mission would like to make the following recommendations:

(1) A detailed geological survey of the alunite deposit in the Chubut Province should be made first, in order to find out the best place for exploitation, on the basis of the result of the mission's investigation on the ore reserves and grade. (From the geological and mineralogical points if view, the laterite deposit in the Misiones Province is not worthwhile consideration.)

(2) To process the alunite ore, laboratory works and operation

of a pilot plant are indispensable. Also, industrial problem involved in the operation of the pilot plant must be studied, and the workers must be trained for the plant operation.

(E) Development of kaolin and other clay resources in Santa Cruz and other provinces: -- As described in the chapter INDIVIDUAL DESCRIPTIONS OF THE MINES INVESTIGATED BY THE MISSION, the kaolin deposits widely distributed in the southern part of the Santa Cruz Province are very hopeful. The kaolin deposits may have a possibility of economical development, if provided with technicians and fund. It is desired that treatment of the ore and some industrial processes are performed near the mine.

The mission recommends further geological and economical investigations as soon as possible, since the mission did not have enough time for doing so. (Another special mission for kaolin and clay industry has been already dispatched from Japan to Argentine in March, 1965.)

(F) Problem of supporting small mines: -- As mentioned in the earlier part of this chapter, there is no doubt that a large deposit is found as a result of mining of many small deposits operated by some people working in inconvenient districts. It is an important fact that many of these small mines are continuously maintained and getting some profits.

After the investigations by this mission, it has become known that Argentine has a great many small but good deposits of such minerals as copper, lead, zinc, tungsten, fluorite, antimony, etc. These deposits, however, remain undeveloped, because of lack of capital and technique. Furthermore, economical value of individual deposits is not large enough to enable each mine to own an independent dressing plant.

Fortunately, these small undeveloped mines are situated close to one another, so it may not be difficult to establish one central dressing plant to treat crude ores collected from the neighboring mines, thus helping the development of the small mines. The mission would like to recommend the Argentine Government to consider this problem.

These are the mission's recommendations to the Argentine Government. Again, the mining industry in Argentine has a bright future, and it is necessary for the Argentine Government to take steps to develop the mines as soon as possible. In the meantime, the mission will advise the Japanese Government to cooperate with Argentine as much as possible.

Yoshikazu HORIKOSHI (D. Sc.)
Chief, Japanese Mining
Mission to Argentine, 1964

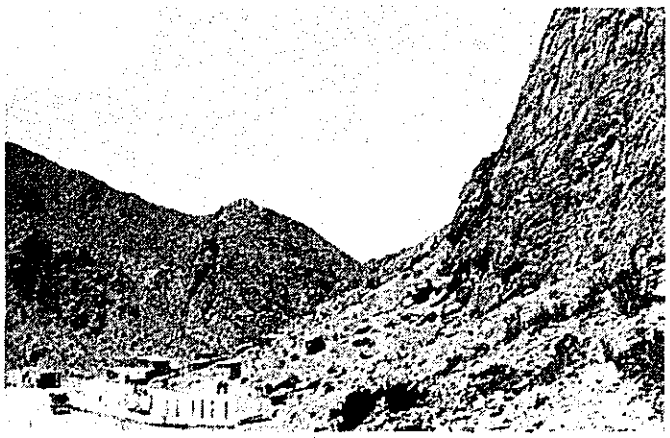


Photo. 1. Mina Farallon Negro, Catamarca Province; The ore vein, black wall in the righthand, goes to continue to the vein in the center.

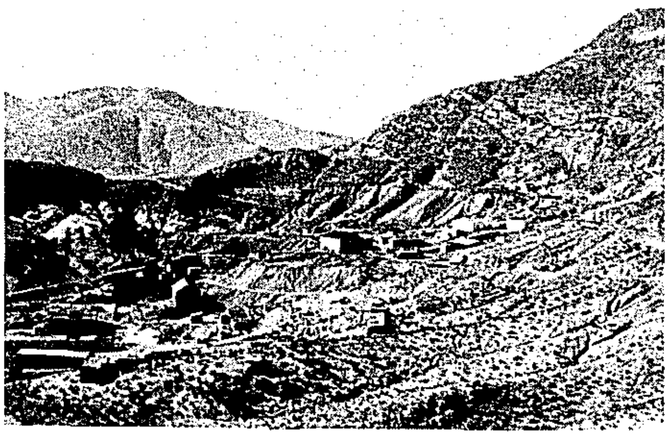


Photo. 2. Mina Capillitas, Catamarca Province; The ore veins are in the mountain righthand. Many houses have been still now kept very well.

Photo. 3. The outcrop of Rio Diamante Mine, Mendoza Prov. Only the oxide lead has been mined in the numerous tunnels. (See Page 45)

Photo. 4. Alunite deposit in Camarones. The upper part of the dotted line is alunite, and the under is asidic tuff or tuff breccia. (See Page 55)

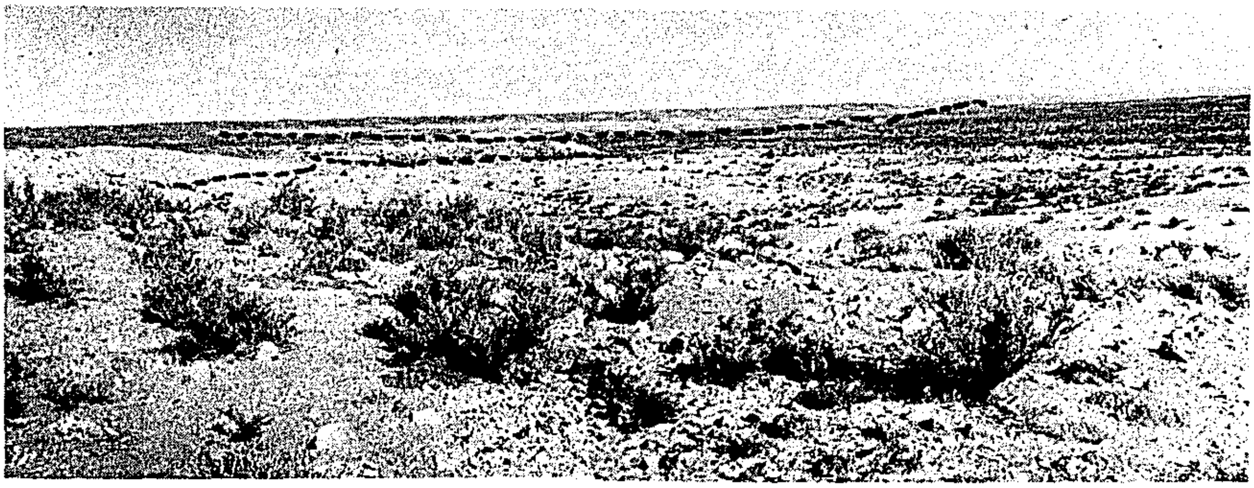
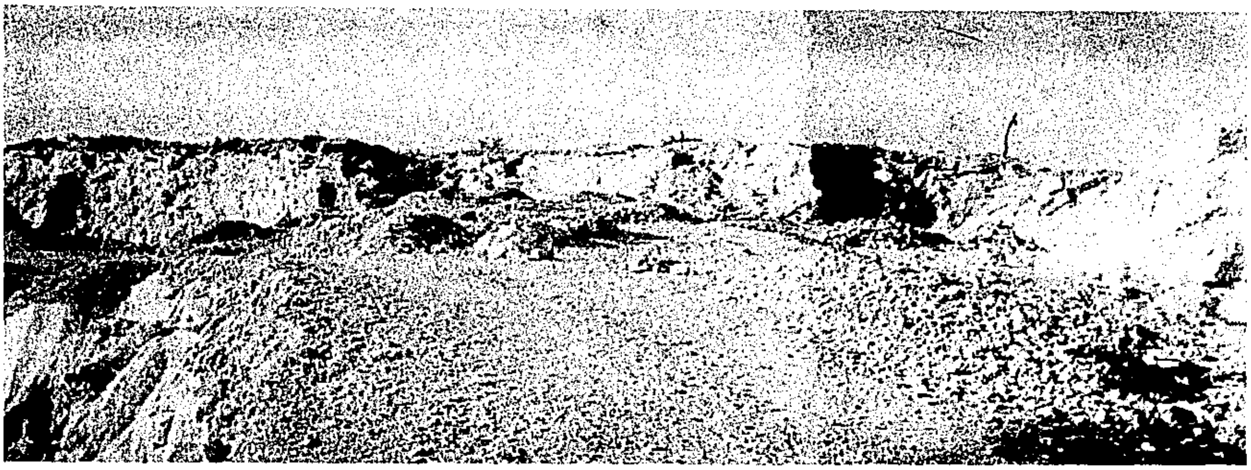
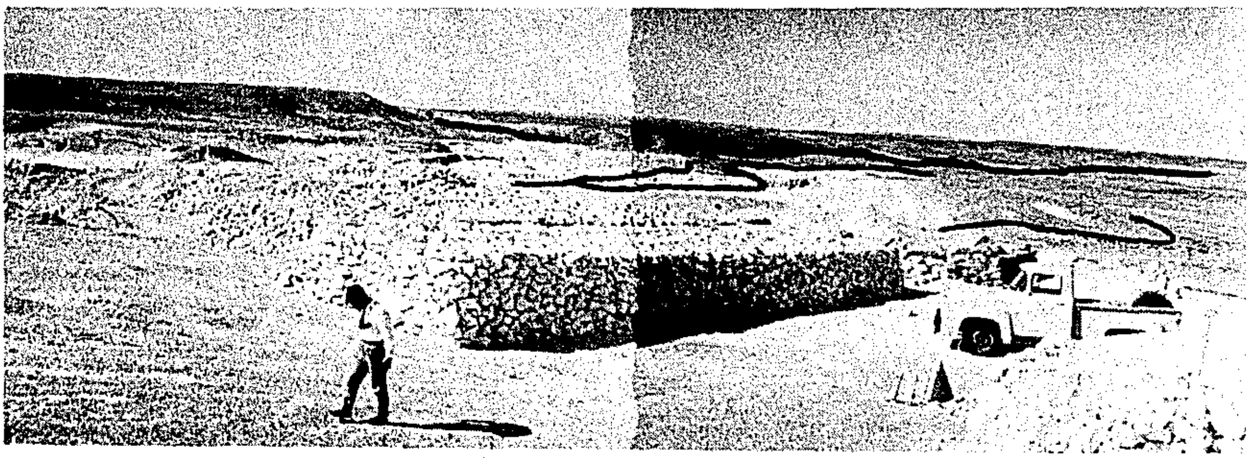


Photo. 5. The upper parts of the dotted lines are the alunitised zone in the vicinity of Camarones.





Photos. 6 & 7. Kaolin bed near Gregores, Prov. Santa Cruz.

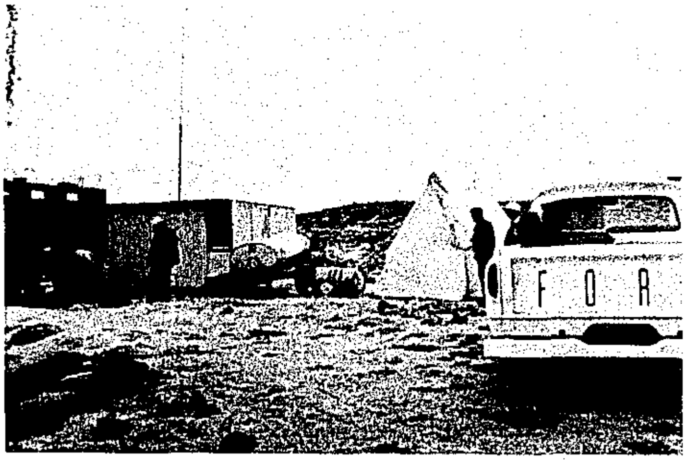


Photo. 8. The Camp of Los Leones Mine. The black house in the left hand is the radio hut communicating with Comodoro Rivadavia.