



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

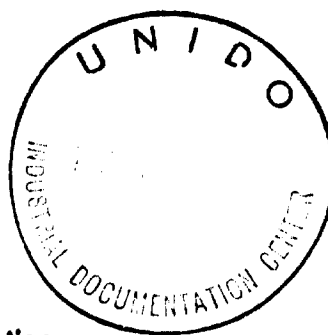
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org



201544



United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.74/8

17 August 1970

ORIGINAL: ENGLISH

Seminar on Copper Production and
Group Study Tour of Copper Plants
in the USSR

Tashkent, USSR, 1 - 15 October 1970

BRIEF ACCOUNT OF THE
COPPER MINING INDUSTRY IN CHILE ^{1/}

by

Ramón Eyzaguirre

Chief

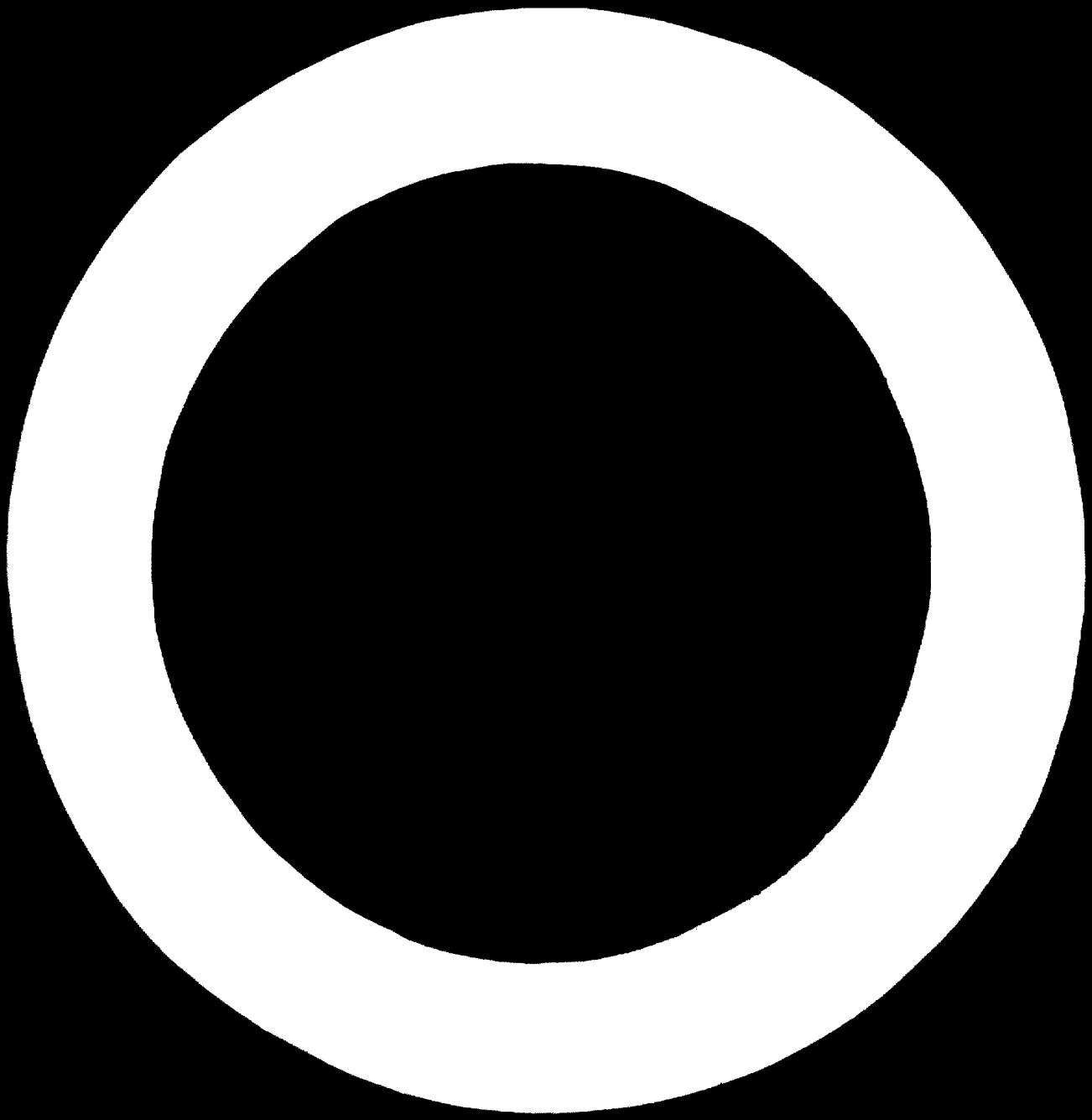
Department of Engineering
and Mines and Metallurgy
Copper Corporation
Santiago, Chile

(Background information paper)

^{1/} The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

Id.70-4495

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.



1. Historical Background.

Prior to the arrival of the Spanish conquerors in America, the aborigines of Peru and Northern Chile manufactured most of their tools and weapons from copper they hand-picked from the mountains. These aborigines did not know the uses of iron, so they took advantage of copper and its malleability. The ores they exploited were oxides with high contents of copper, especially native copper.

Copper mining in Chile did not substantially change at the arrival of the Spanish in the course of 16th. century, since they came mainly in search of gold and silver. However, as the population increased in the kingdom of Chile and a greater number of implements, weapons, tools and other copper objects were needed, this metal began to attract attention of businessmen and explorers who, along the 19th. century, started to work some important ore deposits such as Cerro Tamaya.

In the 1811-1820 period, the average annual output amounted to 1.500 tons. In the 1820 decade, the first reverberatory furnaces were installed in Chile, which meant a revolutionary change in the treating of copper ore, since they incorporated to the production process, those insoluble ores and large slag deposits with rich matte content, whose treatment was unknown at the time.

So, in 1860 copper production increased to 34.122 tons, Chile being the first copper producer in the world. This situation lasted until 1880, when the U.S.A. easily surpassed our country.

In the early years of the present century, electric power, oil and rapidly expanding mechanization appeared in a spectacular way in the world. Simultaneously, American capitals began the exploitation of large porphyritic ore deposits of low grades, which permitted Chilean output to reach an average of 200.000 tons per year in the decade of 1920. In that period, the Anaconda Copper Mining (afterwards The Anaconda Co.) and Braden Copper Co. were already operating, respectively, in Chuquicamata and El Teniente deposits.

These large American enterprises developed and exploited said deposits after a period of 60 years approximately. Besides, there was a proliferation of Small and Medium Size mining companies, in which the national interest predominated under the technical and financial assistance of the State through two of its institutions: Caja de Crédito Mincero and Empresa Nacional de Fudiciones.

They merged afterwards, thus creating the Empresa Nacional de Minería. Here may be found the origins of the constantly expanding copper mining in Chile, until 1968, when its production amounted to 726,000 tons of fine copper in their electrolytic, blister, precipitate and concentrate types.

The increasing importance of the Copper Mining industry in the nation's economy, made it advisable to create a national agency to control and supervise the copper producers and funnel state action in this area. And so in 1955 the Departamento del Cobre was set up. Later on in 1966, a new act broadened the powers of that agency and changes its name to Corporación del Cobre. This is an autonomous State agency and the main sectors of nation's economy are represented on its board, which enables the Government to coordinate in an efficient manner its policy towards the copper industry.

The present Government's decision has meant a direct participation of the Chilean State in the management of large copper producing companies through partnership. Thus the following joint-venture were created: Sociedad Minera El Teniente S.A., Compañía de Cobre Salvador S.A. and Compañía de Cobre Chuquicamata S.A., in which the Chilean State owns 51% of their capital stock. Furthermore Chuquicamata and El Salvador shall be owned entirely by the State in 1982 at the latest, as agreed by purchase of the remaining 49%. Besides, the State participates as minority stockholder in other enterprises recently created in order to develop new copper deposits.

Estimated reserves of copper in the world amount to 250,000,000 tons, of which 81,800,000 (i. e. a third) belong to Chile. At the production rate existing in 1968, our reserves would be consumed at a rate of 0,8% per year, one of the lowest among large copper producers in the world: in the U.S.A. it is around 4% per year.

This fact, and the extraordinarily high prices of copper in the last 6 years made it advisable to expand our copper output through the expansion programs promoted by the Chilean Government, which are about to bear fruit. This expansion will result in an output of approximately 1,200,000 tons of fine copper in 1972, which means almost twice the output of 1968.

In the international field, Chile, Congo, Perú and Zambia constitute the principal group of producing and exporting countries in the world, which led to the recent constitution of the Inter-Governmental Council of Copper Exporting Countries (CIPEC). The objectives of this organization are to unify the commercial policies of its member countries and at the same time to foster technical exchange among them.

Towards 1972 Chile will have recovered the relative position which it held during the 1930 and 1940 decades, producing around one half of the output of CIPEC group and taking second place in the world as copper producer, followed by the Soviet Union, Zambia and Canada.

2. Copper Mining Companies in Chile. -

2.1 Classification. - The Chilean legal system establishes the existence of three types of producing companies in the country:

a) Large Scale Mining Companies: Those producing no less than 75.000 metric tons of metallic copper per year (blister, fire refined or electrolytic copper in any of its forms) through exploitation and treatment of their minerals produced within the country by the companies themselves or their branches or associates.

b) Medium Scale Mining Companies: Those whose actual production capacity is below 75.000 metric tons as defined in paragraph a) above and whose equity capital is over a certain minimum established in the law, and which at present is around US\$ 35.000. -

c) Small Scale Mining Companies: those whose equity capital is below the one indicated in paragraph b) above, provided they are not set up as stock companies.

The above classification has been established with regard to taxation, according to which, small-scale enterprises are entitled to special franchises.

2.2 Large Copper Mining Industry. - The principal copper mining enterprises are:

2.2.1 Chuquicamata: This ore deposit is situated in the Atacama Desert, Province of Antofagasta, in the foot hills of the Andes range, at an approximate altitude of 2.900 meters above sea level.

Systematic exploitation of this deposit began in 1915, with a production capacity of 45.000 tons per year of oxides. In 1952 the Sulphur Plant began its activities, its purpose being the treatment of insoluble ores, which increased as the deposit was deepened.

The mine itself is exploited with the open pit system. The quarry is 3.200 meters long and 1.250 meters wide at its northern end, being, therefore, the largest mine of its type in the world. Its ore deposit may be estimated at 3.000.000.000 tons of ores of 1,25% grade of copper contents.

At present its output amounts to around 290.000 tons of fine copper per year, of which 60.000 tons blister and 230.000 electrolytic types. In 1972 its estimated output will amount to 390.000 tons, of which 312.000 electrolytic.

The ores being treated at present are sulphides, which made the primitive facilities for treating oxides, obsolete. However, the recent start of operations at Exótica will permit the utilization of said facilities again, since its oxides can be treated by leaching and further electro-winning precipitation process.

On January 1st., 1970, Compañía de Cobre Chuquicamata began operations as a joint-venture, in order to continue the exploitation of the deposit and the industrial facilities of Chuquicamata, in place of Chile Exploration Company, a subsidiary of The Anaconda Co.- 51% of the capital stock of the new company belongs to Corporación del Cobre, in the name of the Chilean State. The remaining 49% of the capital stock belongs to The Anaconda Co. Nevertheless, and as agreed, Chile is to buy said 49% after December 31, 1972, and before January 1st., 1982.

2.2.2 Exótica: This oxide deposit is located 2 kilometers from Chuquicamata mine. Its operation began in June 1970. The open pit exploitation, now free from the overburden, will finally produce a total of 112.500 tons of fine copper per year by treating 1,35% grade ores in the old facilities of the Oxide Plant of Chuquicamata. Its estimated reserves amount to 150.000.000 tons.

Compañía Minera Exótica, which owns and exploits the deposit, was established as a joint venture in which Corporación del Cobre owns 25% of the shares; the balance belongs to Chile Copper Co., an Anaconda subsidiary.

2.2.3 El Salvador: This deposit is situated in the high Andes range, at an altitude of 2.600 meters above sea level and 150 kilometers North West of the port of Chafaral.

In 1925, Anaconda's subsidiary Andes Copper Mining Company installed a Metallurgy Plant as well as a smelter and related facilities for treating oxides and sulphides from the Potrerillos deposit, 20 kilometers from El Salvador.

Afterwards, in 1959, it was necessary to close the mine due to exhaustion of the deposit. However, prospecting carried out by the Company in the area made it advisable to start new works in El Salvador. A month before Potrerillos was closed they began the operation of this new deposit of sulphide ores whose treatment is made in a plant near the mine and is then smelted and/or refined in the old facilities, expanded for this purpose.

The mine is worked by the block-caving system and the ore has an average grade of around 1,5%. Estimated reserves amount to 375.000.000 tons. Present production is around 100.000 tons annually, of which 20.000 are blister and 80.000 electrolytic. Once the Expansion Program enters into normal operation in 1971, production will come to 112.500 tons of copper, of which 92.000 tons will be electrolytic.

As in the case of Chuquicamata, since January 1st., 1970, the Chilean State owns 51% of the shares of Compañía de Cobre Salvador S.A., a new mixed mining company. It was the result of the agreements between the Chilean Government and The Anaconda Co., which holds 49% of the shares in conditions similar to those agreed

upon for Chuquicamata.

2.2.4 El Teniente: It was known long ago and has been worked regularly, choosing its highest grade ores until 1904, when American capital, through "Rancagua Mines" enterprise, began systematic and industrial exploitation of the deposit.

The mine is located in the Andes range at an altitude of 2,500 meters above sea level and 130 kilometers South East of Santiago.

Sulphide ore is concentrated, smelted and fire refined in the various facilities at Sewell and Caltones. The extractive works are carried out under-ground and the mine is at present the largest in the world in its type. In 1931 it produced only 10,000 tons of copper per year, which due to continued expansion amounts to 235,000 tons per year at present: 70,000 tons blister, 85,000 tons fire-refined, 57,100 tons electrolytic refined in Chile (Ventanas) and 22,900 tons electrolytic copper refined abroad (Norddeutsche Affinerie). The Expansion Program in El Teniente will result in an output of 302,000 tons per year in 1971: 90,000 tons blister, 109,000 tons fire-refined, 73,000 tons electrolytic refined in Chile (Ventanas) and 30,000 tons electrolytic refined abroad (Norddeutsche Affinerie).

Prospection in this deposit area allows us to estimate reserves around 3,500,000,000 tons of sulphide with an average grade of 0,9%.

In 1904 "Rancagua Mines" changed its name to "Braden Copper Co." which worked the deposit until 1965, when Sociedad Minera El Teniente S.A., whose capital stock belongs to Chilean State (51%) and Braden Copper Company, a wholly owned subsidiary of Kennecott Copper Corporation.

2.3 Medium Size Copper Companies. - The characteristics of the principal companies of this type are, in short, as indicated below, except the Empresa Nacional de Minería, whose importance deserves a special analysis.

2.3.1 Empresa Nacional de Minería: The origins of this national agency may be found in 1927, when the Caja de Crédito Minero was created as an institution aimed at the organisation and co-ordination of activities in connection with the national mining industry.

Continuous modifications in its organic law extended its objectives and functions, especially those related to marketing of ores.

Furthermore, in 1955 the Empresa Nacional de Fundiciones was created, being its predecessor the Sociedad Fundición Nacional de Paipote Ltda., created in 1947. That enterprise was formed

to administer and exploit the Paipote copper smelter and to create and exploit new copper smelters, refineries or concentrates plants.

In 1960 the Caja de Crédito Minero merged with the Empresa Nacional de Fundiciones, thus creating the Empresa Nacional de Minería.

Its essential objective is to promote development of Small and Medium Scale Mining Companies, by giving credit and technical assistance to the miner; by forming joint ventures with them; by purchasing the ores through its purchasing agencies, which afterwards treats and refines them in its smelting and refining plants. Besides, it sells or leases mining equipment for the exploitation of deposits.

In 1968 the total purchases of ores made by ENAMI amounted to 1.107.515 tons, with a fine copper content of 57.291 tons.

In the following table, the present annual capacity of smelting and refining of ENAMI is shown:

	<u>Paipote</u>	<u>Ventanas</u>
Blister copper production Metric tons per year	24.842	42.712
Electrolytic copper production Metric tons per year	--	87.074
Fine copper production (final products contents) Metric tons per year	24.687	87.065

The Expansion Program envisaged by ENAMI shall result in a production of 91.200 tons of copper from 1972 onwards, coming from the purchase of ores, concentrates and cements. One part of its smelting and refining capacity is assigned to the treating of raw materials from other sources, on a toll basis.

2.3.2 Compañía Minera Disputada de Las Condes S.A.: Peñarroya, a French group, owns more than 80% of the shares of this enterprise. At present it is the owner of El Soldado deposit, located 120 kilometers North of Santiago, and Los Bronces deposit, in Las Condes Commune, 60 kilometers East of Santiago, at an altitude of 2.900 meters approximately, in the Andes range. Both deposits have facilities that will produce copper concentrates, mainly smelted in Chagres, a smelter belonging to the Company, 80 kilometers North of Santiago and near Panamerican Highway.

The following figure contains in short the main characteristics of the mining and industrial facilities of Disputada:

	<u>Chagres Smelter</u>	<u>El Soldado</u>	<u>Los Bronces (Disputada)</u>
Installed capacity of the Plant - M. T. per day	-	2.900	6.000
Copper concentrates output M. T. per year	-	54.750	74.800
Fine copper content in output - M. T. per year	20.842	13.779	20.780
Blister copper output M. T. per year	21.030	-	-
Explored reserves Million M. T. ores (grade %)	-	20,0 (1,8%)	48,0 (1,32%)

At present an expansion program is being carried out, which will enable this enterprise to reach a copper content output (in final products) of around 29.300 tons per year.

2.3.3 Empresa Minera Mantos Blancos: The ore body is located in the Atacama Desert approx. 48 kilometers East of the Antofagasta port and next to the Panamerican Highway. The exploitation is by open pit. The existence of this ore body was known since 1912 but its economic exploitation was delayed due to metallurgical problems related to the high content of chlorine, more than 1,5%. However in 1960, after long efforts and research, Mauricio Hochschild and Co. - which has majority interests in this mining enterprise - developed a metallurgical process and started production. A precipitation plant which delivers metallic copper in bars of 99,96% and using a chemical process was set up.

Present level of production is about 33.000 tons of copper per year and ore reserves are estimated at 19.904.000 tons with a grade of 1,66%.

2.3.4 Sociedad Minera Pudahuel: Owner of Lo Aguirre ore body, La Africana mine and its concentrator. The mine-site is located in Las Barrancas, next to the main International Airport of Pudahuel in Santiago. Financial operations of this enterprise were started in 1969, carrying on the exploitation of La Africana, whose former owner was Santiago Mining Co., a subsidiary of Anaconda. Present output runs about 4.500 tons of copper content in concentrates. The remaining ore reserves will allow normal exploitation for approx. 2 to 3 more years; nevertheless, prospecting works done in Lo Aguirre orebody, next to the previous one, assure the continuity of operations with reserves of sulphide, oxide and mixed ore on sites of 9.400.000 tons with 2,14% copper tenure. Works in this mine are scheduled to start in 1973 - 1974.

2.4 Small Scale Mining: - Approx. 20.000 workers depend on the activity of this mining sector. Small Copper Mining works are extensively exploited in the northern part of the country and sometimes concentrated in regional centers. Among these centers we have Andacollo and Copiapó, traditional mining districts for copper, silver and gold.

Production in the Small Scale Mining Area is usually mining of high or medium grade copper ores, soluble and insoluble, which are sold to the purchasing agencies of ENAMI, spread along the country. Besides, some mining works which extract low grade ores, or which are located far from ENAMI agencies, run their own treatment plants to obtain concentrates or copper precipitates. These products are shipped to ENAMI smelters or sometimes exported directly by their producers.

3. Expansion Program. -

Chilean copper output at the beginning of the Expansion Program in 1964 was 686.000 tons a year. Once the new works start production output will gradually increase up to the level of 1.200.000 tons of copper a year by 1972.

The Expansion Program concerns principally the Large Scale Mining Area and to a lesser extent the Medium Scale Mining Sector. However, the Small Scale Mining Area has also been given attention through projects to increase the capacity of the installations of ENAMI and, at the same time, a development program was launched for this Sector.

Investment in the Expansion Program was directed mainly to the enlargement of facilities of mines in operation (Chuquicamata and El Teniente), but also the opening up of several deposits of importance was considered (Río Blanco and Exótica). Financing of the program came from international financing institutions, as the Eximbank and IFC; fiscal contribution; advance payment of customers (Japanese); cash flow of the mining company and equity from private capitalists, national and foreign.

The main characteristics of the Expansion Program in the Chilean copper industry may be followed in the figures below:

	Annual Production		Investment 000' US\$
	000' ton/year		
	1964	1972	
El Teniente	179,6	302,0	247,213
Chuquicamata	317,5	390,0	113,973
El Salvador	84,5	112,5	11,850
Exótica	--	112,5	43,700
Río Blanco (Andina)	--	66,8	157,000
Sagasca	--	28,7	32,500
Carolina de Michilla	--	6,8	6,661
Grupo Disputada	29,1	44,5	16,453
ENAMI	33,0	91,2	76,800
Mantos Blancos	27,2	34,2	--
La Africana	7,7	1,8	--
Others	7,2	30,0	--
Total	685,8	1.221,0	706,150

Exótica, Río Blanco, Sagasca and Carolina de Michilla are the new ore bodies which will start production soon in accordance with the expansion program. Their characteristics, with exception to Exótica, are briefly the following:

The sulphide ore deposits of Río Blanco belong to Compañía Minera Andina S.A., joint venture of Cerro Corporation (of USA) and the Chilean State. The exploitation will be by block caving and the concentrator has been built underground to avoid climatic problems due to its location in the high mountains. The mine lies at an altitude of 3.800 meters above sea level and approx. 50 kilometers from the city of Los Andes. Production will start by the end of 1970 and the final product will be copper concentrate which will proceed to the ENAMI smelter or be exported as such to Japan. Ore reserves have been estimated at 120.000.000 tons with a grade of 1,58%.

The next in importance is the Sagasca orebody located in the ravine of the same name, 100 kilometers East of Iquique port. The soluble oxide ore from the open pit works will be treated in a leaching plant and precipitated with iron scrap. Copper precipitates will be exported or shipped to the ENAMI smelter for further treatment. Investment schedules consider starting the operation by 1972. Minera Sagasca S.A., owner of the orebody, is a joint venture of US Continental Copper and Steel Industries Inc. and the Copper Corporation representing the Chilean State. Reserves have been calculated at 16.154.000 tons of 2,04% and an additional 2.448.400 tons with grade below 1%.

The third most important orebody is Carolina de Michilla, being developed at present by the mining enterprise of the same name, joint venture of local private capitals and the State Development Corporation. The soluble oxide ore is located in the mining district of Michilla, 120 kilometers North of Antofagasta port and at 900 meters above sea level. Production has been scheduled to start by mid 1971.

Ore reserves are estimated at 1.868.200 tons ore on site with a grade of 2,4% and 5.239.000 tons of probable ore with the same grade.

Finally, we have the expansion program of ENAMI, which considers the erection of various plants of medium capacity for the treatment of oxide, sulphide and mixed ore. Those plants will be located preferentially in the northern part of the country, having in mind the development of rich mining districts which at present can not reach an acceptable level of production due to the high cost of transportation. At the same time ENAMI is increasing smelter and refining capacity in order to take care of increasing production of precipitates and concentrates resulting from the expansion program. Besides, ENAMI will provide funds for the development of Small and Medium Sized private mining concerns by means of credit and technical assistance.

4. Importance of the Copper Mining Industry in the National Economy. -

The copper industry has considerable influence in the economy of Chile. In fact, its contribution to the Gross Domestic Product amounts to about 7%; taxation income runs at about 15% to the total fiscal collection and contribution to exports exceeds 75%. With regard to employment, this sector represents 3 to 4% of the employed labor force of the country. The preceding figures do not include the effect of the expansion program under progress, which obviously will increase the importance of the industry.

In summary, our economy is highly dependent on the copper mining industry, especially in exports where Chile appears almost as a mono-producer.

5. Taxation Policy. -

The issuance of Act Nr. 11.828 "New Deal for the Copper Industry" May 5, 1955, starts a period whose main characteristic was a more definite policy towards the mining industry, especially to the large mines. This law ended the system of artificial rates of exchange for the foreign currency which the large producers had to convert into Chilean currency in the Central Bank to defray local cost of production. Besides, this act set up a taxation system on profits which provided a decreasing rate for increasing production as an incentive to develop existing properties; for new mines a flat 50% rate was established. The Copper Department, a semi-independent agency of the Central Bank was created with regulatory functions mainly aimed at the copper mining industry.

In 1964 the present Government put into effect its policy of Chileanization of the Copper Mining Industry, for which purpose joint ventures were given main priority and stimulus, thus making the State a partner. The law which embodied the above mentioned policy was enacted in 1966 (Ley 16.425). The power of the Copper Department were broadened and its name changed to Corporación del Cobre (CODELCO) It also set up the tax policy which is currently being applied.

The State's income from the copper mining industry has two main sources: income tax on profits and profit sharing from dividends (indirect income is excluded from this report).

In the Large Scale Mining Area, the state's share of profits comes to 51% on account of its holdings, with exception of Exótica in which its share is only 25%. At the same time a fair system of profit sharing based on an overprice tax was set up, taking due consideration of factors such as profitability and a base cost, which encourages efficiency.

Concerning the Medium Scale Mining Area, the State's share in a large number of mining concerns, through several Government agencies, is shown in the table below. A simplified overprice tax system is applied to this sector.

Direct taxation of the two sectors falls in two categories:

- a) income tax on profits with variable rates (see table below); and
- b) additional tax on dividend remitted abroad, the usual rate being around 30%.

The Small Scale Mining Area is exempted of all direct taxation and pays only a 2% sales tax.

Table of State holdings and tax rates

Name of Concern	<u>Holdings %</u>		<u>Tax %</u>		Government's share of income %
	State	Other	Income	Additional	
Soc. Minera El Teniente S.A.	51	49	20	30	72,6
Cía. de Cobre Chuquicamata S.A.	51	49	30	32	76,7
Cía. de Cobre Salvador S.A.	51	49	29	30	75,6
Cía. Min. Exótica S.A.	25	75	15	30	55,4
Cía. Min. Andina S.A.	30	70	15	30	58,4
Minera Sagasca S.A.	25	75	15	30	55,4
Cía. Min. Carolina de Michilla S.A.	25	75	18 [#]	-	40,0
Cía. Min. Disputada de Las Condes S.A.	-	100 ^{##}	20 ^{##}	30 ^{##}	46,0
Empresa Minera Mantos Blancos S.A.	10	90	-	37,5	43,8

From May 1977 rate climbs to 20% for the next 15 years

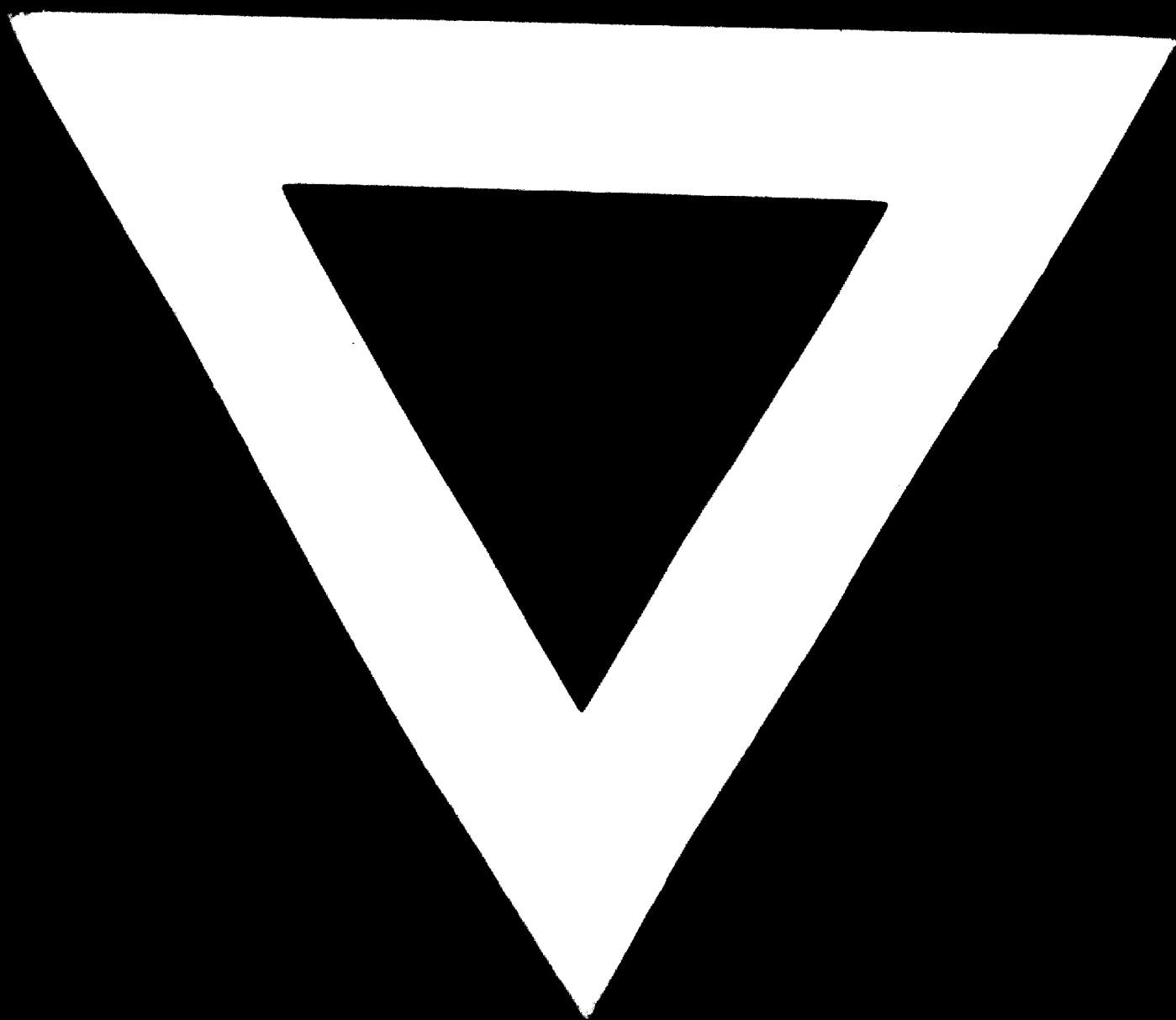
Beginning with fiscal year 1975, rates to be 25% for income tax and 32% for additional tax. No change through fiscal 1985.

The Government's share of income shown in this table corresponds to a minimum level, since overprice tax has not been included as it is a function of profitability.

Note: Figures in tons are "short tons".

Attached: A map with the Geographical Distribution of Mining Works.





74. 10. 14