INSTITUTE OF CURRENT WORLD AFFAIRS

FMF-18
Chile: The Importance of Copper

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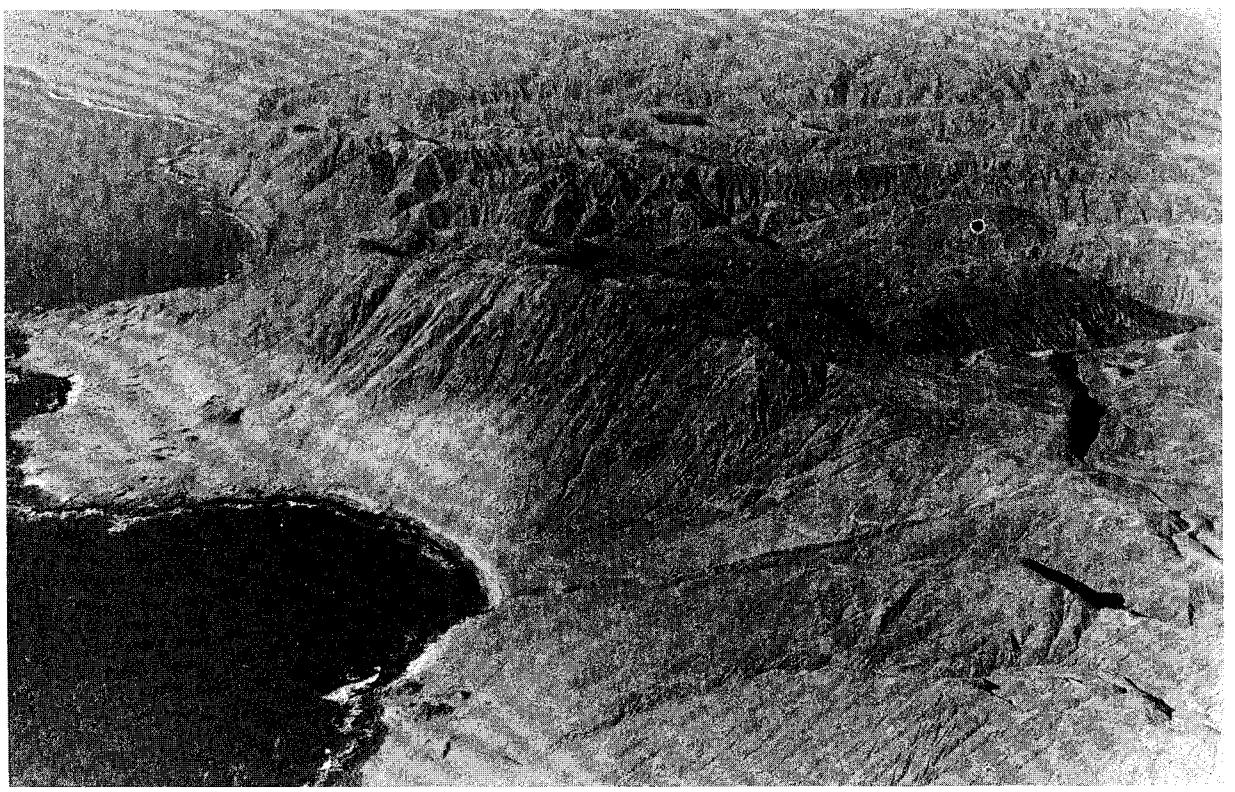
New York, New York 10017

Dear Mr. Nolte:

From Santiago's national airport, Los Cerrillos, a DC-6 takes off each day heading northward to the juncture of the Andean cordillera and the Atacama Desert; LADECO---Airline of Copper---is dedicated to service the outpost of the world's largest open pit copper mine, Chuquicamata. As chic stewardesses wearing rose and violet uniforms serve domestic wines and champagne, the plane follows a stark coastline marking the confrontation between the cold Pacific Ocean and the sterile wasteland.

After some three hours, the course veers out to sea, then sharply inland, sweeping low over crumbling sand cliffs which advance and are consumed by the waves. Determined by the prevailing winds, the trajectory drops straight onto the airstrip of Antofagasta where passengers must disembark and wait 30 to 40 minutes while a valuable air cargo destined for the mine is wrestled into the hold.

The Coastline of Northern Chile.



The half-hour flight on to the mine's airport at Calama is unrelieved by ocean or coastline. The mauve and magenta desert stretches as serrated tiers in all directions---no tree, no grass, not a hint of vegetation on this world's driest strip, some 600 miles long. About 10 minutes out, an extensive grid of core drillings indicates man's interest in the subsoil; the work seems recent---the surveyors' lines still evident, the refuse from the cuttings still piled neatly at the sides of the holes. Instead, they represent a luckless exploration for nitrate in 1912---vestiges which have seldom known rain in the subsequent 56 years.

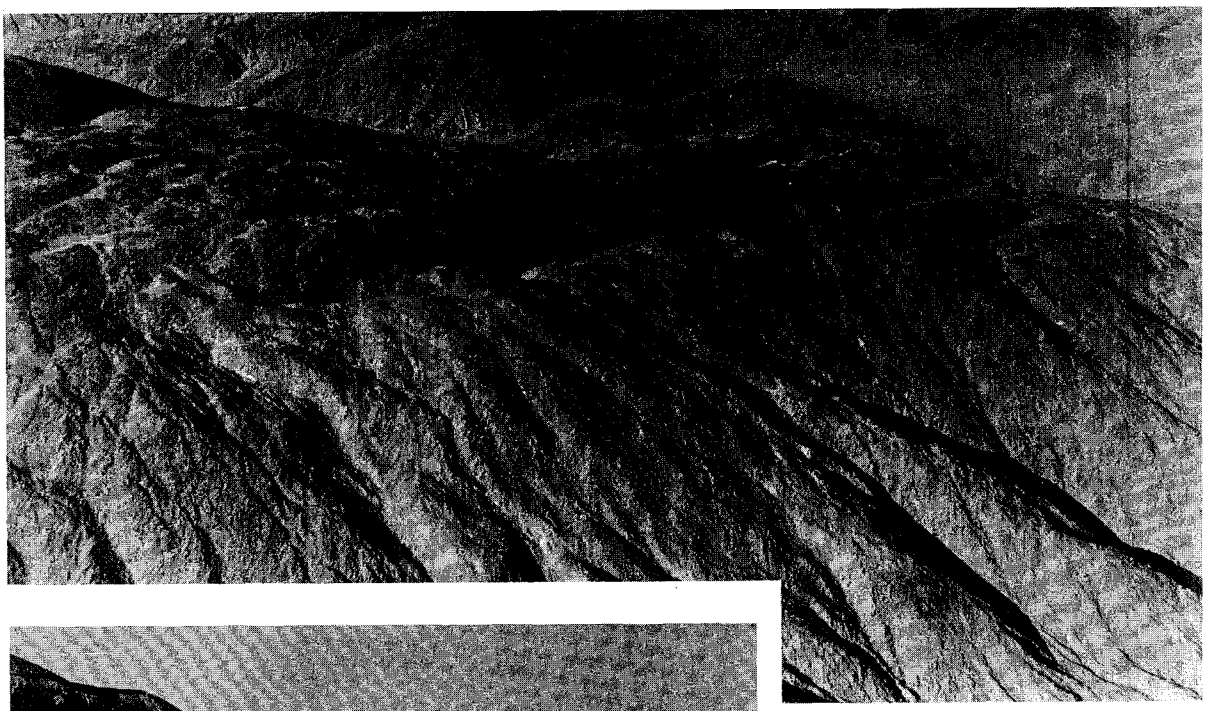
On an arid pampa approximately 9000 ft. above sea level, Chuquicamata is backdropped by a semi-circle of snow-capped mountains. It sits in a land of big sky and constant winds---overhead, crystal blue with tufts of high, dry cirri. Without the intervention of man, the barren plain would be silent and motionless. Now, as one drives off the gravel apron of the airfield, the only significant tattoos seen on the landscape are the two distant stacks of the smelter whose dense plumes of smoke parallel the horizon, attenuated by the strong air current.

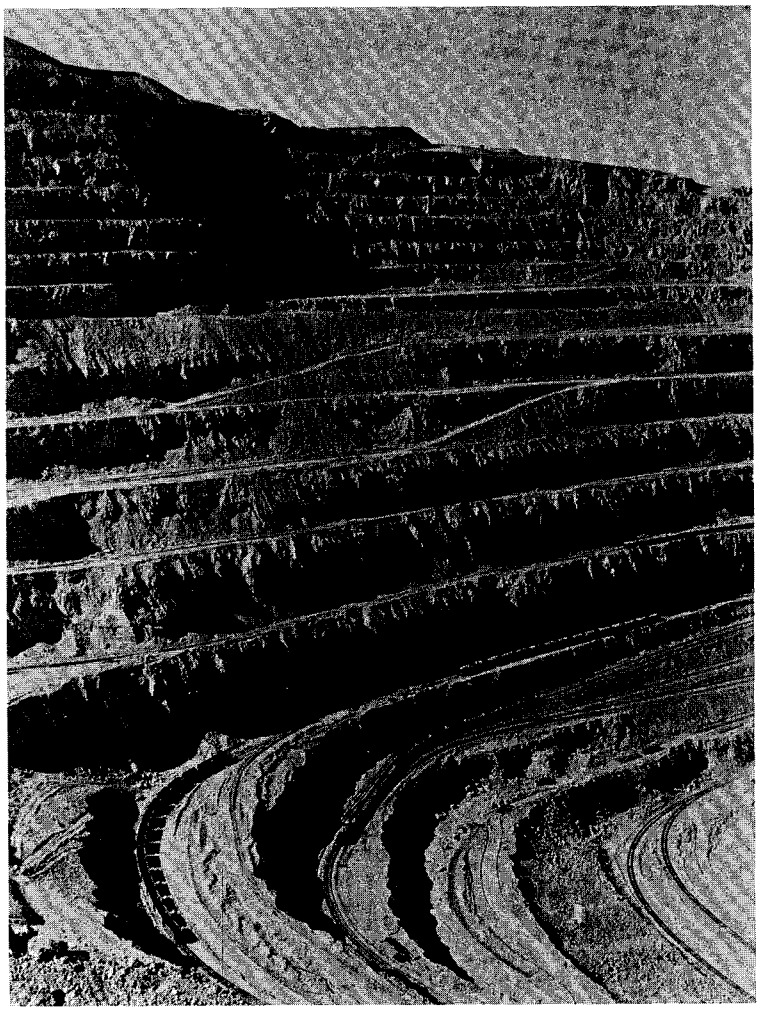
The berm of the asphalt highway is creased by the hashmarks of bulldozer blades which work continually to push back the shifting sands. Seen from the surface, the desert no longer flushes with warm colors but surrounds in umber monotony---only at the fleeting minutes just before the sunset does it glow with a Titian brilliance quickly muted by the night.

The half-hour drive to the company camp first twists through Calama, a satellite city whose 30,000 population includes only about 2500 employees of the Anaconda operation. The rest live off of each other and the richer mine employees who invest in the town's principal enterprise, prostitution.

Chuquicamata also has 30,000 inhabitants but, whereas Calama is ramshackle and cramped, the mine town spreads as an oasis over a slope, its streets bordered by parks and its houses fronted by gardens---all products of water pumped 80 miles from the cordillera. But the feature dominating the site is the huge tailings dump which, in another climate, would stand out as an eyesore but here blends with the desert surrounding it. The waste is largely sulphurous residue from the leaching vats of the oxide plant, and it streaks the sides of the long mound with cobalt, turquoise and russet.

Beyond view from the town, tucked in the fold of an Andean foothill, is the other major man-made scar---the open pit, over two miles long, three-quarters of a mile wide and one-quarter deep. The mine benches swing downward in an ever-tightening spiral, at the top exposing rust-colored rock which below gives way to a blue-grey powder. The upper levels, now exhausted, once gave an oxide ore, but deeper in this core of the world's largest known copper deposit, the chemical form changes to sulphide. Some 200,000 tons of rock are hauled from the crater each day, after it has been loosened by tremendous blasts of explosives, then scooped up by shovels of 12 cubic yard capacity. Traditionally the rock has been carried up and out by trains which wind circuitously to the rim of the pit. Now the preferred means of removal is by the more agile and rapid heavy-duty trucks---Lectra-Hauls and Darts, costing some $200,000 each---which transport a load of 100,000 pounds each.





Above.
The Atacama Desert

To the Left.
The Open Pit
at Chuquicamata

The pit makes its own shape, the geologists constantly probing and sampling to determine the optimum direction of the cuts. As yet there is no sign of exhausting the ore supply, and external factors---Chilean politics, world prices, international competition, technical advances---are more likely to determine the mine's future than the quantity and quality of the deposit itself.

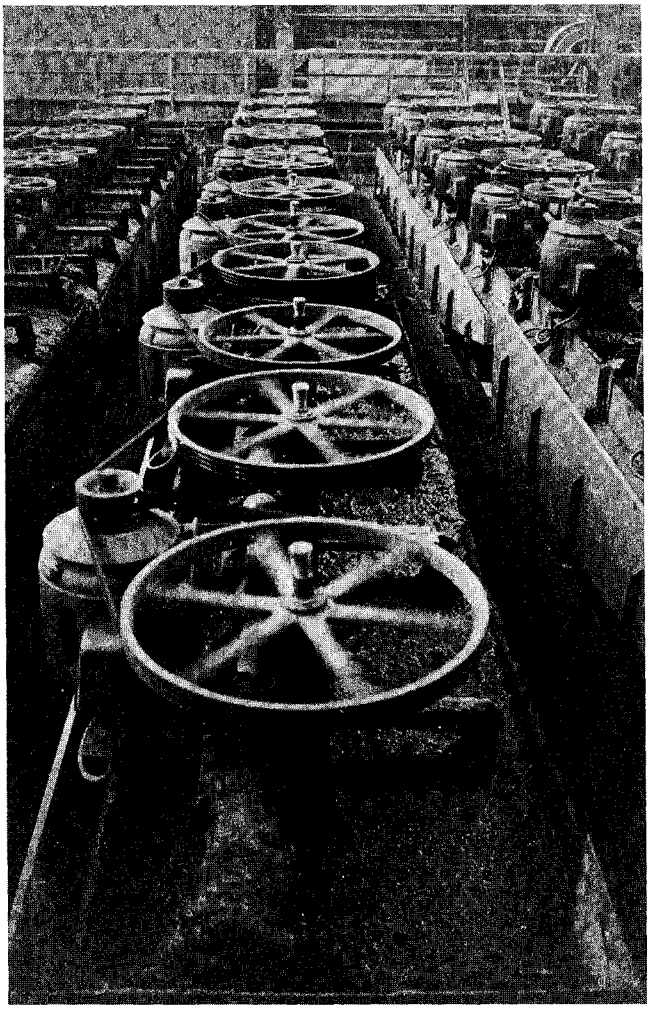
Though the Chuquicamata deposit is huge, geologists little doubt that its equal may exist---unknown---in some similar stretch of the cordillera which extends from Antartica to Alaska. This long orogenic belt contains numerous faults and other zones of weakness which, in some areas, allow deep-seated igneous melts to intrude overlying formations and reach the surface. Just over a decade ago, a new volcano was formed south of Santiago, following a similar plane of weakness. Often the intruding masses, usually consisting of granitic-type igneous rocks, do not reach the surface but remain at considerable depth, only to be exposed after milleniums of erosion. Most of the copper ore bodies are found associated with these granitic masses as are many other types of ore occurrences in this belt (tin, silver, tungsten, bismuth, etc.). In Chile, Peru, the United States and Canada---the leading copper producers within this tectonic province---the rock is a porphyry, i.e., an igneous texture characterized by irregular mineral segregations within a fine-grained matrix.

Two of the world's major producers of copper, the United States (1st) and the U.S.S.R. (3rd), consume the mineral domestically; Chile is a leader in the world's export market (772,000 T. per annum), along with Zambia (755,000 T.) and Gongo (318,000 T.). By means of an energetic program of expansion now underway, Chile aims at becoming the world's largest producer. Chuquicamata, for instance, projects an expansion from 340,000 tons per year to 502,500 tons by 1971.

In South America only El Teniente, the world's largest underground copper mine, has a higher ore content. At Chuquicamata a ton of rock yields about 25 lbs. of ore, averaging 1 1/2 percent content. Besides copper, other minerals recovered are molybdenum, silver and gold.

Of the two types of mining, underground and surface, the second has several advantages---recovery, grade control, economy, flexibility of operation, safety and working conditions. However, El Teniente, near Rancagua south of Santiago, is a snow-covered mountain where neither climate nor overburden favor surface mining. In contrast, Chuquicamata combines a number of features which facilitate an open pit---the large deposit lies near the surface, dry and temperate weather eases the operation, ground water is minimal, etc.

Blasted and trucked from the pit, the rocks ride over dusty tracks and lanes to be heaved into huge coarse-ore bins which feed into rod and ball mills; these gigantic crushers break the chunks into particles, freeing the valuable minerals from the gangue. A treated pulp runs into flotation cells ---vats generally containing one or more reagents through which compressed air is constantly bubbling. The finely crushed copper minerals adhere to the ascending bubbles which overflow from the top of the cells as a sooty froth containing 20-25% ore concentrate. The gangue material remains in the cells, later to be removed and retreated.



Above. Flotation Cells at Chuquicamata.

Piped to the smelter, the concentrate enters another phase, essentially melting to remove impurities. It is first "roasted" to vaporize certain moistures, a step preliminary to the reverberatory furnaces where extreme heat produces an impure mixture--- approximately 50% copper combined with iron and sulphur.

The copper matte reaches its climax in the converters---horizontal furnaces consuming great ladles of the molten rouge. In dimension and design the smelter is a basilica, and the huge cylindrical furnaces are placed as chapels, side by side, along the nave. From windows far above, the sun's rays pierce through the shadow to the ash-laden floor. The liturgy is carried out by men of strange habit, seeming automatons under steel helmets and behind face masks which protect them from the omnipresent dust and fumes. Outside the scene is clear, classical, monochromic, but within the smelter it is dense, heavy and baroque. Dust and darkness contrast with the liquid, opalescent reds which erupt from the open mouths of the converters. Air blasts through the matte eject festive sprays of vermilion sparks as the volatile sulphur burns off in fumes up the giant stacks. From time to time the livid ovens roll downward to waiting ladles and disgorge a molten slag produced by oxidation. Overhead, a crane slides down its gantry to place its great hooks on the ladles and lightly lift their several tons to the side to cool.

Now 99.46% pure copper, the concentrate is again subjected to fire to reduce and further oxidize its impurities. From this refining furnace, fed by eucalyptus trunks, the poling emerges as blister copper of commercial value for coating, sheeting and pipes and as copper sulphate for agricultural purposes.

At Chuquicamata, however, it undergoes yet one more purification in an electrolytic process far different from the previous smelting. Cooled in anode molds, the lustrous bars are suspended in acid tanks juxtaposed with cathodes of pure copper. In the large, silent tank house, thousands of electrodes are activated by a direct electric current causing ions to interchange, copper migrating to the cathodes. Lacking the drama, color and action of the earlier steps, this last refining requires eight days of ap-

The Smelter
at Chuquicamata

parent dormancy, culminating in a copper of 99.99% concentrate which is cast into wirebar for electrical purposes.

Along the way another valuable mineral has also been separated in significant quantity. Molybdenum, of major industrial value, is used to harden and toughen steels and is essential to special alloys such as those subjected to the high temperatures of jet motors.

Though the pit has been in operation since 1915, the sulphide ore treatment plant was completed only in 1953, at a cost of over $130 million. Before that time the overlying ores were oxide and were concentrated by different processes. The oxide plant would soon be closed for lack of raw material from Chuquicamata; however, because of positive results from geological explorations and a new accord with the Chilean Government, a rich mineral occurrence nearby will, by 1971, be transformed into an open pit, called Exótica. A deposit estimated at 155 million tons will yield copper oxide to feed the earlier treatment plant. The mineralized horizon at Exótica lies 80 to 150 meters below the surface, necessitating the stripping of some 85 to 90 million tons of sterile overburden.

Whereas Chuquicamata (Chile Exploration Company) is a wholly-owned subsidiary of Anaconda, the Chilean Government through its Corporation of Copper will hold 25% of the shares in the mixed company which will exploit the new pit.

Exótica is just one example of the energetic program initiated by the present administration of President Eduardo Frei to "Chileanize" the country's major industry. The national economy is tied to this one product; in 1966 Chile's total exports earned $890 million of which copper accounted for $652 million, almost 75%. The well-being of the country is, therefore, highly sensitive to fluctuations in world prices for the "red metal". When the essential income from copper sales abroad falls, Chile must assume additional foreign debts which already burden her accounts; the fate of important development programs---infrastructure for industrialization, expansion of the educational system, construction of "popular" housing, agrarian reform, etc.---is determined by a budget predicated upon earnings from copper exports. Recently the price has been unusually good, about 65 cents per pound; in the last eight years it has ranged between 27 and 99 cents per pound. The difference of only one cent in price represents a gain or loss of seven to eight million dollars.

The recent high prices are result of external conditions over which Chile has no control. First, the Viet Nam war has increased U.S. purchases in the world market to supplement the country's own large production; the eight-month strike in the U.S. further increased purchases abroad. Preceding the strike, in 1967, the U.S. imported 117,000 tons; in the comparable period during the strike, imports reached 268,000 tons. Although the labor impasse was resolved in March of this year, Chileans note the considerable decrease in U.S. stockpiles, the replenishment of which should assure several more months of good prices. In addition, the wage gains of U.S. workers upped production costs by four cents per pound. Another country closely watched is Zambia where a shortage of fuel for refining and political unrest have slowed the production of that important competitor.

Chile, too, struggles with labor and production problems. Union contracts are renegotiated every 15 months to accommodate the rapid inflation.

Serious strikes were averted by this year's bargaining but when a break seemed imminent at El Teniente, it was observed that such a shutdown would cost the Government $215,000 per day in lost earnings from that enterprise.

El Teniente was formerly owned by Braden Copper Co., a subsidiary of Kennecott Copper Corporation; in 1967 ownership was transferred to the Sociedad Minera El Teniente in which Chile holds 51% interest. The investment resulting from this partnership, more than $230 million over five years, represents the largest ever made by one enterprise in one mine. With galleries and shafts cut 600 miles through the mountain, this copper mine is the world's largest; the expansion will increase production 55% from 180,000 tons annually to 280,000.

Besides significant investments in Exótica and El Teniente, the Government also now participates in Rio Branco with the Cerro Corporation and is expanding refining capacities in order to process all concentrate within the country. It has also sought to gain control over the marketing of the product, recently banding with Zambia and Congo to obtain cash payment for immediate delivery in place of "futures"——a new system bringing a price as much as seven cents per pound higher under present market conditions. About 90% of Chile's copper goes to Europe and, because of "Chileanization", sales to Communist countries now become possible.

The prime aim of the current program is to increase total national production from approximately 700,000 tons per year to 1,200,000 tons in 1971 which would make Chile the rival of the United States as the world's leading producer; refining will expand from 278,000 to 750,000 tons. To achieve these goals, $550 million are being invested, representing a major stimulus to the national economy. The 1966 "Chileanization" redefined the position of the foreign enterprises, promising considerably more stability and bringing tangible gains such as the reduction of taxes from an effective level of 85% to 72%.

In the meantime, explorations continue along the Chilean cordillera, drillings and samplings searching for occurrences of the valuable ore. The nation's future will be largely determined by the wealth of its known and unknown deposits and by the course of national and international politics affecting mineral production and sales.

Sincerely yours,

Frances M. Foland

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Photos: FMF

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