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Asarco:

The Metal Maker

Published April 1981

Introduction

Just before the turn of the century, the nonferrous metals industry in the United States was in trouble. Many lead-silver smelters were being adversely affected by the combination of the burden of low prices, excess capacity, labor troubles, and increasingly complex ores. The mines, which contributed so much to the early settling of the American frontier, also faced problems. As the smelters failed, mining companies were faced with the prospect of either having to close or build their own smelters, and the country could hardly afford to lose the output of metals essential to the nation's growth.

The American Smelting and Refining Company was organized in 1899 to help meet this impending crisis. In 1975 the Company changed its name to ASARCO Incorporated. Originally a consolidation of a number of lead-silver smelting companies, the Company has evolved over the years into an integrated miner, smelter and refiner of silver, copper, lead, zinc, and a host of by-product metals. Asarco's expertise in exploration, mining and milling has also led to expansion into related fields such as the mining of coal, asbestos, ilmenite (a titanium-bearing mineral), sand, gravel, and limestone.

The original purpose of the Company, however, remains an important part of Asarco's operations today: custom smelting and refining of ores mined by others. This is an important service provided by Asarco to many mining operations too small to support their own smelters, but whose combined output represents a significant domestic source of metals. The metallurgical sophistication of its smelters makes Asarco the only U.S. firm capable of processing certain complex ores and recovering such valuable by-products as bismuth and arsenic trioxide.

Since its founding, Asarco's refineries have produced more than 28 million tons of copper, enough to make a household size wire that could

be strung 28,000 times around the world; 27 million tons of lead, enough to make 2.7 billion automobile batteries; approximately seven and one-half million tons of zinc, which could coat and protect from corrosion a highway guard rail long enough to cross the U.S. 1530 times; and over six and one-third billion troy ounces of silver, enough to mint nearly 20 billion of the last generation of silver dollars (40% silver content) to actually contain silver. Some of this metal originated from Asarco's own mines, but more came from the mines of others, and from the mines of Asarco's associated companies in other countries.

Metal must be mined where it is found. Almost since its inception Asarco has been involved in mining ventures outside the U.S. Today it has significant interests in three of the world's great mining companies. M.I.M. Holdings Limited in Australia; Southern Peru Copper Corporation; and Mexico Desarrollo Industrial Minero, S.A. Additionally, it operates other mines in Canada, Bolivia, and Peru.

Asarco also has a significant interest in Revere Copper and Brass Incorporated, a major fabricator of copper, brass, aluminum and a producer of primary aluminum in the U.S.

An increasingly important source of metal in the world is the scrap generated by metalworking operations or recovered from obsolescent automobiles, buildings, appliances, and other metal products. Federated Metals Corporation, a subsidiary of Asarco, is a major U.S. recycler of scrap metal, converting it into copper, lead, and zinc alloys for a multitude of uses.

This, then, is Asarco, a company which extracts vital raw materials from the earth and converts them, along with those extracted by others, into metals and minerals useful to mankind. How Asarco does this, and has been doing it for all the years of this twentieth century, is told in the following pages.

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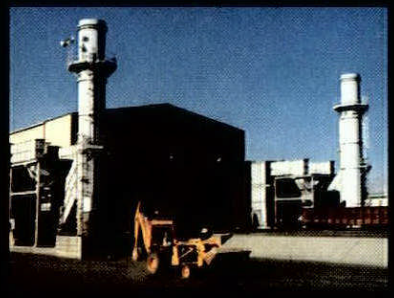
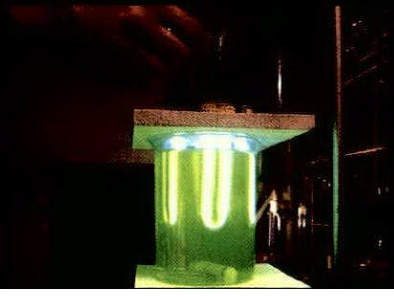
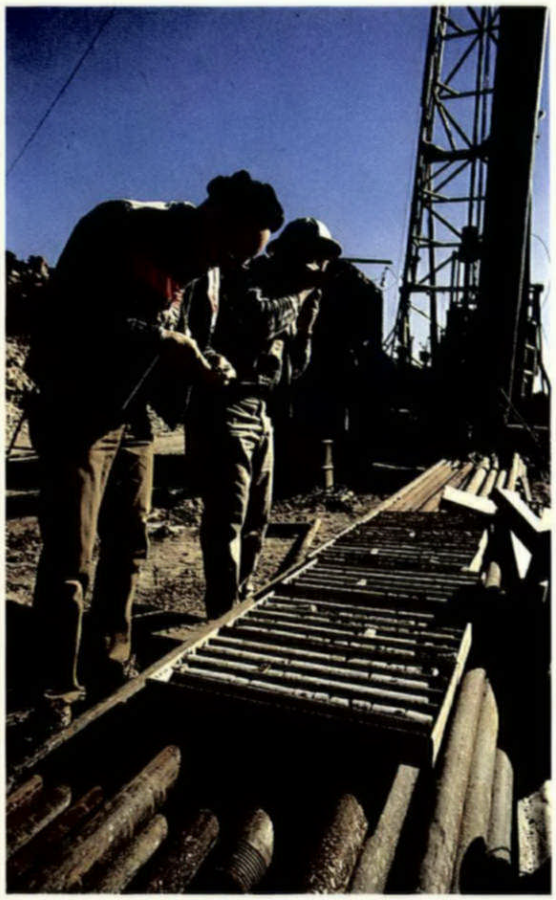
Metals & Minerals





The Explorer



▲ Geologists examine drill core samples which later will be assayed for metal content.

◀ Helicopters carry men and machinery into wilderness areas to lessen the impact of exploration activities on the environment. Asarco exploration crews take precautions to leave drill sites as near as possible to the condition in which they found them.

Mining starts with exploration. A mining company must continually find new ore bodies or eventually go out of business. Discovery is a rare event, however. Once made it may be many years before a find can be developed into a profitable, operating mine.

Exploration has come a long way since the time when two prospectors got so inebriated on a bottle of whiskey that they dug a hole on the very spot where they were imbibing and uncovered great riches. Their discovery in Colorado's mountains was to become the Little Pittsburgh silver mine on Fryer Hill, which for many years shipped ore to Asarco's Arkansas Valley smelter in Leadville.

In those early days of the silver and gold rushes, the fantasies of riches and high living drove men to sell their homes, their souls, and in many cases their sanity in order to strike paydirt. Today, the methods and means of exploration have become more sophisticated, but the object remains the same: to find valuable mineral deposits. In the case of Asarco's exploration department, attention is focused primarily on nonferrous and precious metals, asbestos, stone quarries, coal, and ilmenite. A recent effort has been Asarco's participation in oil and gas exploration ventures.

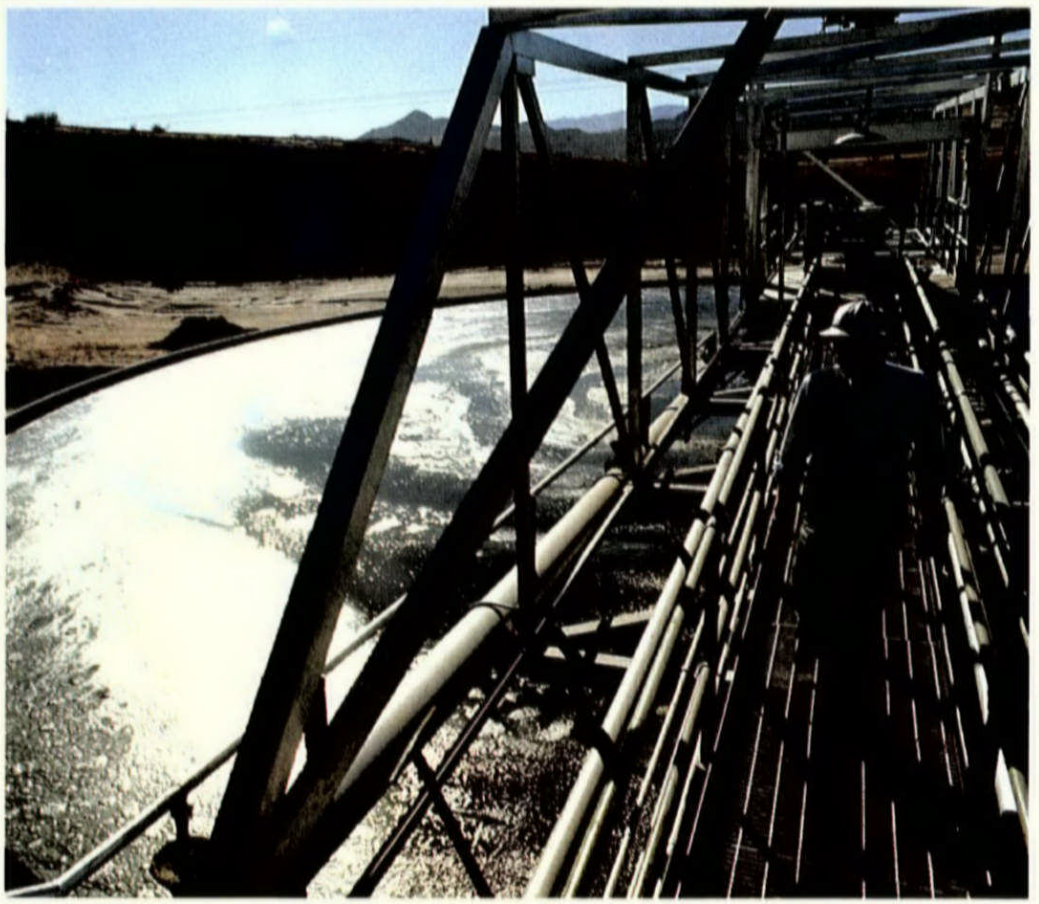
Where does Asarco look for minerals? According to an adage, if you want to find elephants, go to elephant country. Thus, if copper is your quest... In many instances the general geology suggests potential mineral belts. An example of this is the almost continuous series of mountain ranges which run along the west coast of North, Central, and South America, marked throughout by deep faults and massive intrusions of once-molten rock. Today many copper mines are being worked along this belt from Alaska to Chile.

Careful and patient studies of the surface geology often provide obscure clues to possible hidden minerals. To aid these studies, Asarco in some cases employs geophysical and geochemical techniques to explore an area. One geophysical procedure involves sending electric impulses into the earth and then recording and evaluating the data received from these impulses. Geochemical exploration entails analysis of soil, stream sediment, rock chips, and similar materials for minute traces of metals and associated elements. In many instances the location and terrain require Asarco's explorers to be experienced woodsmen, rock climbers, jungle travelers, or desert dwellers.

Consider the exploration story of Asarco's Mission mine in Arizona. In 1950 Asarco's geologists became familiar with a small mine southwest of Tucson. The area north of the mine was unclaimed and thought to be devoid of anything but sand, gravel, cactus, and sagebrush. However, one small hill in the distance caught the attention of Asarco's team, which recognized it as being favorable, well-altered rock. A group of claims was staked by Asarco, but the initial drilling did not turn up ore. Nevertheless, the drill samples showed encouraging geology; geophysical surveys were undertaken and drilling commenced again. Still no good ore was encountered, but enough money was left in the appropriation for one more drill hole. Paydirt!

More was needed, however, than just finding the ore body. It had to be drilled out, and tonnage and grade had to be carefully calculated. Nearly 3,500 acres of adjacent land was required for a mill site, tailings pond, and waste rock dumps. Acquiring this land, plus rights to drill water wells in the valley, took years of negotiations with ranchers and with the Papago Indian tribe since the ore zone extended into the Papago reservation. Still, the end result was Asarco's biggest wholly owned copper mine, the Mission mine.

This is what exploration is all about. Thousands of prospects have been examined by Asarco since the early 1920's—more than 1,450 alone in the years 1970 to 1979. Only a few have actually "panned out", but that's the way it has always been in the mining industry. Even so, the long-term fortunes of Asarco will be determined to a great degree by the success of its exploration.



◀ Development of the Eisenhower mine (center) in Arizona unites the Mission mine (left) with the San Xavier South mine (upper right) and extends significantly the life of the copper mining complex.

▲ Molybdenum concentrates are thickened in large tanks at the Mission Unit.

Mining has been an increasingly important part of Asarco's operations since the early days of the Company. Mining was a relatively small activity of the original Company. However, during the ensuing 80 years, Asarco has expanded its interests to the point where up to 75% of the Company's annual earnings before taxes have come from mining (including mining by the associated companies outside the U.S.).

While mining today is a technical science, one can still sense the color and excitement of mining history and tradition in such places as Leadville, Colorado, and Wallace, Idaho, where some of Asarco's mines are located.

At Leadville, mining has always been king. An offshoot of the great California gold rush, this area became synonymous with mining in the 19th century and, along with California and Nevada, stimulated development of the entire West. Denver blossomed into a city following mineral strikes at Leadville and elsewhere in Colorado.

Leadville is also where the Guggenheims, who played an important role in the early development of Asarco, first entered the mining business. Asarco still operates an underground lead-zinc-silver mine in the area.

The interest in mining stimulated at Leadville spread to the Wallace area in the late 19th century. Located in the Coeur d'Alene mountains in northern Idaho, Wallace today is a blend of modern mining life and the historical flavor of earlier times. Remnants of old mining camps and mines can still be seen in the area, and mining lore is a favorite topic of conversation among old-timers as well as visitors to Wallace.

Local residents refer to Wallace as the "silver capital of the world" with good reason, since nearly half of the silver mined in the United States comes from this small region. There, Asarco operates the second largest U.S. silver mine, in terms of capacity, the Galena, and the fourth largest, the Coeur, and is actively exploring another property nearby through un-

▲ The Coeur mine, fourth largest silver mine in the United States, is located in Idaho's famed "Silver Belt" from which nearly half of the country's silver is mined.

derground workings. Yearly, these two mines yield approximately 6.5 million ounces of silver.

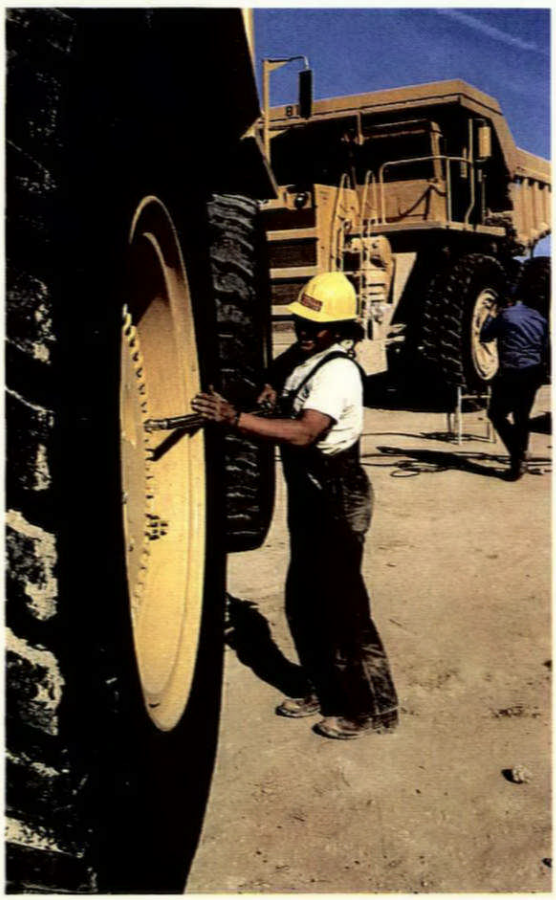
At Galena, miners descend two shafts approximately 4,800 feet and 5,300 feet deep to mine the relatively narrow veins. Throughout the day these miners work to extract and load ore which has been exposed and loosened by blasting done at the close of the previous work shift. Additionally, they prepare for the next shift. Blasting takes place only after the miners have completed their work shift and have returned to the shafts. The ore is hoisted up the shafts and concentrated at the mill adjacent to the mine. The concentrates enter the Asarco smelting circuit after shipment to the El Paso, Texas, or East Helena, Montana, plants.

The Troy mine in Montana, on which construction began in 1979, is the most recent silver property to be developed. Asarco will spend approximately $85 million to bring Troy into production. When fully developed, the mine will have the capacity to produce annually 4.2 million ounces of silver and 20,000 tons of copper in concentrates. The Troy deposit contains approximately 64 million tons of ore averaging 1.54 ounces of silver per ton. The copper grade of the Troy deposit is 0.74%.

Asarco is also a major miner of copper. Three smelters and a refinery in the Asarco metallurgical complex in the United States process the valuable "red metal". Because of Asarco's commitment to copper production, the Company has made a major effort over the past two decades to acquire ore reserves of the metal it has smelted and refined since nearly the beginning of the century.

Asarco's present U.S. copper mines are largely concentrated in Arizona, "the copper state", which accounts for more than half of the total annual U.S. copper mine output.

Asarco's first important copper mine in Arizona was developed at Silver Bell, northwest of Tucson. Natives of the area offer a variety of reasons when



▲ Driver tightens lugs on the wheel of a huge ore-haulage truck. The mammoth vehicles transport 170 tons of copper ore per trip from the open pit to the concentrator at the Mission Unit.

asked how their mining town got its unusual name, since silver mining has never been important in the area. Some say the name comes from a certain flower in the region. Others claim it was named for Belle Caruthers who, in the 1850's, was often seen in town riding a silver horse. The most popular tale is that there was once a dance hall girl named Belle; when she grew older and her hair turned grey they called her Silver Belle and named the town after her.

The Silver Bell area has been mined for well over 100 years; Indians were mining there even before the white man came to the territory. The early miners used hand tools. The first "ore cars" probably held only a fraction of a ton; today, ore trucks at Silver Bell can each haul 85 tons. Development of the Silver Bell copper deposits began on what was called the Mammoth Lode in 1873.

Asarco's current operations at Silver Bell are two porphyry copper open pits, the El Tiro and the Oxide. Ore from both pits is hauled in trucks to a primary crusher, then on conveyor belts through secondary and tertiary crushing equipment, and into the mill for concentrating. Current milling capacity is about 11,000 tons of ore per day.

The Mission Unit is Asarco's largest mining property, and is located near the famous Mission San Xavier del Bac, southwest of Tucson. The mine takes its name from this mission which was built in the 1700's to honor Father Kino, an early Spanish missionary.

In 1967 the capacity of the mill at Mission was increased from 15,000 tons of ore per day to 22,500 tons. In recent years, Mission's production has topped 180,000 tons of concentrate per year, grading at 27% copper.

Both Silver Bell and Mission also produce molybdenum as a by-product of their copper operations. The former began recovering molybdenum in 1956 and produces approximately 420 tons of concentrates per year. The Mission molybdenite plant was built in 1964, and a project to modernize and expand it is scheduled for completion at the end of 1981.

The San Xavier North mine, adjacent to the Mission unit, started operations in 1967 and two years later excavation started on the San Xavier South mine. Both San Xavier mines are located on the Papago Indian Reservation. Between the San Xavier South mine and the Mission mine lies the Eisenhower ore body. In 1976, Asarco formed a general partnership with Anamax Mining Company, a partnership of The Anaconda Company and AMAX Inc., and began development of the Eisenhower mine. By 1979, a breakthrough had been made from the Eisenhower mine into the South San Xavier pit. Mining of the Eisenhower deposit is expected to extend significantly the life of the Mission mining complex.

A $22-million modernization program was begun at the Mission Unit in 1979 to improve ore haulage and to install large-volume flotation cells in the mill. A fleet of 170-ton capacity ore haulage trucks replaced the existing fleet of 85-ton trucks. The large-volume flotation cells also replaced smaller units. The new cells increase recovery of copper from the ore and achieve a 25% reduction in power costs. Nearly all of the output of Asarco's Arizona copper mines is shipped to Asarco's nearby Hayden smelter for further processing into blister copper which will then be ready for refining.

Mining copper ore from an open-pit deposit is not as simple as just loading rocks into trucks. First and foremost, the mine's pit supervisors and shovel operators have to be trained to differentiate the ore from the barren rock. These men are aided by assay maps prepared by the pit engineers from assays of samples from holes which have been drilled in the mine. Part of their job is classifying the ore which varies in copper content and hardness of rock. The ore must be mined selectively because of these variations, and then blended for maximum recovery of metal content in the mill.

Open-pit mines are designed in

"benches" (resembling a large circular stairway) in order to allow more selective mining and easy transporting of the ore. Explosives are used to fragment the ore on the benches. Large electric shovels then load the ore into haulage trucks which dump into a primary crusher near the mill.

The primary crusher breaks up the ore, which can sometimes be in rocks as large as four feet in diameter, into more manageable sizes, usually less than five or six inches across. From the primary crusher the ore is conveyed to secondary and tertiary crushers where the rocks are reduced to sizes ranging from one-half inch to about three-quarters of an inch in diameter, depending upon the mill's specifications.

After crushing, the ore is mixed with water and ground to fine sand-like pulp in a circuit with rod mills and ball mills. The pulp then goes into a cell flotation circuit where reagents are added to the pulp mixture and more than 90% of the copper metal content floats to the top and clings to the froth. The froth is then collected and dried, and the resulting concentrate containing nearly 30% copper is shipped to a smelter to be converted into blister (anode) copper.

Alternatively, copper may be recovered by acid leaching from ores that consist primarily of oxides rather than sulfides. This method is used to recover copper from "waste" dumps at Silver Bell. A network of pipelines carries the acid solution to dumps where the copper ore is stored. The sulfuric acid dissolves the copper, and the resulting copper-rich solution is pumped into precipitation cells containing detinned scrap cans. The copper precipitates out by galvanic action. The copper precipitate contains approximately 82% copper and 15% moisture. It is subsequently shipped to a smelter for reduction to blister copper.

Asarco's Sacaton open-pit copper mine and mill near Casa Grande, Arizona, started production early in 1974. It has an annual production capacity of 21,000 tons of copper contained in concentrates, boosting the Company's domestic mine capacity to over 100,000 tons of copper per year. Asarco expects to mine a second, deeper ore body at Sacaton by underground methods starting in 1983.

Asarco's other mines include the Quiruvilca Unit in Northern Peru, a copper-lead-zinc-silver mine operated by the 80%-owned Corporacion Minera Nor Peru S.A.; the Quioma Unit in Bolivia, a lead and zinc mine operated by Compania Minera Quioma S.A., in which Asarco has a 58% interest; the Buchans Unit in Newfoundland, Canada, which is 49% owned and mines lead-zinc-silver ores; and four zinc mines in Tennessee, purchased in 1971 from the American Zinc Company.

The ores in the Tennessee zinc mines, located near Knoxville, are used chiefly in the production of zinc oxide at Asarco plants in Hillsboro, Illinois, and Columbus, Ohio, which were also purchased from American Zinc. The Tennessee zinc mines contain large, though low-grade, ore bodies (in contrast to the relatively narrow veins in Western lead-zinc or silver mines). The total estimated reserves at the four mines—the Immel, Coy, Young, and New Market—are more than 49 million tons of ore averaging 3 to 4 percent zinc.

Zinc ores from the Immel, Young, and Coy mines are concentrated at the Company's Young mill, while the New Market mine has its own mill.

In 1980 Asarco commenced development of a lead ore body at West Fork, Missouri. Development of the underground mine and construction of the mill will cost an estimated $77 million. The mill is scheduled to start processing development ore in mid-1983. Full operation of both the mine and mill is scheduled for 1984.

▲ A shaft is excavated at the Leadville mine in Colorado. Within sight of this lead-zinc mine are the remnants of the Guggenheims' first mine. The Guggenheims' interest in mining later led them into smelting and refining and the early development of Asarco.

Clamshell buckets unload ore at the modernized El Paso, Texas, smelter. Ventilation system in the new enclosed facility controls dust generated during unloading process.▶


30201

▲ Separate baghouses serve each side of the ore unloading building at El Paso to provide adequate ventilation of all work areas. The unloading building is divided in half to handle copper concentrates and lead concentrates.

Asarco's ore purchasing operation is responsible for maintaining the supply of mineral raw materials from which the Company produces metals. Throughout the Company's history, ore buying has been vital to Asarco's operations. As Asarco has expanded its mining and international operations, the ore department has become both a buyer and seller in international markets of ores, concentrates, precipitates, crude products containing precious metals, blister copper, residues and secondary materials.

The Ore Department buys metal-bearing materials for the Company's processing plants both from Asarco's own mines and from independent mining companies, thereby providing a valuable outlet for the ores of domestic and foreign mining companies which lack facilities to smelt their own mine output. In some cases mining companies that have been able to develop sizable ore reserves because Asarco initially helped provide a market for the output of their mines are now operating their own smelters and refineries.

Asarco converts the mixture of raw materials it purchases into refined marketable metals and endeavors to sell them for enough to cover the price paid to the seller and processing expenses and to provide an adequate profit.

In addition to the technical and physical problems of performing its tasks, Asarco has two principal commercial considerations: one, correlating the unit price paid for the metal content of the raw material with the price eventually received for the resulting refined metals, which normally are not available for sale until two to three months later; and two, being able to sell to the market the amount of metal purchased.

The first problem is dealt with by basing the unit purchase price of the contained gold, silver, lead, copper, or

▲ Ore unloading and bedding operations at El Paso are controlled from this panel.

zinc on published quotations, and using a quotational period that coincides with the time that the refined metal produced therefrom is expected to be available for sale. When making these purchases, deductions of metal content, a smelting charge and other charges are made to cover the costs of processing and to provide for metal losses and an adequate profit.

The second consideration, that is, being able to sell the amount of metal purchased, is dealt with by attempting to sell each day or week or month the same amount of gold, silver, lead, copper, or zinc that is purchased or priced during the same period. Asarco has a pipeline or base supply of metals in process. The pipeline was established years ago and is part of the Company's working capital.

Asarco attempts to sell each month the same amount of metal that it purchases and tries to buy and sell on the same quotation. When the system works it is an effective means of protecting the Company's smelting and refining margins. However, changes in the economic outlook at times will cause sales to fall short of or to exceed purchases. This means Asarco is subject to gains or losses on the changes in its inventories because of price fluctuations.

Prices of nonferrous metals fluctuate in both the United States and international markets in response to local and international supply and demand conditions or, at times, to government controls. Ore buyers at Asarco must study and evaluate all long-range market developments so that the Company may remain competitive with other smelters in purchasing materials.

Asarco's ore buyers must be knowledgeable about the metallurgy at the Company's smelting and refining plants. This expertise is essential to determining the correct quantities and types of raw materials to purchase for the most efficient processing.

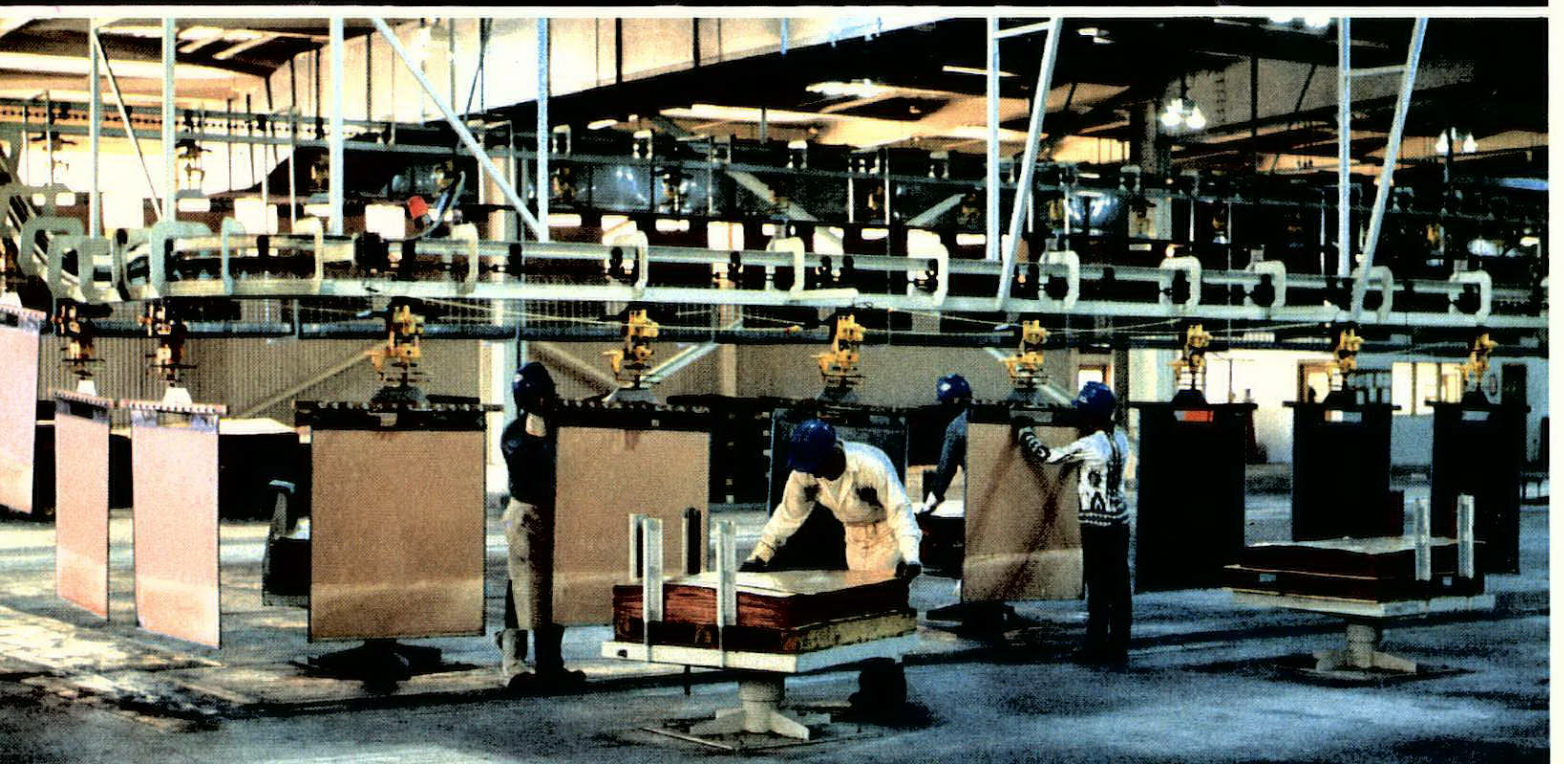
In addition to outright purchases of ores and concentrates, Asarco processes the output of some independent mining companies on a toll basis. Under this arrangement the miner receives his metals back in a refined form and pays Asarco for smelting and refining services. The ore department also handles such toll agreements.

Currently, Asarco purchases or tolls monthly for smelting and refining materials containing about 35,000 tons of copper in concentrates, ore and blister, 20,000 tons of lead in concentrates, and about 8,500 tons of zinc in concentrates. These materials originate in mines, including Asarco's, located in the United States, as well as Canada, South America, Mexico, Central America, Australia, and the Philippines.

In addition to primary ores and concentrates, Asarco also purchases, or treats on toll, copper, lead, zinc, and precious metal scrap. Presently Federated Metals Corporation acts as agent for Asarco in the purchase of copper and lead scrap.

Also, being a refiner, Asarco buys blister copper from some other smelters. At times it has bought lead and zinc from the United States Government stockpile, when available, for processing and casting into commercial forms. Additionally, the Company refines blister copper on a toll basis for other copper producers.

As a seller to other processing companies, the ore department markets copper, lead and zinc concentrates from Asarco's mines when production exceeds Asarco's available smelting capacity. Sales are made to smelters in all parts of the world depending on comparative freight costs, available capacity, and treatment charges at the time the contracts are negotiated.



◀ The tankhouse at the Amarillo Copper Refinery (upper left) is so large that construction plans had to allow for the curvature of the earth's surface. The structure covers 11 acres and contains 2,400 separate tanks.

◀ Copper starting sheets (lower left), about one-thirty-second of an inch thick, become cathodes in Amarillo's refining tanks. After 14 days they are removed, having grown to a thickness of five-eighths of an inch.

▲ Molten lead and slag flow continuously from the lead blast furnace at El Paso to a settler where the two products are separated for subsequent treatment.

Virtually every major nonferrous mining company in the United States has at one time or another used Asarco's smelting and refining services. In fact, many small miners have relied almost entirely on Asarco to process their ores and concentrates. Four of the original 18 smelters and refineries which made up Asarco when it was organized are still in operation today: the Omaha, Nebraska, lead refinery; the Globe by-products plant at Denver, Colorado; and the East Helena, Montana, and El Paso, Texas, lead smelters.

Silver

Asarco is the largest mine producer and refiner of silver in the United States. At its Amarillo, Texas, refinery, the Company has the capacity to refine 60 million ounces of silver a year. That is by far the largest facility of its kind in the world.

As early as the 1950's, Asarco recognized the fundamentally strong long-term supply/demand situation for silver. As industrial consumption of silver became greater than new mine production on a world basis, Asarco made silver a top priority in its exploration activities.

In addition to processing the silver from its mines, Asarco also recovers silver from its copper refining operations and from its lead smelting operations. To call silver an impurity seems curious, but the fact is that silver and several other metals must be separated from copper in the refining process. When nearly pure copper is removed from an electrolytic refining tank, small amounts of silver and other metals are left behind. By processing the residue recovered from the tanks, the Amarillo refinery produces substantial quantities of silver.

Similarly, lead bullion produced by Asarco's East Helena and El Paso smelters is refined at the Company's Omaha lead refinery. In the refining process silver is separated from lead. Silver, in the form of a material called doré, is then shipped to Amarillo for refining.

As the price for silver has risen, the Amarillo refinery has adapted its silver refining operation to the processing of a broader spectrum of high-grade, silver-bearing materials, such as old silver articles and coins.

Copper

Asarco's largest volume of smelting and refining activity is in copper. Three smelters—at Tacoma, Washington; Hayden, Arizona; and El Paso, Texas—process copper ores and concentrates into blister copper. Blister is then refined at the Amarillo Copper Refinery.

The Hayden plant has always been a custom smelter but, with the emergence of Asarco as a leading copper mining company in the Southwest, Hayden also treats output from the Company's Silver Bell, Mission, San Xavier, Eisenhower, and Sacaton mines.

Asarco's El Paso plant is the only complex in the U. S. that smelts lead and copper at a single location. The processes are carried on separately but use the same rail facilities and other services. Asarco smelts ores—both lead and copper—at El Paso which are high in by-product content. Many of these by-products are recovered later at either the Amarillo Copper Refinery or at the Omaha lead refinery. In addition, zinc is recovered in oxide form at El Paso in a fuming operation which treats slag from the lead smelter. El Paso also de-leads the zinc fume produced at the Company's East Helena plant. Zinc fume is shipped to Corpus Christi, Texas, where Asarco refines it and casts it into slab zinc or zinc alloys. El Paso's cadmium is contained in residues shipped to the Globe plant where it is refined into cadmium metal and cadmium chemicals.

The Tacoma plant was purchased by Asarco in 1905 and has since been an important facility for Asarco. Its West Coast tidewater location enables it to treat raw materials from Alaska, Canada, Central and South America, and the Philippines. Additionally, Tacoma is the only plant in the United


ASARCO

◀ Asarco's El Paso Plant, one of the most sophisticated metallurgical smelters in the world, is capable of smelting copper and lead and recovering zinc fume from the blast furnace slag.

▲ Ships carrying ores from as far away as the Philippines discharge their cargo at the Tacoma, Washington, copper smelter.

States equipped to remove arsenic from arsenic-bearing copper ores and reclaim arsenic by-products from residues of other smelters. It is a major world producer of arsenic trioxide and arsenic metal.

Asarco's Amarillo Copper Refinery processes blister copper from El Paso, Hayden and Tacoma, as well as some purchased or toll blister and some copper scrap. It employs the electrolytic method for refining copper, a method which allows efficient recovery of precious metals and other "impurities" in copper blister or scrap.

The Amarillo Copper Refinery started up in 1975, replacing obsolete copper refining plants in Baltimore, Maryland, and Perth Amboy, New Jersey. The Baltimore plant traced its origin back to 1814 when Levi Hollingsworth built what was then called the Gunpowder Copper Works. Hollingsworth's plant was set up to treat ores from various Maryland mines, which also supplied Paul Revere's copper plant near Boston.

At Baltimore, Asarco pioneered many important copper processing methods. Among these were the Peirce-Smith converter, the continuous casting of copper cakes and large billets, and the Asarco vertical shaft furnace, now the principal copper melting furnace used in the industry.

The Amarillo Copper Refinery is capable of producing 420,000 tons of 99.9% pure copper per year. Electrolytic refining of the copper takes place in 2,400 tanks which are housed in a single building—a structure that covers 11 acres, or almost 500,000 square feet.

The refinery is a leading producer of continuous-cast copper rod, the major product used in manufacturing wire. The refinery also produces copper in billet, cake, and wirebar form.

In addition to refining copper and silver, the Amarillo plant also recovers other precious metals such as gold, platinum and palladium. Additionally, other important by-products with industrial applications such as selenium and tellurium are recovered from residues in the refining tanks. Nickel sulfate is reclaimed from the refining solution.

Lead

Asarco smelts lead at East Helena, Montana, and Glover, Missouri, as well as at El Paso. Lead bullion from the smelters is refined at Glover and Omaha.

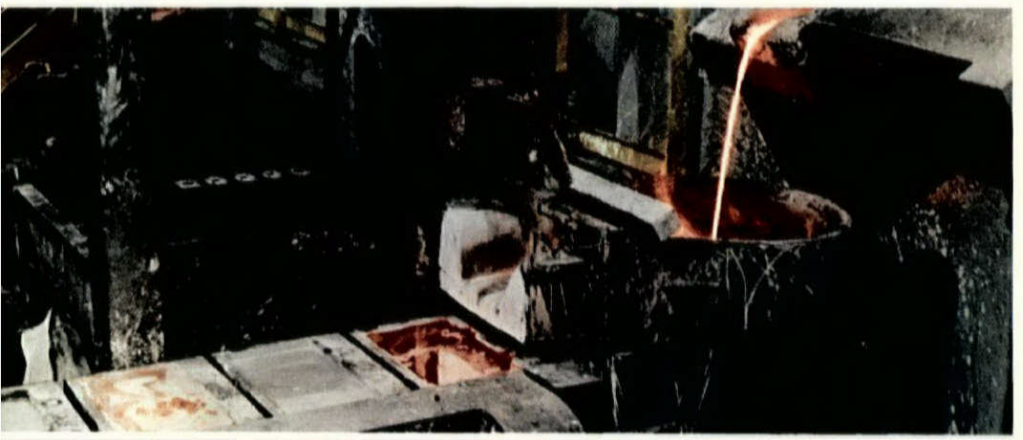
The Omaha lead plant was built in 1870 and became the Omaha and Grant Smelting Company in 1883. The Omaha plant is one of the largest lead refineries in the Western world. Omaha's strategic importance in the Asarco metallurgical complex is that it processes lead bullion produced at both El Paso and East Helena. In addition, Omaha is the largest producer of bismuth in the United States and recovers valuable gold, silver, copper, tellurium, antimony, and antimony oxide in the lead refining process.

The East Helena smelter is a service plant in the full sense of the word. It processes complex ores and concentrates from more than 50 small Montana mines as well as from mines throughout the western U.S., Canada, Australia, and South America. It ships to the Omaha refinery a bullion product that contains precious metal values and is high in bismuth content.

The East Helena plant has contributed much to the community and vice versa. Originally, one fourth of the financing for its construction in 1888 was raised by citizens of nearby Helena, Montana's state capital. Many residents of the small community of East Helena are employed by the smelter.

In 1972 Asarco purchased a zinc fuming plant adjacent to the East Helena smelter to treat lead-smelter slag. It ships the zinc oxide fume product first to El Paso for de-leading and then to Corpus Christi for refining.

The Glover smelter-refinery in the Lead Belt of southeast Missouri was started up in 1968. Since ores in Mis-



▲ Molten silver (above) is cast into anodes which will be electrolytically refined into 99.999% pure silver at Amarillo. The plant has the capacity to produce 60 million ounces of refined silver annually.

▲ Refined zinc (below) is stripped from aluminum cathodes following electrolytic deposition at the Corpus Christi, Texas, plant.

souri are relatively free of impurities, the output from Glover is refined lead of very high quality. Small amounts of silver and copper, contained in the Glover feed, are recovered from residues shipped by Glover to other Asarco plants for processing.

The Globe plant at Denver, which originated as a lead smelter in 1866, is now one of Asarco's chief by-products facilities. Products which occur in relatively small quantities in the circuits of many other Asarco plants but which cannot be efficiently recovered by those plants individually are recovered at Globe. Cadmium is such a material; and Globe's production long made Asarco the world's largest producer of that metal. In 1970 the Globe plant added a high purity metals facility which produces metals — copper, lead, zinc, arsenic, antimony, etc. — of nearly 100% purity. These are used mainly in metallurgical research.

Zinc

Asarco has been a major U.S. producer of zinc since 1915 when it operated two plants in Oklahoma. The natural gas fuel supply for these plants had begun to diminish by the early 1920's, however, so the Company built a new smelter at Amarillo, Texas, to take advantage of the availability of natural gas in the Texas Panhandle. In 1975, with natural gas again becoming scarce and the horizontal retort process for smelting zinc ores becoming obsolete and environmentally unacceptable, the Amarillo zinc plant was closed. Asarco's major slab zinc production is obtained from a newer plant at Corpus Christi, Texas, which utilizes electrolytic methods of recovering zinc metal.

The Corpus Christi plant was built in two stages. The sulfide plant was constructed in 1942 to treat and refine zinc sulfide ores. The oxide department was added in 1953 to process the zinc oxide fume from El Paso. A $42-million modernization program to combine what had been two separate operations is scheduled for completion in 1981 and will enable the plant to process a broader range of zinc concentrates, reduce operating costs, and increase refined zinc output approximately 25%. Special High Grade zinc slab, Prime Western zinc, and zinc die-casting alloys are produced at Corpus Christi. Also, cadmium is recovered during purification of the zinc solution prior to electrolysis.

Copper tubing from this scrap heap will be recycled by Federated Metals Corporation, an Asarco subsidiary.▶

Widespread concern for the environment and the desire to conserve natural resources have made the reuse of metals important in today's society. Federated Metals Corporation, a subsidiary of Asarco, each year converts more than 100,000 tons of scrap metal into hundreds of useful products. In addition, Asarco's primary smelters and refineries handle many thousands of tons of scrap a year. Thus the Company is one of the world's largest nonferrous metal recyclers.

Coincidentally, the history of Federated Metals Corporation parallels that of Asarco in that Federated originally was a consolidation of secondary metals companies brought together in 1924. Asarco purchased the resulting company in 1932.

Today Federated Metals comprises seven plants, three stock supply centers and 16 sales offices in the U.S. and Canada. Federated Metals is the only nationwide secondary metal producer covering so broad a range of nonferrous alloys. The products of Federated Metals serve such industries as automotive, chemical, construction, electronics, electroplating, machinery, primary metals, shipping (maritime), and public utilities.

Reclaiming scrap metals involves careful selection and sorting of the materials acquired from scrap dealers and metal fabricators. The largest sources of recyclable nonferrous metals are used automobiles, trucks, batteries, razed buildings and industrial plants, ship dismantling and other metal goods. Also metalworking plants generate thousands of tons of scrap yearly in the form of turnings, clippings, and other excess metal from cutting, stamping, grinding, and other fabricating and foundry processes.

Basically, there are two kinds of scrap: clean and segregated scrap which can be realloyed and used without refining, and mixed or contaminated scrap which must be completely reprocessed. Clean scrap generally is the by-product of a manufacturing process, whereas contaminated scrap is from metal products which have been used and then discarded and collected by scrap dealers. The dealers sort the material and crush and compress certain types into shapes suitable for processing.

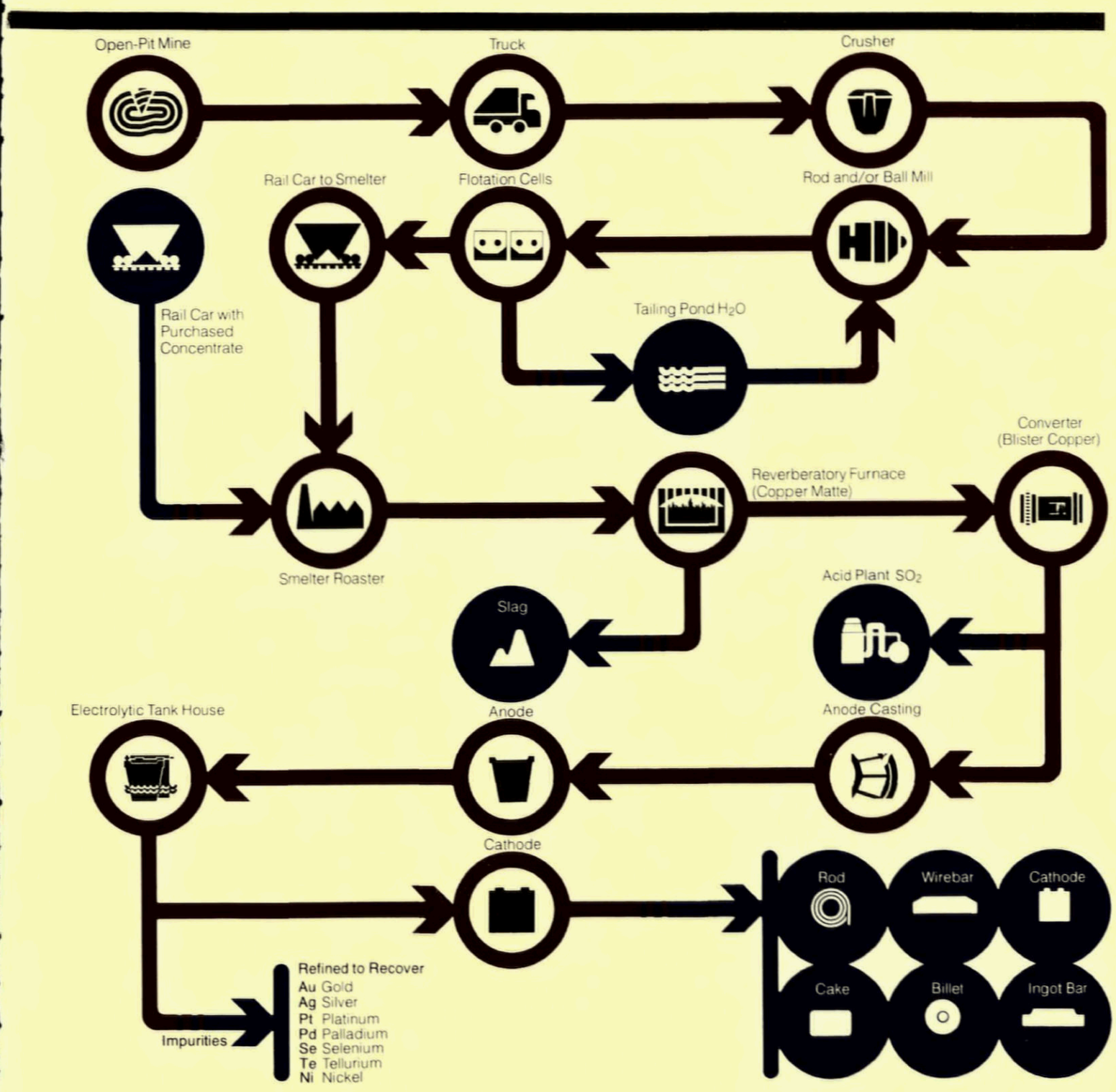
A typical Federated Metals recycling operation is at the Newark, New Jersey, plant. Different kinds of scrap lead, tin-lead residues, discarded type metal, babbitt metal, and lead and solder drosses are melted down and converted into type metal, babbitt alloys, and various solder alloys. After smelting or refining in furnaces and kettles, the composition of the melt is adjusted after analysis to meet metallurgical specifications as rigid as those for primary metals. Then the molten metal is cast into various shapes in Asarco Castomatic® machines, or is extruded into rods and wires.

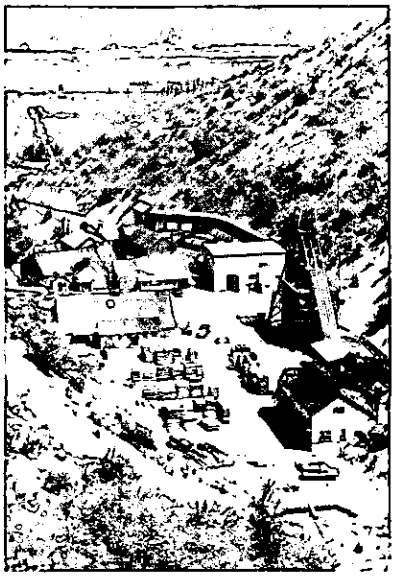
On the marketing side, Federated Metals employs its own sales force and also sells through distributors and manufacturers' representatives. Federated Metals also markets zinc die-casting alloys produced at Asarco's Corpus Christi refinery. Federated Metals salesmen are trained to provide technical and problem-solving assistance to their customers, and are backed up by experienced metallurgists and the analytical and research facilities of Asarco's Central Research Laboratories.

With increasing emphasis on the recovery of reusable materials from municipal and industrial wastes, Federated Metals' ability to convert the resulting scrap metals into refined metals and alloys on a large scale should assure increasing importance.

▲ Solder, coiled and marked for shipment, at a Federated Metals recycling plant.

Copper–from mine to metal

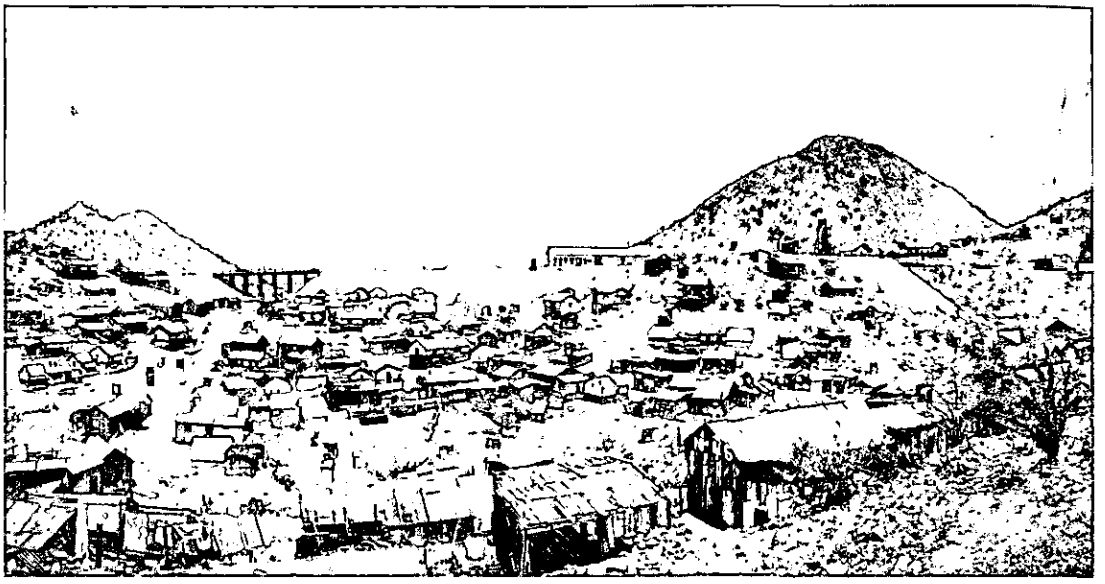




1920-1929—(left) Page mine in Idaho started up. Northern Peru Mining and Smelting Company organized. Buchans mine in Newfoundland brought into production. (right) Ground Hog mine in New Mexico opened.

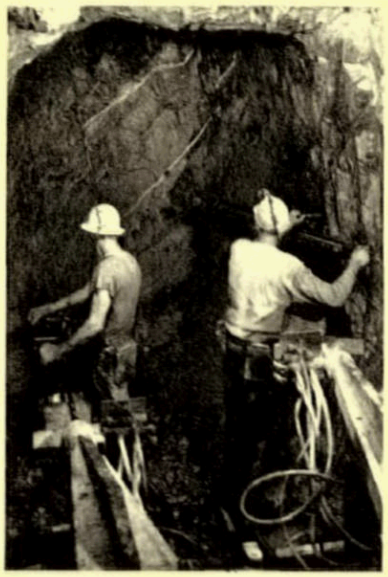
1930-1939—Initial investment made in Australia's Mount Isa Mines Limited. Acquired interest in Neptune Gold Mining Company in Nicaragua.

1899—(above) Asarco organized. Included in original consolidation were mines and mining claims in Colorado and Mexico.



1900-1909—Merged with M. Guggenheim's Sons. Purchased control of Federal Mining and Smelting Company, which owned mining properties in Idaho. Acquired five additional mines in Mexico.

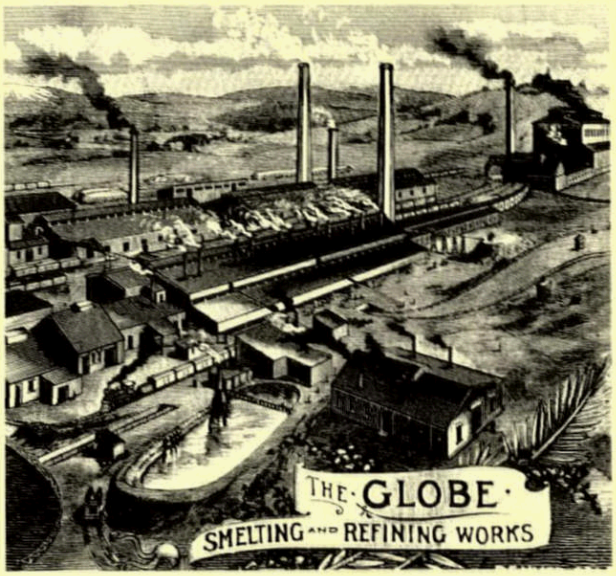
1910-1919—(above) Purchased mining properties in Silver Bell district of Arizona.



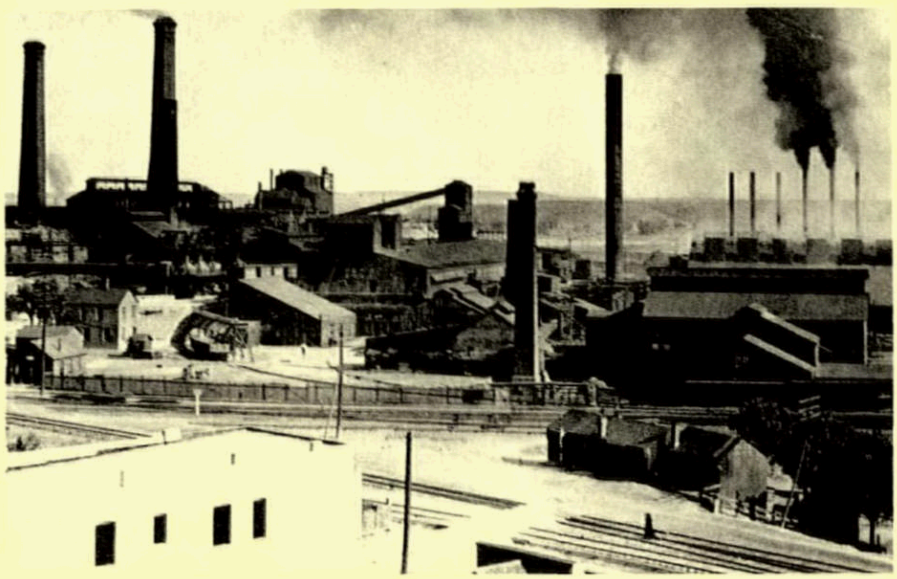
1950-1959— Production commenced at Silver Bell, Asarco's first open-pit mine. (left) Galena silver mine in Idaho started production. Lake Asbestos of Quebec, Ltd. began operations.

1960-1969— Southern Peru Copper Corporation opened Toquepala mine. (left) Mission mine in Arizona started up. Mexican mines and plants organized into Asarco Mexicana, S.A. Page mine closed.

1970-1980— Midland Coal Company Division formed from purchased Illinois mines. Leadville mine in Colorado began mining lead-zinc-silver ore. (upper right) Four Tennessee zinc mines purchased. American Limestone Company of Knoxville, Tennessee, acquired. San Xavier copper mine and leach plant in Arizona started production. Manchester ilmenite mine in New Jersey started up. Copper mining began at Sacaton open pit in Arizona. Cuajone mine of Southern Peru Copper Corporation started up. Asarco Mexicana, S.A. reorganized as Industrial Minera Mexico, S.A. (IMM) and 15% interest sold to Mexican investors. IMM subsequently became a subsidiary of Mexico Desarrollo Industrial Minero, S.A., a holding company 34%-owned by Asarco. Coeur silver mine in Idaho started production. Eisenhower Mining Company, a partnership of Anamax and Asarco, began mining the Palo Verde copper deposit located between Asarco's Mission and San Xavier copper mines. Mission mill modernization begun. Construction of Troy, Montana, silver-copper mine commenced. Mines of Neptune Mining Company expropriated by Nicaraguan government. West Fork, Missouri, lead mine construction began.



1899— Asarco organized. Major plants in consolidation included: (left) Globe (Denver, Colorado), (below) Omaha (Nebraska), East Helena (Montana), El Paso lead plant (Texas), Arkansas Valley (Leadville, Colorado).

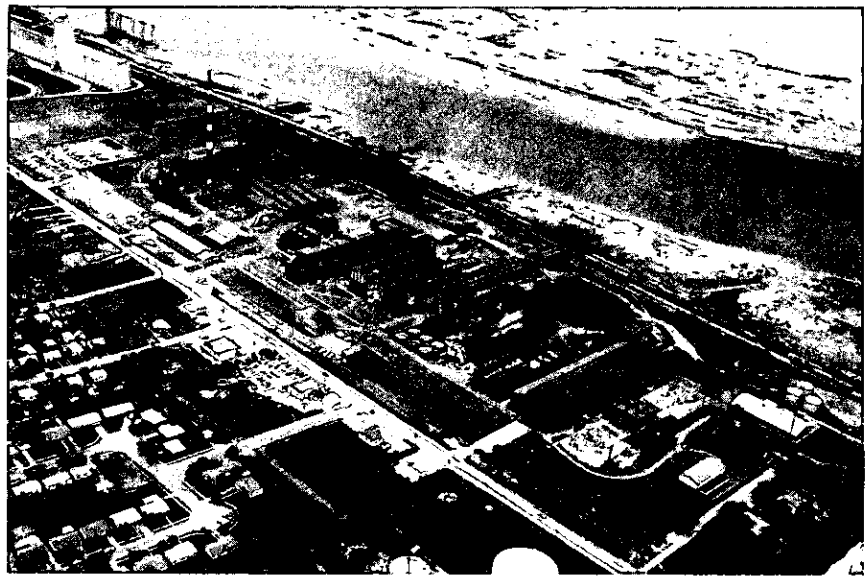


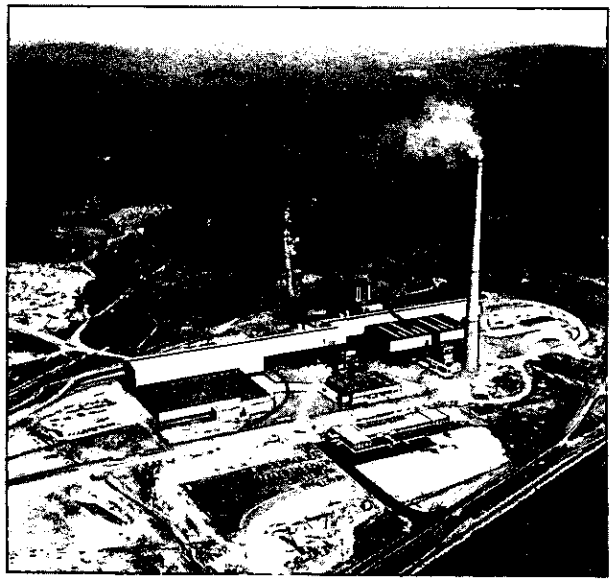
1900-1909— Perth Amboy, New Jersey plant acquired from Guggenheims. Control of the Federal lead smelter in Alton, Illinois, acquired. Selby, California, lead smelter purchased. (upper right) Tacoma, Washington, smelter purchased. Garfield copper smelter in Utah built to process ore from the Bingham pit. Baltimore, Maryland, copper refinery purchased.

1910-1919— Copper smelter built at El Paso plant. Copper smelter constructed at Hayden, Arizona. Copper refinery added to Tacoma plant.

1920-1929— (above) Amarillo, Texas, zinc plant constructed.

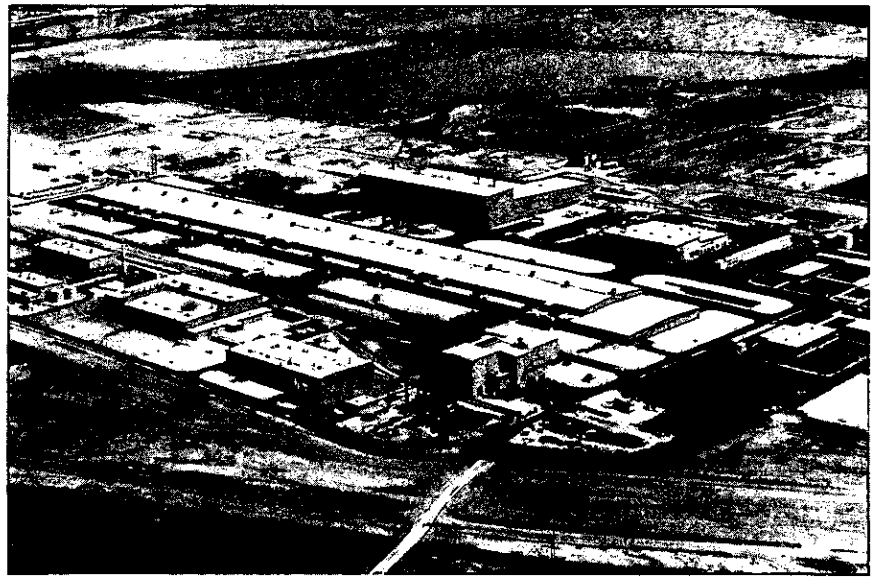
1940-1949— (right) Corpus Christi, Texas, zinc refinery constructed.





1950-1959— Federal lead smelter closed. Garfield copper smelter sold to Kennecott Copper Corporation.

1960-1969— Arkansas Valley lead smelter closed. (above) Glover, Missouri, lead smelter-refinery started up.



1970-1980— Selby lead plant closed. Purchased zinc oxide plants at Hillsboro, Illinois, and Columbus, Ohio. Amarillo zinc refinery closed. Baltimore copper refinery phased out. (above) Amarillo Copper Refinery completed. Perth Amboy copper refinery closed. Modernization of El Paso plant completed. Corpus Christi plant initiated program to integrate oxide and sulfide operations. Tacoma copper refinery closed.

Main Office—ASARCO
New York, New York
Main Offices—Associated Companies
Brisbane, Australia
Lima, Peru
Mexico, D.F., Mexico

Administrative Offices
Knoxville, Tennessee
Salt Lake City, Utah
Tucson, Arizona
Wallace, Idaho

Central Research Laboratories
South Plainfield, New Jersey

Smelters and Refineries

Cadmium, High Purity Metals
Denver, Colorado

Copper
Amarillo, Texas (Refinery)
El Paso, Texas (Smelter)
Hayden, Arizona (Smelter)
Tacoma, Washington (Smelter)

Lead
East Helena, Montana (Smelter)
El Paso, Texas (Smelter)
Glover, Missouri (Smelter, Refinery)
Omaha, Nebraska (Refinery)

Silver
Amarillo, Texas (Refinery)

Zinc
Corpus Christi, Texas (Refinery)
East Helena, Montana (Slag Fuming)
El Paso, Texas (Slag Fuming)

Zinc Oxide
Columbus, Ohio
Hillsboro, Illinois

Mines

Copper
Eisenhower; Sahuarita, Arizona
Mission; Sahuarita, Arizona
Quiruvilca (Also, Lead, Zinc and Silver)
(Corporacion Minera Nor Peru S.A.)
Quiruvilca, Peru
Sacaton; Casa Grande, Arizona
San Xavier; Sahuarita, Arizona
Silver Bell; Silver Bell, Arizona

Lead and Zinc
Buchans; Buchans, Newfoundland, Canada‡
Ground Hog; Vanadium, New Mexico*
Leadville; Leadville, Colorado**
Little River; New Brunswick, Canada**
(Also Copper and Silver)
Quioma
(Compania Minera Quioma S.A.)
Quioma, Bolivia
West Fork, Reynolds County, Missouri***

Silver
Coeur; Wallace, Idaho**
Galena; Wallace, Idaho**
Troy; Troy, Montana***

Zinc
Coy; Jefferson County, Tenn.
Immel; Knox County, Tenn.
New Market; Jefferson County, Tenn.
Young; Jefferson County, Tenn.

Minerals
Coal (Midland Coal Company)
Elm; Trivoli, Illinois
Rapatee; Middlegrove, Illinois
Ilmenite
Manchester; Lakehurst, New Jersey
Agricultural Limestone, Sand, Crushed Rock, Concrete
(American Limestone Company)
Knoxville, Tenn.
Asbestos
(Lac d'Amiante du Québec, Ltée.)
Black Lake, Quebec, Canada
Thetford Mines, Quebec, Canada

Manufacturing Subsidiaries
Federated Metals Corporation

(Acoustilead, additives and hardeners, aluminum alloys, babbitt, brass, brazing alloys, bronze, cathodic protection products, fusible alloys, jewel metal, lead products, nickel salts, plating anodes, solder, type metal, zinc dust.)
Houston, Texas
Newark, New Jersey
San Francisco, California
Sand Springs, Oklahoma
Somerville, New Jersey
Trenton, New Jersey*
Whiting, Indiana

Lone Star Lead Construction Corp.
(Lead burning) Houston, Texas

Asarcon Federal Products Division
(Bronze bearings, bushings and parts)
Somerville, New Jersey

Federated Genco, Ltd.
(Solder, type metal, babbitt, lead products, lead construction)
Burlington, Ontario, Canada
Montreal, Quebec, Canada

Enthone, Incorporated
(Metal finishing chemicals)
Chicago, Illinois
Toronto, Canada
West Haven, Connecticut

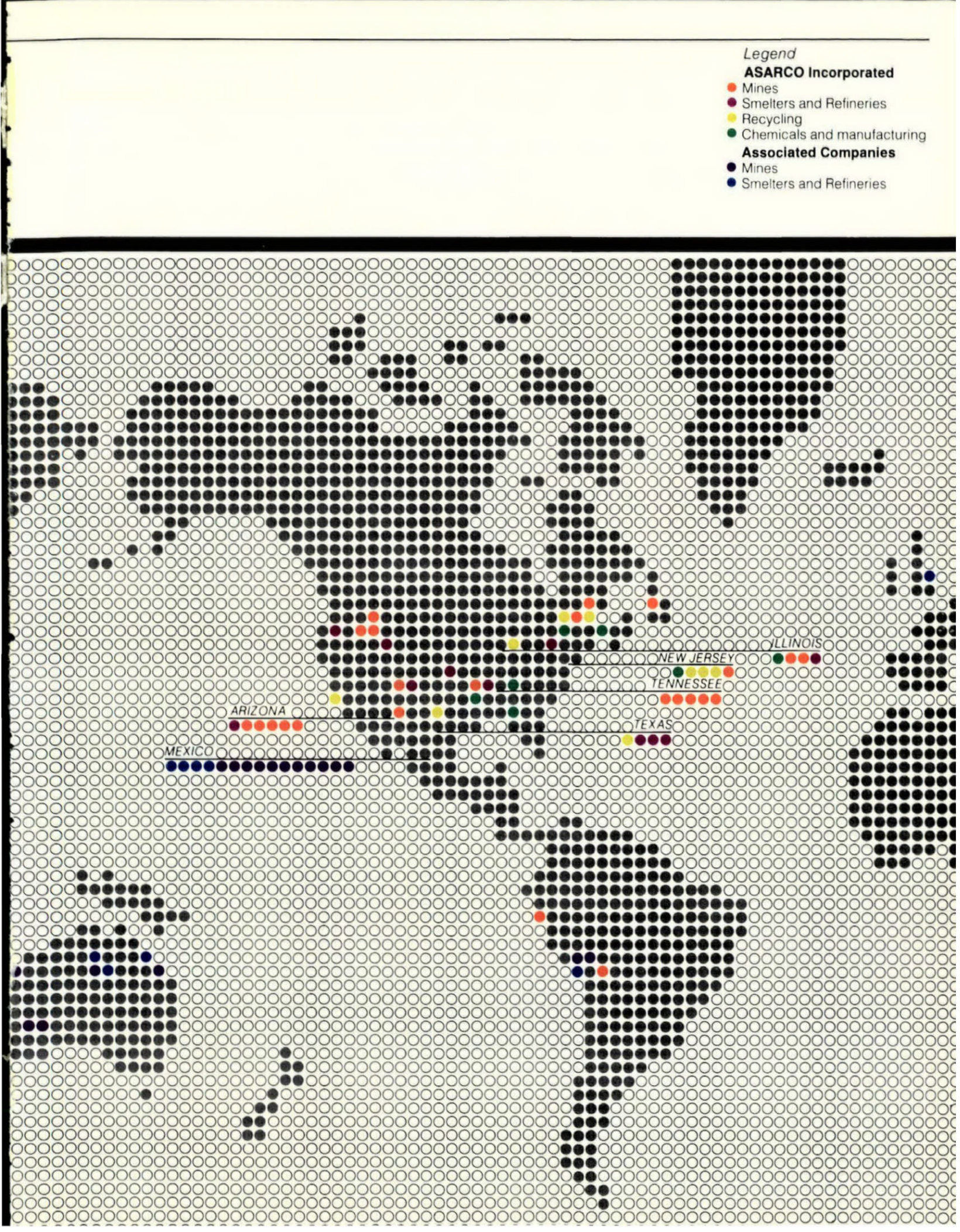
Sunworks Division
(Solar energy collectors)
Somerville, New Jersey

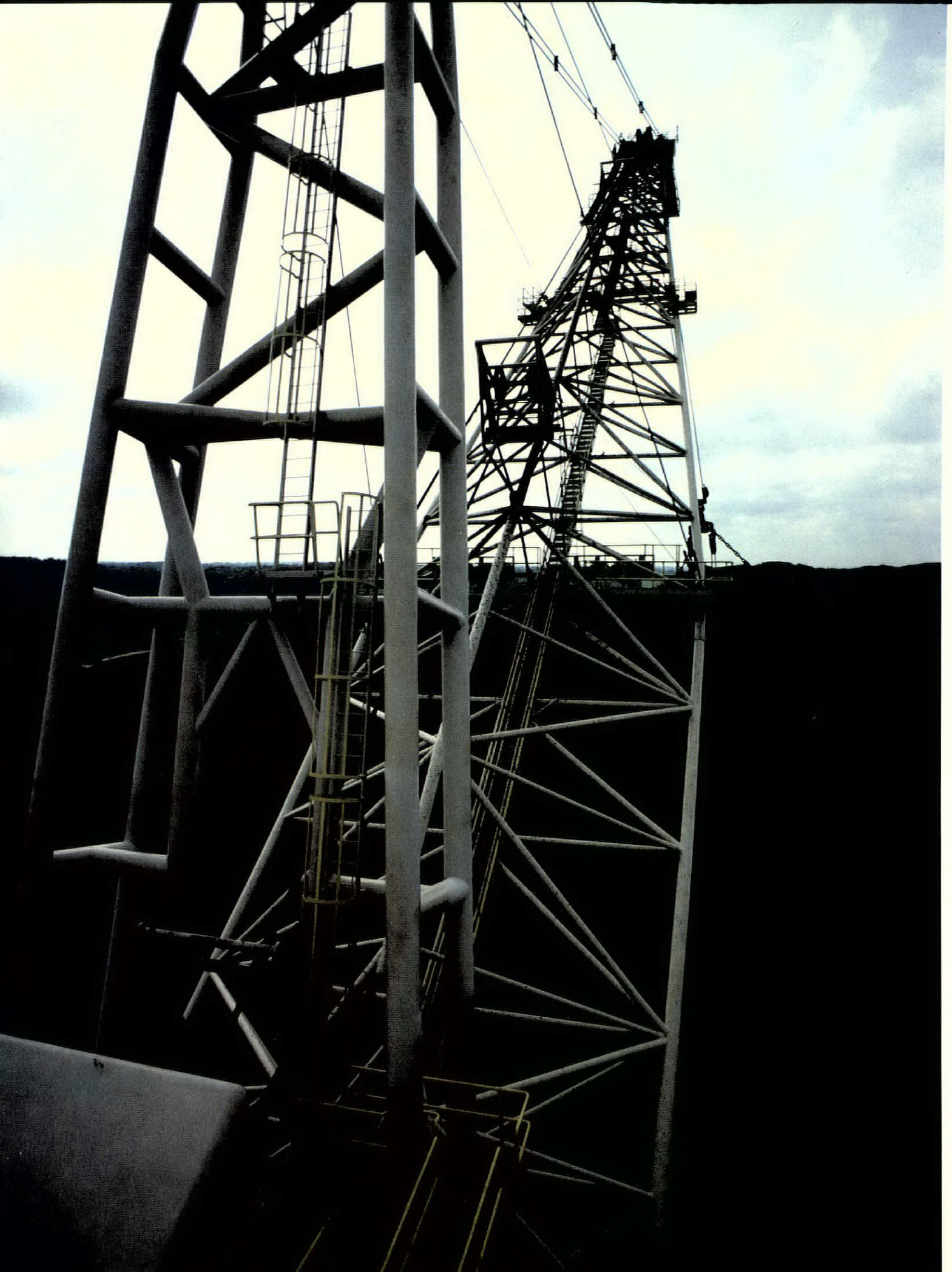
Capco Pipe Company, Inc.
(Asbestos-cement pipe and PVC pipe)
Ragland, Alabama
Van Buren, Arkansas
Evansville, Indiana

Associated Mining Companies

Mexico Desarrollo Industrial Minero, S.A.
Eleven mines, four metallurgical plants throughout Mexico
(Copper, Lead, Zinc, Silver, Gold, Tungsten, Coal, Coke, Fluorspar)
Mexico, D.F., Mexico
M.I.M. Holdings Limited
Mount Isa, (Copper, Lead, Zinc, Silver)
Queensland, Australia
Agnew (Nickel)
Western Australia
Britannia Refined Metals Limited (Lead Refinery) Northfleet, Kent, England
Collinsville Coal Company Pty. Ltd. (Coal)
Queensland, Australia
Copper Refineries Pty. Ltd.
Townsville, Queensland, Australia
Goldsworthy (Iron Ore)
Western Australia
Teutonic Bore (Copper, Zinc, Silver)
Western Australia
Southern Peru Copper Corporation
Cuajone (Copper, Silver, Molybdenum)
Cuajone, Peru
Toquepala (Copper, Silver, Molybdenum)
Toquepala, Peru
Ilo (Copper Smelter) Ilo, Peru

‡ Joint Tenancy.
*On Stand-by
**Joint Venture.
***Under Construction


Legend
ASARCO Incorporated
Mines
Smelters and Refineries
Recycling
Chemicals and manufacturing
Associated Companies
Mines
Smelters and Refineries
ILLINOIS
NEW JERSEY
TENNESSEE
TEXAS
ARIZONA
MEXICO



Midland produces about one and one-quarter million tons of coal annually by surface mining methods. Huge draglines first remove from sixty to eighty feet of earth to uncover the coal seam. The coal is scooped out with electric shovels and loaded into trucks for transporting to a preparation plant where it is crushed, cleaned by washing away the clay and shale, dried, and then shipped to market. The mined area is reclaimed by grading and the planting of forage, trees and shrubs. Reclamation of farm land includes additional procedures to return the land to a condition suitable for restoration to farming.

Stone

The American Limestone Company was purchased in 1971, along with the Tennessee zinc mines. The zinc ore in eastern Tennessee occurs with limestone, and American Limestone was formed originally to process the tailings and waste from the zinc mines into agricultural limestone, building stone, crushed rock, sand, and gravel. Demand for these products eventually exceeded the supply available as a by-product of zinc mining. American Limestone then expanded into quarrying of stone and dredging of sand and gravel. Subsequently, the company expanded further into the ready-mix concrete business.

Ilmenite

Asarco's Manchester ilmenite mine, located near Toms River, New Jersey, started up in 1973. It produces concentrates containing about 63% titanium dioxide, a white pigment used in paints, plastics, and other products. The operation is nearing the end of its economic life.

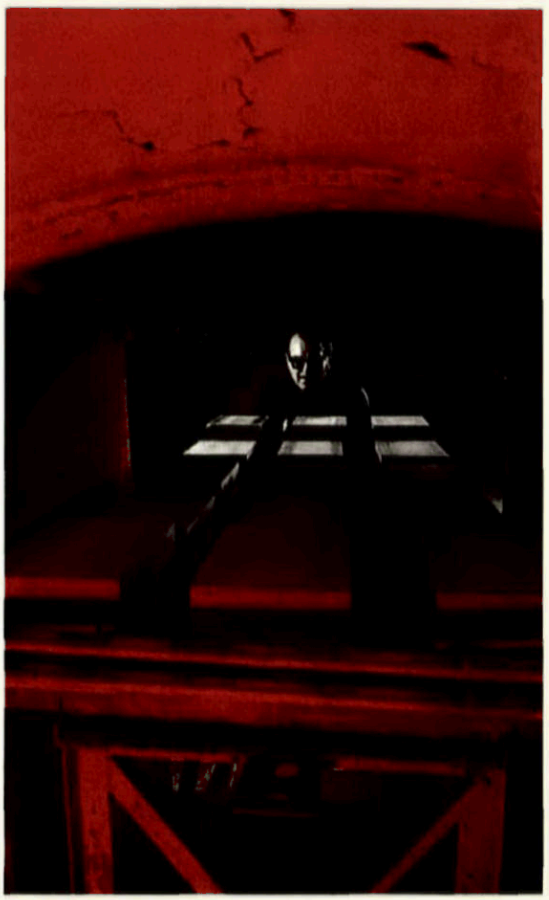
Specialty Chemicals

Enthone Inc., a manufacturer of specialty chemicals for electroplating and metal finishing, was purchased in 1957. Enthone was founded in 1930 and has plants in West Haven, Connecticut, and Chicago, Illinois. Its products are manufactured and sold throughout the Free World by affiliated companies and licensees.

Among the more than 300 Enthone products and processes are those which are used to produce: printed circuit boards; hard, bright, corrosion-resistant electroless coatings of nickel-phosphorous alloy on base metal; bright electrodeposits on functional plastic parts; metal strippers which selectively remove metal plate from base metal; blackening compounds for use on steel, iron, copper and other metals; and protective treatments to prevent tarnishing, staining and corrosion of metals.

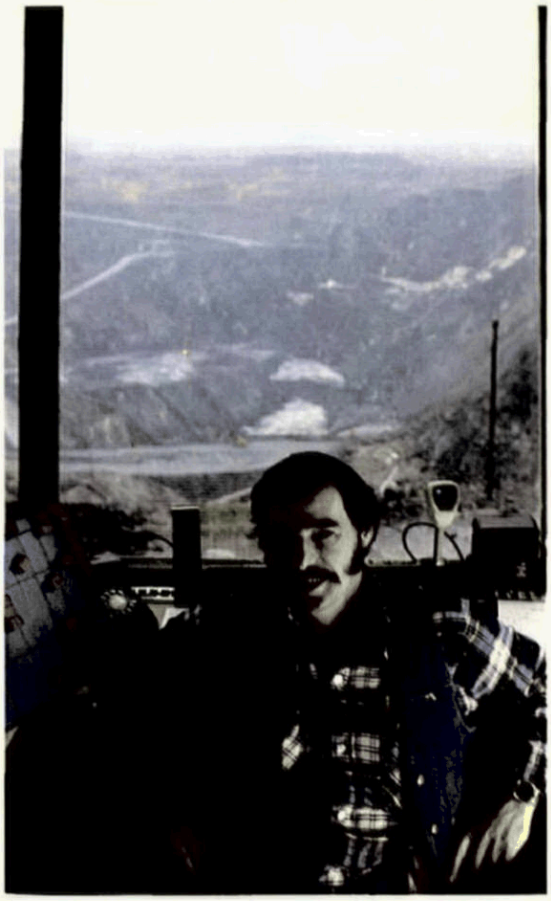
Solar Energy

The Sunworks Division of Sun Solector Corporation, an Asarco subsidiary, is one of the top five manufacturers of solar energy collectors and systems in the United States. Sunworks has the capacity to produce over one million square feet of flat-plate solar collectors annually. The company was begun in 1973 in response to the energy crisis and as an outgrowth of Enthone copper blackening technology. Sunworks remained a division of Enthone until 1979 when it was reorganized into Sun Solector Corporation, a wholly owned subsidiary of Asarco. Sunworks manufactures solar energy collectors for use in heating and hot water systems. The company also markets swimming pool heaters and provides technical design service through its field representatives.



▲ Copper sheets and tubing are brazed as part of the manufacturing process for solar energy collectors at the Sunworks division.

Asarco is the largest refiner of silver in the United States. Mined silver and silver recovered as a by-product from the processing of other metals is refined at the Amarillo refinery ▶



◀ Huge draglines remove the overburden at a Midland Coal Company mine in Illinois. Once the coal seam has been uncovered and mined, the land is reclaimed for further productive use.

▲ Asbestos, used as a reinforcing agent in asbestos-cement pipe as well as a heat resistant substance, is mined by an Asarco subsidiary in Quebec, Canada.

Over the years, Asarco has diversified into fields where its expertise in mining, mineral processing, metallurgy and chemistry has been put to good use. For example, Asarco mines coal, asbestos, limestone, and ilmenite, and manufactures specialty chemicals and solar energy systems.

Asbestos

Asarco's entry into nonmetallic mining began in 1952 with the formation of Lake Asbestos of Quebec Ltd. (LAQ), which was organized as a separate company to develop and operate the Black Lake mining property in Quebec, Canada, held by United Asbestos Corporation. In order to gain access to the asbestos deposit an entire lake had to be dredged and drained. More than 40-million cubic yards of earth and rock had to be removed. After overcoming these obstacles, the company began asbestos production in 1958 and is now producing about 160,000 tons of fiber annually at Black Lake.

The Black Lake deposit contains 3% to 4% asbestos of high quality. The ore is concentrated first by magnetic separation and then milled to recover the asbestos fiber.

In 1973, a nearby mine and mill, previously operated by National Asbestos Mines, Limited, was acquired, expanding LAQ's production. The National mine and mill now produces 125,000 tons of short fiber asbestos annually and provides a better assortment of fiber grades.

In 1978, the name of the company was changed to Lac d'Amiante du Québec Ltée. It continues to be known in the trade as LAQ.

Asbestos is best known as a heat-resistant substance. Because of its great tensile strength, it is also used as a primary reinforcing agent in asbestos-cement pipe and sheet, in plastics, in brake linings, and in floor tile. LAQ today accounts for about 19% of the total Canadian production of asbestos. Sales are made in markets throughout the world.

Much has been written in recent years about asbestos in relation to human health. While airborne asbestos may be hazardous, most asbestos-related disease develops only after long-term exposures to appreciable concentrations of airborne asbestos dust. Such concentrations do not exist in the urban atmosphere and the general public is not at risk. Asbestos-related health risks are basically confined to the work environment where they are subject to government regulations.

In many asbestos products the fiber is "locked-in" by another material. In asbestos-cement sheet, for example, it is "locked-in" by cement; in brake and clutch linings, by a fully baked resin; in gaskets, by rubber or synthetic rubber. Other asbestos materials, like asbestos cloths, can be given treatment to reduce dust emission. Many modern asbestos products are not by their nature dusty to handle.

Asarco's Capco Pipe Company, Inc., manufactures asbestos-cement pipes for water, irrigation and sewage systems. Capco was first organized in 1965 as a joint venture between LAQ and a cement supply source. It became a wholly owned subsidiary of Asarco in 1974. Capco also manufactures polyvinyl chloride water and sewer pipes.

Coal

Asarco's Midland Coal Company division is an important supplier of coal to electric utilities and industrial customers in the midwestern states. It operates two bituminous coal mines in central Illinois.


99.9
6690

▲ Lead "pigs" are stacked and strapped prior to shipment. Asarco ranks as the second largest U.S. refiner of lead.

▲ Zinc from Asarco's Corpus Christi electrolytic zinc refinery is used in galvanizing, die casting and brass products.

Continuous-cast copper rod is a major product of the Amarillo Copper Refinery.▶

"From the earth...metals and minerals for a better life."

Asarco's Sales Department markets copper, zinc, lead, silver, and other metals and minerals to manufacturers who fabricate them into the necessities and luxuries which have become part of modern everyday life.

Silver

Silver in the form of silver halide is the light-sensitive coating on film that makes photography possible. Silver metal is used widely in electrical and electronic components, in brazing alloys, in elegant tableware, in coinage, and in a host of other applications.

Copper

Copper plays a vital role in making some of the wonders of modern technology possible and the comforts of modern life practical. Its ability to conduct electricity makes it essential for electric generators and motors, lighting fixtures and wiring, radio and TV sets, computers—in short, for everything electrical.

Its ability to conduct heat has made copper invaluable for automobile radiators, air conditioner tubing, home heating systems, steam condensers, solar energy collectors, to name a few. Its corrosion resistance and the ease with which it can be joined have made copper the choice for plumbing and piping systems, automotive fuel lines, sea-water desalting plants, hydraulic systems, and many more applications. Alloyed with zinc, it becomes brass; with tin, bronze; and finds its way into a myriad of decorative and functional uses. It's hard to imagine life as we know it without the "red metal", copper.

Lead

Lead's principal use is in storage batteries for cars and trucks, boats, aircraft, and electric-powered vehicles such as golf carts, industrial fork-lift trucks and energy-efficient automobiles. The use of lead in the form of anti-knock additives for gasoline has declined in recent years due to environmental restrictions. However,

consideration is being given in some countries to easing restrictions on lead in gasoline in order to conserve crude oil. The outlook for lead is for increased use in such applications as electric automobiles, heavier batteries required for diesel powered cars, soundproofing, radiation shielding in nuclear plants and energy storage for peak-load use by electric power companies.

Zinc

More than 40% of the zinc consumed in the U. S. is used to protect steel from corrosion. Zinc coating, or galvanizing, extends the life of everything from steel bridges to watering cans. An equally important use of zinc is for die castings, many of which end up as the bright, chrome-plated fixtures on automobiles and appliances. Zinc, in the form of galvanic anodes, provides cathodic protection to steel structures exposed to seawater such as pier pilings, bulkheads and ships.

By-Product Metals

Although produced by Asarco in much smaller quantities, the by-product metals are no less important. Antimony, for example, is used in flameproofing compounds, bismuth in low-melting-point alloys, cadmium in portable batteries, selenium for decolorizing glass, and tellurium to improve the machinability of carbon steel. These are illustrative examples—each metal has many other uses.

Prices of Asarco's major products are influenced greatly by daily trading on the world's metal exchanges. As a custom smelter and refiner, Asarco buys from others in the form of ores, concentrates, and blister much of the metal it sells.

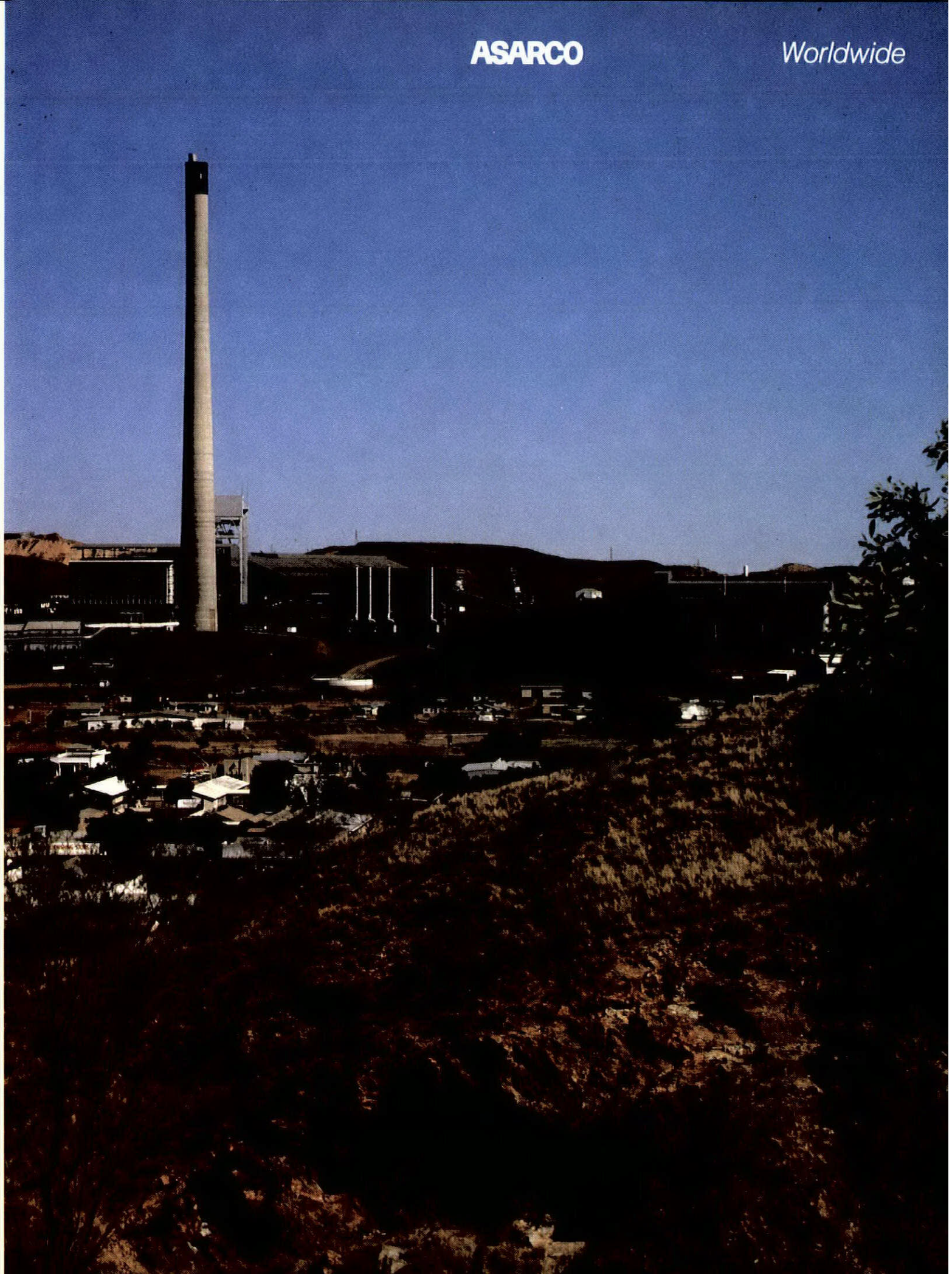
Transporting the large tonnages of ores and metal which Asarco handles also assumes great importance in the overall marketing operation. Asarco pays close to $100 million per year in freight charges in moving raw materials to the plants and metals to consumers.

▲ Copper wirebar is readied for shipment from Amarillo. Customers extrude wirebar into electrical wire.

The sprawling Mount Isa complex in Queensland, Australia, mines copper, lead, silver and zinc and smelts copper and lead.▶

ASARCO

Worldwide



▲ The giant headframe at M.I.M. Holdings Limited's Mount Isa mine hauls ore to the surface from deep beneath the ground.

Asarco has played a prominent role in the development of mineral deposits throughout the world. Since its inception, the Company has been involved in mining and smelting operations in Mexico; and over the years it has expanded across oceans and continents to such countries as Australia, Bolivia, Peru, and Canada. Today, Asarco's major foreign investments are in three associated companies: M.I.M. Holdings Limited in Australia; Southern Peru Copper Corporation; and Mexico Desarrollo Industrial Minero, S.A.

Each of these associated companies is now in its own right one of the world's great mining companies. Asarco and its associated mining companies account for significant proportions of world mine production of silver, copper, lead and zinc. In 1980 Asarco and its associated companies accounted for 13% of the free world mine production of silver; 9% of the copper; 10% of the lead; and 7% of the zinc.

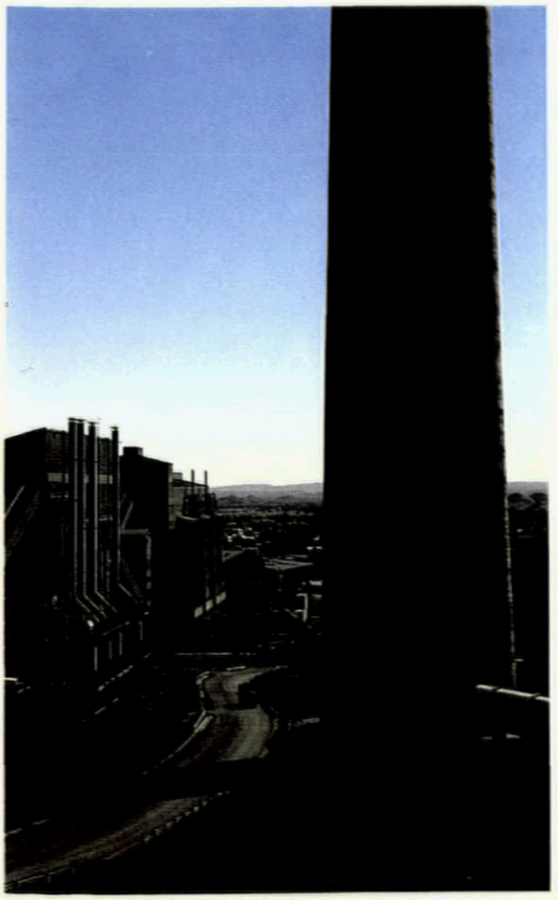
M.I.M. Holdings Limited

M.I.M. Holdings Limited (MIM) is 48.9% owned by Asarco. It is the parent company of Mount Isa Mines Ltd. of Queensland, Australia. Although the Mount Isa property today is the largest nonferrous metal producer in Australia, it achieved this distinction only after years of difficult development work, unremunerative metal prices, and heavy financial burdens.

The Mount Isa story started in 1923 with the discovery of a silver-lead deposit. Its development, however, was handicapped until 1930 when Asarco provided some badly needed engineering and financing. This involved the purchase by Asarco of a substantial holding in what was then called Mining Trust Ltd., an organization formed in 1929 which held a majority interest in Mount Isa. With the financial and technical assistance of Asarco, construction programs were completed at Mount Isa, and mining, milling, and smelting operations got under way in 1931.

Asarco's faith in the long-term future of the Mount Isa project caused it to retain its interest during a long initial period of unprofitability. The first dividend was not paid until 1947—24 years after the discovery of the ore deposit at Mount Isa and 17 years after Asarco's first investment in Mount Isa. Asarco's financial and technical aid kept the project alive during this period and enabled Mount Isa to provide employment for Australians during the world economic depression of the 1930's as well as supplying Australia with valuable metals during the Second World War.

A copper ore body was found near the silver-lead veins. During World War II the Australian government asked the company to concentrate on producing copper for the war effort and to suspend output of lead, zinc, and silver. After a period of reversion to lead out-



▲ 900-foot-high lead smelter stack towers over the milling and flotation facilities at left which treat copper ore at the Mount Isa complex.

put following the war, MIM entered one of the most significant episodes in the company's development. The decision was made to pursue parallel production of copper and silver-lead-zinc. This was achieved in January 1953.

Today Mount Isa has a capacity to produce annually more than 170,000 tons of copper, 14 million troy ounces of silver, more than 160,000 tons of lead, and over 120,000 tons of zinc contained in concentrates.

In 1979, MIM began a three-year, $50-million program to increase its output of lead by 20%. The project involves modifications to the mining program for lead-zinc-silver ore at the Mount Isa mine and to the existing lead concentrator. Upon completion of the project in 1983, annual lead output will increase to 198,000 tons.

In addition to Mount Isa Mines Limited, MIM operates Copper Refineries Pty, Ltd. at Townsville, Queensland; the Britannia Refined Metals Company, which has a lead-silver refinery at Northfleet, England; and Collinsville Coal Company Pty. Ltd. which operates coal mines in Queensland. In Western Australia, the company has a 40% interest in the Agnew nickel mine which produces 11,000 tons of nickel per year and a 20% interest in the Goldsworthy Project which produces over six million tons of iron ore per year.

MIM is devoting considerable resources to the further development of its coal operations. The company's proposed steaming and coking coal export projects in the Collinsville-Newlands region of Queensland are expected to require a total of more than $475-million in capital investment by the mid-1980's. By 1985, it is planned to produce annually nearly 4.5 million tons of steaming coal from Newlands and 1.1 million tons of coking coal from Collinsville for export. An additional 1.1 million tons of steaming coal from Collinsville will be consumed locally. MIM also is planning to build a port at Abbot Point through which the Collinsville-Newlands production will be exported to world markets. MIM also operates the Oaky Creek project in Central Queensland in which it has a 78% interest. Oaky Creek is being developed to produce 2.5 million tons per year of high-grade metallurgical coking coal.

Additionally, MIM is involved in exploration for oil and gas off the coast of Western Australia and in the Otway Basin off Western Victoria; for uranium in South Australia and Western Australia; and for gold and nonferrous metals in Western Australia and Papua New Guinea.

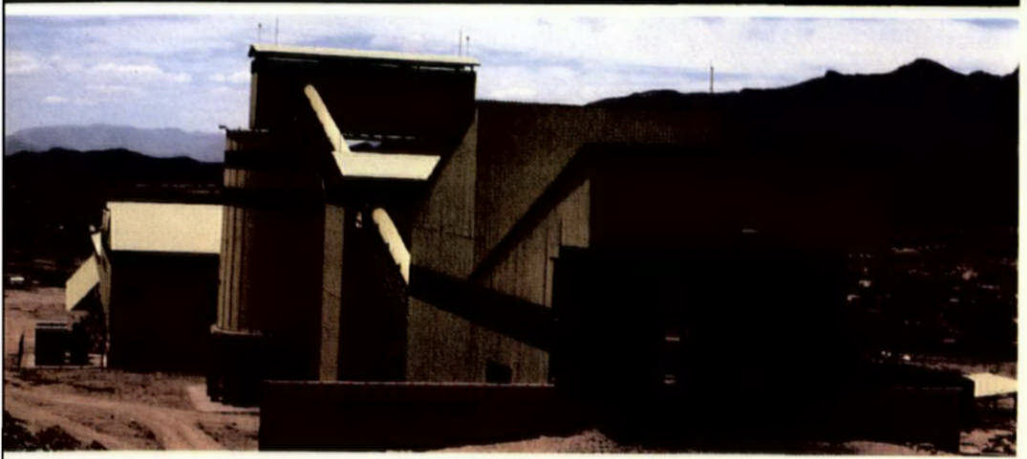
Southern Peru Copper Corporation

Southern Peru Copper Corporation was formed in 1952 and now is jointly owned by four U.S. companies (Asarco, Phelps Dodge Overseas Capital Corporation, subsidiaries of The Marmon Group, and Newmont Mining Corporation) with Asarco holding a 52.3% interest. Southern Peru is one of the world's largest producers of copper with a capacity to produce 300,000 tons of blister copper annually.

Southern Peru operates two open-pit mines and concentrating mills high in the Andes Mountains at Toquepala and Cuajone and a smelter on the Pacific Coast at Ilo, 60 air miles from the mines but 110 miles by rail. Production at the Toquepala mine and Ilo smelter began in 1960 and at Cuajone in 1976. Cuajone is a joint venture between Southern Peru (approximately 90%) and Billiton B.V. (approximately 10%).

At the heart of Southern Peru's success is the combined expertise of the investing companies. The mineral potentialities of the ore bodies were revealed by the exploration work of engineers and geologists of Asarco, Cerro de Pasco (later acquired by The Marmon Group) and Newmont. Stripping and mining methods developed at Phelps Dodge's open-pit copper mines in the U.S. provided patterns for open-pit planning in Peru. Modern design and construction features which Newmont built into its San Manuel, Arizona, copper complex received further application in the Toquepala mill and Ilo smelter. Additionally, the suspended arch reverberatory furnace, first used in the U.S. by Asarco, and the casting wheel designed by Asarco's Engineering Department are indicative of the many technical contributions of the participating companies.

Cuajone has estimated reserves of about 423 million tons of sulfide ore averaging just under 1% copper. Toquepala reserves are about 180 mil-



▲ Southern Peru Copper Corporation's Ilo smelter (above) operates around the clock.

▲ The Velardena unit is one of 11 mines and four metallurgical plants operated throughout Mexico by Mexico Desarrollo Industrial Minero, S.A.

lion tons which are slightly lower in copper content than Cuajone's.

Southern Peru's planning calls for expansion of both operations if agreements can be reached with the Peruvian government on certain rights and obligations of both parties. The project would include a $150-million expenditure at Toquepala to deepen the pit, increase the capacity of the concentrator and supplement the existing ore-transport system. This development would restore ore reserves to about the level estimated when the mine started up in 1960. It should also extend the life of the mine well into the 21st century. Also, approximately $70-million would be spent on enlarging the concentrator at Cuajone to maintain the current production level as the ore grade decreases.

Mexico Desarrollo Industrial Minero, S.A.

In Mexico, Asarco has its longest and probably most involved foreign mining history. One of the principal properties that made up the original Asarco consolidation in 1899 was the Santa Eulalia lead-silver mine in Chihuahua which is still operating. The Guggenheim association with Asarco brought additional Mexican properties to the Company.

Asarco Mexicana, S.A., was organized in 1965 when Asarco sold a 51% interest in its Mexican mines and plants to Mexican nationals in response to developments in Mexican law and policy.

In 1974 Asarco sold an additional 15% interest in Asarco Mexicana to Mexican investors, reducing its equity to 34%. At that time, the company changed its name to Industrial Minera Mexico, S.A. (IMM). Late in 1978, IMM was reorganized to comply with certain new requirements of Mexican law and policy. Asarco now owns 34% of Mexico Desarrollo Industrial Minero, S.A. (MEDIMSA), a new company organized to hold the shares of IMM and shares of other operating subsidiaries.

MEDIMSA operating companies and wholly owned subsidiaries operate 11 mines and four smelters and refineries in Mexico, which smelt copper, lead and zinc and which refine lead, zinc, silver and gold.

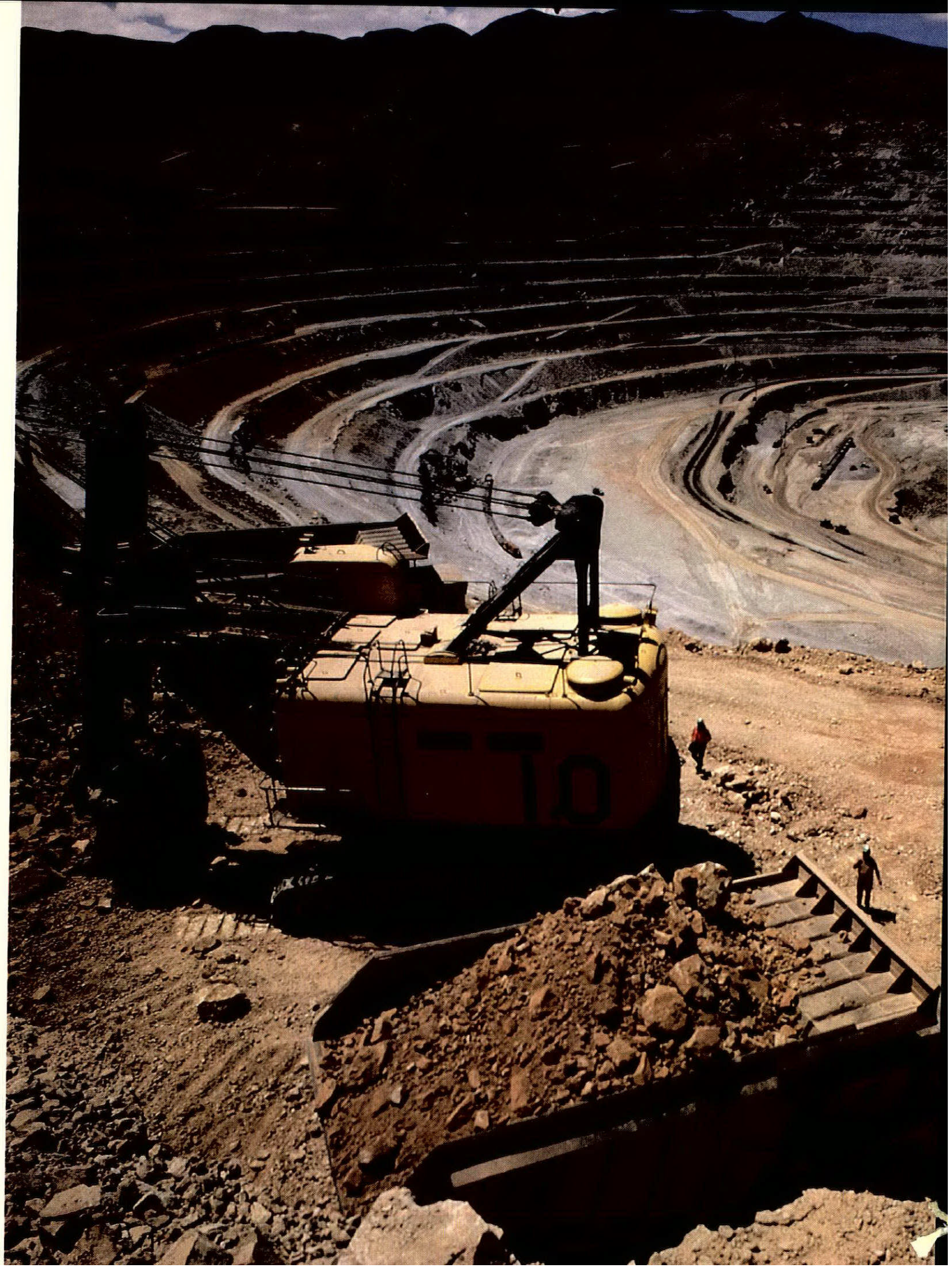
MEDIMSA is the largest silver and zinc producer in Mexico, and a leading producer of copper, lead, coal, coke and fluorspar.

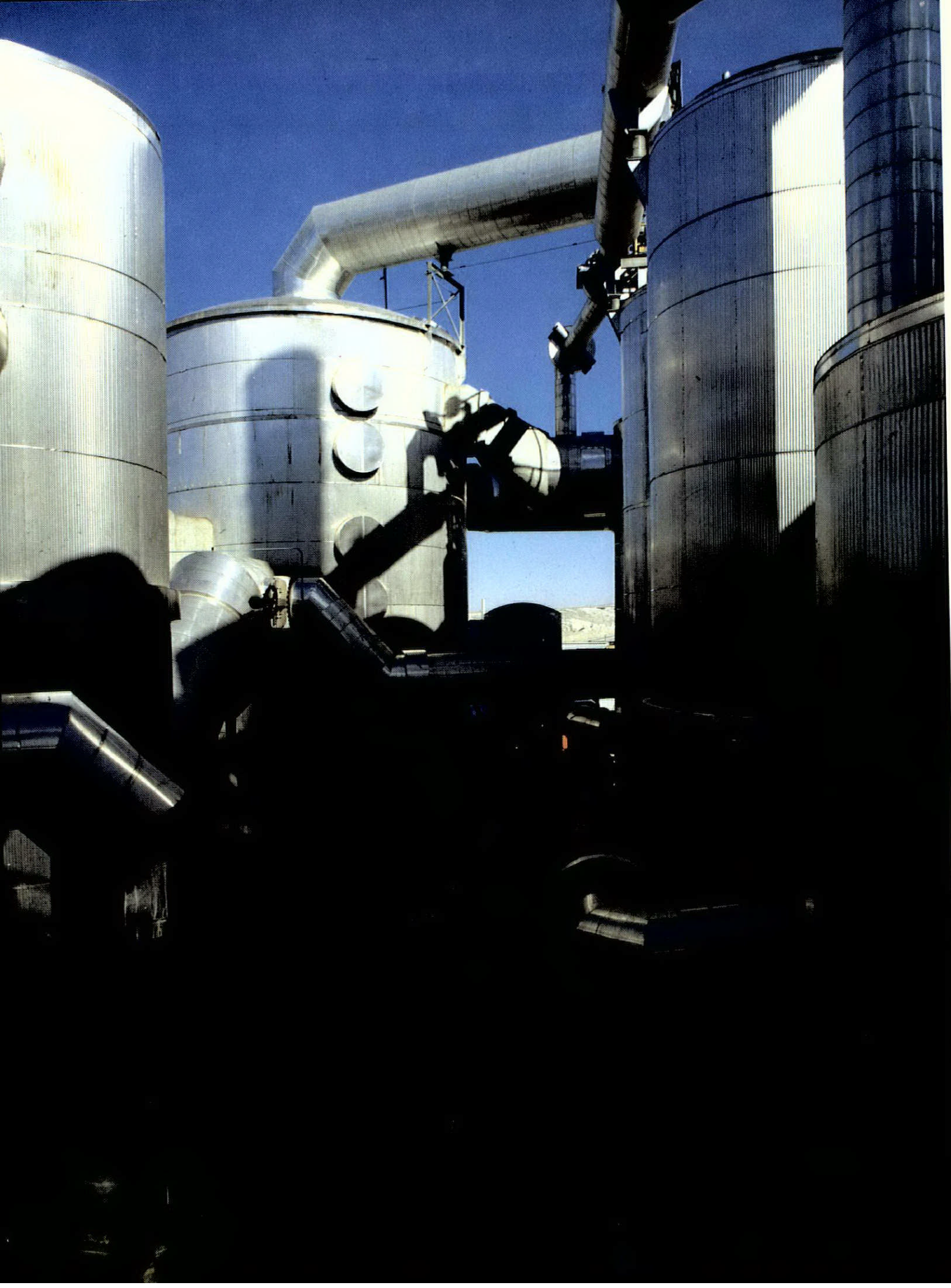
Nonferrous metal mine capacity will increase 60% by 1985 under MEDIMSA's ambitious expansion plans. Capacity is being increased at Taxco, a silver-lead-zinc mine; at Santa Barbara, a silver-lead-copper-zinc mine; and at San Martin, a silver-copper-zinc mine. A new mine, the Rosario silver-lead-zinc mine in Sinaloa, will be completed in 1981.

MEDIMSA also is constructing a $175-million electrolytic zinc plant at San Luis Potosi which will produce 125,000 tons of refined zinc and alloys annually following completion in late 1981.

A major resource for the future has been built and continues to be enhanced by the capital expansion programs of the associated mining companies. The value of Asarco's equity in these companies has steadily increased. Investments in mining are long-term in nature, but they pay off over an even longer period.

The Toquepala copper mine of Southern Peru Copper Corporation.▶





The Environmentalist

◀ Acid plants at Asarco units use the sulphur dioxide created during the smelting process to produce sulfuric acid, a useful chemical.

▲ Hydroseeding of a tailings pond dam in the Arizona desert is one of the steps Asarco takes to preserve the environment in the areas in which the Company operates.

The mining and smelting of ores to produce the metals needed by society inevitably disturbs the environment to some degree. The earth's surface must be penetrated, rock must be crushed, metallic compounds must be concentrated, and waste material must be disposed of. The smelting of ores and concentrates to free the contained metals from their chemical bonds to sulfur produces large quantities of sulfur dioxide(SO_2). High temperatures and swiftly moving streams of process air generate metal oxide fumes and dusts which can create formidable environmental problems. But long before such problems became matters of general public concern, Asarco was working to solve them.

In 1911 at its former Perth Amboy plant, Asarco installed one of the first units in the nation to capture smelter sulfur dioxide and convert it into sulfuric acid. An improved acid production process was utilized in 1916 at the Company's Garfield, Utah, smelter. The first electrostatic precipitator, a device developed by Frederick Gardner Cottrell to clean dust-laden gas streams, was installed at Asarco's Selby, California, lead smelter in 1907. Not long afterward, techniques were employed to filter particles from gases in "baghouses" containing hundreds of hanging woolen bags.

By 1914 the Company had established in Salt Lake City a laboratory, later known as the Department of Agricultural Research, exclusively devoted to study the effects of smelter emissions and to develop means of better control. In the years since, the laboratory's scientists have made many contributions to the scientific literature, especially on the subject of SO_2 and its effects on vegetation. The first successful automatic instrument for detecting and recording traces of SO_2 in ambient air was invented by Asarco's Dr. M. D. Thomas in 1928. The Thomas Autometer, as it is called, has been widely used in studies of urban air pollution.

In recent years when air quality standards for SO_2 were adopted by federal, state, and local air pollution control agencies, Asarco responded by developing a "closed-loop" system to meet the standards. By monitoring the ambient air and local and regional weather data, Asarco meteorologists, aided by computers, are able to predict conditions unfavorable to SO_2 dispersion so that curtailment of operations can be ordered in advance of any SO_2 accumulation.

Properly designed tall stacks are important to environmental control programs for smelters. No SO_2 abatement short of perfection would be adequate if smelter gases were discharged near ground level. Again, Asarco pioneered by conducting scientific studies at Garfield, Selby, and Tacoma to evaluate and prove the effectiveness of tall stacks for dilution and dispersion of SO_2. Beyond their value as dispersion devices, stacks conserve energy by utilizing unrecoverable waste heat to provide draft for smelting processes and air-cleaning devices.

In addition, Asarco removes sulfur dioxide from smelter gases and converts it into sulfuric acid. Acid plants are in operation at the Company's three copper smelters, the East Helena and El Paso lead smelters, the zinc refinery at Corpus Christi and the Columbus zinc oxide plant. Also, another facility at the Tacoma copper smelter produces liquid sulfur dioxide from smelter gases.

Water quality control likewise receives a great deal of attention at Asarco's plants and mines. For example, facilities have been installed at Corpus Christi to collect and treat effluents from operations as well as rain water drainoffs. The treated water is partially reused by the plant.

In the area of land use, the mining industry has been widely criticized by civic and governmental groups in recent years. What many fail to take into account, however, is that since 1776 the total land area mined in the United States has amounted to only 0.3% of the country's land area. From this small portion of the land have come the metals and minerals which have helped build the nation. Moreover, of this 0.3%, one-third has been reclaimed. An example of Asarco's land reclamation is at the Company's Midland Coal surface mining operations in Illinois. There Asarco is reclaiming mined land by grading banks and planting forage, wheat, trees, and shrubs.

Control of the in-plant environment and protection of the safety of its workers is another area to which Asarco devotes much effort.

Asarco's policy is based on the belief that a healthy environment and society's need for minerals and metals are compatible. Environmental impact can't be totally eliminated, but it can be controlled at safe levels. The Company is pledged to do what is required to insure that its operations do not endanger the health and welfare of its workers or its neighbors.

▲ Agronomists take samples of new growth at reclaimed farm land at a Midland Coal Company facility.

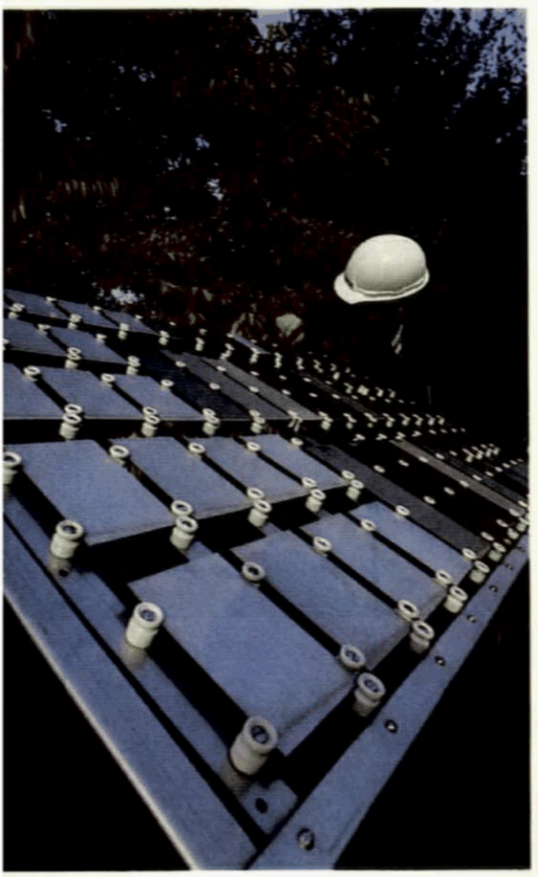
▲ With this Instron tester and the quartz-lamp furnace accessory, an Asarco metals application specialist measures the mechanical properties of copper at temperatures close to the melting point.

▲ Advanced model atomic absorption spectrophotometer is widely used for quantitative analysis of metals, from parts-per-million trace amounts to high percentages of a sample.

Extracting and processing ores into metals requires complicated steps utilizing skills and technology developed over many years. The Central Research Department has contributed significant technological developments to the growth and success of Asarco's operations. Research activities are related to nearly every phase of the Company's business—from exploration through marketing of end products.

Asarco's efforts in both basic and applied research and technical service are directed toward improved methods for discovery and evaluation of potential ore bodies; improved ore-dressing methods for recovering metals and minerals; more efficient metallurgical processes for all phases of smelting and refining; development of new products; aiding customers with specific problems; and surveillance of product quality. In recent years, environmentally oriented research programs have been intensified to develop methods to control smelter emissions, maintain water quality and reduce noise pollution more effectively.

Asarco's research activities were centralized in 1925 when the Central Research Laboratories were organized at the Perth Amboy plant. Central Research was moved and expanded in 1952 in a large new laboratory located on a 27-acre plot in South Plainfield, New Jersey. This facility has the latest instruments and equipment for conducting metallurgical research. Scientists representing a broad spectrum of mineral sciences, chemistry, metallurgy and engineering work together on problems which demand a multi-faceted solution. As a result, Asarco today is a leader in nonferrous research and has gained recognition for contributions to science and technology in this field.



▲ Research engineer from Asarco's Central Research Department checks the effects of the environment on painted panels. Zinc dust produced by Federated Metals is used by paint manufacturers as an anti-corrosive agent.

To cite a few examples: the Asarco shaft furnace for continuous melting of copper cathodes has been adopted by practically all major copper refineries in the world; a process to control the lead content of refined zinc produced by electrolysis made commercial production of Special High Grade zinc feasible; a vacuum dezincing process is an important step in the refining of lead; and a new technique employing magnetic separation to recover asbestos from ore made the processing of lower-grade asbestos ore practical.

The successful recovery of by-product metals is due in part to techniques developed by Asarco research. The recovery of bismuth during lead refining was made practical by the Betterton-Kroll process, first used commercially at the Omaha plant about 1929. Asarco's research efforts have also contributed to the recovery of antimony, selenium, tellurium, germanium, and other metals present in minute proportions in nonferrous metal ores.

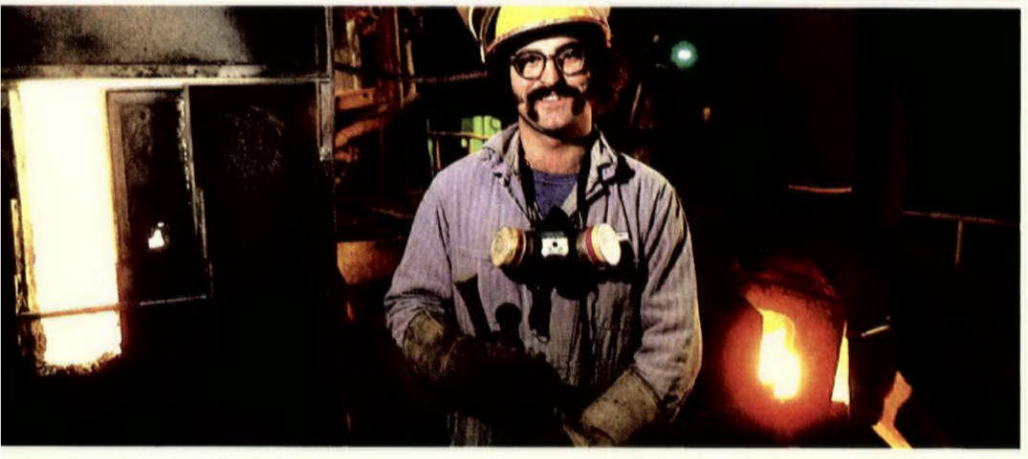
Development of new products to broaden Asarco's marketing potential is of major concern in the research department. Some achievements are a white brass die-casting alloy named Bronwite®; calcium-lead alloys for maintenance-free batteries; and Asarco's Acoustilead® continuous-cast lead sheet to reduce industrial noise levels.

The control of sulfur dioxide emissions from smelters has long occupied the attention of Asarco researchers. For example, in the 1930's Asarco engineers developed a method of absorbing and concentrating SO_2 from weak smelter gases with dimethylaniline. This process is used in the liquid SO_2 plant which helps control emissions from the Tacoma smelter and has achieved limited use by other nonferrous firms as well.

Asarco actively supports several group research and technical programs. Included are programs of industry-wide organizations such as the International Lead-Zinc Research Organization, International Copper Research Association, Selenium-Tellurium Development Association, the Silver Institute, the Smelter Control Research Association, and the American Society for Testing Materials. This is supplemented by individual participation of Asarco researchers in many professional societies related to their specific fields of interest.

Through the achievement of higher quality and improved efficiency in producing Asarco's products, Asarco research benefits consumers of nonferrous metal goods.

Asarco employs approximately 13,000 men and women around the world including this underground miner in Idaho. ▶



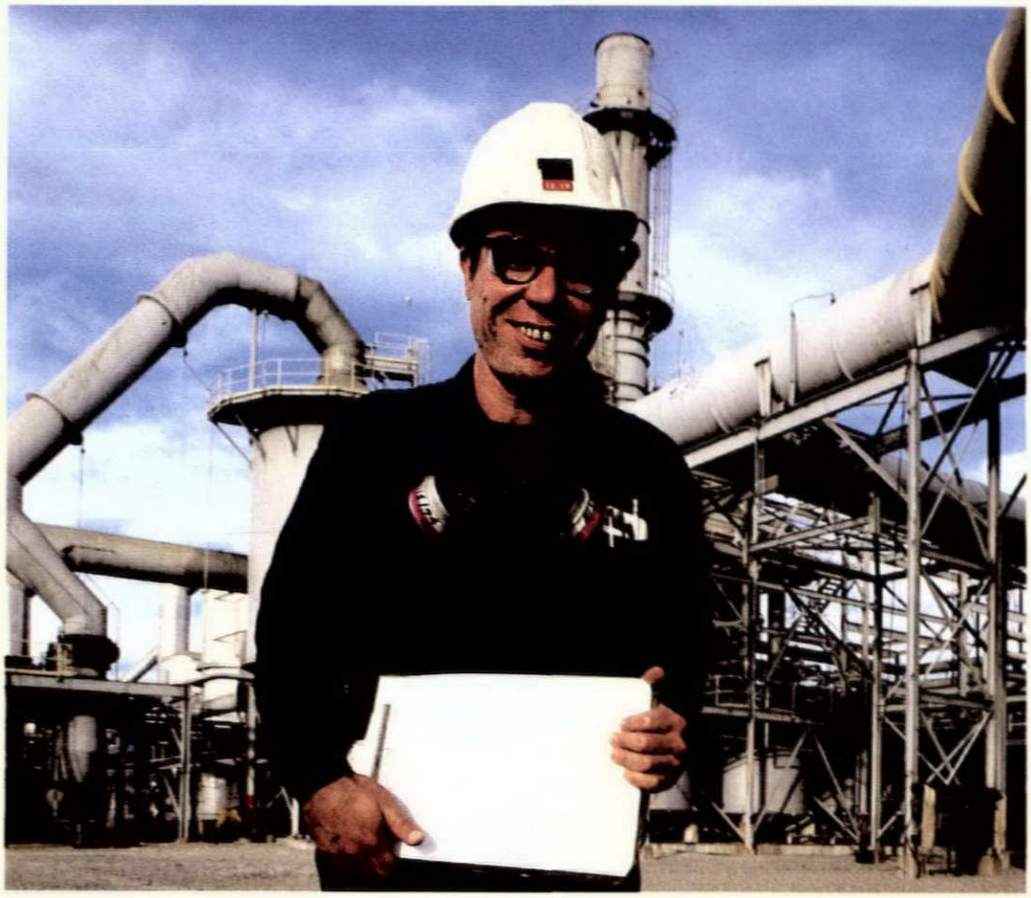
▲ Pension, benefits and health programs have been constructively worked out with employee representatives over the years providing coverage for employees including this ore-haulage truck operator in the Southwest (above).

▲ Safety and health programs are important aspects of the Company's efforts. (below) This smelter worker and others compete for awards given to the unit which achieves the best safety record.

Concern for the well-being of its employees prompted Asarco to establish a group life insurance program as early as 1912, and a pension plan as early as 1909. Asarco was among the pioneers in both fields. Now, besides Company-funded pension, disability, and life insurance programs, Asarco offers non-contributory medical and dental plans; a savings plan for salaried employees; a tuition-refund plan to help salaried employees advance their education; supervisory and management development programs; and numerous on-the-job training and apprenticeship programs to enable workers to increase their skills and advance in their jobs. Other employee benefits for hourly employees have been constructively worked out with employee representatives over the years.

Additionally, Asarco makes every effort to remain competitive in the areas of salaries and wages, job security, bonuses, and sound personnel practices generally. Asarco maintains close relations with educational institutions through its Technical Employment Department and other Industrial Relations Department activities. Asarco has for many years sponsored scholarships, fellowships, and grants to individuals and schools across the country.

Asarco has a long-standing policy that its employment practices shall provide equal opportunity for all employees without regard to race, color, creed, sex or national origin. Hiring practices, promotions and transfers at all levels of employment are based on an individual's qualifications and ability to perform the job requirements satisfactorily with due regard to seniority, while furthering the principles of Equal Employment Opportunity.



▲ On-the-job training, apprenticeship, and supervisory and management development programs enable workers to increase their skills and advance in their jobs.

Recognizing the occupational hazards that exist in mining, smelting, and refining, Asarco in 1914 was one of the first major corporations to undertake monthly reports on the number of disabling injuries per million man-hours worked. Based on this information, an operation's safety performance can be measured and analyzed. In addition, these statistics are used to award Safety Plaques each year in several different categories of plants to the operations having the lowest rates. Competition for these plaques is keen and employees take pride in obtaining these awards.

In 1979 a comprehensive written safety and health policy was published reiterating practices which were common policy over many past years. Frequent and extensive safety "audits" are conducted in the various operations by corporate safety staff members to assist local management and safety personnel in the pursuit of accident reduction. Operating management works closely in cooperation with employee representatives to promote a safe and healthful work environment.

An employee health program is conducted by Asarco's Environmental Sciences and Medical Departments. Biological monitoring through routine blood and urine tests protects the health of employees, particularly those exposed to potentially hazardous substances. Regular health surveys are made at all operations by the staff of the Environmental Sciences Department. Medical facilities are monitored and coordinated to ensure employee well-being.

Attesting to Asarco's concern for its employees and its stable employment policies are the more than 3,700 long-service members of the Company's 25-year Club.

ASARCO *And The Future*

The world will never outgrow its need for metals and minerals. Together with petroleum, agricultural produce, fish, timber, and other products which come from the earth and the sea, they constitute the basic raw materials from which all material things derive.

Asarco views its business as the mining, smelting and refining of nonferrous metals and the production of other raw materials which utilize Asarco's skills. As the world's population increases and as developing nations increase their standard of living, the demand for metals and minerals will continue to grow.

Asarco will continue to expand to meet this growing demand so that it will be in the future, as it is today, one of the world's leading suppliers of the range of elements it now produces. Additionally, just as Asarco's expertise in the production of nonferrous metals has been successfully applied to the extraction of coal, asbestos, and titanium-bearing ilmenite, so the Company will continue to be alert to other areas where this expertise can be utilized to advantage.

Repeatedly the public reads studies that suggest that world mineral reserves are being rapidly exhausted and may be depleted by the end of this century. While minerals are undeniably nonrenewable resources, so much progress has been made in techniques of exploration and in technology for extraction that, in fact, known identifiable reserves have been greatly increased during the era since the end of World War II. Thus, the most recent U.S. Bureau of Mines tabulation of world copper reserves, published in 1977, sets the figure at a level four-and-a half times a comparable estimate published in 1950. And in the interim the quantity actually mined exceeded the amount of the 1950 estimate.

The key, of course, is exploration for new deposits and improving technology to make feasible the mining of lower-grade deposits. Asarco has an ongoing exploration program to find more reserves to replace those it mines. Increased recycling of metals will likewise help to supply the world's needs, and in this area Asarco's Federated Metals Corporation is ready to play an increasingly important role.

Mining a great share of the material which it smelts and refines is another important goal of Asarco. Once known primarily as the world's greatest custom smelter, an increased proportion of material processed in Asarco plants now comes from its own mines and those of its associated companies abroad.

The associated companies in Australia, Mexico, and Peru all have substantial ore reserves and programs of mine development to increase output from these reserves. Asarco's management believes that by being responsive to the political, economic, and social objectives of the countries in which the Company has investments, it can continue to meet the requirements of both the host country and Asarco.

Finally, as in its past, Asarco's future will rest on its smelting and refining capabilities, among the most diversified and metallurgically sophisticated in the industry. In order to keep them so, the Company completed in the 70's a major expansion and modernization program highlighted by the 420,000-ton-per-year Amarillo Copper Refinery. As a result, Asarco has a modern smelting and refining complex incorporating the latest technology and meeting sound standards of environmental quality.

Asarco the Metal Maker will continue providing vitally needed metals and minerals to the nation and the world in the years to come.

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