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VISITOR'S
INFORMATION
PAMPHLET

DUVAL SIERRITA CORPORATION

GEOLOGY DEPARTMENT

ROBERT A. METZ, CHIEF MINE GEOLOGIST

A. HARVEY JAMES, MINE GEOLOGIST

BOB GALYON, DRAFTSMAN

Set "F"

DUVAL SIERRITA CORPORATION

SIERRITA PROPERTY

ORGANIZATION

Resident Manager	J. P. McCarty
Mine Superintendent	A. P. Holzworth
Chief Mine Engineer	F. H. Buchella, Jr.
Chief Mine Geologist	R. A. Metz
Safety Supervisor	D. L. Gidak
Chief Accountant	S. C. Polasek
Purchasing Agent	J. K. Peters
Personnel Relations Supervisor	J. W. Fortson
Mill Superintendent	R. L. Bevers
Plant Maintenance Superintendent	F. W. Schweitzer
Chief Warehouseman	W. E. Hoskinson
Chief Chemist	C. E. Hodge
Chief Metallurgist	A. Gomez, Jr.

SIERRITA PROPERTY

The Sierrita property consists of over 13,000 acres, which includes property rights for water field, tailing disposal and rights of way for pipe lines and a railroad spur. Included in this total acreage are 143 unpatented mining claims which were purchased by Duval Corporation. Approximately 58 percent of the Sierrita ore body was acquired in the purchase of these claims. The remaining 42 percent of the ore body was controlled by patented mining claims which were part of Duval's Esperanza Property. Duval has transferred these unpatented and patented mining claims to the Sierrita property.

EXPLORATION AND PRELIMINARY DEVELOPMENT

A total of 137 test holes have been drilled in order to delineate the Sierrita ore body and to test proposed waste dump areas. Some of the tests were drilled to check certain holes drilled by another mining company which had previously drilled 60 core tests in the area.

ORE RESERVES

The exploration and preliminary development program delineated an ore body of 414 million tons with an average copper content of 0.35% (Seven pounds) and an average molybdenum content of 0.036% (0.72 pounds). Engineering pit design indicates that a total of 634 million tons of waste must be handled prior to and during the mining of the 414 million tons ore reserve. This total of over a billion tons of ore and waste, which will be mined, represents more than twice the tonnage excavated in the construction of the Panama Canal.

MINING

It is anticipated that the eventual perimeter of the Sierrita open pit will encompass an area of approximately 460 acres. As presently designed, the pit will ultimately reach a depth of 1850 feet below the highest elevation of the pit area prior to commencement of mining. By comparison, the Empire State Building is only two-thirds as tall as the pit will be deep.

The mining plans provide for the removal of 105 million tons of waste overburden before the commencement of ore mining operations. A daily average of 200,000 tons per day will be mined during the pre-mine stripping period. Thereafter, the mining of ore and waste will be conducted on a scale of approximately 235,000 tons per day for the initial six-year production period, after which the scale of mining operations will be somewhat reduced as less waste will be handled.

MINING EQUIPMENT AND FACILITIES

The mining equipment features six power shovels of P & H manufacture equipped with 15 cubic yard buckets and an initial order of 28 electric wheel haul trucks of 120-ton capacity which will be expanded to 40 by the completion of pre-mine stripping. These shovels and trucks are of the largest presently used in the copper mining industry. In addition, six rotary blast hole drills, 11 dozers and numerous other units such as motor patrols, fork lifts, cranes, water trucks, personnel buses and miscellaneous small trucks supplement the operation. Service facilities consist of two modern shops, steam cleaning pad, change room and offices.

Because the power shovels and haul trucks represent the largest of these machines used in the industry, some pertinent facts concerning these units are of interest:

Power Shovels:

1. The weight of each shovel is approximately 450 tons.
2. Shovels are rated at 750 HP and are electrically powered by 4160 volt AC current.
3. When loaded, the 15 cubic yard bucket contains approximately 25 tons.

Haul Trucks:

1. The initial purchase of 28 electric wheel trucks was evenly divided between KW Dart Company and Westinghouse Air Brake Company.
2. The truck engines are 12 cylinder diesels rated at 1000 HP.
3. Engines drive DC electric generators, which supply power to electric motor assemblies in the rear wheels.
4. Trucks have a rated capacity of 120 tons and weigh approximately 75 tons empty.
5. Fuel tanks hold 450 gallons of diesel oil and the engines use one gallon per mile under full load conditions and level haul.
6. Truck tires are constructed of 48 ply, stand nine feet in height and weigh 3000 pounds.

PLANT FACILITIES

Stearns-Roger Corporation of Denver, Colorado has been awarded an engineering construction contract to build the Sierrita concentrator and associated facilities. The concentrator, which will have a designed capacity in excess of 60,000 tons of ore per day, and the associated

facilities are estimated to cost \$84 million. This capacity will be greater than any single copper-molybdenum concentrator in North America. The construction of plant facilities is expected to be completed in the third quarter of 1969.

PRODUCTION

The Sierrita property will produce an annual minimum average of 114 million pounds of copper during the first five years of operations and 136 million pounds thereafter. In addition, the property will produce approximately 12 million pounds of molybdenum and 455,000 ounces of silver annually. When Sierrita reaches full production, Duval Corporation will rank fourth in U. S. copper mine production and supply approximately 14 percent of the free world's molybdenum.

EMPLOYMENT

Peak employment during construction at the Sierrita property is expected to reach some 2,800. It is estimated, average permanent employment during production will be 1,100.

UTILITIES

Power and natural gas will be supplied by Tucson Gas and Electric Company. Power requirements are expected to be approximately 60,000 kilowatts or 40 million kilowatt hours per month. This amount of power would supply an average city of more than 100,000 population.

Gas requirements are expected to be some 50 million cubic feet per month with all but a fraction of the gas being utilized in roasting molybdenum sulphide concentrates into the oxide form.

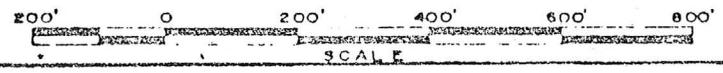
Water requirements for the operation will be on the order of 15,000 gallons per minute with most of this amount being used in the milling operation. This water will be pumped from wells along the Santa Cruz River Basin belonging to the Sierrita property. To secure this advantageous site with its water rights, a 5900-acre ranch, which was part of an original Spanish Land Grant, was purchased.



EXPLANATION

- | | | | |
|--|---|--|---------------------------|
|  Qss | Quaternary stream sediments |  Kqd | Quartz diorite |
|  Kwd | Rhyolitic welded tuffs (includes flows, breccias) |  Kmp | Quartz monzonite porphyry |
|  Ksbp | Silverbell andesite porphyry |  Kqlp | Quartz latite porphyry |
|  45 | Fault or shear showing dip |  | Inferred fault |
|  | Contact showing dip |  | Inferred contact |

DUVAL - SIERRITA CORPORATION



92 E

93 E

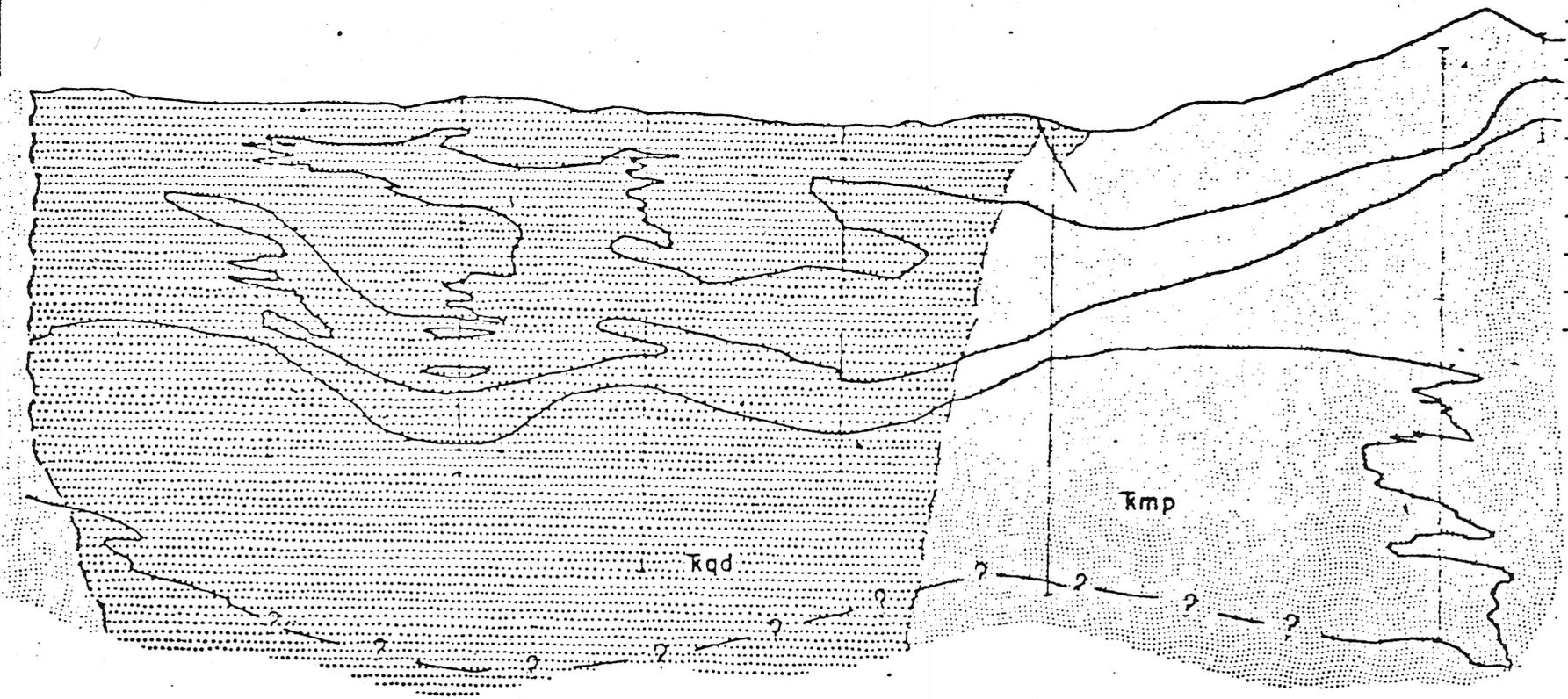
94 E

95 E

VERTICAL SECTION SIERRITA PIT
100 4 NORTH

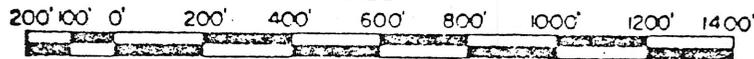
- 4400
- 4300
- 4200
- 4100
- 4000
- 3900
- 3800
- 3700
- 3600
- 3500

-6-

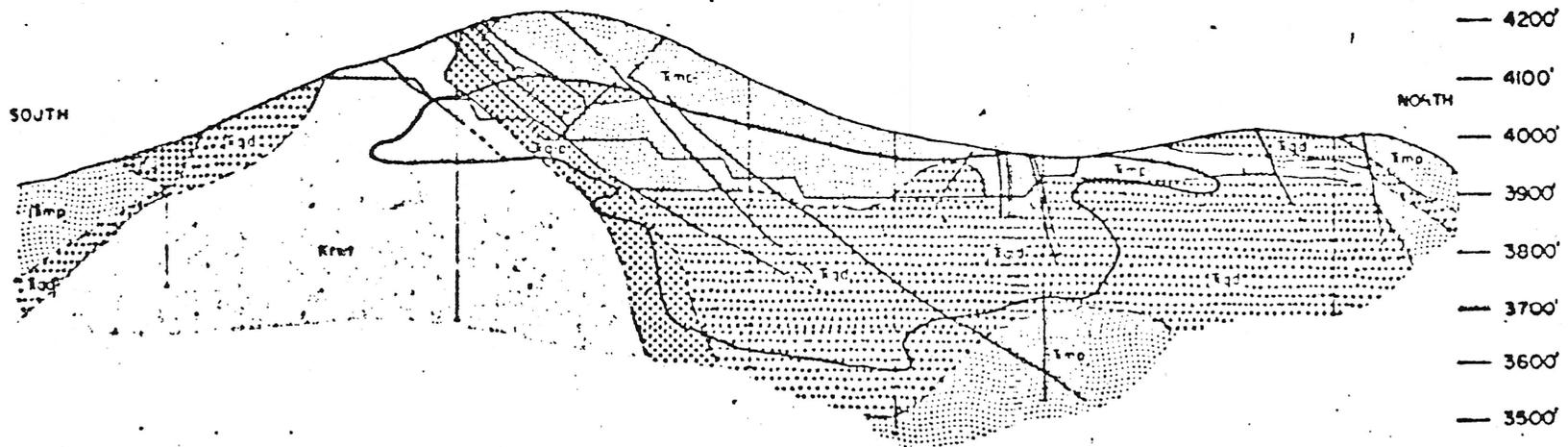


DUVAL - SIERRITA CORPORATION

SCALE

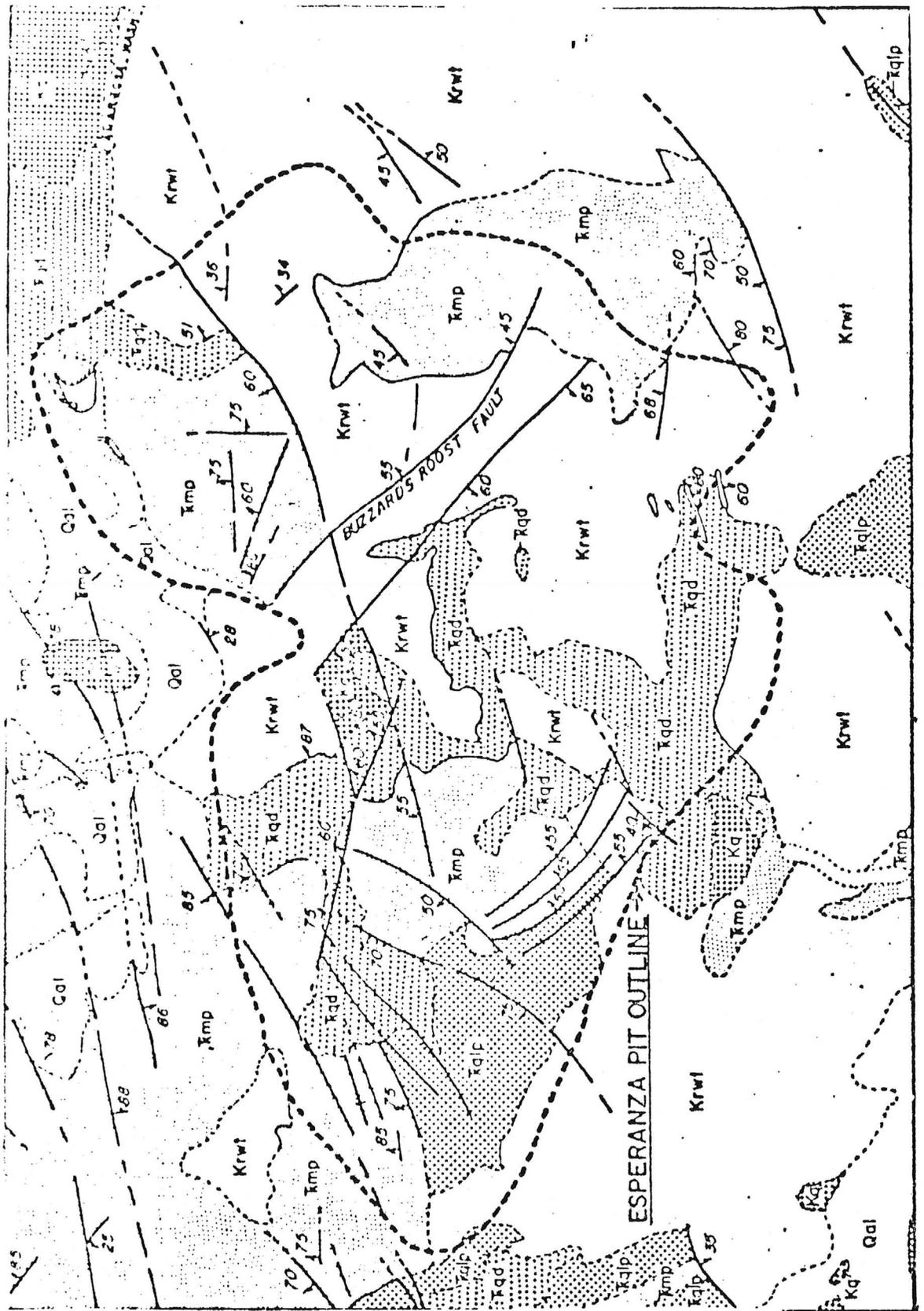


VERTICAL SECTION ESPERANZA PIT
LOOKING WEST



DUVAL CORPORATION
SCALE

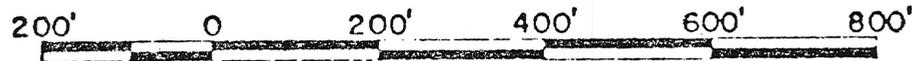




EXPLANATION

 Qol	Alluvium		Fault or shear showing dip
 Krwf	Rhyolitic welded tuff (includes flows, breccia)		Inferred fault
 Ka	Quartzite		Contact showing dip
 Kqd	Quartz diorite		Inferred contact
 Tmp	Quartz monzonite porphyry		Pit outline
 Kqip	Quartz latite porphyry		Dump or shaft

DUVAL CORPORATION



SCALE

Geology - Esperanza and Sierrita

ESPERANZA

Rock types within the ore zone consist of cretaceous welded tuffs, quartz diorite, latite, quartz monzonite porphyry. Hypogene metallization is syngenetic with rock type formation and consists of chalcopyrite, pyrite, molybdenite with minor sphalerite, galena and magnetite. Favored hypogene ore host is quartz monzonite porphyry. Supergene (chalcocite) metallization zone averaged 125 feet thick. Dominant structural trend is NE to ENE.

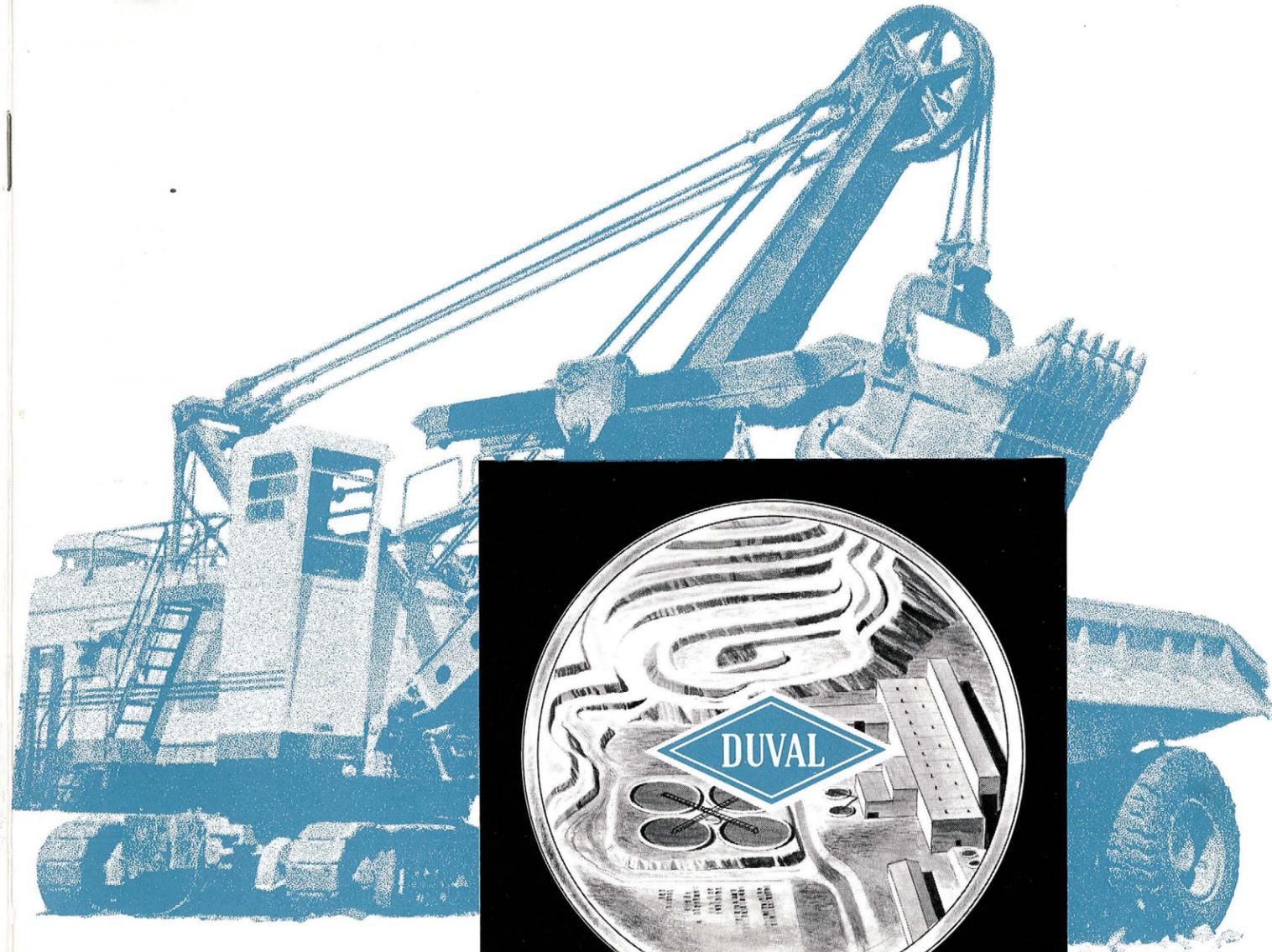
SIERRITA

Rock types within the ore zone consist of quartz diorite, quartz monzonite, and quartz monzonite porphyry. Metallization, again partly syngenetic, consists of chalcopyrite and molybdenite with minor amounts of sphalerite, galena and magnetite. There is no enriched blanket in the Sierrita ore body. Dominant structural trend is identical to that of Esperanza, which is NE to ENE.

THIS PAMPHLET EXCERPTED FROM "AIME" FIELD TRIP 3 PAPER.

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DUVAL SIERRITA CORPORATION



The Mining Subsidiary of Pennzoil United, Inc.

Duval Sierrita Corporation
Sierrita Property
P.O. Box 125
Sahuarita, Arizona 85629

Duval Corporation
1906 First City National Bank Building
Houston, Texas 77002

Duval Corporation
4715 East Fort Lowell Road
Tucson, Arizona 85716

Duval Sales Corporation
300 The Main Building
Houston, Texas 77002

Sierrita Property



Aerial view of Duval Sierrita and Esperanza Properties. Copper-molybdenum ore from the Sierrita pit (upper center) travels two and one-half miles on a 54-inch belt conveyor system to the Sierrita mill (lower center).

How the Duval Sierrita Project Came About

In the Sierrita Mountains some 20 miles south of Tucson, Arizona, and about 40 miles north of Nogales, Sonora, Mexico, Duval Corporation, in July, 1964, acquired a large low-grade copper-molybdenum ore body adjacent to its Esperanza Property. The purpose of the acquisition was to provide additional reserves for the Esperanza Property which began operations in 1959.

In May, 1966, the General Services Administration (GSA) announced a program to encourage additional domestic production of copper in the interest of national security. The program, which was authorized by President Johnson in March, 1966, was formulated under authority contained in the Defense Production Act of 1950, as amended. Upon learning of the copper production expansion program, Duval Corporation entered into negotiations with the GSA for development of the Sierrita copper-molybdenum property under the program.

After more than a year and a half of negotiations, Duval Sierrita Corporation, a wholly-owned subsidiary of Duval Corporation, and the GSA signed contracts in November, 1967, for development of the Sierrita Property. Out of the total of \$100 million allocated to the program, Duval was assigned \$83 million as advances against future delivery of copper to the government at a fixed price of 38 cents per pound. Total cost of the project will exceed \$165 million. Additional financing beyond the \$83 million is being

provided to the extent of \$48.75 million by government-guaranteed V-Loans, with the remainder to be provided by Duval.

The \$83 million will be repaid by June 30, 1975, through deliveries to GSA of 218.4 million pounds of wirebar copper credited at the rate of 38 cents per pound. During this time, Duval Sierrita Corporation will sell on the open market its molybdenum and silver production plus such of its copper production as may be required to cover cash operating costs, interest and asset replacements.

History of Duval Corporation

Duval Corporation was chartered in Texas on August 18, 1926, under the name of Duval Texas Sulphur Company. The Company acquired its name from the location of its first sulphur property in Duval County, Texas. In 1935, Duval commenced production of sulphur on a portion of Boling Dome in Wharton County, Texas, and this property was successfully operated until 1940. Duval commenced production at its third sulphur property, Orchard Dome in Fort Bend County, Texas, in 1938, and operated the property until 1970.

Duval embarked upon a program of exploration for potash in New Mexico in 1947, and in November of 1951 began mining potash from its Saunders Mine located near Carlsbad. Since then Duval has brought

two other potash mines in the Carlsbad area into operation—the Wills-Weaver Mine in 1961, and the Nash Draw Mine in 1964.

In March, 1959, the Company initiated production at its Esperanza copper-molybdenum property near Tucson, Arizona, and in 1964, brought its second copper-molybdenum property, Mineral Park, near Kingman, Arizona, into production. The Battle Mountain, Nevada, copper-gold-silver property was placed in operation in 1967.

Within a period of 24 months commencing in 1968, Duval brought four additional mining properties into production. These properties, representing an investment in excess of \$300 million, were the Fort Stockton, Texas, sulphur property and the Saskatoon, Saskatchewan, Canada, potash property, both brought into production in 1968; the Culberson County, Texas, sulphur property brought into production in 1969; and the Sierrita copper-molybdenum property near Tucson, Arizona, where production commenced in the first quarter of 1970.

In 1950, the Company changed its name to Duval Sulphur & Potash Company and in 1963 to Duval Corporation. In 1930, United Gas Corporation acquired controlling interest in Duval Corporation. In April of 1968, United Gas Corporation merged with the Pennzoil Company to form Pennzoil United, Inc. Duval, now essentially a wholly-owned subsidiary of Pennzoil, continues to operate as a corporate entity.

History of Pennzoil United, Inc.

Pennzoil United, Inc., a large Houston based natural resources company resulting from the consolidation of Pennzoil Company and United Gas Corporation, today lists assets totaling over \$1.35 billion. Both companies have histories dating back to the early days of the oil and gas industry.

Pennzoil Company was formed in 1955, by the merger of South Penn Oil Company, leading producer of Pennsylvania Grade crude, and The Pennzoil Company, largest refiner and marketer of Penn Grade products.

South Penn, organized in 1889, had acquired controlling interest in Pennzoil in the early 1920's, and for three decades prior to the merger, the two companies maintained a close relationship as producer-refiner-marketer.

In 1963, Zapata Petroleum and Stetco Petroleum, two West Texas-based companies with substantial oil and gas holdings, merged with South Penn and the corporate name was changed to Pennzoil Company.

As these developments were shaping the course of Pennzoil, similar events in the natural gas industry were paving the way for formation of United Gas.

Principal occurrence in the evolution of this huge, fully integrated natural gas system was the joining together in 1930 of more than 40 gas companies in Texas and Louisiana.

Power shovel bucket drops approximately 23 tons of copper-molybdenum ore into 1000 HP haul truck. When fully loaded, the haul truck will carry 120 tons of ore. Each truck tire is 48-ply, stands nine feet high and weighs 3000 pounds.



From this nucleus, United Gas ultimately became one of the largest handlers of natural gas in the world, spanning a vast five-state area along a broad arc from Laredo, Texas, to Pensacola, Florida. By 1965, its widespread operations included exploration and production, transmission and distribution of natural gas, refining of gasoline and petroleum by-products, and mining.

Final consolidation of Pennzoil and United Gas occurred on April 1, 1968.

Sierrita Property

The Sierrita Property consists of over 13,000 acres. Included in this total acreage are 143 unpatented mining claims which were purchased by Duval. Approximately 58 percent of the Sierrita ore body was acquired in the purchase of these claims. The remaining 42 percent of the ore body was controlled by patented mining claims owned by Duval. Duval has transferred these patented claims to Sierrita.

Exploration and Preliminary Development

A total of 178 test holes were drilled in order to delineate the Sierrita ore body and to test proposed waste dump areas. Some of the tests were drilled to check certain holes drilled by another mining

company which had previously drilled 60 core tests in the area.

Ore Reserves

The exploration and preliminary development program delineated an ore body of 414 million tons with an average copper content of 0.35 percent (seven pounds per ton) and an average molybdenum content of 0.036 percent (0.72 pounds per ton). Engineering pit design indicates that a total of 634 million tons of waste must be handled prior to and during the mining of the 414 million-ton ore reserve. This total of over a billion tons of ore and waste which will be mined, of which 131 million tons were removed during the pre-mine stripping operations, represents more than twice the tonnage excavated in the construction of the Panama Canal.

Mining

It is anticipated that the eventual perimeter of the Sierrita open pit will encompass an area of approximately 460 acres. As presently designed, the pit will ultimately reach a depth of 1850 feet below the highest elevation of the pit area prior to mining. Such an ultimate depth will represent a distance of almost one and one-half times the height of the Empire State Building.

Mining is accomplished by establishing a series of

levels or benches, each bench being approximately 50 feet high. The first step in the mining cycle is the blasting of the various benches. To blast a bench, rotary drills drill holes 59 feet in depth and from nine inches to 12¼ inches in diameter.

Blast holes which contain water are loaded with a gelatin explosive in slurry form. Holes which are dry are loaded with a mixture of ammonium nitrate and fuel oil.

A typical blast consisting of detonation of the explosives in 40 blast holes requires 75,000 pounds of explosives to break 200,000 tons of rock. A blast of this size provides enough broken material to keep one power shovel in production for approximately four days.

Mining Equipment and Facilities

The mining equipment features six power shovels equipped with 15 cubic-yard buckets and 32 haul trucks of 120-ton capacity. These shovels and trucks are among the largest presently used in the copper mining industry. In addition, six rotary blast-hole drills, 12 dozers and numerous other units such as motor patrols, fork lifts, cranes, water trucks, personnel busses and miscellaneous small trucks supplement the operation. Service facilities consist of two modern shops, steam cleaning pad, change room and offices. Because the power shovels and haul trucks are

among the largest used in the industry, some pertinent facts concerning these units are of interest:

Power Shovels

1. The weight of each shovel is approximately 450 tons.
2. Shovels are rated at 750 HP and are electrically powered by 4160-volt alternating current motors.
3. The 15 cubic-yard bucket has a capacity of approximately 23 tons.

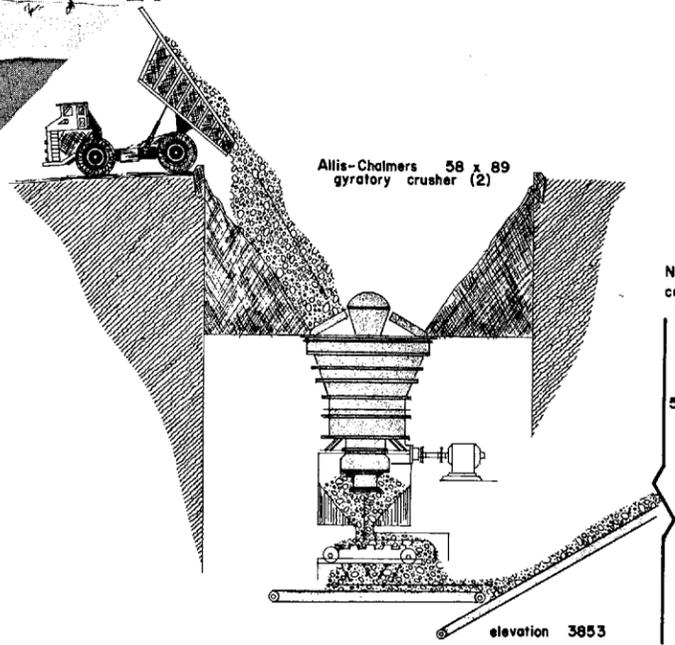
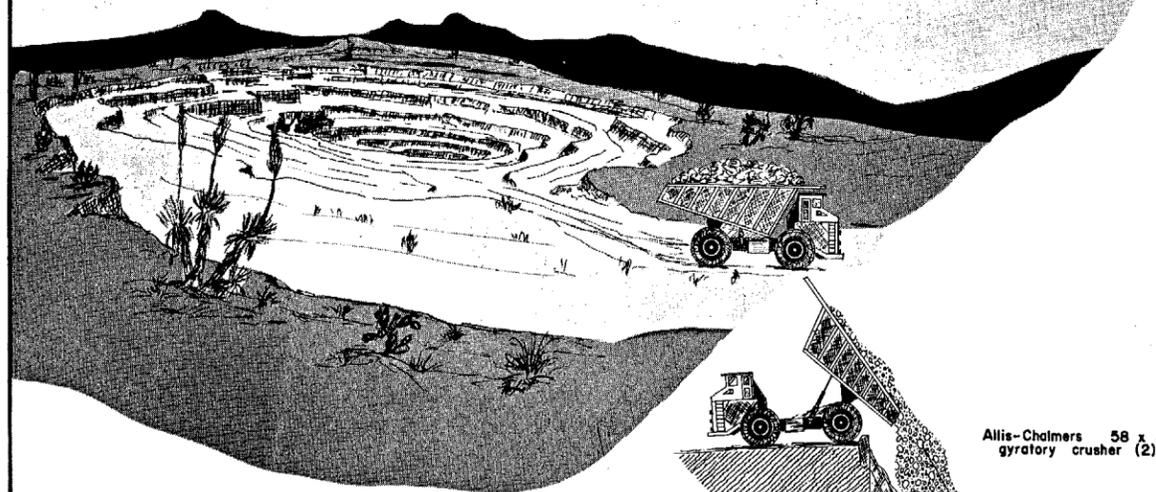
Haul Trucks

1. The truck engines are 12-cylinder diesels rated at 1000 HP.
2. The truck engine drives a direct current generator, which supplies power to electric motor assemblies in the rear wheels.
3. Trucks have a rated capacity of 120 tons and weigh approximately 75 tons empty.
4. Fuel tanks hold 450 gallons of diesel oil and the engines use one gallon per mile under full-load conditions and level haul.
5. Truck tires are 48-ply, nine feet in diameter and weigh 3000 pounds.
6. The expected life of each truck is five to seven years, after which replacement is anticipated.

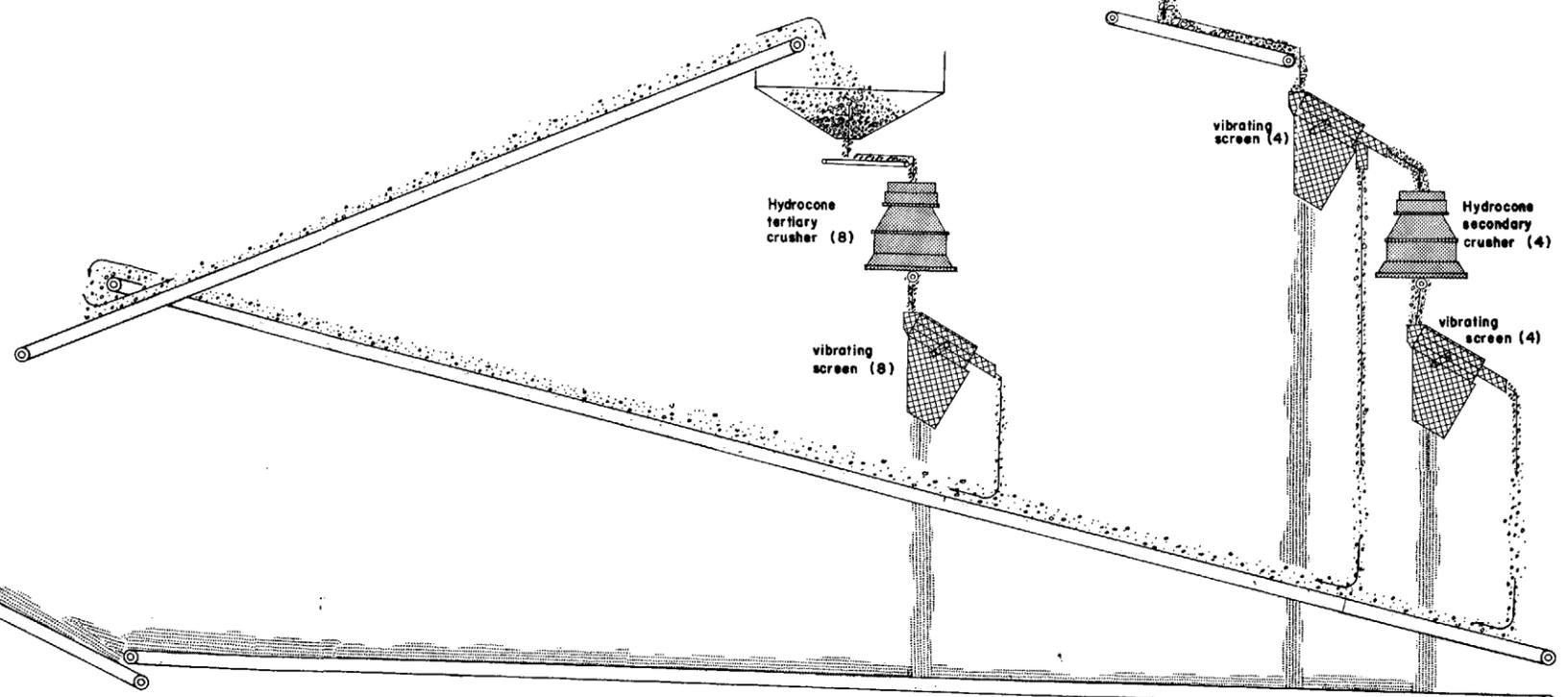
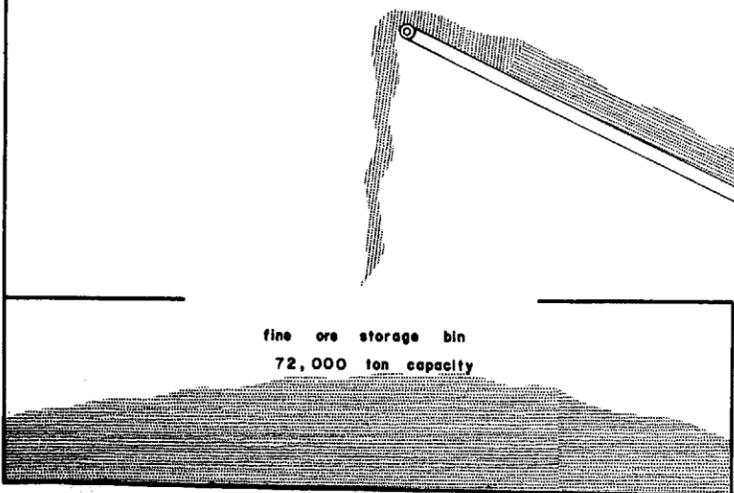
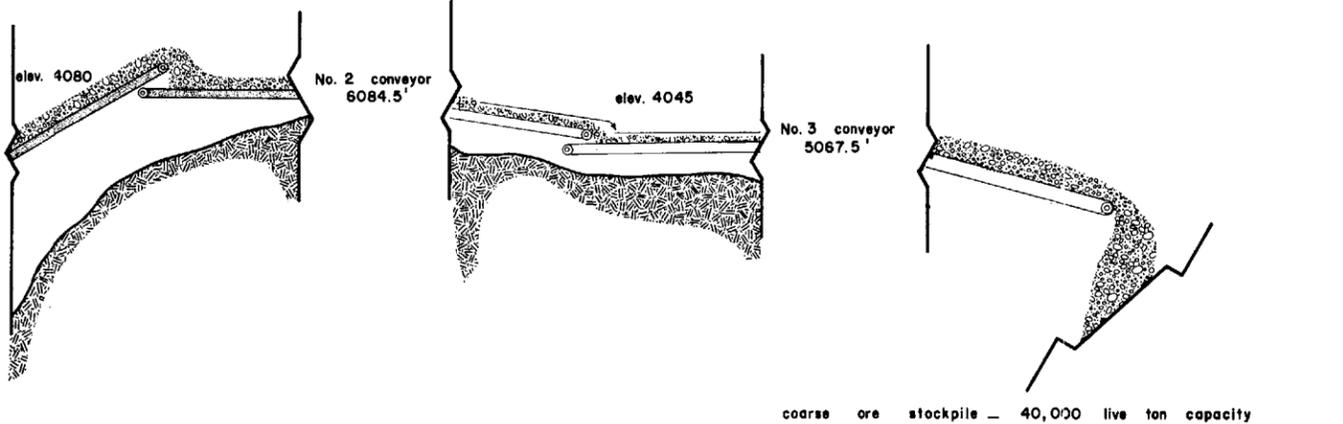
Plant Facilities

The concentrator, which has a design capacity of 72,000 tons of ore per day, and its associated facilities

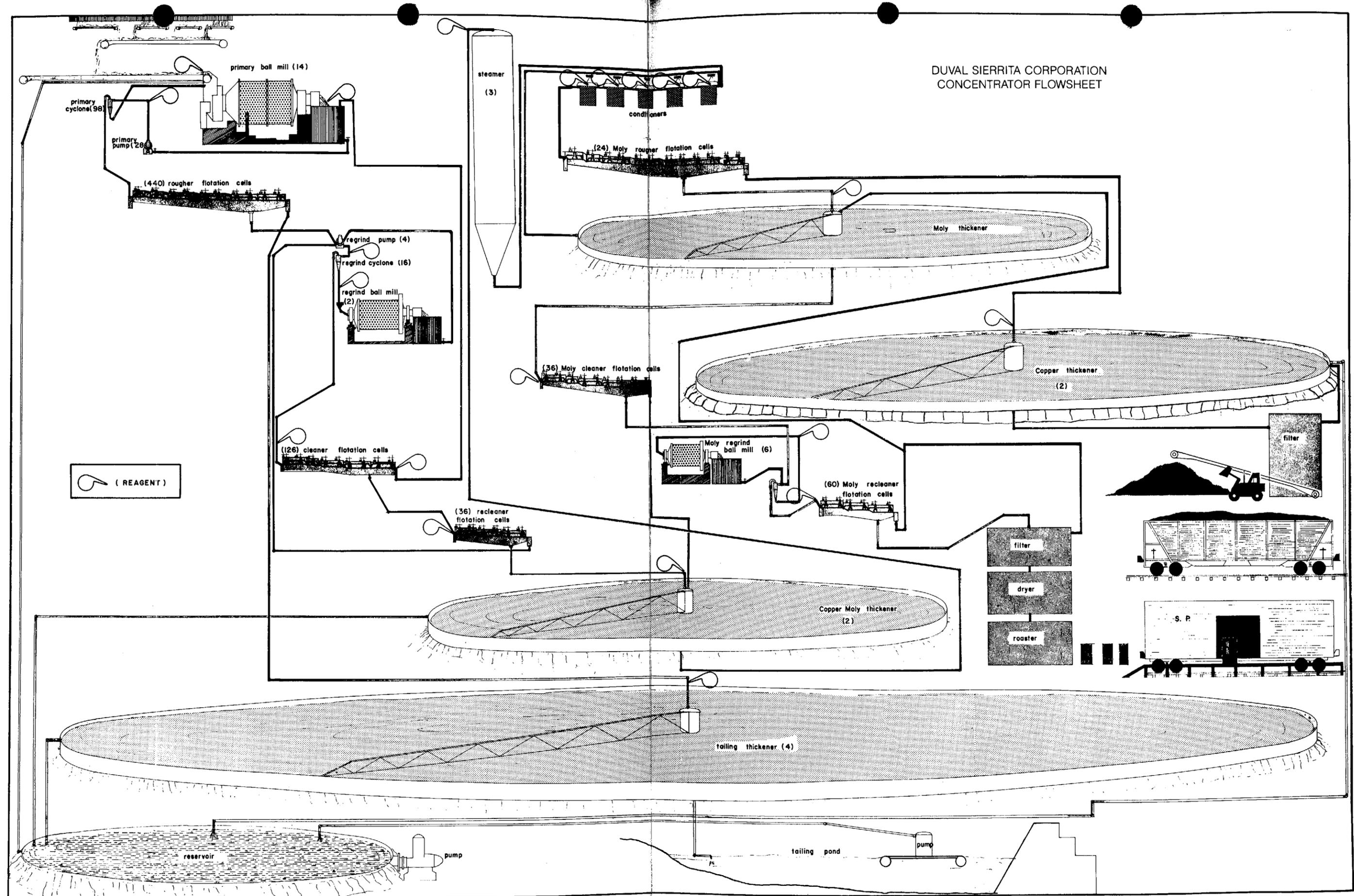
DUVAL SIERRITA CORPORATION
CRUSHING FLOWSHEET



No. 1
conveyor
1193.8'
long
54" wide



DUVAL SIERRITA CORPORATION
CONCENTRATOR FLOWSHEET



are expected to cost approximately \$100 million. This capacity will be greater than that of any single copper-molybdenum concentrator in North America. The construction of plant facilities, as originally designed, will be completed by mid-1970. In May, 1970, an agreement was reached with the GSA for a \$12 million expansion at the Sierrita Property. This expansion program, when completed in 1971, is expected to increase significantly the mining and milling capacity at the property.

Crushing

Primary size reduction of the mined ore is achieved by two 60-inch by 89-inch gyratory crushers located near the south perimeter of the Sierrita open pit. The crushers, which reduce the mine ore to about 85 percent minus six-inch, have a total operating capacity of 5000 tons-per-hour. The crushed ore is transported by a 54-inch wide belt conveyor to a 40,000-ton coarse ore open storage — an overland distance of about two and one-half miles.

Feeder belts under the coarse ore pile collect the ore to feed the fine-crushing plant. Ore is first fed to four vibrating double-deck scalping screens ahead of four 84-inch secondary crushers. The secondary crusher product is again screened, and the oversize material is further reduced by eight 84-inch tertiary crushers operating in a closed-circuit system consisting of a 2400-ton surge bin feeding the crushers

and vibrating screens. The finished product, essentially all minus half-inch, is transported to a 72,000-ton live capacity fine-ore bin located in the concentrator building.

Concentrating

The process of flotation is used to concentrate the copper and molybdenum minerals. To accomplish this, the crushed ore must be further reduced by grinding to achieve liberation of the mineral particles from the host rock.

The ore from the fine-ore storage is wet-ground in 14 16½-foot diameter by 19-foot-long ball mills driven by 3000 HP motors. The ball mills operate in a closed circuit with cyclone classifiers. The ground ore in an ore-water slurry, after being conditioned with reagents, is introduced into flotation machines which produce a low-grade (rougher) concentrate of copper and molybdenum minerals. The rougher concentrate is then re-ground in two 11-foot diameter by 15-foot-long regrind ball mills that are operated in a closed circuit with cyclone classifiers. The rougher concentrate is floated and re-floated to a final concentrate. A total of 602 flotation machines are used in the copper-molybdenum concentration. The tailing from the flotation process is thickened before disposal in four 350-foot diameter rake thickeners, the water, which is recovered from the slurry, is re-used in the

Duval Sierrita mill facilities for copper and molybdenum. Four 350-foot diameter rake tailing thickeners in the foreground reclaim water from the slurry for re-use.

process. The concentrate is thickened in 100-foot diameter thickeners.

The combined copper-molybdenum concentrate is then subjected to flotation to separate the two products. The concentrate is steamed and conditioned with reagents before flotation. In the first flotation, the copper minerals are depressed and the molybdenum floated. The copper concentrate is the tailing from this flotation and, after thickening in a 125-foot diameter thickener, is de-watered in four drum filters and loaded in open gondola railroad cars for transporting to the smelter. The molybdenum is further concentrated by cleaning and re-cleaning stages of flotation. The final molybdenum concentrate is filtered, dried and stored for packaging for marketing as molybdenum sulfide or for roasting in two 23½-foot diameter multiple-hearth roasters. The roasted product, molybdenum trioxide, is packaged and marketed as technical molybdcic oxide.

Production

Production from the Sierrita Property as originally designed is expected to average 130 million pounds of copper annually during the first five years of oper-

ation and 150 million pounds thereafter. In addition, the property will produce approximately 13 million pounds of molybdenum and 500,000 ounces of silver annually. With Sierrita's production, Duval Corporation will rank fourth among United States copper producers and will be the second largest producer of molybdenum in the United States.

Employment

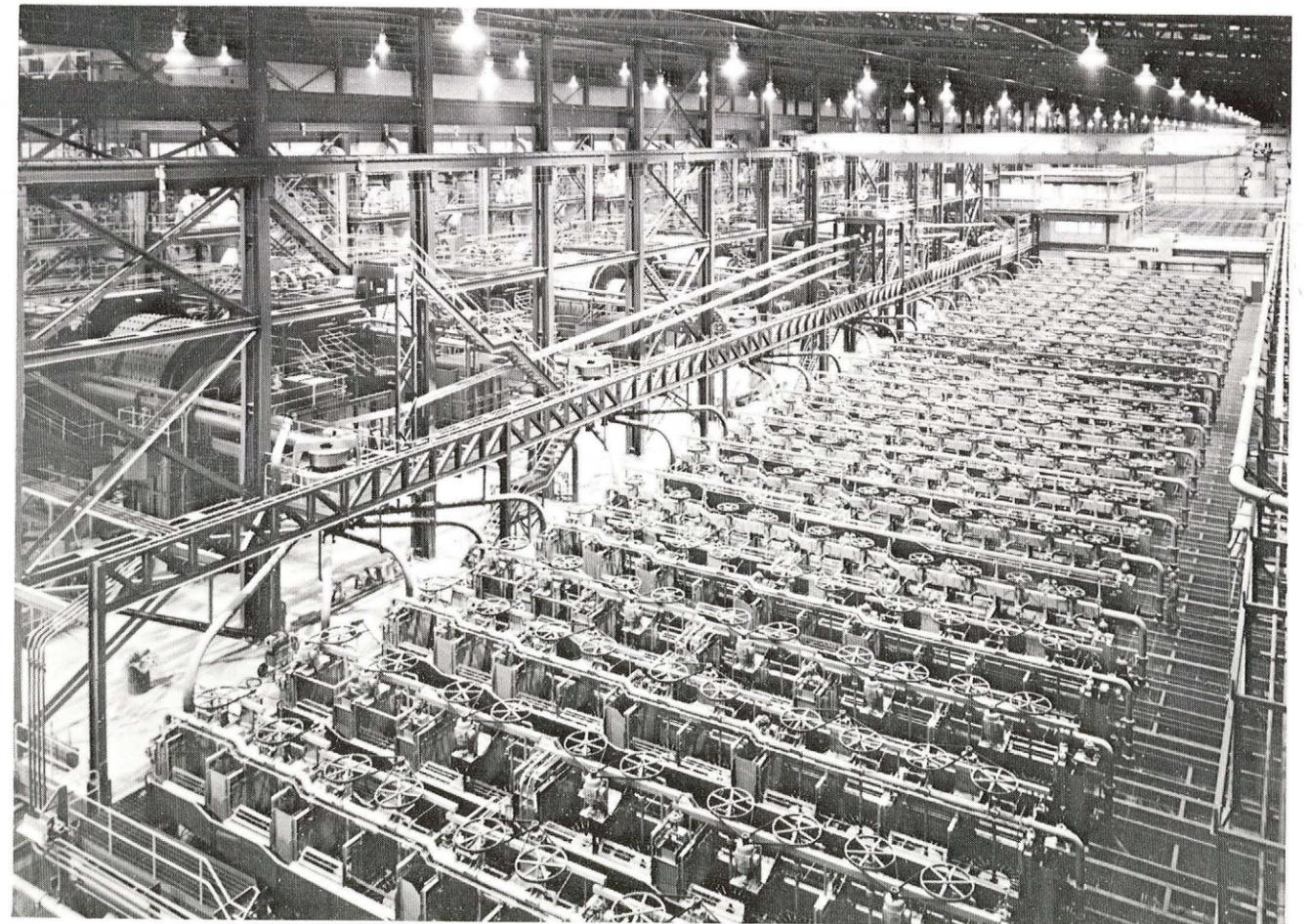
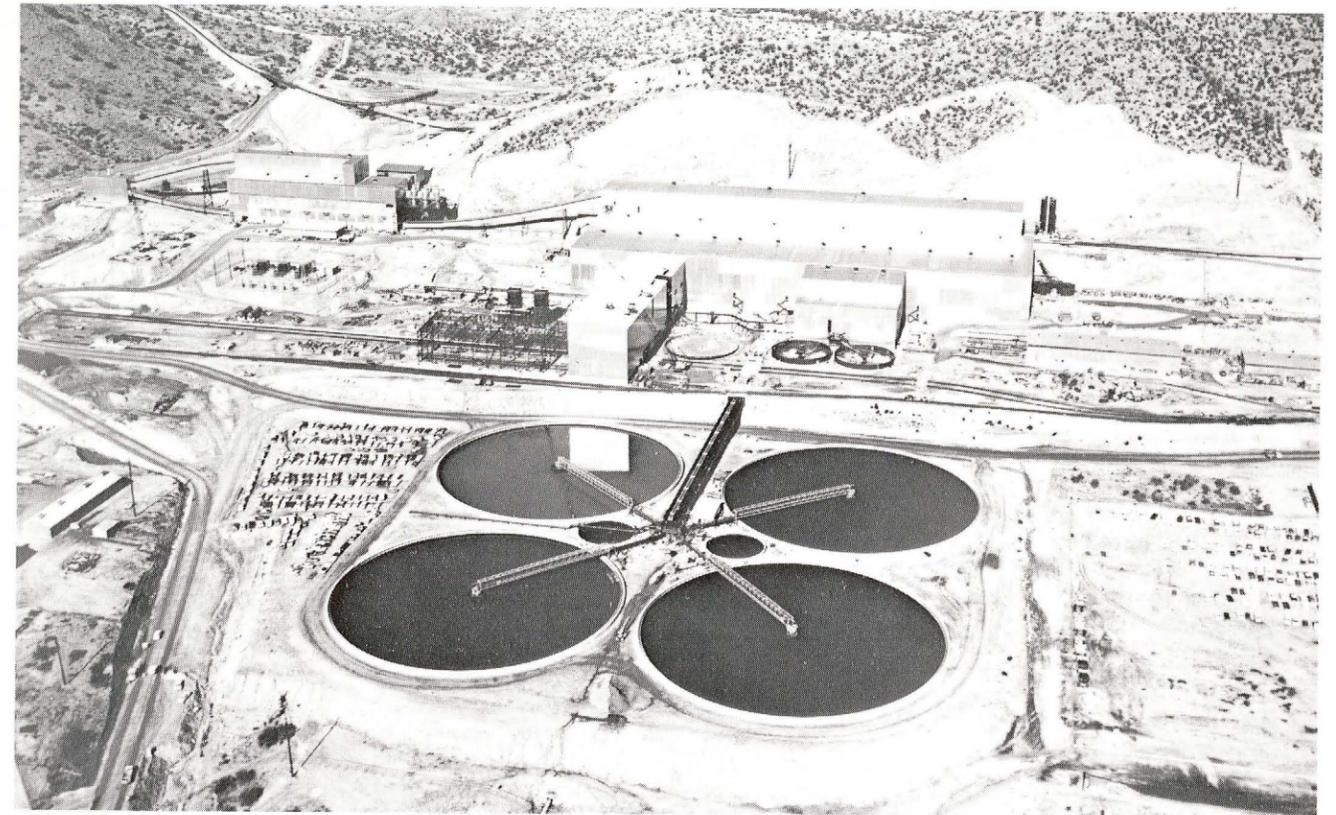
Peak employment during development of the Sierrita Property was 2400. Average employment during production will be 1100.

Utilities

Electric power and natural gas will be supplied by a local utility company. Power requirements are expected to be approximately 60,000 kilowatts or 40 million kilowatt-hours per month. This amount of power would supply a city of 100,000 population.

Natural gas requirements are expected to be some 50 million cubic feet per month with all but a fraction of the gas being used in roasting molybdenum sulphide concentrate into the oxide form.

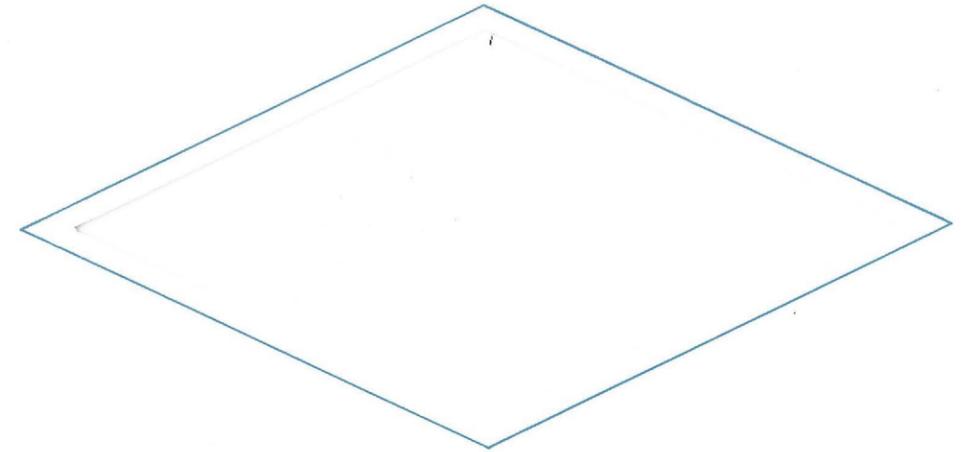
Concentrator building is nearly as long as three football fields. Final ore grinding takes place in the 14 cylindrical ball mills (left center). The ground copper-molybdenum ore then goes to the 602 flotation machines (foreground) where it is separated mechanically and concentrated.





CORPORATION
A Pennzoil Company

4715 East Fort Lowell Road
Tucson, Arizona 85712



DUVAL SIERRITA CORPORATION

Production from Duval Corporation's Sierrita-Esperanza copper/molybdenum properties near Tucson, Arizona, has helped rank Duval as the second largest producer of molybdenum in the world and one of the five leading producers of copper in North America.

How the Duval Sierrita Project Came About

In the Sierrita Mountains some 20 miles south of Tucson, Arizona, and about 40 miles north of Nogales, Sonora, Mexico, Duval Corporation, in July 1964, acquired a large low-grade copper-molybdenum ore body adjacent to its Esperanza Property. The purpose of the acquisition was to provide additional reserves for the Esperanza Property which began operations in 1959.

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project exceeded \$190 million. Additional financing beyond the \$83 million was being provided to the extent of \$48.75 million by government-guaranteed V-Loans, with the remainder provided by Duval.

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In 1950, the Company changed its name to Duval Sulphur & Potash Company and in 1963 to Duval Corporation. In 1930, United Gas Corporation acquired controlling interest in Duval Corporation.

In April of 1968, Pennzoil Company consolidated with United Gas Corporation to form Pennzoil United, Inc. The consolidated company name was changed to Pennzoil Company effective June 1, 1972.

Duval, now a wholly-owned Pennzoil Company subsidiary, continues to operate as a corporate entity.





Mining is accomplished by establishing a series of levels or benches, each being approximately 50 feet high. The first step in the mining cycle is the blasting of the various benches. To blast, rotary drills bore holes 59 feet in depth and nine to 12¼ inches in diameter. The holes are then loaded with explosives. A typical blast involving 40 holes breaks loose 200,000 tons of rock—enough material to keep one power shovel in production for approximately four days.

Sierrita Property

The Sierrita Property consists of over 13,000 acres. Included in this acreage are 143 unpatented mining claims which were purchased by Duval. Approximately 58 percent of the Sierrita ore body was acquired in the purchase of these claims. The remaining 42 percent of the ore body was controlled by patented mining claims owned by Duval. Duval has transferred these patented claims to Sierrita.

Exploration and Preliminary Development

A total of 178 test holes were drilled in order to delineate the Sierrita ore body and to test proposed waste dump areas. Some of the tests were drilled to check certain holes drilled by another mining company which had previously drilled 60 core tests in the area.

Ore Reserves

The exploration and preliminary development program delineated an ore body of 414 million tons with an average copper content of 0.35 percent (seven pounds per ton) and an average molybdenum content of 0.036 percent (0.72 pounds per ton). Subsequent development continues to expand this reserve. Engineering pit design indicates that a total of 634



million tons of waste must be handled prior to and during the mining of the 414 million-ton ore reserve. This total of over a billion tons of ore and waste which will be mined, of which 131 million tons were removed during the pre-mine stripping operations, represents more than twice the tonnage excavated in the construction of the Panama Canal.

Mining

It is anticipated that the eventual perimeter of the Sierrita open pit will encompass an area of approximately 460 acres. As presently designed, the pit will ultimately reach a depth of 1850 feet below the highest elevation of the pit area prior to mining. Such an ultimate depth will represent a distance of almost one and one-half times the height of the Empire State Building.

Mining is accomplished by establishing a series of levels or benches, each bench being approximately 50 feet high. The first step in the mining cycle is the blasting of the various benches. To blast a bench, rotary drills drill holes 59 feet in depth and from nine inches to 12¼ inches in diameter.

Blast holes which contain water are loaded with a gelatin explosive in slurry form. Holes which are dry are loaded with a mixture of ammonium nitrate and fuel oil.

A typical blast consisting of detonation of the explosives in 40 blast holes requires 75,000 pounds of explosives to break 200,000 tons of rock. A blast of this size provides enough broken material to keep one power shovel in production for approximately four days.



Giant haul trucks used to transport the ore from the benches to the crusher have a rated capacity of 120 and 150 tons. They weigh approximately 110-140 tons empty. Fuel tanks hold 450 to 500 gallons of diesel oil and the 48-ply tires stand nine to ten feet high and weigh some 3000 pounds.

Mining Equipment and Facilities

The mining equipment features nine power shovels equipped with 15 cubic-yard buckets, 38 haul trucks of 120-ton capacity and 14 of 150-ton capacity. These shovels and trucks are among the largest presently used in the copper mining industry. In addition, six rotary blast-hole drills, 12 dozers and numerous other units such as motor patrols, fork lifts, cranes, water trucks, personnel busses and miscellaneous small trucks supplement the operation. Service facilities consist of two modern shops, steam cleaning pad, change room and offices.

Because the power shovels and haul trucks are among the largest used in the industry, some pertinent facts concerning these units are:

Power Shovels

- The weight of each shovel is approximately 450 tons.
- Shovels are rated at 750 HP and are electrically powered by 4160-volt alternating current motors.
- The 15 cubic-yard bucket has a capacity of approximately 23 tons.

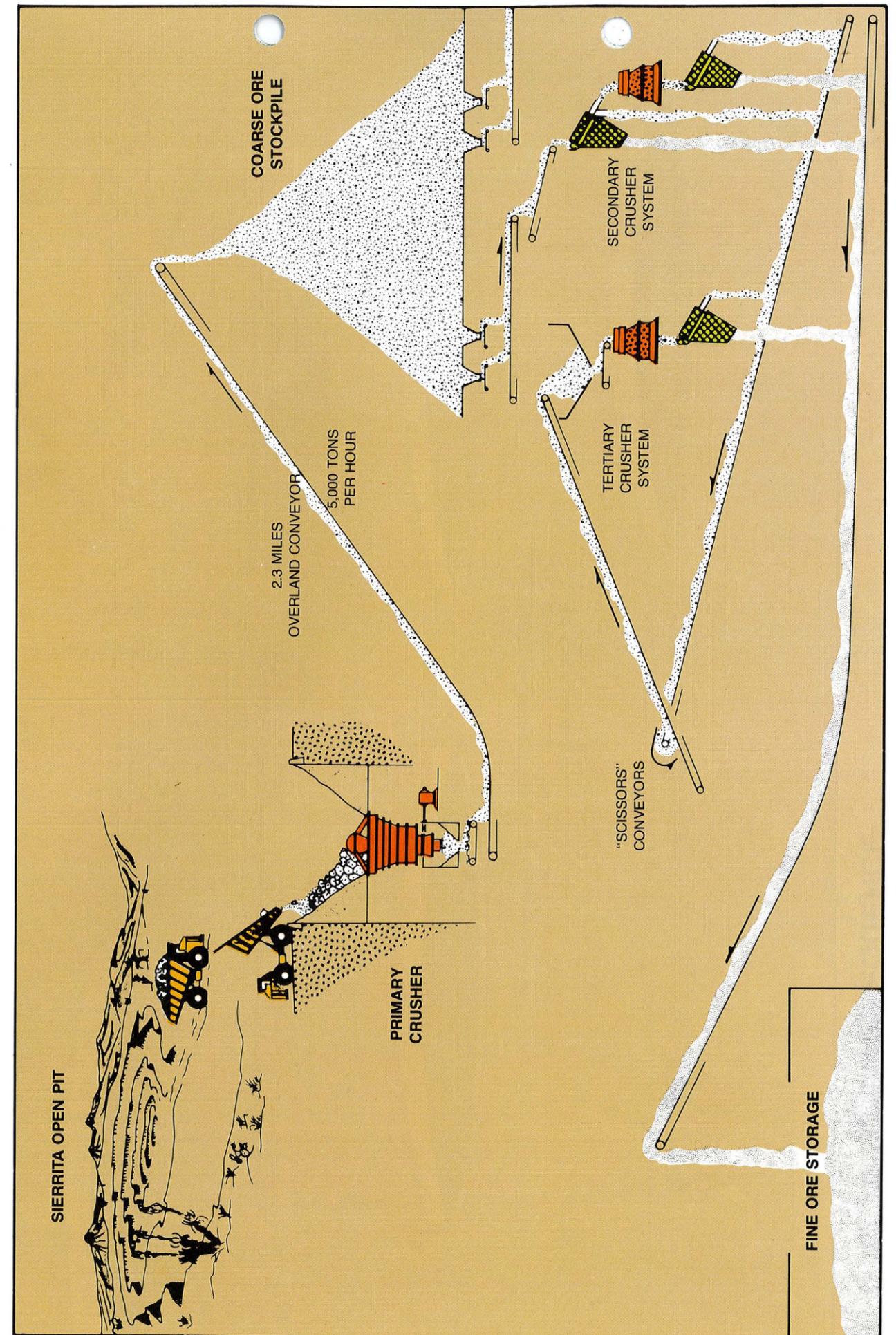
Haul Trucks

- The truck engines are 12 and 16 cylinder diesels rated at 1200 and 1600 HP.
- The truck engine drives a direct current generator, which supplies power to electric motor assemblies in the rear wheels.
- Trucks have a rated capacity of 120 and 150 tons. They weigh approximately 110-140 tons empty.
- Fuel tanks hold 450 to 500 gallons of diesel oil and the engines use about one gallon per mile under full-load conditions and level haul.
- Tires are 48-ply, nine to ten feet in diameter and weigh approximately 3000 pounds, depending on truck size.
- The expected life of each truck is about seven to ten years, after which replacement is anticipated.

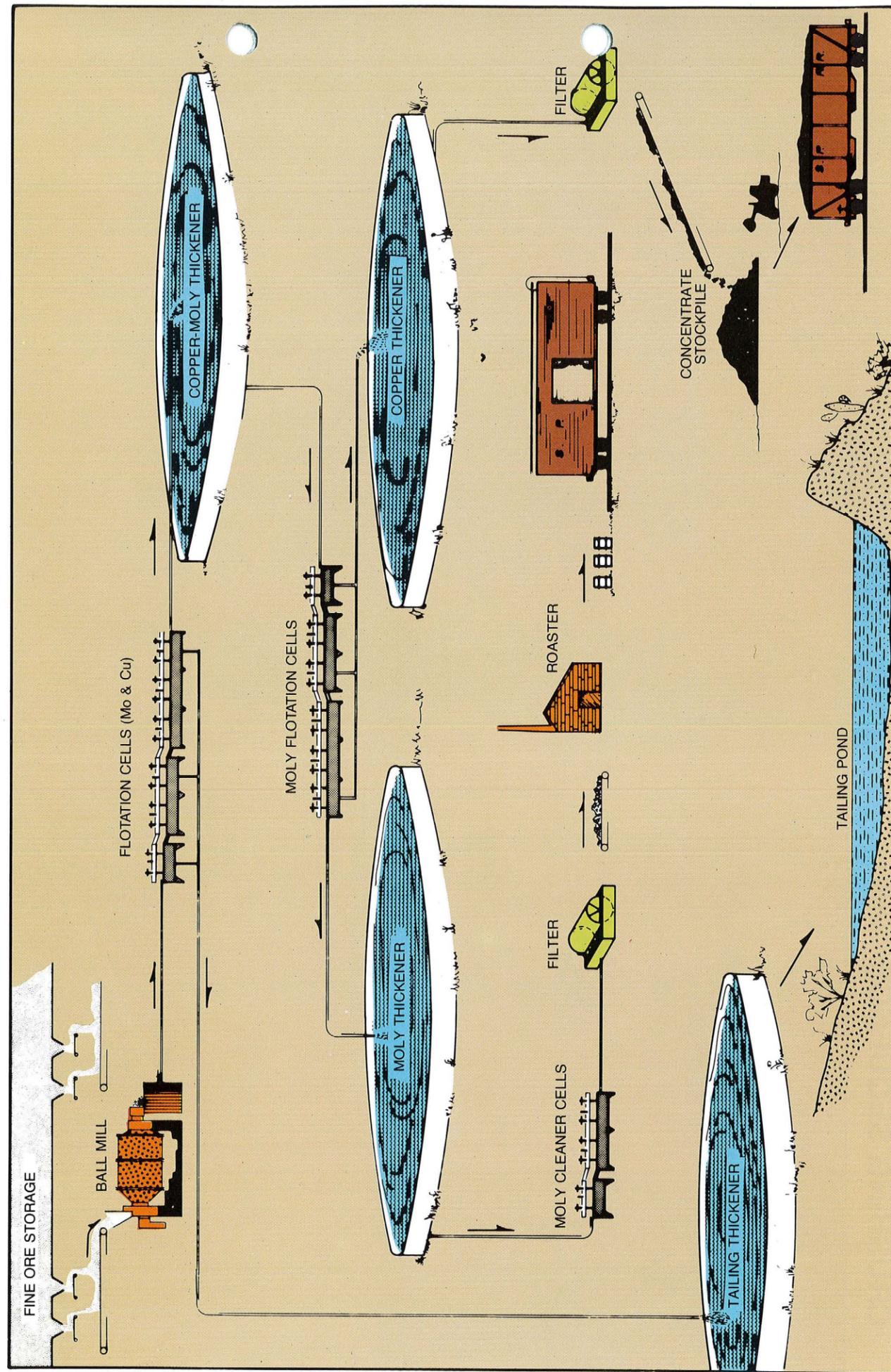
Plant Facilities

The concentrator was designed for a capacity of 60,000 tons of ore per day. Its associated facilities cost approximately \$112 million. This capacity is greater than that of any single copper-molybdenum concentrator in North America. The construction of plant facilities, as originally designed, was completed by mid-1970. In May, 1970, an agreement was reached with the GSA for

CRUSHING SEQUENCE



CONCENTRATING SEQUENCE



a \$12 million expansion at the Sierrita Property. This expansion program, completed in 1971, increased the mining and milling capacity at the property to 72,000 tons per day. Subsequent changes and modifications have increased this capacity to 86,000 tons per day.

Crushing

Primary size reduction of the mined ore is achieved by two 60-inch by 89-inch gyratory crushers located near the south perimeter of the Sierrita open pit. The crushers, which reduce the mine ore to about 85 percent minus six-inch, have a total operating capacity of 5000 tons-per-hour. The crushed ore is transported by a 54-inch wide belt conveyor to a 40,000-ton coarse ore open storage—an overland distance of about two and one-half miles.

Feeder belts under the coarse ore pile collect the ore to feed the fine-crushing plant. Ore is first fed to four vibrating double-deck scalping screens ahead of four 84-inch secondary crushers. The secondary crusher product is again screened, and the oversize material is further reduced by ten 84-inch tertiary crushers operating in a closed-circuit system consisting of a 2400-ton surge bin feeding the crushers and vibrating screens. The finished product, essentially all minus half-inch, is transported to a 60,000-ton live capacity fine-ore bin located in the concentrator building.

Concentrating

The process of flotation is used to concentrate the copper and molybdenum minerals. To accomplish this, the crushed ore must be further reduced in size by grinding to achieve liberation of the mineral particles from the host rock.

The ore from the fine-ore storage is wet-ground in 16 ball mills each measuring 16½ feet in diameter by 19 feet long and driven by 3000 HP motors. The ball mills operate in a closed circuit with cyclone classifiers. The ground ore in an ore-water slurry, after being conditioned with reagents, is introduced into flotation machines which produce a low-grade (rougher) concentrate of copper and molybdenum minerals. The rougher concentrate is then re-ground in two 11-foot diameter by 15-foot-long regrind ball mills that are operated in a closed circuit with cyclone classifiers. The rougher concentrate is floated and re-floated to a final concentrate. A total of 662 flotation machines are used in the copper-molybdenum concentration. The tailing from the flotation process is thickened before disposal in four 350-foot diameter rake thickeners; the water, which is recovered from the slurry, is re-used in the process. The concentrate is thickened in 100-foot diameter thickeners.

The combined copper-molybdenum concentrate is then subjected to flotation to separate the two products. The concentrate is steamed and conditioned with

reagents before flotation. In the first flotation, the copper minerals are depressed and the molybdenum floated. The copper concentrate is the tailing from this flotation and, after thickening in a 125-foot diameter thickener, is de-watered in four drum filters and loaded in open gondola railroad cars for transporting to the smelter. The molybdenum is further concentrated by cleaning and re-cleaning stages of flotation. The final molybdenum concentrate is filtered, dried and stored for packaging for marketing as molybdenum sulfide or for roasting in two 23½-foot diameter multiple-hearth roasters. The roasted product, molybdenum trioxide, is packaged and marketed as technical molybdc oxide.

Production

Annual metal production from the Sierrita Property amounts to 180 million pounds of copper, 14 million pounds of molybdenum and 850,000 ounces of silver. Duval Corporation ranks fifth among United States copper producers and is the second largest producer of molybdenum in the world.

Landscaping Program

Duval landscapes spoil banks and tailing dams from its copper operations. Utilizing a drip irrigation system, liquid fertilizers are injected into soil devoid of mineral value. Native plants and trees are then planted into the revitalized soil, blending the tailing dams with the adjacent countryside.

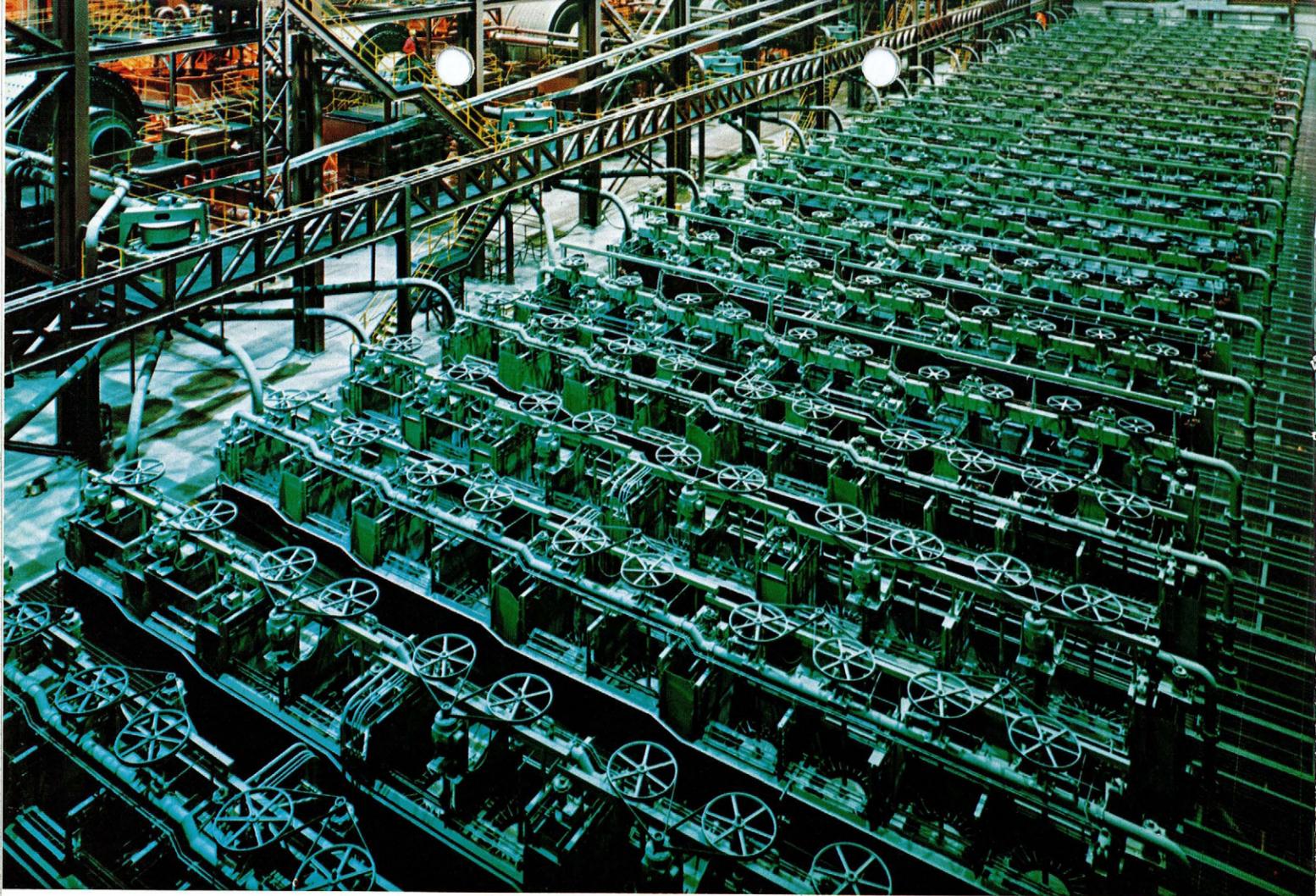
Employment

Peak employment during development of the Sierrita Property was 2400. Average employment during production is 1750.

Utilities

Electric power and natural gas is supplied by a local utility company. Power requirements are approximately 70,000 kilowatts or 50 million kilowatt-hours per month. This amount of power would supply a city of 100,000 population.

Natural gas requirements are 50 million cubic feet per month with most of the gas used to process the molybdenum minerals.



The ground ore in an ore-water slurry, after being conditioned with reagents, is introduced into flotation machines which produce a low-grade (rougher) concentrate of copper and molybdenum materials. Further grinding and flotation is then carried out before the final concentrate is produced.

The process of flotation is used to concentrate the copper and molybdenum minerals. To accomplish this, the crushed ore must be further reduced in size by grinding. The ore from the fine-ore storage is wet-ground in 16 ball mills each measuring 16½ feet in diameter by 19 feet long and driven by 3000 HP motors.



Glossary

Ball Mill: a rotating, horizontal cylinder partially filled with steel balls and water that grinds the ore stored in the fine ore bin to free the valuable minerals from the waste rock.

Coarse Ore Pile: where the product from the primary crusher is stockpiled prior to being fed into the secondary crushers.

Concentrator: a plant where ore or metal is freed and separated from its containing rock or earth. The concentration of ores always proceeds in steps or stages, e.g.: crushing, sizing, and flotation to produce a concentrate.

Cyclone Classifier: a device for classification by centrifugal means of fine particles suspended in water, whereby the coarser grinds collect at and are discharged from the lower apex of the apparatus and the fine particles along with the water are discharged from a top opening.

Fine Ore Bin: a place of temporary storage for the product from the tertiary crushers (½" sized ore) that will be fed into the ball mills in the concentrator.

Flotation: the process of separating valuable minerals from waste rock with the use of chemicals, reagents and air. (Reagents coating the ore particles are attracted to air bubbles which then float to the pulp surface and are skimmed off as concentrate.) Waste particles are not coated and are, therefore, not floated. Accordingly, a separation is accomplished.

Molybdenite: a black platy disulfide of molybdenum (MoS₂) which is processed to molybdenum trioxide and is used in steel alloys and electrodes of mercury vapor lamps.

Ore: a natural occurring mineral or mineral compound that can be mined at a profit.

Primary Crusher: a heavy duty dry crushing machine capable of accepting mine run ore (blocks of rock up to 4' in size) and reducing it to less than 6" pieces.

Reagent: a chemical or solution used to produce a desired chemical reaction or conditioning of the slurry prior to flotation.

Scalping Screen: a vibrating screen designed to separate coarse and fine ore so that the coarse fraction can be further crushed.

Secondary Crusher: the second stage of crushing (by machine) in which the product from the primary crusher is further reduced in size as part of the process to free the valuable minerals from the rock.

Slurry: a liquid mixture of finely ground particles of rock and minerals in water.

Slurry Blasting Agents: a dense, insensitive high velocity explosive of very high water resistance.

Spoil Bank: a pile or bank of waste rock or dirt.

Surge Bin: a compartment for temporary storage of ore which will assure a constant rate of supply to the crushers or grinding mills.

Tailing Pond: an impoundment or storage area for the waste rock and water from the concentrator that no longer contains mineral values of any significance.

Tailings: the finely crushed rock that no longer contains any mineral values. (Residue from the flotation process.)

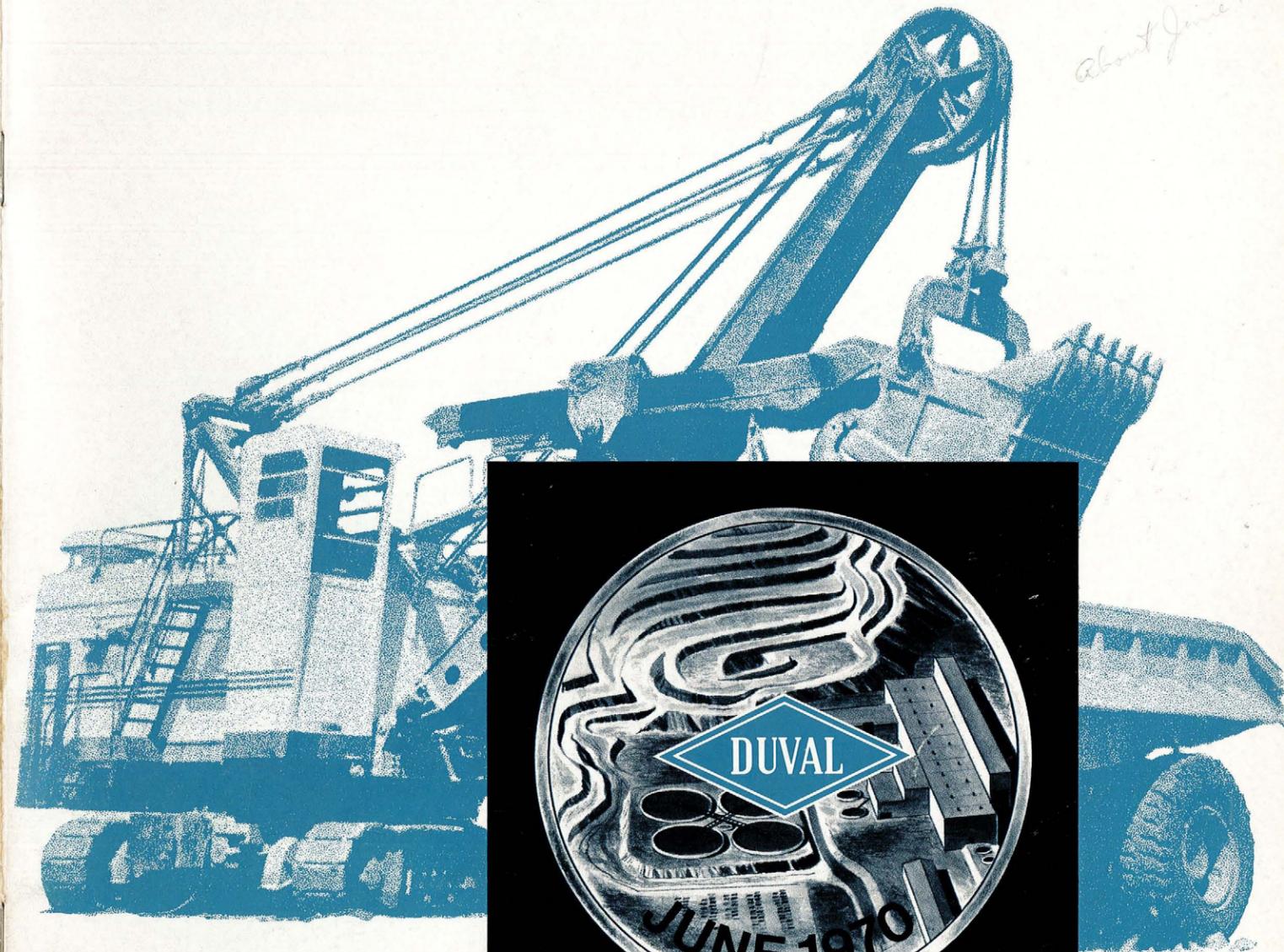
Tertiary Crusher: the third stage of grinding by a machine in which the product from the secondary crusher is further reduced in size (to about ¾") as part of the process of freeing the valuable minerals from the rock.

Thickener: a circular pond or impoundment that is used to reduce the amount of liquids from a liquid-solid mixture and permit the recovery of clear overflowing water for re-use in the process.

Wirebar Copper: a cast shape of copper which has a cross section approximately square with tapered ends designed for hot rolling to rod for subsequent drawing into wire and is approximately 99.99% pure copper.

B T 90

About June 1970



The Mining Subsidiary of Pennzoil United, Inc.

Duval Sierrita Corporation
Sierrita Property
P.O. Box 125
Sahuarita, Arizona 85629

Duval Corporation
1906 First City National Bank Building
Houston, Texas 77002

Duval Corporation
4715 East Fort Lowell Road
Tucson, Arizona 85716

Duval Sales Corporation
300 The Main Building
Houston, Texas 77002

Sierrita Property Dedication

98

B3



Aerial view of Duval Sierrita and Esperanza Properties. Copper-molybdenum ore from the Sierrita pit (upper center) travels two and one-half miles on a 54-inch belt conveyor system to the Sierrita mill (lower center).

How the Duval Sierrita Project Came About

In the Sierrita Mountains some 20 miles south of Tucson, Arizona, and about 40 miles north of Nogales, Sonora, Mexico, Duval Corporation, in July, 1964, acquired a large low-grade copper-molybdenum ore body adjacent to its Esperanza Property. The purpose of the acquisition was to provide additional reserves for the Esperanza Property which began operations in 1959.

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History of Pennzoil United, Inc.

Pennzoil United, Inc., a large Houston based natural resources company resulting from the consolidation of Pennzoil Company and United Gas Corporation, today lists assets totaling over \$1.35 billion. Both companies have histories dating back to the early days of the oil and gas industry.

Pennzoil Company was formed in 1955, by the merger of South Penn Oil Company, leading producer of Pennsylvania Grade crude, and The Pennzoil Company, largest refiner and marketer of Penn Grade products.

South Penn, organized in 1889, had acquired controlling interest in Pennzoil in the early 1920's, and for three decades prior to the merger, the two companies maintained a close relationship as producer-refiner-marketer.

In 1963, Zapata Petroleum and Stetco Petroleum, two West Texas-based companies with substantial oil and gas holdings, merged with South Penn and the corporate name was changed to Pennzoil Company.

As these developments were shaping the course of Pennzoil, similar events in the natural gas industry were paving the way for formation of United Gas.

Principal occurrence in the evolution of this huge, fully integrated natural gas system was the joining together in 1930 of more than 40 gas companies in Texas and Louisiana.

Power shovel bucket drops approximately 23 tons of copper-molybdenum ore into 1000 HP haul truck. When fully loaded, the haul truck will carry 120 tons of ore. Each truck tire is 48-ply, stands nine feet high and weighs 3000 pounds.



From this nucleus, United Gas ultimately became one of the largest handlers of natural gas in the world, spanning a vast five-state area along a broad arc from Laredo, Texas, to Pensacola, Florida. By 1965, its widespread operations included exploration and production, transmission and distribution of natural gas, refining of gasoline and petroleum by-products, and mining.

Final consolidation of Pennzoil and United Gas occurred on April 1, 1968.

Sierrita Property

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The mining equipment features six power shovels equipped with 15 cubic-yard buckets and 32 haul trucks of 120-ton capacity. These shovels and trucks are among the largest presently used in the copper mining industry. In addition, six rotary blast-hole drills, 12 dozers and numerous other units such as motor patrols, fork lifts, cranes, water trucks, personnel busses and miscellaneous small trucks supplement the operation. Service facilities consist of two modern shops, steam cleaning pad, change room and offices.

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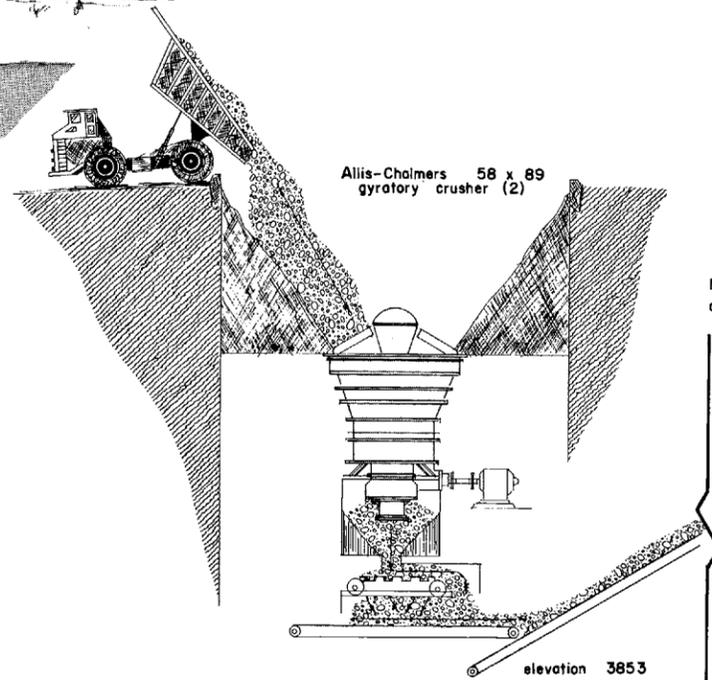
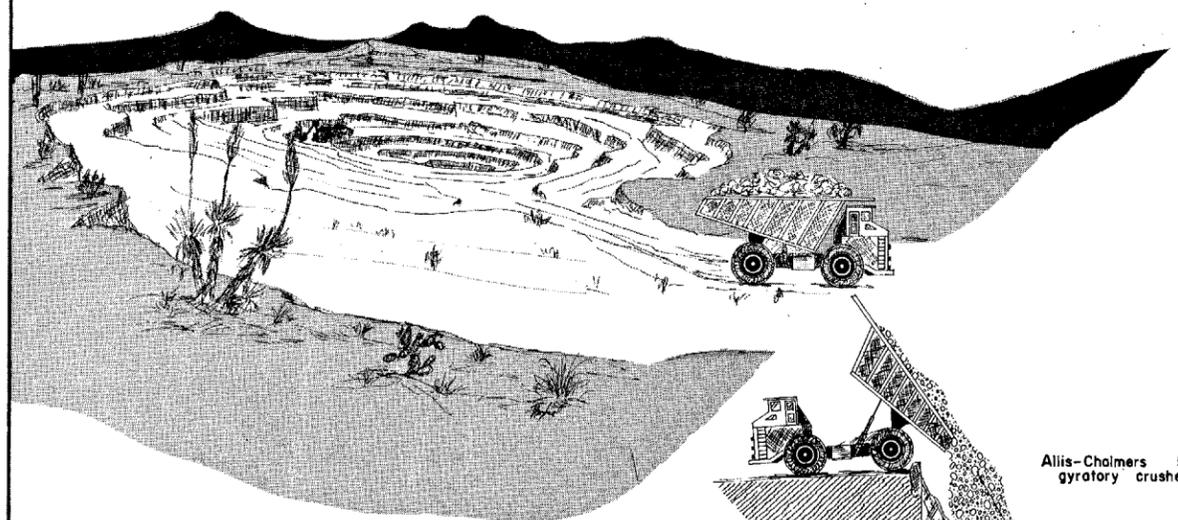
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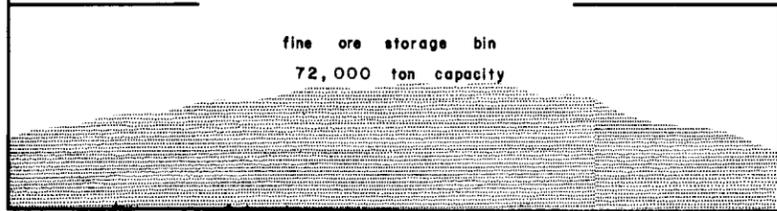
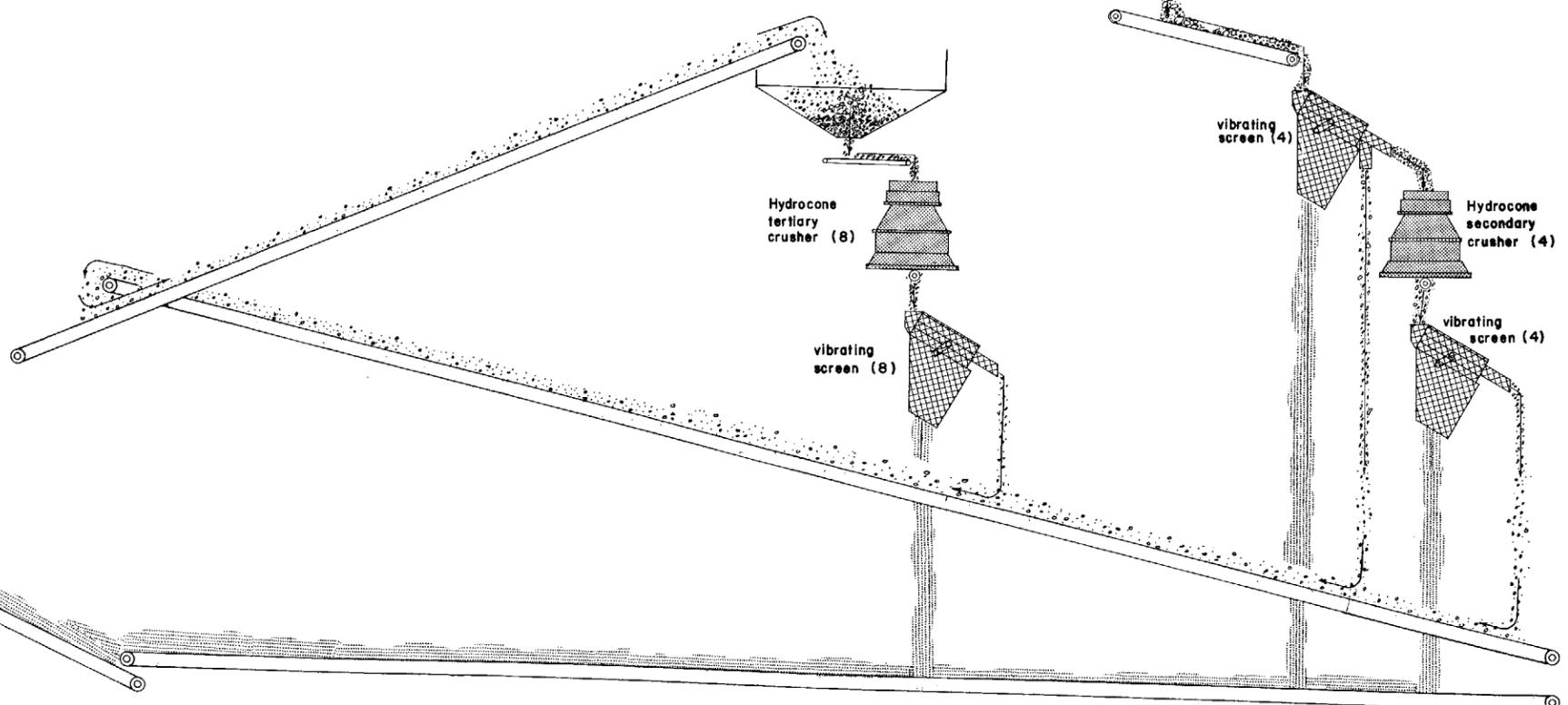
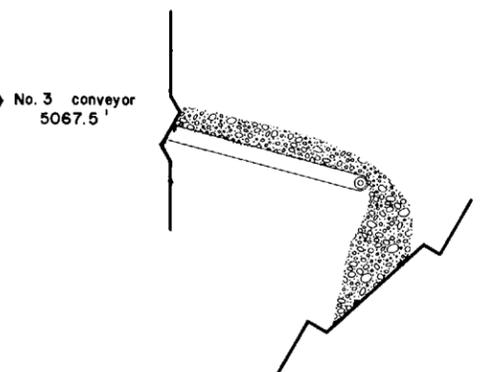
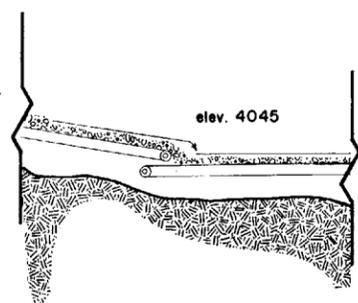
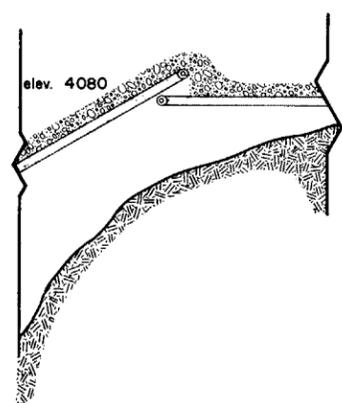
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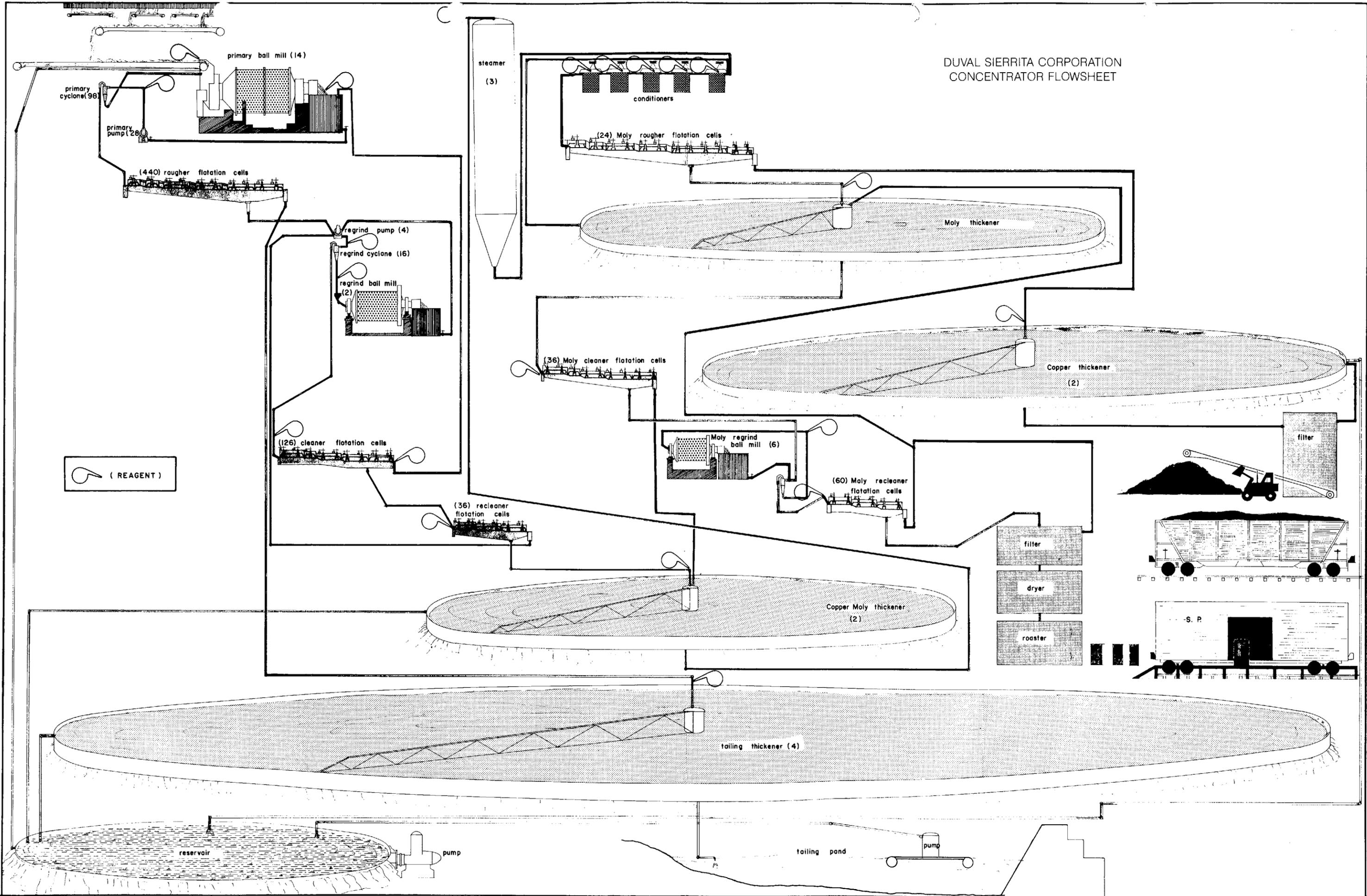
DUVAL SIERRITA CORPORATION
CRUSHING FLOWSHEET



No. 1
conveyor
1193.8'
long
54" wide



DUVAL SIERRITA CORPORATION
CONCENTRATOR FLOWSHEET



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Duval Sierrita mill facilities for copper and molybdenum. Four 350-foot diameter rake tailing thickeners in the foreground reclaim water from the slurry for re-use.

process. The concentrate is thickened in 100-foot diameter thickeners.

The combined copper-molybdenum concentrate is then subjected to flotation to separate the two products. The concentrate is steamed and conditioned with reagents before flotation. In the first flotation, the copper minerals are depressed and the molybdenum floated. The copper concentrate is the tailing from this flotation and, after thickening in a 125-foot diameter thickener, is de-watered in four drum filters and loaded in open gondola railroad cars for transporting to the smelter. The molybdenum is further concentrated by cleaning and re-cleaning stages of flotation. The final molybdenum concentrate is filtered, dried and stored for packaging for marketing as molybdenum sulfide or for roasting in two 23½-foot diameter multiple-hearth roasters. The roasted product, molybdenum trioxide, is packaged and marketed as technical molybdic oxide.

Production

Production from the Sierrita Property as originally designed is expected to average 130 million pounds of copper annually during the first five years of oper-

ation and 150 million pounds thereafter. In addition, the property will produce approximately 13 million pounds of molybdenum and 500,000 ounces of silver annually. With Sierrita's production, Duval Corporation will rank fourth among United States copper producers and will be the second largest producer of molybdenum in the United States.

Employment

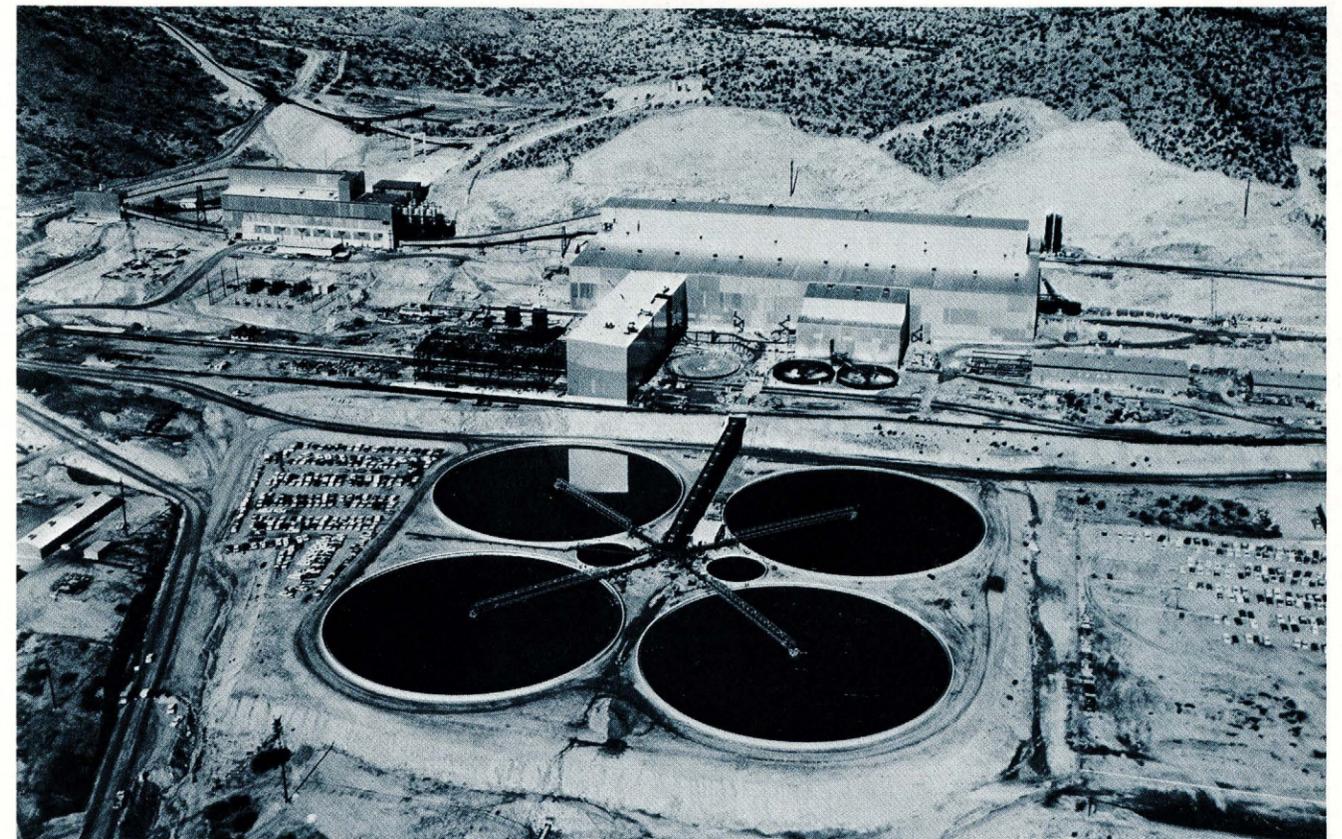
Peak employment during development of the Sierrita Property was 2400. Average employment during production will be 1100.

Utilities

Electric power and natural gas will be supplied by a local utility company. Power requirements are expected to be approximately 60,000 kilowatts or 40 million kilowatt-hours per month. This amount of power would supply a city of 100,000 population.

Natural gas requirements are expected to be some 50 million cubic feet per month with all but a fraction of the gas being used in roasting molybdenum sulphide concentrate into the oxide form.

Concentrator building is nearly as long as three football fields. Final ore grinding takes place in the 14 cylindrical ball mills (left center). The ground copper-molybdenum ore then goes to the 602 flotation machines (foreground) where it is separated mechanically and concentrated.



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VISITOR'S
INFORMATION
PAMPHLET

DUVAL SIERRITA CORPORATION
GEOLOGY DEPARTMENT

ROBERT A. METZ, CHIEF MINE GEOLOGIST

A. HARVEY JAMES, MINE GEOLOGIST

BOB GALYON, DRAFTSMAN

and

and

DUVAL SIERRITA CORPORATION

SIERRITA PROPERTY

ORGANIZATION

Resident Manager	J. P. McCarty
Mine Superintendent	A. P. Holzworth
Chief Mine Engineer	F. H. Buchella, Jr.
Chief Mine Geologist	R. A. Metz
Safety Supervisor	D. L. Gidak
Chief Accountant	S. C. Polasek
Purchasing Agent	J. K. Peters
Personnel Relations Supervisor	J. W. Fortson
Mill Superintendent	R. L. Bevers
Plant Maintenance Superintendent	F. W. Schweitzer
Chief Warehouseman	W. E. Hoskinson
Chief Chemist	C. E. Hodge
Chief Metallurgist	A. Gomez, Jr.

The Sierrita property consists of over 13,000 acres, which includes property rights for water field, tailing disposal and rights of way for pipe lines and a railroad spur. Included in this total acreage are 143 unpatented mining claims which were purchased by Duval Corporation. Approximately 58 percent of the Sierrita ore body was acquired in the purchase of these claims. The remaining 42 percent of the ore body was controlled by patented mining claims which were part of Duval's Esperanza Property. Duval has transferred these unpatented and patented mining claims to the Sierrita property.

EXPLORATION AND PRELIMINARY DEVELOPMENT

A total of 137 test holes have been drilled in order to delineate the Sierrita ore body and to test proposed waste dump areas. Some of the tests were drilled to check certain holes drilled by another mining company which had previously drilled 60 core tests in the area.

ORE RESERVES

The exploration and preliminary development program delineated an ore body of 414 million tons with an average copper content of 0.35% (Seven pounds) and an average molybdenum content of 0.036% (0.72 pounds). Engineering pit design indicates that a total of 634 million tons of waste must be handled prior to and during the mining of the 414 million tons ore reserve. This total of over a billion tons of ore and waste, which will be mined, represents more than twice the tonnage excavated in the construction of the Panama Canal.

MINING

It is anticipated that the eventual perimeter of the Sierrita open pit will encompass an area of approximately 460 acres. As presently designed, the pit will ultimately reach a depth of 1850 feet below the highest elevation of the pit area prior to commencement of mining. By comparison, the Empire State Building is only two-thirds as tall as the pit will be deep.

The mining plans provide for the removal of 105 million tons of waste overburden before the commencement of ore mining operations. A daily average of 200,000 tons per day will be mined during the pre-mine stripping period. Thereafter, the mining of ore and waste will be conducted on a scale of approximately 235,000 tons per day for the initial six-year production period, after which the scale of mining operations will be somewhat reduced as less waste will be handled.

MINING EQUIPMENT AND FACILITIES

The mining equipment features six power shovels of P & H manufacture equipped with 15 cubic yard buckets and an initial order of 28 electric wheel haul trucks of 120-ton capacity which will be expanded to 40 by the completion of pre-mine stripping. These shovels and trucks are of the largest presently used in the copper mining industry. In addition, six rotary blast hole drills, 11 dozers and numerous other units such as motor patrols, fork lifts, cranes, water trucks, personnel buses and miscellaneous small trucks supplement the operation. Service facilities consist of two modern shops, steam cleaning pad, change room and offices.

Because the power shovels and haul trucks represent the largest of these machines used in the industry, some pertinent facts concerning these units are of interest:

Power Shovels:

1. The weight of each shovel is approximately 450 tons.
2. Shovels are rated at 750 HP and are electrically powered by 4160 volt AC current.
3. When loaded, the 15 cubic yard bucket contains approximately 25 tons.

Haul Trucks:

1. The initial purchase of 28 electric wheel trucks was evenly divided between KW Dart Company and Westinghouse Air Brake Company.
2. The truck engines are 12 cylinder diesels rated at 1000 HP.
3. Engines drive DC electric generators, which supply power to electric motor assemblies in the rear wheels.
4. Trucks have a rated capacity of 120 tons and weigh approximately 75 tons empty.
5. Fuel tanks hold 450 gallons of diesel oil and the engines use one gallon per mile under full load conditions and level haul.
6. Truck tires are constructed of 48 ply, stand nine feet in height and weigh 3000 pounds.

PLANT FACILITIES

Stearns-Roger Corporation of Denver, Colorado has been awarded an engineering construction contract to build the Sierrita concentrator and associated facilities. The concentrator, which will have a designed capacity in excess of 60,000 tons of ore per day, and the associated

facilities are estimated to cost \$84 million. This capacity will be greater than any single copper-molybdenum concentrator in North America. The construction of plant facilities is expected to be completed in the third quarter of 1969.

PRODUCTION

The Sierrita property will produce an annual minimum average of 114 million pounds of copper during the first five years of operations and 136 million pounds thereafter. In addition, the property will produce approximately 12 million pounds of molybdenum and 455,000 ounces of silver annually. When Sierrita reaches full production, Duval Corporation will rank fourth in U. S. copper mine production and supply approximately 14 percent of the free world's molybdenum.

EMPLOYMENT

Peak employment during construction at the Sierrita property is expected to reach some 2,800. It is estimated, average permanent employment during production will be 1,100.

UTILITIES

Power and natural gas will be supplied by Tucson Gas and Electric Company. Power requirements are expected to be approximately 60,000 kilowatts or 40 million kilowatt hours per month. This amount of power would supply an average city of more than 100,000 population.

Gas requirements are expected to be some 50 million cubic feet per month with all but a fraction of the gas being utilized in roasting molybdenum sulphide concentrates into the oxide form.

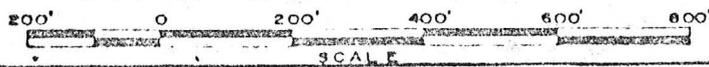
Water requirements for the operation will be on the order of 15,000 gallons per minute with most of this amount being used in the milling operation. This water will be pumped from wells along the Santa Cruz River Basin belonging to the Sierrita property. To secure this advantageous site with its water rights, a 5900-acre ranch, which was part of an original Spanish Land Grant, was purchased.



EXPLANATION

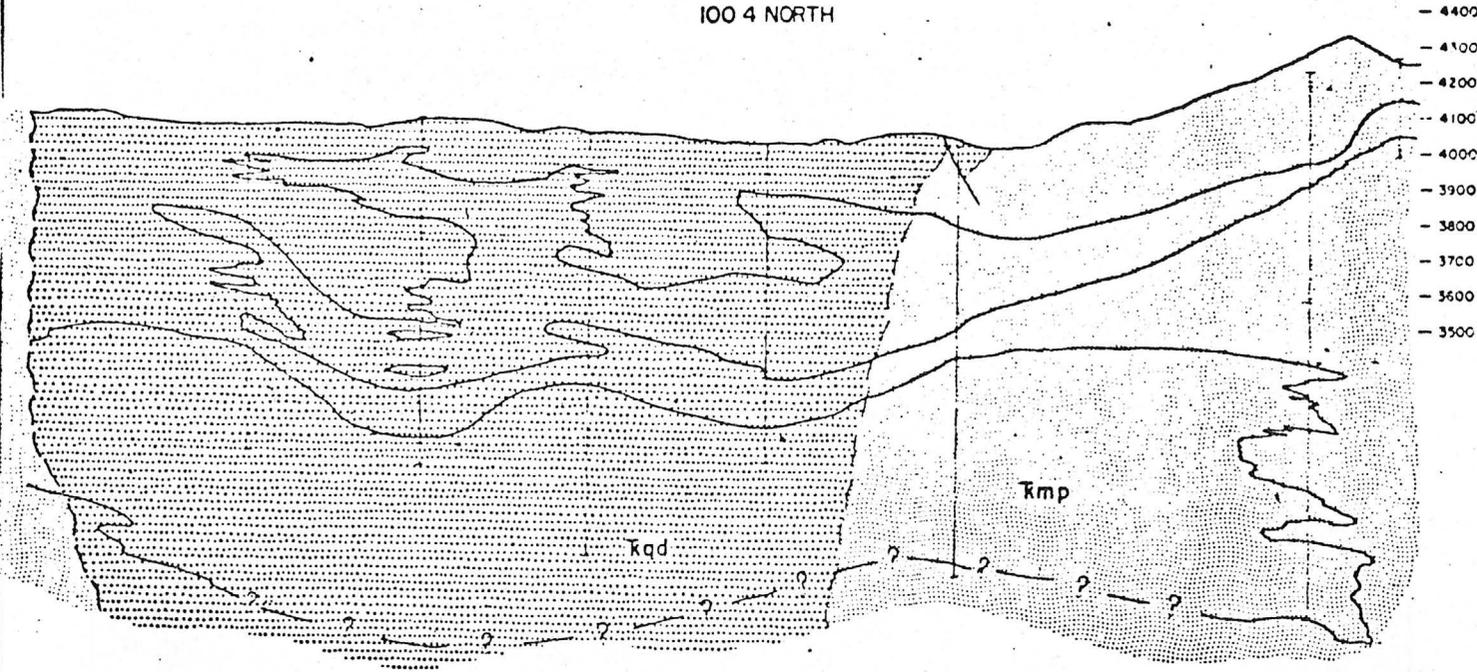
- | | | | |
|--|---|--|---------------------------|
|  Qss | Quaternary stream sediments |  Kqd | Quartz diorite |
|  Krlw | Rhyolitic welded tuffs (includes flows, breccias) |  Kmp | Quartz monzonite porphyry |
|  Ksbp | Silverbell andesite porphyry |  Kslp | Quartz latite porphyry |
|  45 | Fault or shear showing dip |  | Inferred fault |
| | |  | Contact showing dip |
| | |  | Inferred contact |

DUVAL - SIERRITA CORPORATION

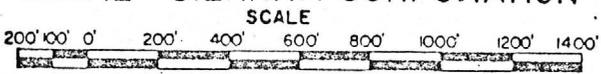


VERTICAL SECTION SIERRITA PIT
100 4 NORTH

-6-

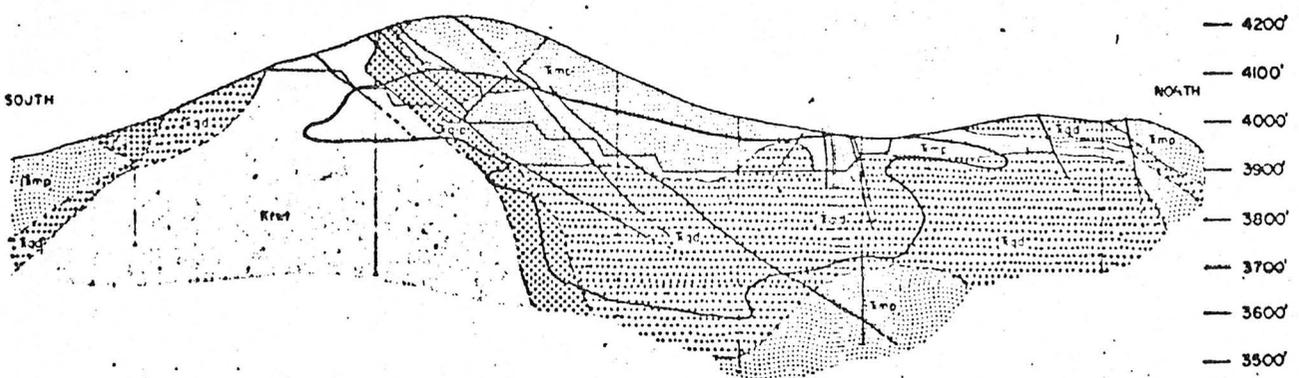


DUVAL - SIERRITA CORPORATION

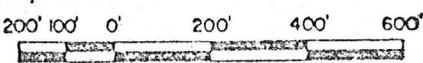


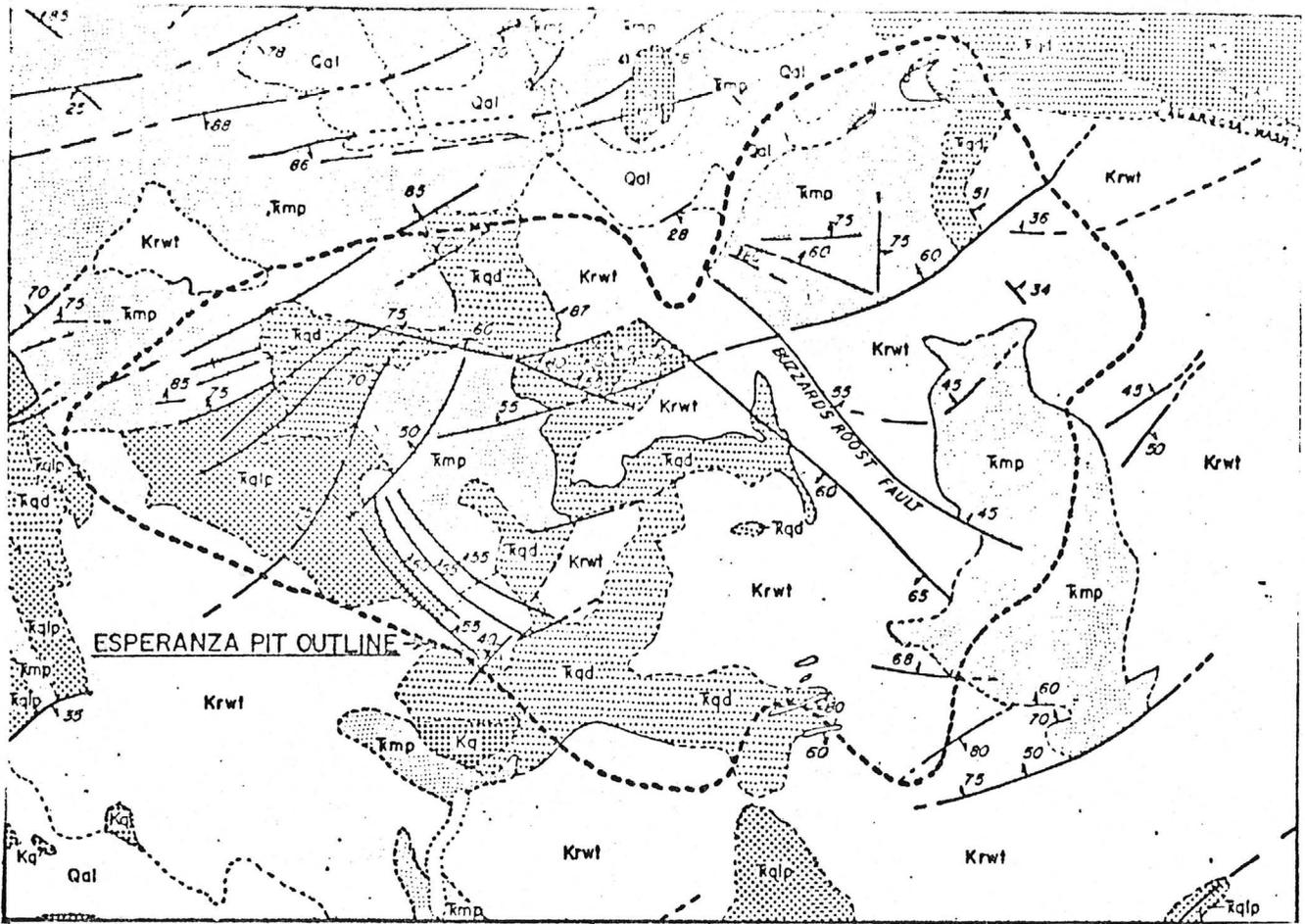
VERTICAL SECTION ESPERANZA PIT
LOOKING WEST

-10-



DUVAL CORPORATION
SCALE





-11-

EXPLANATION

- | | | | |
|--|---|--|----------------------------|
| | Alluvium | | Fault or shear showing dip |
| | Rhyolitic welded tuff (includes flows, breccia) | | Inferred fault |
| | Quartzite | | Contact showing dip |
| | Quartz diorite | | Inferred contact |
| | Quartz monzonite porphyry | | Pit outline |
| | Quartz latite porphyry | | Dump or shaft |



DUVAL CORPORATION



SCALE

-12-

Geology - Esperanza and Sierrita

ESPERANZA

Rock types within the ore zone consist of cretaceous welded tuffs, quartz diorite, latite, quartz monzonite porphyry. Hypogene metallization is syngenetic with rock type formation and consists of chalcopyrite, pyrite, molybdenite with minor sphalerite, galena and magnetite. Favored hypogene ore host is quartz monzonite porphyry. Supergene (chalcocite) metallization zone averaged 125 feet thick. Dominant structural trend is NE to ENE.

SIERRITA

Rock types within the ore zone consist of quartz diorite, quartz monzonite, and quartz monzonite porphyry. Metallization, again partly syngenetic, consists of chalcopyrite and molybdenite with minor amounts of sphalerite, galena and magnetite. There is no enriched blanket in the Sierrita ore body. Dominant structural trend is identical to that of Esperanza, which is NE to ENE.

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