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AZ

DESERT VENTURES INC.

SUMMARY PROPERTY REPORT

| | |
|---|---|
| Property name SANCHEZ COPPER OXIDE | Date 2/9/89 |
| Person contacted Dick Moores Panorama Group | By KB |
| Title | Client |
| Company AZCO | |
| Address 808 10th St<br>Golden, Colorado 80401 | |
| 303 279 0908 FAX 279 1905 | |

SUMMARY OF PROPERTY

The Sanchez copper oxide deposit is located near Safford Arizona (See Arizona) and is presently held by AZCO under lease from the owners. Oxide reserves of 220 million tons @ 0.30% Cu and 100 million tons of sulfide reserves @ 0.30 % Cu, 0.01 opt Au, 0.15 opt Ag and some moly. The property has been drilled, underground sampled, met tested and a preliminary feasibility study completed. AZCO is in the proces of preparing an updated, "bankable" feasibility study for the project. Total production costs are approximately 50¢/lb A three page data summary has been sent to Roger Plasse, and it contains more detailed information on geology, capital and operating costs etc. AZCO would sell a part of its interest in the project in order to raise capital, but because of the value of the deposit a price of $15 to 20 million or more for a 50% interest should be considered. All of the data to date is quite favorable, and with low cost production the operation could survive the vagaries of the coper market. AZCO will be on the property the 15th of Feb. and would be glad to meet with Cambior at that time. After the property visit a trip to the Denver office to review geologic and economic data would be in order.

If Cambior is serious about broadening its resource base into commodities other than precious metals this is an outstanding opportunity and should be persued.

# PHELPS DODGE
# CORPORATE PROFILE

Phelps Dodge is the world's second largest producer of copper. Chile's state owned company, Codelco, is the first. The company is 157 years old and has operations in 22 countries. It employs 14,000 people. The company has 34.44 million outstanding shares. Current share price is around $65.

Phelps Dodge has total assets of $2.83 billion. Net income for 1990 was $454 million of $13.20 per share. Cash on hand at the end of 1990 totaled $162 million while total debt stood at $557 million.

In 1990 Phelps Dodge produced 1.3 billion pounds of copper. Fully 40% of this came from SX/EW of oxide ores. In 1991 it is forecasted that 45% of all copper production will come from SX/EW facilities.

Total 1990 gold production amounted to 60,000 ounces.

## Ore Reserves

Ore reserves at December 31, 1990, at each of Phelps Dodge's copper operations and at La Candelaria are estimated as follows:

| | Milling Reserves | | Leaching Reserves | | Phelps Dodge Interest |
|---|---|---|---|---|---|
| | Million Tons | % Copper | Million Tons | % Copper | (%) |
| Morenci | 664.6 | 0.79 | 959.8 | 0.35 | 85.00 |
| Chino | 304.7 | 0.70 | 191.7 | 0.30 | 66.67 |
| Tyrone | 33.9 | 0.72 | 48.4 | 0.30 | 100.00 |
| La Candelaria | 390.0 | 1.14 | - | - | 100.00* |
| Ojos del Salado | 15.6 | 1.50 | - | - | 100.00 |

* Minority interests may eventually acquire up to 30 percent of the La Candelaria project.

The Corporation's share of aggregate ore reserves at the above named properties is estimated as follows at year-end (with La Candelaria included beginning in 1990):

| | 1990 | 1989 | 1988* | 1987* | 1986* |
|---|---|---|---|---|---|
| Milling reserves (billion tons) | 1.2 | 0.9 | 0.9 | 1.0 | 1.1 |
| Leaching reserves (billion tons) | 1.0 | 1.1 | 0.8 | 0.9 | 0.9 |
| Commercially recoverable copper (million tons) | 11.8 | 8.3 | 7.3 | 7.8 | 7.8 |

* Amounts for the years 1986, 1987 and 1988 have been restated to remove the milling reserves and commercially recoverable copper for Ajo and Dos Pobres (see the first table on page 10 for further information).

Ore reserves are those estimated quantities of ore that, under conditions anticipated by the Corporation, may be profitably mined and processed for extraction of their constituent values. Estimates of the Corporation's reserves are based upon the Corporation's engineering evaluations of assay values derived from samplings of drill holes and other openings. In the Corporation's opinion, the sites for such samplings are spaced sufficiently close and the geologic characters of the deposits are sufficiently well defined to render the estimates reliable. Stated tonnages and grades of ore do not reflect waste dilution in mining or losses in processing. Leaching reserves include copper estimated to be recoverable from leach reserves remaining to be mined at Morenci, Chino and Tyrone. Commercially recoverable copper includes copper estimated to be recoverable from milling and leaching reserves and from existing stockpiles of leach material at Morenci, Chino and Tyrone.

## ORE RESERVES

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| Chino | 304.7 | 0.70 | 191.7 | 0.30 | 66.67 |
| Tyrone | 33.9 | 0.72 | 48.4 | 0.30 | 100.00 |
| La Candelaria | 390.0 | 1.14 | – | – | 100.00* |
| Ojos del Salado | 15.6 | 1.50 | – | – | 100.00 |

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The company's share of aggregate ore reserves at the above named properties is estimated as follows at year-end (with La Candelaria included beginning in 1990):

| | **1990** | 1989 | 1988* | 1987* | 1986* |
|---|---|---|---|---|---|
| Milling reserves (billion tons) | **1.2** | 0.9 | 0.9 | 1.0 | 1.1 |
| Leaching reserves (billion tons) | **1.0** | 1.1 | 0.8 | 0.9 | 0.9 |
| Commercially recoverable copper (million tons) | **11.8** | 8.3 | 7.3 | 7.8 | 7.8 |

*Amounts for the years 1986, 1987 and 1988 have been restated to remove the milling reserves and commercially recoverable copper for Ajo and Dos Pobres (see the table below for further information).

Ore reserves at each of Phelps Dodge's other mining operations and investments at year-end 1990 are estimated as follows:

| | Ore Reserves (million tons) | Ore Reserves (% copper) | Gold Ounces (per ton) | Phelps Dodge Interest (%) |
|---|---|---|---|---|
| Black Mountain | | | | |
| Broken Hill deposit* | 20.2 | 0.40 | – | 44.60 |
| Santa Gertrudis | 8.0 | – | 0.070 | 49.00 |
| Southern Peru Copper Corp. | 504.0 | 0.86 | – | 16.25 |

*Black Mountain's Broken Hill deposit also contains 5.9 percent lead, 2.7 percent zinc and 2.6 ounces of silver per ton. In addition, the Black Mountain deposit has 20 million tons of mineral resources containing 0.50 percent copper, 7.56 percent lead, 3.43 percent zinc and 3.1 ounces of silver per ton.

Ore reserves are those estimated quantities of ore that, under conditions anticipated by the company, may be profitably mined and processed for extraction of their constituent values. Estimates of the company's reserves are based upon the company's engineering evaluations of assay values derived from samplings of drill holes and other openings. In the company's opinion, the sites for such samplings are spaced sufficiently close and the geologic characters of the deposits are sufficiently well defined to render the estimates reliable. Stated tonnages and grades of ore do not reflect waste dilution in mining or losses in processing. Leaching reserves include copper estimated to be recoverable from leach reserves remaining to be mined at Morenci, Chino and Tyrone. Commercially recoverable copper includes copper estimated to be recoverable from milling and leaching reserves and from existing stockpiles of leach material at Morenci, Chino and Tyrone.

## OTHER MINERAL RESOURCES

At year-end 1990, the company held various other properties containing mineral deposits that it believes could be brought into production should market conditions warrant. Significant capital expenditures would be required before operations could commence at these properties. These deposits are estimated to contain the following mineralization:

| | (Location) | Mineralized Material (million tons) | (% copper) | Gold Ounces (per ton) | Phelps Dodge Interest (%) |
|---|---|---|---|---|---|
| Cochise (a) | Arizona | 210 | 0.40 | – | 100.00 |
| Copper Basin (b) | Arizona | 70 | 0.53 | – | 100.00 |
| Coronado (c) | Arizona | 150 | 0.70 | – | 85.00 |
| Lone Star (a) | Arizona | 1,600 | 0.38 | – | 100.00 |
| Western Copper (b) | Arizona | 150 | 0.72 | – | 85.00 |
| Seven-Up Pete/McDonald Meadows (a) | Montana | 33 | – | 0.043 | 72.40 |
| Ajo(b/d) | Arizona | 160 | 0.56 | – | 100.00 |
| Dos Pobres (b/d) | Arizona | 230 | 0.89 | – | 100.00 |

(a) Mineralization primarily consists of leaching material.
(b) Mineralization primarily consists of milling material.
(c) Mineralization consists of both milling and leaching material.
(d) Accounting reserve provisions were established in 1989 for obsolescence at these locations (see Management's Discussion and Analysis on page 25.)

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Pe Rg. Place — M. Drouin Graham
John DRG - 303-969-0591
AZCO

SANCHEZ COPPER OXIDE DEPOSIT/PROJECT
Lone Star Mining District
Graham County, Arizona

## Summary

Established reserves at the Sanchez porphyry copper deposit total more than 350 million tons of copper oxide ore and 100 million tons of sulfide ore containing over 2 billion pounds of copper. This includes over 50 million tons of oxide averaging .50%+ copper and 125 million tons at .4%+. Open pittable oxide reserves exceed 200 million tons @ .32% copper at a 1.1:1 strip ratio including 100 million tons at .4%+ and 60+ million tons at .45%. Located in the Lone Star Mining District, Graham County, Arizona about 10 miles northeast of Safford, AZ, the deposit outcrops at an elevation of 3200 feet, forming a ridge about 1 1/2 miles north of the Gila River.

Some 8 million tons/yr will be mined and treated for 28 years, producing 35-45 million lbs of copper/yr from an SXEW plant. Cash costs are expected to be about $.40-.55/lb, with total costs of $.50-.60/lb of copper. Annual pretax cash flow is estimated at $15-25 million. Project net cash flow should exceed $350 million, with net profits exceeding $300 million. Costs at comparable Arizona facilities total $.45/lb, with amortization.

## Location/Infrastructure

Two paved roads, city water and telephone lines reach the property. The property is less than 9 miles from an established rail siding and 5 miles from the county airport.

Adequate power is readily available from a 69 kV line 3 miles south of the property. Previous discussions with the local power company have indicated a willingness to run the 7.5 kV line required, step down the system and supply power at $.05 to $.058 per Kwh. Tests to date indicate adequate process water (1500 gpm) can be readily and cheaply developed on and adjacent to the property. An adequate supply of labor is available locally (Graham County has the highest unemployment rate in Arizona and provides a third of Morenci's workforce). Sufficient surface has been tied up to carry the project to planned completion.

## Previous Work

The deposit was originally staked in 1899 and was worked in a small way through the 1930's. Kennecott optioned the property from the current owners in 1955 and outlined a large, low grade copper deposit, but it wasn't until 1964 that Harpoon (United Nuclear) delineated the current orebody. Inspiration Copper Company (ICC) optioned the property from Harpoon in 1969, undertook an extensive drilling program and performed a number of metallurgical testing programs, a test pit, engineering studies and a feasibility study.

ICC was actively pursuing development of the property when excessive EPA requirements on their producing operations ($250 million +) and low copper prices forced them to terminate all exploration and new projects. At this point, 148 holes had been drilled (133 core, 15 rotary), a test pit had been mined, thousands of tons of material had been underground mined to check drill resultsand provide material for heap leach testing (numerous 50-100 ton tests, several 5000 ton tests).

Since ICC's termination, a number of companies have looked at Sanchez. More recently, ICC, Cyprus and Phelps Dodge expressed interest in picking up the property, but had not made acceptable proposals at the time AZCO negotiated their deal.

A very large body of data is available which, with a minimum amount of additional metallurgical/engineering work, should permit preparation of a final feasibility study in very short order. Initiation of the permitting process and final, detailed engineering would also be pursued.

Geology/Ore Reserves

The Sanchez deposit is an outcropping porphyry copper related to Laramide quartz monzonite emplaced in Cretaceous andesites along northwest and east-west trending faults. Copper metallization accompanied the intrusive rocks and related hydrothermal alteration. The core of the deposit is characterized by potassic and minor phyllic alteration that grades laterally into a biotite zone, a biotite/chlorite zone and a fringing propylitic zone. The system is relatively low in iron and sulfide content and relatively high in copper. Ore grade copper mineralization occurs in a zone 2100' in diameter and at least 2000' thick. The highest grade mineralization occurs almost entirely within the main stock and breccia pipes, but the bulk of copper mineralization is found in andesite host rock.

Copper mineralization at Sanchez can be divided into three zones: an oxide zone, a thin mixed zone and a sulfide zone. Ore mineralogy of the 1000-1200' thick oxide zone consists principally of malachite, chrysocolla, copper pitch, and tenorite, minor amounts of cuprite and chalcanthite and very minor azurite and native copper. Chalcopyrite and bornite predominate in the sulfide zone, with lesser amounts of pyrite, chalcocite and molybdenite. The mixed zone is a fairly thin band (0-500')that occurs at the interface of the oxide and sulfide zones, has minerals from both zones present and exhibits increased quantities of chalcocite and native copper.

The outcropping oxide zone contains an estimated 350 million tons of reserves @ .28% copper (.10% cutoff). Within this is an open pit mineable block containing 225 million tons @ .30% Cu at a 1.1 strip ratio including a core of 62 million tons @ .45%+ copper and 100 million tons at .40%+ copper. Essentially all of the copper in this zone is highly acid-soluble malachite and chrysocolla.

The sulfide/mixed zone contains more than 100 million additional tons at about .30% copper, .01 oz/t Au, .15 oz/t Ag and .006% Mo, including a block of approximately 50 million tons averaging .45% copper. There is potential for adding to the sulfide inventory, but this has not received a high priority in the past. Later drilling by ICCCo indicated a sizeable, high-grade chalcocite zone of undefined dimensions that is <u>not</u> included in the above reserves.

Proposed Operations

AZCO is currently doing additional metallurgy/engineering, to be followed by a formal, final feasibility study and initiation of the permitting process. The deposit will then be put into production as rapidly as possible as an open pit, heap leach operation.

Ore and non-alluvial waste will be drilled and blasted, loaded

of the pit. Ore will be hauled directly to leach pads, with crushing of oversize to -1" or -2". According to the test mine, most of the ore is -4" after blasting, so very little crushing is anticipated. Alluvial overburden, representing 1/4 of total waste, can be removed by bulldozers at very low cost. Under present plans, the high grade ore will be mined first and prestripping should not be necessary.

A series of heaps will be established, with loaded effluent from one heap being reacidified and used as leachate on the next. A series of 10' to 40' lifts will be used, building to an eventual height of 300' or more. The topograpy lends itself to heap leaching.

Sulfuric acid will be used to leach copper from the heaped ore, progressively building solution strength before bringing it to the solvent extraction unit. Head grades of about 2 grams Cu per liter are anticipated. After solvent extraction, the highly enriched solution is sent to the electrowinning unit where high purity wallhanger copper is produced. Copper will be electrowon onto stainless steel cathodes or starter sheets under high current density, reducing operating costs and producing a superior product.

Mining will proceed at 22,000 TPD on a 7-day basis (31,000 TPD on a 5 day basis). An additional 25,000 tons (35,000) of waste will also be removed daily. Approximately 8 million tons of ore will be produced annually, containing an average 7 pounds of copper per ton. Leaching is expected to extract 80-90% or more of the contained copper over time, most of it within the first 90 days.

The SXEW plant will operate 24 hours/day, 7 days/week, producing 35-45 million pounds of copper annually at the rate of approximately 110 thousand pounds daily (excluding production from low grade dumps; possibly 5-15 million lbs/yr). All copper produced will be of very high purity. No byproducts are anticipated during production of copper oxide. (The sulfide ore contains approximately 1 million ounces of gold, 15 million ounces of silver and some molybdenum, much of which should be recovered during production).

## Economics

Mining costs with owned equipment should approximate $.50/ton or less for rock that is drilled, blasted and hauled and $.30/ton for alluvium ($.15 to $.18/lb Cu produced). Leaching ($.05 to $.15/lb Cu), solvent extraction ($.05/lb Cu) and electrowinning ($.10/lb Cu) should total $.20 to $.30/lb Cu produced. The base royalty is 2% NSR and other costs should total no more than $.03 to $.07/lb Cu. This yields total cash costs of $.40 to $.55/lb Cu produced, generating $.45 to $.60 of pretax cashflow per pound of copper produced ($15 to $20 million annually), with copper at $1.00/lb.

Capital costs are estimated at $16 to $20 million for the SXEW plant, $10 to $12 million for the mining equipment and $10 to $12 million for pad preparation and initial prestripping (minimal), support facilities, infrastructure, engineering, working capital and all other costs. These numbers are preliminary, but should be close.

## Conclusion

The Sanchez deposit provides an excellent opportunity to use modern heap leach and SXEW technology to produce low-cost, high quality copper. At current prices for copper, high profitability is anticipated, similar to that currently obtained from heap leach gold.

## Previous Metallurgy

The bulk of metallurgical tests run at Sanchez by ICCCo were directed at confirming the applicability of the Mangula Process. This process consists primarily of a light crushing of material to be leached, followed by a washing step to remove fines to improve permeability. Fines removed averaged 3% to 5%, contained about .60% copper and could be processed by agglomeration/leaching or agitation leach.

Tests performed by Sanchez involved recovery of copper through precipitation of copper on iron, followed by reacidification and recirculation of solutions onto the heap. This introduced iron onto the heaps, which interferes with the process and increases acid consumption.

Tests ran for 16 to 23 days, after which the partially leached material was removed and discarded. Use of SXEW, coupled with the "stacking" of weakly acidified pregnant solutions to build solution strength and retention of heaped material for long-term processing should lead to maximum recoveries and lower acid consumption.

Summary of ICCCo Sanchez Mangula Metallurgical Leach Tests

| Test | Tons | Orig % Cu | Recov % | # Acid / # Cu | Days | Comments |
|---|---|---|---|---|---|---|
| MPad | 5000 | .37 | 65.4 | 11.2 | 23 | -1/2" Washed, Monz/And,20'deep |
| M2 | 700 | .36 | 85.5 | 10.2 | 23 | -1/2" And, 2" Monz from UG |
| M3 | 700 | .40 | 72.1 | 9.5 | 30 | -1/2" NoWash, Surf Monz/And |
| M4 | 700 | .34 | 66.5 | 4.5 | 16 | -1/2" Washed, Surf Monz/And |
| M5 | 700 | .43 | 74.9 | 4.1 | 27 | -1/2" NoWash, Surf Monz/And |

As can be seen by the above test results, the oxide copper at Sanchez is highly leachable. By treating the heaped material over a longer period of time (years) with weakly acidic solution which is processed via SXEW instead of the iron launder/precipitation used by ICCCo, a significantly higher copper recovery and lower acid consumption should be achievable (90-95%+ at San Manuel, Twin Buttes, etc.). Periodic "resting" of the heaps, during which they dry out, should reestablish a steeper recovery curve and also lead to higher overall recovery, as at other operations. Recent column leach tests lead us to anticipate a 70% recovery within 60 days and the balance (90%) over a longer time frame.

Visit to Sanchez Property

Following tours of the San Manuel, Miami, Pinto Valley and Morenci SXEW operations, the investors went to the Sanchez property for an onsite inspection. The preferred access is by a road that turns north over the highway at the town of Solomon, crosses a bridge over the Gila River and follows the north side of the Gila to the property. This route is paved except for the last half mile or so. Fire plugs along this road indicate the presence of city water right up to the Sanchez property line. The participants could see for themselves the nearness of the 69 KV power line and that telephone lines went right to Sanchez.

Once on the property, the geology/mineralization was reviewed. The participants had the opportunity to determine for themselves the character of the ore from the outcrop. Extent of the ore was also indicated by the extensive exposures (some very high grade) on the outcrop, as well as by the capped drillholes evident in the gravel-covered areas. The relative lack of stripping, favorable terrain (for both mining and processing), character of the ore (fracture control, low iron content), ore grade and copper mineralogy compared favorably with the operations seen previously.

The Sanchez property has a similar grade, larger reserve, lower overall strip ratio and somewhat more favorable mineralogy than the San Manuel oxide operations. The availability of excellent plant/pad sites and relatively low power costs is also an enhancement. Scale of mining operations and copper production will be similar to San Manuel, but the planned higher PLS head grades, lack of prestripping, lack of facility moving/disruption costs and ability to develop a more compact processing site should significantly lower capital costs. The relative abundance of good heap sites should also permit AZCO to gain additional economic uplift from recovery of values from low grade material, unlike at San Manuel (where costs total $.43/lb).

Compared to Miami (in-situ; $.43/lb), Pinto Valley ($.30/lb) and Morenci ($.20-.30/lb), Sanchez has much higher grade, overall better mineralogy and will have its heap leach sites designed to enhance production, not just as an afterthought. Control of leach solution at Sanchez should be far better, as should ultimate recovery of values. Sanchez will have to underwrite the cost of mining, unlike Pinto Valley and Morenci where mining cost is assumed by associated operations. Miami does have the cost of maintaining the underground workings within which their collection system is located.

| | | | |
|---|---|---|---|
| PROJECT | : Sanchez | REGION | : North America |
| DEPOSIT TYPE | : Porphyry | COUNTRY | : USA |
| METALS | : Cu | LOCATION | : Arizona |
| OPERATOR | : The Arizona Copper Company (AZCO) | | |
| OWNERSHIP | : The Arizona Copper Company (AZCO) | | |

LEVEL OF INVESTIGATION REACHED : Feasibility study completed
CURRENT STATUS : Financing

## Summary and Outlook

After four decades of exploration by several companies, Sanchez is now close to the point of becoming an operating mine. Once finance is in place, the property could be developed in just over a year into a small to medium-size heap leaching operation producing cathodes. Although low-grade, the project has the advantage of being easily accessible, and not requiring any infrastructure. The most important features of Sanchez are presented below:

| | | |
|---|---|---|
| Project duration | : | 17 years + |
| Start-up date | : | after 1991 Q3 |
| Reserves (diluted) | : | 152 million tonnes at 0.336% Cu |
| Mining method | : | open pit |
| Waste to ore ratio | : | 1.3 to 1 |
| Treatment method | : | HL/SX/EW |
| Treatment capacity | : | 25,000 tonnes/day |
| Annual throughput | : | 9 million tonnes |
| Head grade | : | 0.336% Cu |
| Ore type | : | oxides |
| Annual cathodes output | : | 25,900 tonnes |
| CAPEX to start-up | : | US $ 55.8 million (1989 terms) |
| Net cash oper. cost | : | 46 c/lb (1989 terms) |

In our base case copper price scenario of 75 c/lb, Sanchez has a payback period of 5.5 years and an internal rate of return of 17.6%. Using a discount rate of 10%, its net present value is 28.9 million US dollars (1989 terms). The attraction of the project is enhanced by a rise in the copper price. At 90 c/lb, the net present value at 10% becomes 72.3 million US dollars (1989 terms).

## Critical Factors

The advances in leach technology have turned this previously marginal project into a potentially viable copper producer. The company's consultants are confident that the cost figures and operating parameters used in this analysis are realistic. At this stage, the

Critical Factors (continued)

potential for further cost reductions or an increase in copper recovery are not obvious. On the downside, the project is sensitive to an under-estimation of operating costs; a cost increase from 46 c/lb to 51 c/lb, would have the effect of reducing the net present value at 10% by 54%.

Location and Infrastructure

Sanchez is located in Graham County in southeastern Arizona, USA, at approximately 32°52′ northern latitude and 109°33′ western longitude (see location map accompanying Cochise profile). It is connected with Safford, the nearest major community by 25 km of paved roads. Power lines extend to close to the project site.

The main outcrops lie at just over 1,000 metres above sea level, at the base of a low range. The landscape is typical of that of a semi-desert environment. Rainfall is just over 250 mm, but the very short catchment behind the property dries up rapidly. The nearby Gila River, however, carries water all year round.

Project History to date

With about 25% of the deposit outcropping, it must be assumed that Sanchez has been known for many centuries. Several old shafts on the property bear witness to small-scale silver and gold mining at the end of last century.

A number of major mining companies conducted exploration campaigns in the 1950s and 1960s. Both Bear Creek (Kennecott subsidiary) and Ranchers Exploration and Development drilled several holes on the property but walked away. It was not until 1964, that Harpoon (United Nuclear subsidiary) drilled the discovery holes. All in all, this company and its parent put down 35 diamond drill holes for a total length of 16,400 metres.

In 1969, Inspiration Consolidated Copper Company acquired Sanchez. It undertook an extensive programme, consisting of geological mapping, 30,000 metres of diamond drilling,

Project History to date (continued)

800 metres of underground workings, 570 metres of underground drilling and bulk sampling for metallurgical testing. All this work culminated in a feasibility study in 1972. We assume that the project concept must have been based on mining of the oxides from an open pit followed by heap leaching with precipitation of copper on scrap. In 1984, the company surrendered the property at a time of low metal prices.

Berween 1984 and 1986, the site was not leased. Butte Resources Ltd., acquired a lease in 1987, but carried out no work and, due to financial difficulties, relinquished the property in 1988. The Arizona Copper Company (AZCO) acquired a lease on Sanchez in July, 1988, with a right to purchase the property for US $ 5 million. The lease contains provisions for the payment of a royalty of 2% of gross revenue up to a maximum of US $ 2 million. In the event that AZCO excercises its option to purchase Sanchez, all payments made to the owners to that date will be credited to the purchase price.

AZCO undertook a complete review of all the data compiled by Inspiration and its predecessors and, assisted by several groups of consultants, prepared a pre-feasibility study in 1989 based on open pit mining of the oxides with state-of-the-art heap leaching/ solvent extraction/electrowinning technology. A full feasibility study by Fluor Daniel of Vancouver followed soon thereafter. Permitting has been completed. Detailed engineering is almost completed. The company is currently examining the various financing options for bringing Sanchez into production.

Project Geology

Sanchez is the southernmost of a group of copper porphyries (Dos Pobres, San Juan, and Lone Star), which lie on a NW - SE trend on the western slopes of the Gila Mountains. The district geology is characterised by late Cretaceous to early Tertiary volcanics and co-magmatic monzonitic intrusives, overlain by Upper Tertiary volcanics. It is thought that a major regional northwesterly fault together with ENE shear zones controlled the emplacement of the porphyries.

PROJECT: Sanchez OPERATOR: The Arizona Copper Company (AZCO)

Project Geology (continued)

The deposit is 600 by 750 metres in diameter and over 600 metres thick. The bulk of the mineralisation occurs in andesites, but the best copper values are found in a number of small porphyries aligned on a NW - SE trend through the orebody. High-grade breccia zones are characteristic of the district. One has been intersected at Sanchez to date. However, it is likely that more could be exposed once mining starts. All the ore developed to date is in the potassic alteration zone and is characterised by low sulphides, a high copper to iron ratio, potassic feldspar, biotite, and a lack of clays. A chalcocite blanket in phyllic alteration exists some 300 to 500 metres outside the currently defined orebody.

Primary mineralisation in the intrusives is both in veinlets and disseminated, whereas in the andesites the sulphides occur commonly as fracture fillings. The main primary sulphide minerals are chalcopyrite and bornite with minor amounts of chalcocite, pyrite and molybdenite. The deposit exhibits a thick oxide blanket as a result of deep oxidation during the Tertiary. However, the virtual absence of pyrite and the overall basicity of the rocks prevented any significant leaching and secondary enrichment. The oxide minerals are chrysocolla and copper pitch with lesser amounts of malachite, brochantite, cuprite, minor native copper, chalcocite and chalcanthite. In detail, vertical zoning in the deposit is as follows :

| | | |
|---|---|---|
| oxide zone | : | 250 to 300 metres |
| mixed zone | : | 15 to 90 metres |
| primary sulphides | : | 300 metres + |

Resource Potential

Because of lack of communication between the successive exploration groups in the past, the centre of the deposit has been overdrilled and the peripheral areas underdrilled. Core recoveries, in general, appear to have been excellent; seldom less than 90%. Practically all holes drilled were vertical.

Resource Potential (continued)

AZCO's consultants have compiled geological and assay data for more than 27,000 intervals from 132 holes. The vast majority of these holes must have bottomed in primary mineralisation. The assay data has been composited into 7,054 composites of 25' length by rock type and ore type. Kriging was used to first estimate the geological reserves and, subsequently, mineable reserves (by applying a floating cone approach) for the oxide portion of the deposit. Mineable oxide reserves estimated by AZCO and Fluor Daniel at a 0.20% Cu cut-off compare as follows:

AZCO : 141.5 million tonnes at 0.342% Cu Tot.
FD : 152.4 million tonnes at 0.336% Cu Tot.

Fluor Daniel has classified 100% of these reserves as "proven plus probable". In addition, some 27 million tonnes of low-grade reserves have been delineated within the pit.

Development Plan

It is planned to mine the oxides at Sanchez at a rate of 10 million short tons (9,072,000 metric tonnes) per annum for a period of at least 17 years. The low-grade oxides will be stacked on separate piles, and their future treatment is being considered. No plans exist at this stage to mine the underlying sulphides. The ultimate pit will measure approximately 1,200 by 1,000 by 400 metres. The waste to ore ratio over the life of the operation will be 1.3 to 1.0, but is likely to be 1 to 1 at the start of the pit. Counting the low-grade material as processed, the life-of-mine strip ratio becomes 1 to 1.

Notwithstanding the highly fractured nature of the volcanics, it should be possible to achieve an overall pit slope of 42° to 45°. Bench heights will be 12 metres. Equipment to be used in the pit will consist of 9-7/8" rotary blast hole drills, 15 to 12 cu yd. shovel front hydraulic excavators, 155 ton haulage trucks, and auxiliary equipment.

The crusher plant will be located near the SW edge of the pit. Recent blast tests indicate that 2/3 of the run-of-mine ore is minus 1 1/2" after blasting. Two-stage crushing will further reduce the ore to 100% minus 1 ". 78% of the ore consists of andesite and 22% of

Project Economics (continued)

With total costs to start-up equivalent to only US $ 2,150 per annual tonne of installed capacity, Sanchez ranks very favourably compared with other new mine-for-leach projects. However, its operating costs are towards the high end of the scale of this group, but low compared to most other existing producers. The company does not have operating experience, but with the assistence of several well known consultants, it should stand a good chance of achieving its cost targets.

Completion of the project below budget or, alternatively, a slight budget overrun will only marginally affect the economics of Sanchez. It is difficult to imagine that copper could be produced at a lower cost than presently forecast. On the downside, a rise in operating costs by 10%, to say 51 c/lb, would increase the payback period to 7 years and halve the net present value at 10%.

The low clay content in the ore should enhance the percolation of the solutions and will hopefully minimise the build-up to design capacity.

SANCHEZ, ARIZONA

CASH FLOW PROJECTIONS ('000 US Dollars) - constant 1989 terms
PROJECT DURATION : 1 year to start-up, then 17 years of production
FINANCING : all equity
TAXATION : Assume 35%
DEPRECIATION : straight line over 10 years , DEPLETION ALLOWANCE :10% of gross income

| | |
|---|---|
| NET PRESENT VALUE 5% ('000 US Dollars) | 67162 |
| 10% | 26069 |
| 15% | 7385 |
| INTERNAL RATE OF RETURN (%) | 17.4 |
| PAYBACK PERIOD (Years after start-up) | 5.5 |

| | 0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 | Y8 | Y9 | Y10 | Y11 | Y12 | Y13 | Y14 | Y15 | Y16 | Y17 | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ore placed on pads ('000 tonnes) | | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 154224 |
| Copper content (%Cu) | | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 |
| Total recovery (%) | | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| HG Cathodes produced ( tonnes) | | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 440454 |
| HG Cathodes produced (mill. lbs) | | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 969.02 |
| Copper price (US c/lb) | | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| Net cash prod'n costs (US c/lb) | | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 |
| Revenue | | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 42751 | 728765 |
| Less: Operating costs | | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 445749 |
| Royalty -2% (US $ 5m. cap) | | 855 | 855 | 855 | 855 | 855 | 855 | 855 | 212 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6197 |
| Depreciation + Depletion | | 9855 | 9985 | 10247 | 10509 | 10771 | 11033 | 11295 | 11557 | 11819 | 12081 | 6763 | 6897 | 6897 | 6897 | 6897 | 6897 | 17383 | 167785 |
| Profit before tax | | 5820 | 5510 | 5428 | 5166 | 4904 | 4642 | 4380 | 4761 | 4711 | 4449 | 9767 | 9633 | 9633 | 9633 | 9633 | 9633 | -633 | 107634 |
| Less: Taxation - 35% | | 0 | 2045 | 2048 | 1954 | 1860 | 1766 | 1671 | 1577 | 1716 | 1696 | 3582 | 3516 | 3448 | 3448 | 3448 | 3448 | 3161 | 38532 |
| PROFIT AFTER TAX | | 5820 | 3595 | 3380 | 3212 | 3044 | 2877 | 2709 | 3184 | 2997 | 2753 | 6185 | 6117 | 6185 | 6185 | 6185 | 6185 | -4014 | 68502 |
| PROFIT AFTER TAX | | 5820 | 3595 | 3380 | 3212 | 3044 | 2877 | 2709 | 3184 | 2997 | 2753 | 6185 | 6117 | 6185 | 6185 | 6185 | 6185 | -4014 | 68502 |
| Add : Depreciation + Depletion | | 9855 | 9985 | 10247 | 10509 | 10771 | 11033 | 11295 | 11557 | 11819 | 12081 | 6763 | 6897 | 6897 | 6897 | 6897 | 6897 | 17383 | 167785 |
| Less: Capital expenditure | 55800 | 1300 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 1500 | 0 | 95169 |
| Working capital | | 8740 | | | | | | | | | | | | | | | | 8740 | 0 |
| NET CASH FLOW | -55800 | 5435 | 10958 | 11005 | 11099 | 11193 | 11288 | 11382 | 12119 | 12194 | 12212 | 12387 | 10372 | 10440 | 10440 | 10440 | 11762 | 22110 | 141178 |
| CUM. NET CASH FLOW | -55800 | -50365 | -39407 | -28402 | -17303 | -6110 | 5178 | 16560 | 28680 | 41074 | 53286 | 65673 | 75985 | 86425 | 96865 | 107304 | 119068 | 141178 | |

SANCHEZ, ARIZONA

CASH FLOW PROJECTIONS ('000 US Dollars) - constant 1987 terms
PROJECT DURATION : 1 year to start-up, then 17 years of production
FINANCING : all equity
TAXATION : Assume 36%
DEPRECIATION : straight line over 10 years , DEPLETION ALLOWANCE 15% of gross income

| | |
|---|---|
| NET PRESENT VALUE 8% ('000 US Dollars) | 138215 |
| 10% | 77366 |
| 15% | 39226 |
| INTERNAL RATE OF RETURN (%) | 25.8 |
| PAYBACK PERIOD (Years after start-up) | 3.5 |

| | 0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 | Y8 | Y9 | Y10 | Y11 | Y12 | Y13 | Y14 | Y15 | Y16 | Y17 | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ore placed on pads ('000 tonnes) | | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 9072 | 154224 |
| Copper content (%Cu) | | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 | 0.336 |
| Total recovery (%) | | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| US Cathodes produced (' tonnes) | | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 25910 | 440464 |
| US Cathodes produced (mill. lbs) | | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 57.00 | 969.02 |
| Copper price (US c/lb) | | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Net cash prod'n costs (US c/lb) | | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 |
| Revenue | | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 51301 | 872118 |
| Less: Operating costs | | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 26221 | 445749 |
| Royalty -2% (US $ 5m. cap) | | 1026 | 1026 | 1026 | 1026 | 1026 | 1026 | 1026 | 212 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7354 |
| Depreciation + Depletion | | 10710 | 10840 | 11102 | 11364 | 11626 | 11888 | 12150 | 12412 | 12674 | 12936 | 7618 | 7752 | 7752 | 7752 | 7752 | 7752 | 18238 | 182326 |
| Profit before tax | | 13344 | 13214 | 12952 | 12690 | 12428 | 12166 | 11904 | 12456 | 12406 | 12144 | 17682 | 17328 | 17328 | 17328 | 17328 | 17328 | 1842 | 236655 |
| Less: taxation - 36% | | 0 | 4804 | 4757 | 4663 | 4569 | 4474 | 4380 | 4286 | 4484 | 4368 | 6372 | 6238 | 6238 | 6238 | 6238 | 6238 | 0701 | 85195 |
| PROFIT AFTER TAX | | 13344 | 8410 | 8195 | 8028 | 7860 | 7692 | 7524 | 8171 | 7922 | 7776 | 11308 | 11092 | 11090 | 11090 | 11090 | 11090 | -1859 | 151459 |
| PROFIT AFTER TAX | | 13344 | 8410 | 8195 | 8028 | 7860 | 7692 | 7524 | 8171 | 7922 | 7776 | 13090 | 11092 | 11090 | 11090 | 11090 | 11090 | -1859 | 151459 |
| Add : Depreciation + Depletion | | 10710 | 10840 | 11102 | 11364 | 11626 | 11888 | 12150 | 12412 | 12674 | 12936 | 7618 | 7752 | 7752 | 7752 | 7752 | 7752 | 18238 | 182326 |
| Less: Capital expenditure | 55600 | 1300 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 2622 | 1300 | 0 | 95369 |
| Working capital | | 8748 | | | | | | | | | | | | | | | | 8748 | 0 |
| NET CASH FLOW | -55600 | 14014 | 16628 | 16675 | 16770 | 16864 | 16956 | 17053 | 17961 | 17974 | 17992 | 18084 | 16172 | 16220 | 16220 | 16220 | 17542 | 25119 | 238570 |
| CUM. NET CASH FLOW | -55600 | -41586 | -25157 | -8482 | 8288 | 25152 | 42110 | 59162 | 77123 | 95097 | 113090 | 131176 | 147348 | 163568 | 179788 | 196008 | 213551 | 238670 | |

[redacted]

# AZCO

# PROJET SANCHEZ

**DOCUMENT INTERNE**

**DATE:** Le 9 mai 1990

**DOSSIER:** AZCO (Cie privée)

**OBJET:** **Commentaires sur le projet Sanchez de la Cie Azco**

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## INTRODUCTION

Suite à la lecture du feuillet transmis à M. L.P. Gignac par la compagnie Gerald Metals Inc., concernant le projet cuprifère Sanchez (voir en annexe), nous avons effectué une recherche sommaire sur les techniques de récupération du cuivre dans les gisements à basse teneur. La méthode en question est principalement celle de l'extraction du cuivre par solvant (Solvant Extraction **SX**) et de l'électrolyse, pour la production de cathodes d'une grande pureté (electro-winning **EW**).

## TECHNIQUE SX-EW

La technique SX-EW fut utilisée pour la première fois à la fin des années soixante par la mine Bluebird (Ranchers Exploration & Dev.) en Arizona qui produisait alors 14 tonnes par jour de cuivre affiné (cathodes). De nos jours, les opérations de SX-EW ont une capacité variant de 50 000 à 100 000 tonnes de cuivre par an. On dénombre dans le monde quelques 40 sites de traitement par SX-EW dont plus d'une dizaine dans le sud-ouest des États-Unis. L'utilisation de cette méthode agée d'une quainzaine d'années, est en très forte progression au niveau mondial. En 1989 près de 20% (soit 291,500 tonnes de cuivre) de la production cuprifère des Etats Unis était de ce type.

Comme le démontre le tableau en annexe, les gisements à basse teneur en cuivre aux États-Unis sont de plus en plus exploités au moyen de cette technique et ce, en raison des faibles coûts de main d'oeuvre, de matériel et d'opérations. Le procédé peut s'appliquer à la lixiviation en tas (heap leaching), en place (in situ l.), en

bassin (vat leaching), comme à d'autres types de procédé de percolation du minerai.

**DONNÉES DE BASE ET COUTS**

Les réserves minières décrites dans le feuillet sont de 168,4 Mtc à 0,336 % Cu; la teneur est en moyenne plus faible que dans la plupart des gisement en exploitation à ce jour ( 0,40 % et plus). Les réserves ont été calculées à partir des travaux d'exploration effectués antérieurement par des compagnies comme Inspiration Consolidated Copper Co. De plus, Azco ne semble pas avoir entrepris d'importants travaux d'exploration sur le terrain.

Compte tenu des caractéristiques physico-chimiques du gisement (cuivre porphyrique, oxydé, dim: 2 000'- 2 500'/diamètre x 1 000 ' épaisseur) les opérations d'exploitation proposées et décrites dans le feuillet (eg. taux de production: 10 Mtc/a) semblent plausibles.

Les coûts d'opérations mentionnés quoique réalistes,(43,5 cents/lb) ne sont cependant pas justifiés; Un article de E&MJ (sept.89, p.24) stipule: "SX-EW's advantages lies in low operating costs, **normally less than 30 cents per lb**, and the direct production of a high-grade copper cathode". Il est hasardeux de comparer les données de coûts de production des autres producteurs (voir tableau comparatif) en raison de leur taille, de la nature des gisements et des opérations.

Les coûts en capital d'une telle opération sont normalement en fonction de la taille des opérations et de la quantité de solvant à utiliser. En 1986, les coûts en capital des opérations de SX-EW variaient entre 1 800 $ US et 2 500 $ US par mètre carré de surface utile (E&MJ, sept.89, p.25). Le détail des coûts de 73,8 millions de dollars EU figure en page 9 du feuillet.

Les prémisses utilisées dans le calcul du flux monétaire (eg. Cu=90 cents) sont, elle aussi, réalistes.

Il existe une royauté de 2 % sur les revenus bruts, rachetable pour 5 M $ ou, expirant à concurrence du même montant.

## INTERPRÉTATION DES RÉSULTATS

Notre évaluation du projet reprend à priori les données brutes du cas de base du feuillet. Dans tous les scénarios calculés, nous présentons la valeur actualisée nette (NPV) en utilisant un taux d'actualisation de 10 %. Dans notre cas de base, nous assumons un financement bancaire nul, des dépenses d'explorations de 1 M $ par an et une dépréciation linéaire des actifs en utilisant une valeur de récupération de de 18,75 M $ (soit 25 %). On obtient dans ce cas une NPV de 44,48 M $ US.

Lorsque l'on fait fluctuer les coûts d'opérations de 0,30 $ à 0,60 $, on obtient une NPV variant de 88,56 à -8,86 M $ US; cela est compréhensible étant donné la basse teneur du gisement.
La variation du prix du cuivre de 0,80 à 1,00 $ US se traduit quant à elle par des NPV allant de 15,14 à 73,87 M $ US.

Nous avons élaboré d'autres scénarios utilisant une variation de la dette puis de la teneur (voir annexe). On peut déduire de cet exercice que le risque associé au projet Sanchez porte principalement sur les coûts d'opérations.

## CONCLUSION

Ce survol rapide du dossier nous permet de faire ressortir les points suivants:

**Eléments positifs:**

1 - Azco est à la recherche de financement
2 - Le projet est sérieux et semble valable
3 - Le ratio risque vs. retour est attrayant
4 - Les paramètres utilisés semblent conservateurs

5 - Le potentiel géologique semble appréciable

6 - La marge d'autofinancement ~~et~~ paraît suffisante

7 - Ces technologies minières (SX-EW, OP) serviront à CBJ

8 - Les montants d'investissement requis sont relativement faibles

9 - La mise en exploitation pourrait se faire rapidement

**Eléments négatifs**

1 - Le secteur du cuivre est à risque en raison de surcapacités de production

2 - L'expertise "cuivre" n'est pas encore développée chez CBJ

3 - Aucune indication n'est faite sur le ratio stérile - minerai

4 - Il faudrait obtenir un détail des coûts d'opération

5 - Il n'existe que peu d'information historique sur les coûts en capital et d'opération.

Compte tenu des items susmentionnés, je crois qu'il serait dans les intérêts de Cambior de **poursuivre l'étude du présent dossier.**

Rédigé par Jean Demers,
pour le groupe de développement corporatif
le 9 mai 1990.

**ANNEXE:**

1. Tableau comparatif de producteurs du S-O des États-Unis
2. Copie de la grille de calcul financier du projet
3. Article (E&MJ): Solvent extraction, a key in maintaining Copper production
4. Article (E&MJ): Technology turns S.W. waste into ore
5. Feuillet envoyé par Gerald Metals inc.
6. Shearson Lehman Hutton
   - Annual Review of the World Copper Industry - 1990
   - Étude périodique sur le cuivre
7. Randol Mining Directory
   - Copper in the 90's (pp 19,20)
   - Mining listings

FILE: SX-EW.WK1

QUELQUES PROJETS D'EXPLOITATION PAR SX-EW DANS LE S-O DES E.U.

| MINE/PROJECT NAME | US LOC. | OWNER/ OPERATOR | METAL | TYPE | RESERVES Mtc | GRADE % | CAPACITY Mtn/y ORE | Cu-PROD. Mlbs/y | EMPLOYES # | OP.COST $/LB | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BAGDAD | AZ | CYPRUS | CuMoAg | OP HL SX-EW | 605.6 | 0.430 | 19.25 | 200.6 | 672 | | |
| COCHISE | AZ | PHELPS DODGE | Cu | HL SX-EW | ... | ... | ... | ... | ... | | PROJECT BEING PREPARED |
| CASA GRANDE | AZ | CYPRUS | Cu | OP R SX-EW | 15.5 | 0.790 | ... | 10.0 | 113 | $0.40 | |
| MIAMI | AZ | CYPRUS | CuAg | OP HL SX-EW. | 260.3 | 0.440 | ... | 100.0 | 1,006 | $0.55 | Combined production |
| SIERRITA | AZ | CYPRUS | CuMo | OP HL SX-EW | 343.0 | 0.290 | ... | 250.0 | 1,133 | ... | + RESV. 39 Mtc @ 1%Cu |
| KORN KOB | AZ | KEYSTONE MNRLS | Cu | OP HL EW | 20.0 | 0.500 | ... | ... | ... | ... | START-UP 1991 |
| MIAMI TAILINGS | AZ | MAGMA CU | Cu | T SX-EW | 35.0 | 0.331 | ... | 16.00 | ... | $0.30 | CAP COST 20 M $us,EXPANSION |
| MORENCI MINE | AZ | PHELPS DODGE | CuMo | OP SX-EW | 684.8 | 0.760 | ... | 100.0 | 1,572 | $0.30 | + RESV. 226 Mtc @ 0.7%Cu |
| PINTO VALLEY | AZ | MAGMA CU | CuMo | OP S SX-EW | 404.4 | 0.395 | 21.35 | ... | 547 | ... | |
| SAN MANUEL | AZ | MAGMA CU | CuMoAu | UG OP S SX-E | ... | ... | ... | 184.0 | 3,800 | ... | |
| SANCHEZ | AZ | AZCO | Cu | OP HL SX-EW | 168.0 | 0.340 | ... | 50-60 | ... | ... | |
| SANTA CRUZ | AZ | ASARCO J.V. | Cu | S SX-EW | 800.0 | 0.400 | ... | ... | ... | ... | + RESV. 600 Mtc @ 0.7%Cu |
| CHINO MINES | NM | PHELPS DODGE | CuMo | OP SX-EW | 336.8 | 0.710 | 16.71 | ... | 509 | ... | |
| TYRONE MINE | NM | PHELPS DODGE | Cu | OP SX-EW | 79.8 | 0.770 | 16.24 | 110.0 | 661 | $0.30 | |
| EMERALD ISLE | AZ | ARIMETCO CU | CuAu | OP SX-EW | ... | ... | 0.90 | ... | ... | $0.70 | PRODUCT: PRECIPITATE |

Legend:

SX: Solvant Extr. EW: Electrowinning
OP: open pitt R: Roasting
S: Smelting HL: Hydrolicking
HL: Heap leaching T: Tailings

file: azco.wk1

| All values in US$ | | BASE CASE | SCEN-1 OPC(-) | SCEN-2 OPC(+) | SCEN-3 Cu (-) | SCEN-4 Cu (+) | SCEN-5 DEBT-1 | SCEN-6 DEBT-2 | SCEN-7 DEBT-3 | SCEN-8 GRADE(-) | SCEN-9 GRADE(+) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cu price | US$ | 0.90 | 0.90 | 0.90 | 0.80 | 1.00 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Discount | % | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| OPC/lb | $/lb | 0.435 | 0.300 | 0.600 | 0.435 | 0.435 | 0.435 | 0.435 | 0.435 | 0.435 | 0.435 |
| Mineable resrv. | Mts | 168.4 | 168.4 | 168.4 | 168.4 | 168.4 | 168.4 | 168.4 | 168.4 | 168.4 | 168.4 |
| Grade of ore | % | 0.336% | 0.336% | 0.336% | 0.336% | 0.336% | 0.336% | 0.336% | 0.336% | 0.300% | 0.500% |
| Mining rate | Mts/y | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 | 10.000 |
| Recovery rate | % | 76.0% | 76.0% | 76.0% | 76.0% | 76.0% | 76.0% | 76.0% | 76.0% | 76.0% | 76.0% |
| Tot. Cu produced | Mlbs | 860.05 | 860.05 | 860.05 | 860.05 | 860.05 | 860.05 | 860.05 | 860.05 | 767.90 | 1279.84 |
| Mine life | years | 16.84 | 16.84 | 16.84 | 16.84 | 16.84 | 16.84 | 16.84 | 16.84 | 16.84 | 16.84 |
| Capital investment | M US$ | 75.000 | 75.000 | 75.000 | 75.000 | 75.000 | 75.000 | 75.000 | 75.000 | 75.000 | 75.000 |
| Salvage value (end) | 25.00% | 18.75 | 18.75 | 18.75 | 18.75 | 18.75 | 18.75 | 18.75 | 18.75 | 18.75 | 18.75 |
| O/S Debt incured | M US$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 25.000 | 50.000 | 75.000 | 0.000 | 0.000 |
| Interest rate | % | 14.0% | 14.0% | 14.0% | 14.0% | 14.0% | 14.0% | 14.0% | 14.0% | 14.0% | 14.0% |
| Income | M US$ | 696.643 | 696.643 | 696.643 | 619.238 | 774.047 | 696.643 | 696.643 | 696.643 | 622.002 | 1036.670 |
| OPC | | 374.123 | 258.016 | 516.031 | 374.123 | 374.123 | 374.123 | 374.123 | 374.123 | 334.038 | 556.730 |
| NSR | | 322.5196 | 438.6267 | 180.6110 | 245.1149 | 399.9244 | 322.5196 | 322.5196 | 322.5196 | 287.964 | 479.94 |
| Rylties @ 2% | | 5.000 | 5.000 | 3.612 | 4.902 | 5.000 | 5.000 | 5.000 | 5.000 | 5.000 | 5.000 |
| Oth. expenses | 1.000 | 16.840 | 16.840 | 16.840 | 16.840 | 16.840 | 16.840 | 16.840 | 16.840 | 16.840 | 16.840 |
| financial | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 58.940 | 117.880 | 176.820 | 0.000 | 0.000 |
| Amortiz & deprec. | 75.000 | 56.250 | 56.250 | 56.250 | 56.250 | 56.250 | 56.250 | 56.250 | 56.250 | 56.250 | 56.250 |
| Total expenses | | 78.090 | 78.090 | 76.702 | 77.992 | 78.090 | 137.030 | 195.970 | 254.910 | 78.090 | 78.090 |
| income before tax | | 244.430 | 360.537 | 103.909 | 167.123 | 321.834 | 185.490 | 126.550 | 67.610 | 209.874 | 401.850 |
| Income tax Current @ | 20.0% | 48.886 | 72.107 | 20.782 | 33.425 | 64.367 | 37.098 | 25.310 | 13.522 | 41.975 | 80.370 |
| Net income | | 195.544 | 288.429 | 83.127 | 133.698 | 257.468 | 148.392 | 101.240 | 54.088 | 167.899 | 321.480 |
| Net Cashflow | | 251.794 | 344.679 | 139.377 | 189.948 | 313.718 | 204.642 | 157.490 | 110.338 | 224.149 | 377.730 |
| Cash flow/year | | 14.952 | 20.468 | 8.277 | 11.280 | 18.629 | 12.152 | 9.352 | 6.552 | 13.311 | 22.431 |
| Present value @ | 5.0% | 92.55 | 154.36 | 17.74 | 51.40 | 133.75 | 86.17 | 79.80 | 73.42 | 74.15 | 176.35 |
| INV=75.000 M$ | 10.0% | 44.48 | 88.56 | -8.86 | 15.14 | 73.87 | 47.11 | 49.73 | 52.36 | 31.37 | 104.25 |
| | 15.0% | 15.21 | 48.49 | -25.07 | -6.95 | 37.39 | 23.32 | 31.42 | 39.53 | 5.30 | 60.33 |

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The following statistics in relation to the mine represents the Directors' best estimates based on work undertaken by various consultants retained by Azco. These estimates are in the process of being optimised and are subject to change.

| | |
|---|---|
| Name | Sanchez |
| Location | Nr. Safford, Graham County, Arizona, USA |
| Proven/Probable Leachable Ore Reserves | 168.4 million tons of proven and probable reserves |
| Average grade | 0.336% copper |
| Contained copper | 566 thousand tons (1.132 million lbs) |
| Mining and Recovery process | Open cast mining, crushing, heap leaching, solvent extraction, electrowinning. |
| Proposed Mining Rate | 10 million tons of ore p.a. |
| Copper Production (life of mine average) | 51.13 million lbs/p.a. |
| Operating Costs | 43.5 cents/lb |
| Capital Expenditure | $73.8 million |
| Mine Life | 17 years |
| Estimated production start date | Early 1991 |

## INTRODUCTION

Azco was founded in 1988 to acquire the mining rights to the Sanchez porphyry copper deposit located about 10 miles North-east of Safford in Southeastern Arizona. This deposit is estimated to contain 168.4 million tons of mineral reserves with an average grade of 0.336% copper. Azco also owns an interest in the Strong & Harris copper, zinc, and silver deposit in Cochise County, Arizona.

A preliminary feasibility study has indicated that the Sanchez Project has the potential to be viable and recommended that additional drilling and test work be carried out in order to optimise its operation and design.

Azco now wishes to raise up to which will mainly be applied towards financing a final feasibility study and pre-production drilling, test work, and engineering work. This work is now proceeding and includes the preparation of engineering drawings, specifications and the selection of major equipment items. Following this work a production decision will be made.

It is expected that in the first half of 1990, the Company will seek to raise approximately $70 million. This money, together with part of the proceeds of the Placing, will be used to fund the capital expenditure programme of $73.8 m which is the estimated requirement to bring the mine into full production during the first quarter of 1991.

## HISTORY OF SANCHEZ PROJECT

Between 1957 and 1980 five operating companies conducted exploration and drilling programmes at Sanchez. A total of 132 surface holes were drilled, 69 by Inspiration Consolidated Copper Company ("Inspiration"), the last company to conduct drilling at Sanchez. Inspiration also undertook underground sampling, metallurgical and mine testing, and engineering work. Historically low copper prices, coupled with financial and operating problems at other Inspiration properties, prevented development at Sanchez. Between 1984 and 1986 the site was not leased. Buttes Resources Limited ("Buttes") acquired a lease in 1987 but carried out no work on the site. In 1988 Buttes had financial difficulty and relinquished the property. Azco, with a view to improvements in the copper price and in the recovery process, acquired a mining lease over the property in 1988 from the original owners. The lease contains provisions for the payment of a royalty of 2% of gross revenue up to a maximum of $5 million, with advance royalties of up to $100,000 payable annually. Azco has the exclusive and irrevocable right and option to purchase all of the property for the sum of $5 million. All payments including royalties made by Azco to the owners shall be credited to the purchase price. (Advance royalties of $140,000 have been paid to date; see note 3 to the financial statements set out in Appendix I for further details.)

## GEOLOGY AND ORE RESERVES

Sanchez is a porphyry-type copper deposit located along the west flank of the Gila Mountains near Safford, in Graham County, Arizona. A cylindrical mass of monzonitic porphyry intruding andesitic volcanic rocks has been the focus of large scale low grade copper mineralisation. The resultant ore body, approximately 2000 to 2500 ft in diameter, is zoned mineralogically with copper oxide minerals at the surface, giving way vertically to mixed oxides and sulphides. The oxide zone, approximately 1000 feet thick, is that part of the deposit which Azco is seeking to develop.

In February 1989, Azco engaged the services of several consultants in order to establish the technical and economic viability of mining the Sanchez deposit, and to examine the available data from the drillholes. The conclusions of the reports indicated that total proven/probable mineable reserves in the oxide zone were 168.4 million tons with an average grade, above a 0.2% total copper cut off, of 0.336%.

## MINING AND PROCESSING

Azco proposes to mine the ore body, at a nominal rate of 10 million tons per year, using conventional open pit mining techniques and equipment. The ore will be hauled by truck to an on-site three stage crushing plant. The crushed ore will be transported by conveyor belts to a stock pile adjacent to the leach pad area then transported and dumped onto the leach pad in designated areas.

The crushed ore will then be impregnated (cured) with a strong sulphuric acid solution for fifteen days. The wetted ore is then continuously washed with a weaker raffinate solution for approximately 119 days (17 weeks), completing one leach cycle. Production is estimated to improve with each succeeding cycle. In this process the copper oxide is dissolved to produce a pregnant leach solution ("PLS") which flows down to the leach pad and is collected in a pond. The PLS is then transferred to a Solvent Extraction ("SX") plant where the PLS, by a process using organic reagents and gravitational separation, is turned into a solution containing 50-60 gms/litre pure copper sulphate solution. This solution is then transferred to the electrowinning ("EW") plant where high purity copper cathode sheets are plated out by simple electrolysis. These sheets require no further refining.

The SX-EW process is a tested and proven method of copper recovery, and is used as a low cost alternative to the smelting process. There are now some 40 SX-EW plants throughout the world. Over the last 15 years, in particular, leaching and SX-EW techniques have been refined and improved resulting in a higher percentage extraction of copper. Azco engaged the services of specialist SX-EW consultants to conduct a series of tests to determine the economic optimum level of copper recovery by the leaching and SX-EW process.

It is proposed that for the final feasibility study further drilling and test work will be conducted to establish the optimal ore size, acid concentration, and to define further the rate of production.

## SALES AND MARKETING

The Company intends to market its copper production which will comprise high grade copper cathodes (which typically command a premium to the prevailing spot copper price) either to traders or directly to customers who may include manufacturers and copper producers.

## ENVIRONMENTAL AND REGULATORY BACKGROUND

A number of environmental permits are required from regulatory bodies including the Bureau of Land Management and the State of Arizona. Azco has commissioned a number of independent surveys to establish the impact that the Sanchez Project would have on air quality, hydrology, wildlife, plant species, noise levels, archeological sites and on the viewscape, and has been advised that the project will have a minor impact on the aesthetic values of the area and that no significant or long term adverse impacts are anticipated due to the development of the planned mine facilities.

The appropriate permitting applications are currently being processed and the Company expects to obtain the permits required for the project within the construction period.

It should be noted that environmental laws and regulations may be enacted and adopted in the future which may have an impact on Azco's operations. For example, Arizona has proposed regulations requiring an "aquifer protection permit" for certain mining and milling operations. While Azco does not expect that obtaining an aquifer permit will have a material effect on its operations, Azco cannot now definitively predict the impact of the application of the aquifer protection permit requirements on its operations, nor can it accurately estimate the effect of other future environmental laws or regulations on its operations. Azco is not currently subject to any pending administrative or judicial enforcement proceedings arising under environmental laws and regulations.

A preliminary estimate of the cost of funding the Sanchez Project is approximately $73.8 million. This is analysed as follows:-

| Item | $ million |
|---|---|
| Mining equipment | 17.3 |
| Crushing plant/conveyors | 14.0 |
| Leach pads | 10.0 |
| SX-EW process plant | 15.5 |
| Site services/ancillary | 8.5 |
| Engineering/procurement/construction management | 4.5 |
| Pre production stripping | 2.0 |
| Working capital | 2.0 |
| | 73.8 |

It is the Directors' intention to maximise borrowings according to market conditions, and to fund the balance of the Company's funding requirements by way of equity.

## FINANCIAL PROJECTIONS

Based on the data set out in the section headed Summary of Mine Details on page 6 and on the principal assumptions set out below, a financial model has been created to estimate net revenues and cash flows. This model is designed so that an amount may be computed to represent the net present value of the Sanchez Project using discounted cashflow techniques. The Directors have based the model in part on information contained in the pre-feasibility study and it should be noted that many of the variables contain factors that may be subject to change. In addition the model assumes the mining of a constant average grade of material, whereas ore grades may, in fact, be expected to vary as mining progresses. The model, therefore, is not intended to be a forecast and is illustrative only.

### Assumptions

- Copper price 90 cents
- Discount rate 10% p.a.
- Debt/equity ratio 60:40
- Real cost of funds 6%
- Escalation of costs 0%
- Escalation of prices 0%
- The Company's only business during the period will be the development and exploitation of the Sanchez mine
- Production will commence 1st quarter of 1991

## Net Present Value

On the basis of the above assumptions the net present value of the mine is estimated at $65.0 million.

## Sensitivities

The base model (NPV $65.0 million) was run with single variations to assess various sensitivities as follows:-

| Parameter | Adjustment | NPV ($m) | % Difference to Base NPV |
|---|---|---|---|
| Operating Costs | +10% | 53.5 | -17.7% |
| | -10% | 76.4 | +17.5% |
| Capital Costs | +10% | 58.2 | -10.5% |
| | -10% | 71.8 | +10.5% |
| Copper Price | +10% | 89.4 | +37.5% |
| | -10% | 40.6 | -37.5% |
| Debt | 100% debt | 69.8 | +7.4% |
| | 0% debt | 60.4 | -7.1% |
| Discount | at 5% | 123.9 | +90.6% |
| | at 15% | 33.9 | -47.8% |
| Interest Rates | at 14% | 59.1 | -9.1% |

## Break Even

The break even point (ie when net corporate cashflow is zero) over the life of the mine is calculated to occur with a copper price of approximately 58 cents/lb.

## Cashflow estimates

Set out below for the purpose of illustration only is a projected cashflow statement of the Company. It is emphasised that these projections do not constitute a forecast, whether of profits or otherwise.

| (Full years of production) | Yr 0 $m | Yr 1 $m | Yr 2 $m | Yr 3 $m | Yrs 4-24 $m | Total $m |
|---|---|---|---|---|---|---|
| Gross Revenue | - | 41.5 | 42.2 | 43.4 | 742.7 | 869.8 |
| Operating Costs | - | (20.1) | (20.4) | (21.0) | (335.4) | (396.9) |
| Royalty | - | (1.0) | (1.1) | (1.1) | (1.8) | (5.0) |
| Taxation | - | (3.3) | (2.6) | (3.2) | (98.8) | (107.9) |
| Cashflow before capital cost | - | 17.1 | 18.1 | 18.1 | 306.7 | 360.0 |
| Capital Costs | (67.2) | (6.0) | (0.9) | 0.1 | (34.7) | (108.9) |
| Working Capital | - | (2.0) | - | - | 2.0 | - |
| Cashflow before financing | (67.2) | 9.1 | 17.2 | 18.0 | 274.0 | 251.1 |
| Loan Received | 45.0 | - | - | - | - | 45.0 |
| Loan Repayment | - | (6.6) | (15.4) | (17.1) | (5.9) | (45.0) |
| Interest | -(2.5) | (1.8) | (0.9) | (0.2) | (5.4) | |
| Net Cash Flow | (22.2) | 0.0 | 0.0 | 0.0 | 267.9 | 245.7 |

## DIRECTORS, MANAGEMENT, STAFF AND CONSULTANTS

*Directors*

There are at present four members of the Board of Directors:

Anthony R Harvey, British, aged 54, is President of the Company. He has been associated with the Company since its incorporation on 13th July, 1988, and has been a full-time director since 18th May, 1989, prior to which he spent 30 years with Wright Engineers where he gained extensive experience of the mining industry in various management positions including mine construction and ore extraction, bulk handling and processing, project management and corporate marketing and development, in many countries in the world including the US. He is a member of the American Society of Mechanical Engineers, and is also a director of Bunker Hill Mines Limited and was previously a director of Panorama Resources Limited.

Richard C Moores, American, aged 42, is Director, Vice President and Chief Financial Officer, and Secretary. He has been a director since the Company's incorporation and is now engaged full-time on the Company's business. He received a BA in Geology from Cornell University and both an MS in Geology and an MBA from the University of Arizona. He has had more than 20 years' experience in the mining industry, including metals exploration in the western US, project evaluation, mine planning and mine development, analysis and support of mine operation, short and long range planning, acquisitions marketing, economic analysis, public relations legislative/litigative efforts, negotiations and financing with several organisations including Silver State Mining Corporation, Shearson Lehman Brothers, Mobil Oil and Conoco.

Alan P Lindsay, Canadian, aged 39, is Director and Vice President of Corporate Development. He has been associated with the Company since its incorporation and became a director on 24th July, 1989. He is engaged full-time on the Company's business and has the responsibility for marketing and corporate development and maintaining investor and public relations and plays a key role in raising finance for the Company, and developing support and recognition of Azco in the market place. Most recently Mr Lindsay was manager of the financial services division of the North American Life Assurance Company in Vancouver, and is currently a director of International Barron Resources Limited and was previously a director of Panorama Resources Limited.

John E Dreier, American, aged 47, is a Director and Vice President of Exploration. He has been a director since the Company's incorporation. Mr Dreier's professional experience spans more than 25 years and includes management positions in mineral exploration, acquisitions, development and production. As a mine geologist with Kennecott Copper Corporation he gained experience in copper leaching operations. He is a Director (and until recently President) of Panorama Resources Limited. He holds a Doctorate in geology and geochemistry from the University of Arizona and is a member of The Geological Society of America, The Society of Economic Geologists, The American Institute of Mining Engineers and The Denver Regional Exploration Geologists Society.

The Directors are currently considering the appointment of non-executive directors and it is expected that appointees will be persons with appropriate mining and public company experience.

*Management and Staff*

There are currently no full-time staff but the Company has to date retained the services of several consultants, who are specialists in their fields. The Company expects to engage a number of employees, so that by the end of the first quarter of 1990 there will be up to a dozen full time staff including some key personnel. Development and construction work will be undertaken by contractors and subcontractors. When the mine is in full production Azco anticipates having approximately 120 full time employees. There is a pool of skilled SX-EW labour available in the region, and the Directors do not envisage any problems in recruiting and training a sufficiently skilled workforce.

*Consultants*

Wright Engineers Limited have acted as mining, engineering and construction consultants to the Company since February 1989, and it is expected that Wright Engineers Limited will continue to act in this capacity throughout the development of the Sanchez Project.

Lion Mining Finance Limited ("LMF"), a London-based mining finance consultancy, has been retained by the Company as mining finance adviser.

The following individuals have also advised the Company on a consultancy basis:-

Mr Richard Bideaux: is a geological engineer with over 25 years industry experience. He has worked on the estimates of the mineable ore reserves at Sanchez. He has previously worked with CalTech and the GFI Group and in 1971 founded his own company, C.A.I., offering a service involving mineral deposit modeling and ore reserve studies. Following the disposal of C.A.I. to Control Data Group in 1978 and the expiry of a non compete agreement, he has acted as an independent consultant. He has a BS in Geological Engineering (University of Arizona), an MA in Geology (Havard University) and an honorary degree of Professional Geological Engineer (University of Arizona). Mr Bideaux is a Fellow the Mineralogical Society of Arizona and is a member of the Arizona Geological Society and the American Institute of Mining Engineers.

Mr Fred Brost: has over 20 years experience as a mining engineer and has been retained by Azco to oversee the permitting application process. Mr Brost has a BS in mining engineering from the Missouri School of Mines and Metallurgy and is a member of the American Institute of Mining Engineers. Mr Brost runs a private consultancy practice - Arizona Consultants & Investments.

Dr. David Hackman: has over 20 years experience as a mining geologist. He has worked with companies such as Amoco and Mobil, and is a principal of SAGE Associates Inc, a consulting company offering expertise in ore reserve estimation, mine evaluation, feasibility studies and mine development. Mr Hackman has been engaged by Azco to oversee and update the feasibility study. He has a BS from the Colorado School of Mines, a BS and Ph.D in Geological Engineering from the University of Arizona and is a member of the American Institute of Mining Engineers and Society of Economic Geologists.

Mr Paul Hodges: has over 35 years experience in the mining industry covering project startups, management and financing and has worked with Asarco and RTZ, was formerly President of Anamax and until recently President of Companies Minera St. Jose. He is responsible for overseeing the feasibility study. He has a degree of Mining Engineering from the Colorado School of Mines, is a registered professional engineer in Arizona, and is a member of the American Institute of Mining Engineers.

Mr Michael Sierakoski: has over 25 years experience as an engineering metallurgist. He has worked with Inspiration Consolidated Copper Co., Anaonda, Magma and the Bagdad Copper Co. He is presently the Director of Marketing & Technical Service (Latin America) with the Henkel Corporation. His main area of experience has been the extraction of copper from acidic solutions via solvent extraction and he has been engaged by Azco to advise on various aspects of the SX-EW process. He has a BA and BS from the University of Arizona and is a member of the American Institute of Mining Engineers.

Dr. Brent Hiskey: is Professor of Materials Science and Engineering and Director of the Arizona Mining and Minerals Resources Research Institute at the University of Arizona. Prior to joing the university in 1984 he was manager of metallurgical research at Kennecott's Process Technology Centre. He has responsibility with Mr Sierakoski, for advising Azco on the heap leaching and solvent extraction stages of the copper extraction process. He has received a BS, MS and PhD in metallurgical engineering from the University of Utah.

Mr Paul Thompsen: has over 25 years industry experience, having worked as a mining engineer and metallurgist with Bechtel Inc, Holmes and Narvar Inc and Magma Copper. He is at present General Manager of Knight Foundry & Manufacturing Inc., which provides equipment to electrowinning plants and smelters. He has responsibility for advising Azco on technical aspects of

the elctrowinning process. He has a BS in metallurgical engineering from the Colorado School of Mines and is a member of the American Institute of Mining Engineers

Mr James Loghry: has over 25 years experience in mining and exploration. Since 1976 he has been an independent consulting geologist. His clients include Amax, Asarco, Cyprus, Chase Manhattan Bank and the US Department of Energy. He is a registered professional geologist in the States of Arizona and Oregon and received his Bachelors Degree in Geology from Darmouth College. He is a member of the Society of Economic Geologists, the American Institute of Mining Engineers. He has responsibility for conducting an overview on the geological ore reserve interpretation.

## FUTURE DEVELOPMENT AND STRATEGY

Although Europe has historically played an important role in global mining finance, many of the older European mining companies have either emigrated, been taken over, or grown away from their beginnings. The Directors believe that there is now a niche to build a new operating mining company based in Europe for ease of access to sophisticated financial markets and further mining development opportunities and therefore plan to give active consideration to relocating in Europe. The Sanchez mine is seen as the first of several projects which the company will own and operate, and using the cash flow generated, it is planned to diversify the earnings base over a range of commodities and countries.

## DIVIDENDS

The Company intends to pay dividends as soon as revenues from the Sanchez Project permit.

## STRONG & HARRIS PROJECT

In addition to the Sanchez Project, Azco holds a lease on the Strong & Harris Deposit that includes 90 unpatented mining claims covering approximately 1800 acres of federal lands in Cochise County, Arizona. The deposit contains copper, zinc and some silver.

In order to maintain the Strong & Harris lease, the Company must expend $40,000 per year for the benefit of the leased premises and must pay the lessors annual advance royalties. These royalties started at $7,500 in 1989 and increase to a maximum of $100,000 per year in 1997. (Additional details of the lease are set out in note 3 to the financial statements in Appendix I).

A large body of data is available for the Strong & Harris Deposit, but a significant amount of additional metallurgical and engineering work is required before a final feasibility study can be prepared. The impact of the Strong & Harris Deposit on the Company's affairs has been deemed to be neutral for the purpose of the Placing.

## RISK FACTORS

The Company's proposed development and mining operations, in common with other mineral companies, involve a substantial degree of risk. Some of the factors which should be taken into account, and which could cause loss or deferral of income, include the following:

1. The basis for the geological ore reserve estimate of the Sanchez deposit is the result of exploration drilling and underground development carried out by previous operators of the property. The data base from previous exploration has been assembled and analysed in accordance with accepted industry practices. The geological interpretation has been carried out by professional geologists with experience in porphyry copper deposits. The geological interpretation of the deposit, the grade of the ore and the tonnage cannot be verified until the ore has been mined and processed.

2. The metallurgical production rates from the Sanchez deposit have been estimated from prior and recent test work and from companies with similar mines in other locations. The Company is, however, undertaking additional work further to define and optimise the precise recoveries to be expected. The results of this work cannot be predicted.

3. Ore grades may vary as mining progresses, resulting in a variation in extraction efficiency compared to projections prepared by the Directors.

4. Upon completion of the final feasibility study to establish the viability of the project and final design parameters, substantial additional funds will be required for the development and routine mining operations of the Sanchez deposit. In addition, the Company will require to finalise planning and other permissions in order to proceed to mine in the area. There is no guarantee that these funds and permissions will be forthcoming, nor that changes in applicable laws will not significantly affect the Company's business.

5. The Company's income will be derived from the sale of copper whose value is affected by numerous factors beyond the Company's control and can suffer wide fluctuations.

6. Delays in installing and commissioning plant and equipment, in hiring and training skilled labour, or other technical difficulties may result in projected target dates, or production, being delayed, or greater capital expenditures being required.

7. The Company may become subject to liability for hazards arising from its activities which cannot be insured against, or against which it may elect not to be insured because of high premium costs. The Company may incur liabilities to third parties in excess of any insurance cover arising from environmental pollution or other damage or injury, or may be required to cease activities temporarily or otherwise.

8. Azco is at an early stage in its development and has no significant history of operations that can be demonstrated to investors. Consequently the Company faces the risks inherent in commencing new operations.

**Accordingly, investment in the Company involves a high degree of risk and should not form more than a small percentage of a diversified portfolio. Investors should be prepared for the total loss of their investment and be able to bear such loss.**

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**LME cash prices (¢/lb)**

| | Average | Range |
|---|---|---|
| 1988 | 118 | 95-167 |
| 1989 | 129 | 108-161 |
| 1990 | 115 | 90-135 |
| 1991 | 95 | 80-110 |

# Copper

## The bull market lives on

*This report highlights the summary and conclusions of Shearson Lehman Hutton's Annual Review of the Copper Industry 1990, which was published on April 11.*

During 1988 and 1989, the copper market, on paper at least, had the potential to move into oversupply. The outcome was different; not only was production seriously affected by supply disruptions, and inevitable delays in the timing of capacity additions, but demand continued to grow strongly. As a consequence market stocks remained at chronically-low levels entering 1990.

Our analysis of the market fundamentals suggest that inventories are only to be rebuilt modestly over the next two years. We project a surplus of just 140,000 tonnes in 1990 and 90,000 tonnes in 1991. By the standards of the early-1980s these are relatively modest additions - commercial stocks should remain less than five weeks of consumption at the end of 1991, compared with peak levels of over 12 weeks in 1982 and 1983.

As a result prices will remain at historically high levels and the average for 1990 is only slightly below the bull market peak of 1988 and 1989, and certainly well above the levels that characterised the bulk of the early/mid 1980s. Prices may ease slightly in 1991 as the market moves into modest oversupply, but will remain at profitable levels for all but the highest cost producer.

# Summary

1988 and 1989 were exceptional years for copper prices with LME spot prices reaching an all-time high of $1.67/lb towards the end of 1988 and averaging over $1.15/lb in both years. This compares with an average of only 65.8¢/lb over the five depressed years from 1982-1986. Prices were driven to these levels by successive recent-high levels of demand in every year since 1986, which caused market stocks to fall to critically low levels from 1987 onwards. Between 1987 and 1989, commercial market stocks have been below four weeks of consumption, compared with peak 1980s levels of over 12 weeks' consumption in 1982 and 1983.

Supply has risen sharply since 1986, but, particularly in recent years, primary production has failed to fulfill its potential due to major mine production disruptions and delays in the timing of capacity additions and new projects.

Market stocks remained at chronically low levels entering 1990. Our analysis of the market fundamentals suggest that inventories will remain relatively low by historical standards. We believe that the fears of sharply higher production associated with such projects as Neves Corvo, Escondida and Ok Tedi have been overdone. Not enough account is taken of lower grades/technical problems and mine exhaustions elsewhere. We are only looking for net additions to mine capacity of 90,000 tpy in 1990 and 199,000 tpy in 1991. As we project modest demand growth this year, followed by a pick up in 1991, we expect market stocks to remain relatively low by historical standards and prices should remain well above levels achieved during the early- and mid-1980s.

We view our best estimate as being fairly conservative. Against a background of low inventories, high utilisation rates and the high proportion of copper mined in economically/politically unstable areas such as Peru, PNG, Zaire and Zambia, prices are more likely to gravitate towards our "high estimate" rather than to our "low estimate". The downside risk lies more in a downturn in economic conditions rather than factors specific to the copper market.

**Table 1** **The price forecasts : LME copper spot prices period averages, 1987-1991 (US¢/lb)**

| | Actual | | | Forecast (1) | | | |
|---|---|---|---|---|---|---|---|
| | 1987 | 1988 | 1989 | 1990 H1 | 1990 H2 | 1990 Year | 1991 Year |
| High case | - | - | - | 140 | 130 | 135 | 115 |
| Best case | 81 | 118 | 129 | 120 | 110 | 115 | 95 |
| Low case | - | - | - | 105 | 85 | 95 | 80 |

**Note:** (1) Forecasts also apply to COMEX high-grade spot prices

# Market Fundamentals

## Back to steady consumption growth

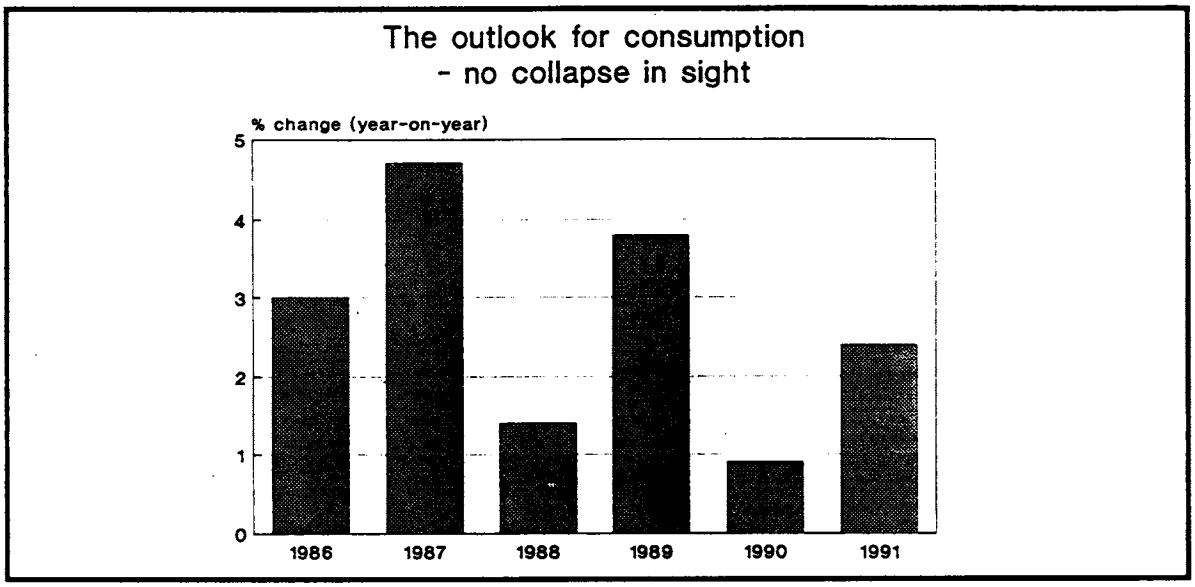
Since 1982, demand has risen more or less continuously; over the 1982-1989 period, consumption growth averaged 3.2% a year. This perhaps overestimates the underlying growth rate since it is from a trough to a peak. Peak-to-peak consumption growth from 1979 to 1989 in the western world in fact averaged only 1.3%. It also disguises the fact that the "intensity of use" consumption of copper per unit of overall economic growth, normally measured either in terms of IP (industrial production) or GDP (gross domestic product), is still declining in the industrialised economies.

Looking forward, one positive factor for consumption growth is that while intensity of use is declining in the industrialised countries, it is still rising on a trend basis in the developing countries. As a group the developing countries are also increasing their share of total consumption; it has risen from 11.0% in 1979 to 17.8% in 1989.

Growth in **Japan** should remain relatively robust at 2.1% this year and 2.4% in 1991. These forecasts are based on still-strong economic growth forecasts despite recent interest rate hikes. **European** growth prospects are perhaps the hardest to quantify following recent changes in Eastern Europe. We expect some slowdown this year, with only 1.0% year-on-year growth projected, but then a rise to 2.0% in 1991. Outside the main industrialised countries, growth should remain fairly strong, despite poorer prospects in Latin America. We are projecting 4.1% growth in 1990 and 3.8% growth in 1991 for these countries as a whole. In summary, our forecasts are for **slower growth** of only 0.9% in 1990 to 8.615m tonnes, followed by an acceleration in 1991 to 2.4% to 8.825m tonnes.

**Table 2** **Non-Socialist world copper consumption by major area, 1987-1991 ('000 tonnes)**

| | Actual and estimated | | | Forecast | |
|---|---|---|---|---|---|
| | 1987 | 1988 | 1989 | 1990 | 1991 |
| Western Europe | 2,803 | 2,873 | 3,017 | 3,045 | 3,105 |
| Japan | 1,284 | 1,331 | 1,450 | 1,480 | 1,515 |
| USA | 2,195 | 2,214 | 2,190 | 2,135 | 2,175 |
| Others | 1,829 | 1,808 | 1,879 | 1,955 | 2,030 |
| Total non-Socialist | 8,111 | 8,225 | 8,536 | 8,615 | 8,825 |
| % change (year-on-year) | +4.7 | +1.4 | +3.8 | +0.9 | +2.4 |




## East-West trade : No major changes expected

East-West trade is a relatively minor part of the total copper business in terms of total copper demand or supply, but at certain times it can have a significant short-run influence on the market. Since 1986, the Eastern bloc countries as a whole have become net **suppliers** instead of buyers of refined copper from the West. This reflects two distinct trends in recent years. First, China has become a much smaller importer of copper in recent years. From a peak of around 430,000 tonnes in 1983, Chinese purchases are believed to have fallen to under 100,000 tpy since 1987 as the domestic copper industry has expanded. This declining trend should continue over the next few years. The second trend is a rise in Western imports of copper from the Eastern bloc countries. We estimate that these imports rose to 260,000 tonnes in 1989 as Soviet exports to Western Europe almost doubled to an estimated 140,000 tonnes. These exports are expected to decline from 1989's peak levels in 1990 and 1991.

## Primary production : Modest capacity additions in prospect

We estimate that copper mine production in the non-Socialist world was 7.15m tonnes in 1989, a rise of 6.6% on 1989's level. That production showed such a high year-on-year growth rate is somewhat surprising in view of the major supply disruptions experienced during 1989. Major production losses took place in Papua New Guinea, where the 180,000 tpy Bougainville mine was closed in May following terrorist action at the mine; in Canada, where there was a three-month strike at the 170,000 tpy Highland Valley mine, and in Mexico, where the 145,000 tpy state-owned producer, Cananea, was closed between August and November. These and other smaller losses probably caused the loss of around 250-300,000 tonnes of output last year.

Primary refined output grew by an estimated 4.2% to 6.994m tonnes. Following 1988's implied 133,000 tonne fall in blister and concentrate stocks, we estimate that the concentrate market was in rough balance last year. In projecting likely increases in refined output for 1990 and 1991, we have assumed that this rough balance between concentrate supply and demand will be maintained in 1990 and 1991. In other words, refined production will be determined by the level of mine and SX-EW production.

We estimate that non-Socialist world effective mine and SX-EW production capacity was around 8.9m tpy at the end of 1989. Based on our detailed operation-by-operation review of capacity increases and reductions over the next few years we estimate that capacity should increase by 90,000 tpy in 1990 and by 199,000 tpy in 1991. Mine and SX-EW production is forecast to grow by 1.1% in 1990 to 7.376m tonnes, and then by a further 2.6% in 1991 to 7.57m tonnes.

Our major assumptions on production changes for 1990 and 1991 are as follows:

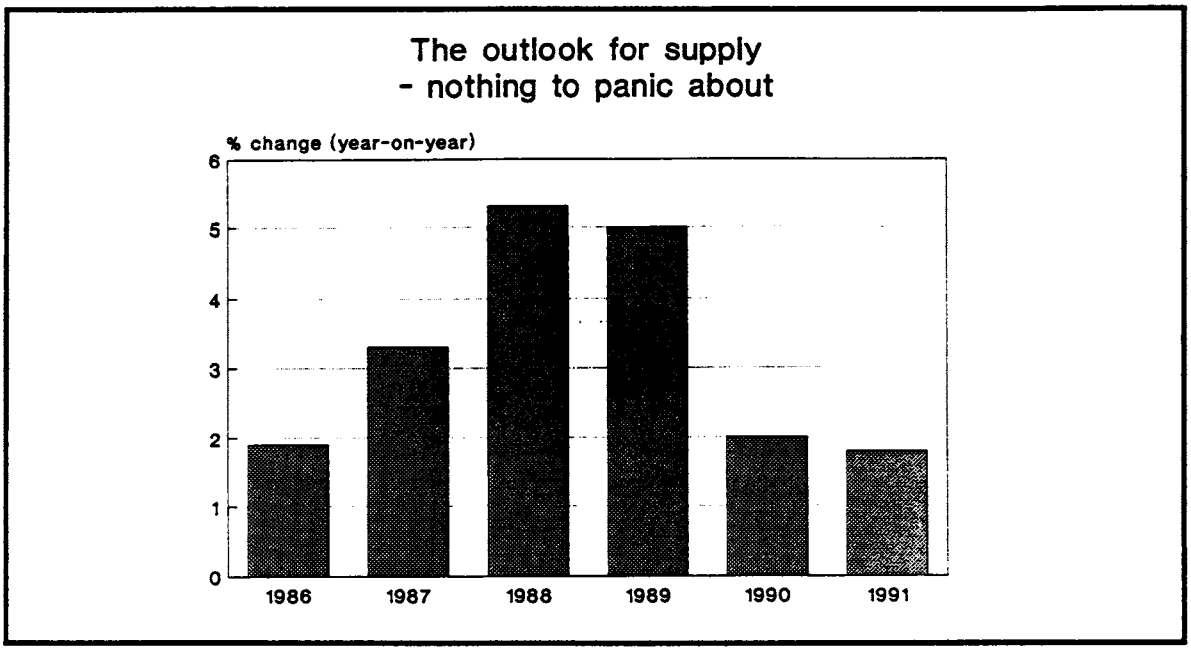
- Bougainville to be out of action until end 1991.
- A return to full production levels at Highland Valley and Cananea following last year's losses of around 100,000 tonnes in total.
- Codelco's production is unlikely to reach 1989's all-time high level of 1.244m tonnes in the foreseeable future following recent problems at Chuquicamata and El Teniente; production at the El Salvador mine should fall by 30,000 tonnes in 1990, and by a further 10,000 tonnes in 1991, as a result of lower availability of slag feed from Chuquicamata.
- The 320,000 tpy La Escondida mine in Chile is due onstream in late-1990/early-1991. Its 1991 scheduled output is 175,000 tonnes. The only other new Chilean project likely to come onstream before the end of 1991 is the 20,000 tpy Lince SX-EW project.
- US production should continue to rise strongly despite the expected closure of Phelps Dodge's 100,000 tpy Tyrone mine by the end of 1991. We are forecasting a 4.0% rise in 1990 to 1.585m tonnes, mainly as a result of expansions at Cyprus Minerals and Magma Copper's mine operations and Phelps Dodge's SX-EW operations (Morenci, Tyrone and Chino).
- Output from the Ok Tedi mine in Papua New Guinea should continue to grow strongly as capacity moves from its current 140,000 tpy to around 200,000 tpy by end 1991.
- Following last year's 22.1% recovery in mine output to 364,000 tonnes, Peruvian output is not expected to show much growth over the next two years.

Table 3

## Non-Socialist world copper supply/demand balance, 1980-1991

('000 tonnes contained copper)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | *Forecast 1990* | *Forecast 1991* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Mine production | 6065 | 6656 | 6274 | 6226 | 6350 | 6471 | 6481 | 6710 | 6709 | 7152 | *7376* | *7570* |
| (2) Net exports of concs/ blister to Eastern bloc | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 50 | *50* | *50* |
| (3) Smelter/refinery losses and direct use of blister | 91 | 100 | 94 | 93 | 95 | 97 | 97 | 101 | 101 | 107 | *111* | *114* |
| (4) Primary refined production | 5798 | 6179 | 5982 | 6116 | 6113 | 6108 | 6283 | 6473 | 6712 | 6994 | *7235* | *7385* |
| (5) Implied rise (fall) in conc/ blister stocks * [(1)-(2)-(3)-(4)] | **177** | **377** | **197** | **17** | **142** | **267** | **101** | **136** | **-133** | **1** | *-20* | *22* |
| (6) Secondary refined production | 1239 | 1176 | 1176 | 1216 | 1084 | 1215 | 1181 | 1206 | 1330 | 1450 | *1400* | *1400* |
| (7) Total refined production | 7036 | 7355 | 7158 | 7332 | 7197 | 7323 | 7464 | 7679 | 8042 | 8444 | *8635* | *8785* |
| (8) Socialist exports to West | 140 | 138 | 162 | 129 | 177 | 149 | 152 | 192 | 248 | 260 | *240* | *250* |
| **(9) TOTAL REFINED SUPPLY** | **7176** | **7494** | **7320** | **7461** | **7374** | **7472** | **7616** | **7870** | **8289** | **8704** | *8875* | *9035* |
| (10) Total refined consumption | 7091 | 7479 | 6851 | 7047 | 7594 | 7521 | 7750 | 8111 | 8225 | 8536 | *8615* | *8825* |
| (11) Socialist imports from West | 115 | 123 | 139 | 474 | 300 | 325 | 145 | 139 | 123 | 130 | *120* | *120* |
| **(12) TOTAL REFINED DEMAND** | **7206** | **7602** | **6990** | **7521** | **7893** | **7847** | **7895** | **8250** | **8349** | **8666** | *8735* | *8945* |
| **(10) Implied rise (fall) in stocks [(9)-(12)]** | **-29** | **-108** | **331** | **-60** | **-520** | **-375** | **-279** | **-380** | **-60** | **38** | *140* | *90* |
| **Total commercial stocks (WBMS)** | 1035 | 1133 | 1640 | 1709 | 1220 | 1074 | 893 | 522 | 560 | 598 | *738* | *828* |
| **No of weeks of consumption** | 7.6 | 7.9 | 12.4 | 12.6 | 8.4 | 7.4 | 6.0 | 3.3 | 3.5 | 3.6 | *4.5* | *4.9* |
| **LME Cash Price (cents/lb)** | **99** | **79** | **67** | **72** | **62** | **64** | **62** | **81** | **118** | **129** | *115* | *95* |




- Output at Somincor's new Neves Corvo mine in Portugal should continue to rise strongly towards the 145,000 tpy capacity in 1990 and 1991, following 1989's output of 103,300 tonnes.

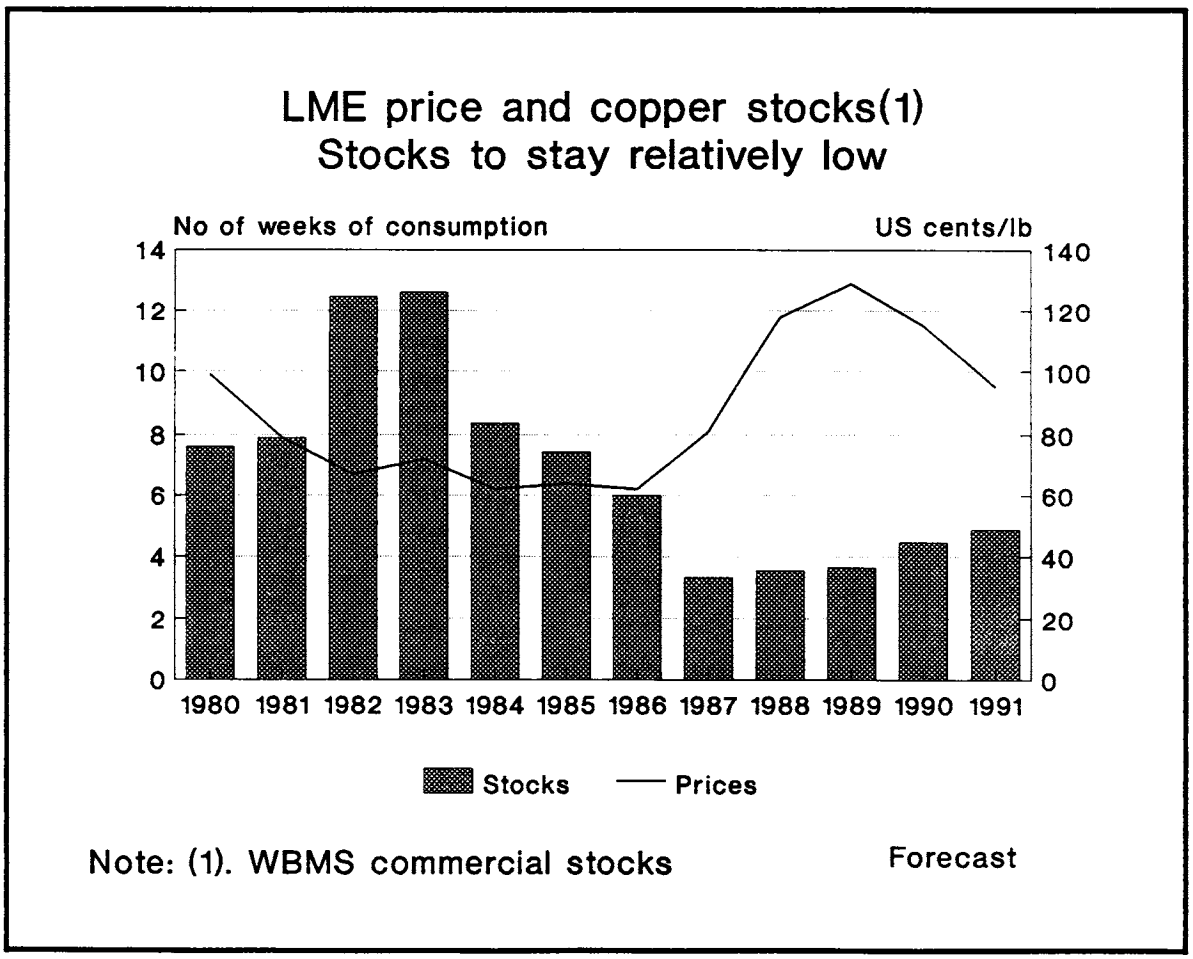
- Freeport Indonesia's new Grasberg mine will continue its build-up towards maximum capacity of 260,000 tpy by 1993, although production is unlikely to exceed 180,000 tonnes in 1990, or 1991.

## Supply/demand balance and price forecasts

Historically there has been a strong inverse relationship between the level of market stocks and prices. During 1988 and 1989, the market, on paper at least, had the potential to move into oversupply. The outcome was different: not only was production seriously affected by supply disruptions, and inevitable delays in the timing of capacity additions, but demand continued to grow strongly. As a consequence market stocks remained at chronically-low levels entering 1990.

Our supply/demand balance figures in Table 2 point to a 140,000 tonne stock build-up in 1990 and a 90,000 tonne rise in 1991. By the standards of the early-1980s these are relatively modest stock additions - commercial stocks would remain less than five weeks of consumption at the end of 1991, compared with peak levels of over 12 weeks in 1982 and 1983.

However, some of the pressure on prices should ease during the second half of 1990 and, **in the absence of new serious supply disruptions**, we expect prices to head back below the $1.00/lb level. Our **best case** price forecast is for an average of $1.15/lb in 1990 and 95¢/lb in 1991.

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US mine production continued to rise strongly during 1989. Production rose to an estimated 1.55m tonnes, the highest level of the decade and 9.2% higher than 1988's level, which was in turn 13.0% higher than production in 1987. Much has been written about the resurrection of the US copper industry from the dead (e.g. see January 1990's edition of the **Engineering and Mining Journal**). It is indeed a remarkable story with much of the growth in recent years being based on low-cost SX-EW production. During 1989, SX-EW production was an estimated 291,500 tonnes, equivalent to 18.8% of total US production. During 1990 we are forecasting a further 19.7% growth in SX-EW output to 349,000 tonnes, 22% of total US production. US production as a whole should rise by only 2.3% to 1.585m tonnes.

## Future copper mine and SX-EW capacity and production

In total, we estimate that effective mine production capacity rose by around 450,000 tonnes, or 6.0% during 1989 to around 7.9m tpy. This figure represents our best estimate of the actual production capability of the industry at the end of 1989. This figure is considerably below some "name-plate" capacity estimates which include unrealistic estimates of potential output in some countries. We have used recent year's output levels as a guide to determining effective capacity levels, adjusted for known production losses due to one-off events such as strikes, accidents or technical problems.

The potential for **increases** in production for 1990 and beyond is best determined by taking actual 1989 production (7.15m tonnes), adding back in any one-off production losses due to strikes etc (around 250-350,000 tonnes) and then assessing additions to capacity during 1989 and for 1990 onwards. Offsetting this is the high probability that there will **always** be losses somewhere in the world from strikes, technical problems etc. Our production forecasts for 1990 and 1991, for example, assume that the 180,000 tpy Bougainville mine will be out of production over the entire period. Our feeling is that even if it does return to production at some stage over this period, losses of the same order of magnitude of a Bougainville will always be likely. In any case our projections of production imply a reasonably realistic capacity utilisation rate of just under 92.5% in 1990 and 1991.

Our estimates of effective mine and SX-EW production capacity for 1989-1993 and beyond 1993 are summarised by country and region in Table 4.3. Table 4.5 breaks out the changes by type. The more detailed figures, outlining the expected changes by mine are presented in Table 4.4. The basis for these numbers is outlined in the regional reviews which follow later on in this section.

In our forecasts of capacity changes, we have attempted to measure capacity **reductions** as a result of falling ore grades or reserve exhaustions as well as mine expansions. During 1990 and 1991 contractions are a significant feature in limiting the impact of several major increases in capacity. The most important contractions are at Brenda (17,000 tpy lost in 1990 and 1991), Hudson Bay Mining and Smelting (43,000 tpy lost between 1990 and 1993), Noranda's Bell mine (22,000 tpy lost in 1991 and 1992), Codelco (an expected 80,000 tpy loss at El Teniente and Salvador in 1990 and 1991), RTB Bor (15,000 tpy loss in 1990), ZCCM (20,000 tpy loss in 1990) and at Phelps Dodge's Tyrone mine (100,000 tpy loss in 1990 and 1991). As a result of these and other smaller losses, capacity at existing mines is projected to fall by 29,000 tpy in 1990 and by 92,000 tpy in 1991.

The reductions in capacity at existing mines will be more than offset, however, by the effects of the opening of new mines and SX-EW facilities. During 1990, SX-EW additions dominate, while during 1991 and beyond, new mine production assumes greater importance.



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**Table 4.3** **Summary of effective mine and SX-EW production capacity by country and region ('000 tpy)**

| Country | Capacity levels 1989 | 1990 | 1991 | 1992 | 1993 | Beyond 1993 | Capacity changes 1990 | 1991 | 1992 | 1993 | Beyond 1993 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Botswana | 24 | 26 | 29 | 29 | 29 | 29 | +2 | +3 | - | - | - |
| Morocco | 21 | 21 | 21 | 9 | 9 | 9 | - | - | -12 | - | - |
| Namibia | 45 | 41 | 50 | 50 | 50 | 50 | -4 | +9 | - | - | - |
| South Africa | 193 | 186 | 189 | 192 | 192 | 192 | -7 | +3 | +3 | - | - |
| Zaire | 525 | 555 | 525 | 525 | 525 | 525 | +30 | -30 | - | - | - |
| Zimbabwe | 22 | 22 | 22 | 22 | 22 | 22 | - | - | - | - | - |
| Zambia | 500 | 480 | 480 | 480 | 480 | 480 | -20 | - | - | - | - |
| Indonesia | 175 | 180 | 180 | 240 | 260 | 260 | +5 | - | +60 | +20 | - |
| India | 69 | 69 | 69 | 69 | 69 | 69 | - | - | - | - | - |
| Iran | 70 | 70 | 70 | 70 | 70 | 70 | - | - | - | - | - |
| Japan | 13 | 13 | 13 | 13 | 13 | 13 | - | - | - | - | - |
| Malaysia | 30 | 30 | 30 | 30 | 30 | 30 | - | - | - | - | - |
| Pakistan | - | - | - | - | - | 16 | - | - | - | - | +16 |
| Philippines | 226 | 217 | 236 | 232 | 232 | 232 | -9 | +19 | -4 | - | - |
| Turkey | 58 | 61 | 63 | 63 | 73 | 88 | +3 | +2 | +10 | +15 | - |
| Finland | 20 | 17 | 15 | 15 | 15 | 15 | -3 | -2 | - | - | - |
| France | - | - | - | 7 | 7 | 7 | - | - | +7 | - | - |
| Norway | 15 | 13 | 11 | 11 | 11 | 11 | -2 | -2 | - | - | - |
| Portugal | 110 | 145 | 147 | 149 | 149 | 149 | +35 | +2 | +2 | - | - |
| Sweden | 80 | 79 | 79 | 88 | 88 | 88 | -1 | - | +9 | - | - |
| Spain | 30 | 30 | 30 | 30 | 30 | 30 | - | - | - | - | - |
| UK | 1 | 1 | 1 | 4 | 6 | 6 | - | - | +3 | +2 | - |
| Yugoslavia | 120 | 105 | 105 | 115 | 120 | 120 | -15 | - | +10 | +5 | - |
| Brazil | 45 | 43 | 42 | 39 | 18 | 8 | -2 | -1 | -3 | -21 | -10 |
| Chile | 1675 | 1617 | 1783 | 1918 | 2113 | 2445 | -58 | +166 | +135 | +195 | +332 |
| Mexico | 300 | 315 | 319 | 319 | 319 | 319 | +15 | +4 | - | - | - |
| Peru | 435 | 454 | 445 | 442 | 449 | 449 | +19 | -9 | -3 | +7 | - |
| Canada | 860 | 885 | 878 | 840 | 838 | 978 | +25 | -7 | -38 | -2 | +140 |
| USA | 1606 | 1628 | 1618 | 1768 | 1768 | 1768 | +22 | -10 | +150 | - | - |
| Australia | 312 | 337 | 359 | 370 | 370 | 370 | +25 | +22 | +11 | - | - |
| Papua New Guinea | 320 | 350 | 380 | 380 | 380 | 380 | +30 | +30 | - | - | - |
| **Total Non-Socialist** | **7900** | **7990** | **8189** | **8529** | **8750** | **9228** | **+90** | **+199** | **+340** | **+221** | **+478** |
| % change (year-on-year) | +6.0 | +1.1 | +2.5 | +4.2 | +2.6 | n.a. | | | | | |
| Total Africa | 1330 | 1331 | 1316 | 1307 | 1307 | 1307 | +1 | -15 | -9 | - | - |
| Total Asia/Middle East | 641 | 640 | 661 | 717 | 747 | 778 | -1 | +21 | +56 | +30 | +31 |
| Total Europe | 376 | 390 | 388 | 429 | 441 | 426 | +14 | -2 | +41 | +12 | -15 |
| Total Latin America | 2455 | 2429 | 2589 | 2718 | 2899 | 3221 | -26 | +160 | +129 | +181 | +332 |
| Total North America | 2466 | 2513 | 2496 | 2608 | 2606 | 2746 | +47 | -17 | +112 | -2 | +140 |
| Total Oceania | 632 | 687 | 739 | 750 | 750 | 750 | +55 | +52 | +11 | - | - |

**Table 4.4(a) Major changes to copper mine and SX-EW capacity by company ('000 tpy of contained copper)**

| Country and Company | Mine | Type[1] | 1989 Capacity | Capacity changes 1990 | 1991 | 1992 | 1993 | Beyond 1993 |
|---|---|---|---|---|---|---|---|---|
| **Australia** | | | | | | | | |
| Aberfoyle | Que River | MXC | 2 | | -1 | -1 | | |
| Agip/Whim Creek | Radio Hill | NM | - | | 1 | | | |
| Barrack Mines | Broadhurst | NM | - | | +18 | | | |
| Macquarie Resources | Benambra | NM | - | | +11 | +17 | | |
| MIM | Mount Isa | NSX | - | +3 | | | | |
| Murchison Zinc//ExxonAztec | Golden Grove | NM | - | +2 | +6 | | | |
| Murchison Zinc/Exxon/Aztec | Gossan Hill | NM | - | +5 | | | | |
| NBH Peko-Wallsend | Warrego/Gecko | MXC | 17 | -4 | -13 | -5 | | |
| Pancontinental/Outokumpu/Agip | Thalanga | MXC | 3 | +7 | | | | |
| Triako/Cyrpus Minerals | Mineral Hill | MXC | 1 | +2 | | | | |
| Western Mining | Olympic Dam | MXC | 37 | +10 | | | | |
| **Botswana** | | | | | | | | |
| BCL | Selibi North | NM | - | +2 | +3 | | | |
| **Brazil** | | | | | | | | |
| Caraiba Metals | Jaguari | MXC | 29 | | | | -19 | -10 |
| Cia Braz de Cobre | Camagua | MXC | 12 | -2 | -1 | -3 | -2 | |
| **Canada** | | | | | | | | |
| Brenda | Peachland | MXC | 17 | -9 | -8 | | | |
| Equity Mining (Placer Dome) | Sam Goosly | MXC | 6 | | -1 | -4 | -1 | |
| Geddes Resources | Wingy Craggy | NM | - | | | | | +140 |
| Heathsteel (Noranda/Brunswick) | Heathsteel | MXC | 42 | +2 | | | | |
| Highland Valley | Highland Valley | MXC | 170 | +10 | | | | |
| Hudson Bay Mining & Refining | Snow Lake | MXC | 19 | -1 | -1 | -4 | -2 | |
| Hudson Bay Mining & Refining | Namew Lake | MXC | 6 | -3 | | | | |
| Hudson Bay Mining & Refining | Ruttan | MXC | 32 | -7 | -5 | -20 | | |
| Hudson Bay Mining & Refining | Callinan | NM | - | +4 | 2 | | | |
| Inco | McCready East | NM | - | | | | +6 | |
| Minnova | Ansil | MXC | 14 | +18 | | | | |
| Minnova | Opemiska | MXC | 6 | -6 | | | | |
| Noranda | Gaspe | MXC | 20 | | | | -5 | |
| Noranda | Bell | MXC | 22 | | -12 | -10 | | |
| Noranda | Matagami/Isle Dieu | MXC | 5 | +7 | -2 | | | |
| Placer Dome | Gibraltar | MXC | 25 | | +20 | | | |
| Teck/Metall Mining | Afton Mill | MXC | 8 | +10 | | | | |
| **Chile** | | | | | | | | |
| Anglo American | Mante Verde | NM | - | | | | +15 | +5 |
| Antofagasta/Midland Bank/ Lucky Goldstar | Los Pelambres | NM | - | | | +15 | +5 | |
| Antofagasta/Outokumpu/ Chemical Bank | Lince | NSX | - | | +10 | +10 | | |
| BHP/RTZ/Mitsubishi/ Nippon Mining | La Escondida | NM | - | | +175 | +100 | +95 | |
| Billiton/Citibank | Los Luces | NM | - | | | | | +8 |
| Codelco | El Teniente | SXE | 5 | | | +10 | | |
| Codelco | El Teniente | MXC | 330 | -30 | -10 | | | |
| Codelco | Chuquicamata | SXE | 100 | | | | +20 | +30 |
| Codelco | Salvador | MXC | 130 | -30 | -10 | | | |
| Cominco/Enami/Pudahuel | Quebrada Blanca | NSX | - | | | | | +4 |
| Disputada (Exxon) | Los Broncos | MXC | 40 | | | | +40 | +40 |
| Outokumpu | Cerro Zaldivar | NSX | - | | | | +20 | +20 |
| Outokumpu/Mincar | Amolanas | NSX | - | | | | | +20 |
| Phelps Dodge | La Candelaria | NM | - | | | | | +90 |
| Pudahuel | La Cascada Sagasca | MXC | 15 | -3 | -4 | | | |
| Rayrock Yellowknife Resources | Ivan/El Zar | NSX | - | | | | | +15 |
| Rio Algom | Cerro Colorado | NM | - | | | | | +40 |
| Shell Chevron | Collahuasi | NM | - | | | | | +20 |
| Tocopilla | Lipised | NM | - | +5 | +5 | | | |
| **Finland** | | | | | | | | |
| Outokumpu | Keratti/Vihanti | MXC | 5 | -3 | -2 | | | |
| **France** | | | | | | | | |
| BRGM/Aztec//Metaleurop | Chessy | NM | - | | | +7 | | |
| **Indonesia** | | | | | | | | |
| Freeport Indonesia | Ertsberg/Grasberg | MXC | 175 | +5 | | +60 | +20 | |
| **Mexico** | | | | | | | | |
| CM de Cananea | Cananea | NSX | 25 | +7 | | | | |
| Cumobabi | Minera Frisco | MXC | 3 | +1 | +1 | | | |
| Minera Frisco/Cominco | Maria | MXC | 1 | +7 | +3 | | | |
| **Morocco** | | | | | | | | |
| Somifer | El Bleida | MXC | 12 | | | -12 | | |

**Table 4.4(b) Major changes to copper mine and SX-EW capacity by company ('000 tpy of contained copper)**

| Country and Company | Mine | Type[1] | 1989 Capacity | Capacity changes 1990 | 1991 | 1992 | 1993 | Beyond 1993 |
|---|---|---|---|---|---|---|---|---|
| **Namibia** | | | | | | | | |
| Tsumeb | Kombat | MXC | 0.2 | +2 | +3 | | | |
| Tsumeb | Asis West Teco | MXC | 6 | -6 | +6 | | | |
| **Norway** | | | | | | | | |
| Outokumpu | Bidjovagge | MXC | 4 | -2 | -2 | | | |
| **Pakistan** | | | | | | | | |
| RDC | Saindak | NM | - | | | | | +16 |
| **Papua New Guinea** | | | | | | | | |
| Ok Tedi | Fubilan-Olgal | MXC | 140 | +30 | +30 | | | |
| **Peru** | | | | | | | | |
| Centromin | Morocodia | MXC | 3 | -3 | | | | |
| Mineru Peru | Coroccohuayco | NM | - | +15 | | | | |
| Mineru Peru/Centromin/Cofide | Tintaya | NSX | - | | | +10 | +7 | |
| Mineru Peru/Centromin/Cofide | Tintaya | MXC | 60 | +12 | -9 | -13 | | |
| SPCC | Cuajone | MXC | 145 | -5 | | | | |
| **Philippines** | | | | | | | | |
| Atlas Consolidated | Cebu | MXC | 90 | | +8 | | | |
| Marcopper | Taipan | MXC | 22 | -9 | -9 | -4 | | |
| Marcopper | San Antonio | NM | - | | +20 | | | |
| **Portugal** | | | | | | | | |
| Pirites Alentajanas | Aljustrel | MXC | 2 | | +2 | +2 | | |
| Somincor (RTZ/Edma) | Neves Corvo | MXC | 105 | +35 | | | | |
| **South Africa** | | | | | | | | |
| Palabora | Phalaborwa | MXC | 125 | | +6 | | | |
| Phosphate Dev. Corp. | Foskor | MXC | 15 | | | +3 | | |
| Prieska | Copperton | MXC | 10 | -7 | -3 | | | |
| **Sweden** | | | | | | | | |
| Outokumpu | Viscaria | MXC | 26 | -1 | | -2 | | |
| Boliden | Aitik | MXC | 40 | | | +11 | | |
| **Turkey** | | | | | | | | |
| Etibank | Kure-Asikoy | MXC | 15 | +3 | +2 | | | |
| Metall Mining | Cayeli | NM | - | | | +10 | +15 | |
| **UK** | | | | | | | | |
| IMI | Parys Mountain | NM | - | | | +3 | +2 | |
| **USA** | | | | | | | | |
| Asarco | Silver Bell | NM | - | | | +16 | | |
| Asarco | Mission | MXC | 79 | | | +23 | | |
| Asarco | Ray | MXC | 68 | | | +39 | | |
| Cyprus Minerals | Sierrita + Twin Buttes | MXC | 111 | | | -15 | | |
| Cyprus Minerals | Bagdad | MXC | 80 | +15 | | | | |
| Magma Copper | San Manuel | SXE | 35 | +5 | +5 | | | |
| Magma Copper | Miami | SXE | 7 | +6 | +7 | | | |
| Magma Copper | Superior | NM | - | +2 | +12 | | | |
| Metall Mining | White Pine | MXC | 50 | | | +10 | | |
| Phelps Dodge | Tyrone | MXC | 100 | -50 | -50 | | | |
| Phelps Dodge | Bisbee | MXC | 5 | | | | | +35 |
| Phelps Dodge | Tyrone | SXE | 35 | +15 | | | | |
| Phelps Dodge | Chino | MXC | 85 | -1 | -2 | | | |
| Phelps Dodge | Morenci | SXE | 60 | +30 | +20 | +45 | | |
| Kennecott (RTZ) | Bingham Canyon | MXC | 230 | | | +32 | | |
| **Yugoslavia** | | | | | | | | |
| RTB Bor | Majdanpex | MXC | 55 | | | +10 | +5 | |
| RTB Bor | Bor | MXC | 30 | -15 | | | | |
| **Zaire** | | | | | | | | |
| Gecamines/Sodimiza | Various mines | MXC | 525 | +30 | -30 | | | |
| **Zambia** | | | | | | | | |
| ZCCM | Various Mines | MXC | 500 | -20 | | | | |
| **GRAND TOTAL** | | | | **+90** | **+199** | **+340** | **+221** | **+478** |
| **Effective capacity** | | | **7900** | **7990** | **8189** | **8529** | **8750** | **9228** |
| Year-on-year change (%) | | | +6.0 | +1.1 | +2.5 | +4.2 | +2.6 | n.a. |
| Actual production | | | 7152 | 7376 | 7570 | | | |
| Capacity utilisation (%) | | | 90.5 | 92.3 | 92.4 | | | |

Note (1) **MXC = Mine expansion/contraction**
**NM = New mine**
**NSX = New SX-EW operation**
**SXE = SX-EW expansion**

**Table 4.5 Summary of mine and SX-EW capacity changes by type ('000 tpy)**

| | End 1989 | End 1990 | End 1991 | End 1992 | End 1993 | Beyond 1993 |
|---|---|---|---|---|---|---|
| **Conventional mines** | | | | | | |
| Expansion/contractions | n.a. | -11 | -94 | +97 | +36 | +30 |
| New mines | n.a. | +35 | +253 | +168 | +138 | +319 |
| Sub total | n.a. | +24 | +159 | +265 | +174 | +349 |
| **Capacity levels** | **7050** | **7074** | **7233** | **7498** | **7672** | **8021** |
| **% of total** | **89.2** | **88.5** | **88.3** | **87.9** | **87.8** | **86.9** |
| **SX-EW plants** | | | | | | |
| Expansion/contractions | n.a. | +56 | +30 | +55 | +20 | +30 |
| New plants | n.a. | +10 | +10 | +20 | +27 | +99 |
| Sub-total | n.a. | +66 | +40 | +75 | +47 | +129 |
| **Capacity levels** | **850** | **916** | **956** | **1031** | **1078** | **1207** |
| **% of total** | **10.8** | **11.5** | **11.7** | **12.1** | **12.2** | **13.1** |
| **Total conventional + SX-EW capacity** | **7900** | **7990** | **8189** | **8529** | **8750** | **9228** |
| **Changes** | **+450** | **+90** | **+199** | **+340** | **+221** | **+478** |

During our survey of new mine projects, we discovered that many of the projects currently being considered as not as far advanced as had previously been believed. This is not a surprising discovery since very few mines ever come onstream as originally planned. However, what it does mean is that 1990 and 1991 are likely to be years of **relatively modest** net additions to effective capacity worldwide. We are projecting net additions of only 90,000 tpy in 1990 and 199,000 tpy in 1991. In the context of a still growing copper market these increases are relatively small beer. Beyond 1991, however, the size of the increases begins to rise as many of the new Chilean projects come onstream and as production at Freeport Indonesia's operations begins to rise sharply. In addition, the prospect of the 180,000 tpy Bougainville mine returning to production must be reckoned with. Nevertheless, if the recent past is any experience, there will continue to be further slippages on the projected start-up dates of many of these projects. In addition, there are bound to be further announcements of capacity reductions over the 1992-1995 period beyond those that we currently know about.

The importance of the potential Chilean additions to capacity over the 1991-1995 period cannot be underemphasized. We expect Chilean capacity to rise from around 1.68m tpy at the end of 1989 to 1.92m tpy by 1992 an increase of just under 15%. The main increase over this period will come from the 320,000 tpy Escondida project which starts production early in 1991. Production plans from the project indicate that full capacity output will not be reached until 1993, although some in the industry believe that an operating rate of 340,000 tpy or even 360,000 tpy may be achievable well before 1993. It should be noted that our estimate of 1992 Chilean capacity of 1.92m tpy is considerably below some recently well-publicised forecasts of production reaching 2.3-2.5m tpy by 1992. We believe that these latter forecasts are based on over-optimstic assumptions about Codelco's output and about the timing of many of the planned projects. Our telephone interviews with a number of the promoters of many of the new projects indicate that the **earliest** that many of them will come onstream will be in 1993 and that many are unlikely to see the light of day until the mid-1990s, if at all.

Based on our projections of capacity changes, we are forecasting a 3.1% rise in Western world mine production to 7.38m tonnes in 1990, followed by a 2.6% increase in production to 7.57m tonnes in 1991.

## Refined copper production

During recent years, certainly from 1986 onwards, refined copper output has been constrained by available mine output. The "shortage" of copper concentrate output has, to a certain extent, been eased by increased availability of copper scrap, which enabled secondary refined production to rise from 1.18m tonnes in 1986 to an estimated 1.45m tonnes in 1989. However, the strong growth in SX-EW production over this period to somewhere around 825,000 tonnes in 1989, has ensured that concentrate availability has remained tight and there remains considerable excess smelter and refinery production capacity in place. This situation should not change dramatically over the next two years with increases in refined output being dictated mainly by availability of new sources of concentrate supply and additions to SX-EW capacity.

The regional distribution of refined copper production is somewhat different to that of copper output. It is still the case that the bulk of copper refinery output takes place in the main copper consuming regions of North America, Europe and Asia, which together accounted for 68.1% of refined copper output in 1989. In recent years, Latin American production has grown rapidly outside Peru, which has had its own problems, due to new refined capacity coming onstream at Codelco, and in Brazil, and to new SX-EW capacity in Chile and Mexico. Further Chilean and Mexican growth is likely in 1990 and 1991 as Codelco increases its own refined production and also as SX-EW production continues to edge upwards.

Little growth can be expected from Asia during 1990 and 1991. The closure of the Bougainville mine is limiting Japanese production (partly due to the Japanese producers' unwillingness to compete in the spot market for alternative supplies of spot concentrate).

The main area of growth in 1990 and 1991 is likely to be North America, where US SX-EW production will continue to grow strongly, especially in 1990. In addition, Magma Copper is raising its non-SX-EW refined copper output by around 70,000 tonnes during 1990. A significant part of this growth should come from the processing of concentrate from the Cananea mine in Mexico. This growth will be somewhat offset, however, by lower production from Phelps Dodge, which will become increasingly reliant on SX-EW production as the Tyrone mine is exhausted.

In total we are projecting a 2.3% growth in western world refined output to 8.635m tonnes in 1990, followed by a 1.9% rise in 1991 to 8.785m tonnes. The rises in refined copper output in 1990 and 1991 are slightly smaller than the equivalent rises in copper mine and SX-EW production (2.8% in 1990 and 2.3% in 1991). This reflects our expectation of an easing off in secondary refined production from 1989's high levels.

There are not nearly as many changes to smelter and refinery output planned over the next few years as there are mine changes. This is a reflection of the probable existing overcapacity in this area at the present time. The major smelter additions in 1990 are expected in Chile, where Codelco and Enami have planned increases totalling 170,000 tpy.

Beyond 1990 there are two major additions - the 182,000 tpy Texas City smelter in the USA and the Sines smelter in Portugal. Both are linked to the Escondida mine expansion in Chile. The Portuguese smelter would also have a linked refinery development. The other major refinery developments are in Zaire, where Gecamines is planning a 100,000 tpy refinery to become more self-sufficient in refined production and in Mexico where Industrias Reunidas plans to bring on a 60,000 tpy refinery in 1991, while Mexicana de Cobre plans a 60,000 tpy refinery for the mid-1990s.

**Table 4.6** **Major changes to copper smelter capacity ('000 tpy)**

| Country | Company | Location | 1989 Capacity | Additional capacity 1990 | 1991 | 1992 | 1993 | Beyond 1993 |
|---|---|---|---|---|---|---|---|---|
| Yugoslavia | RTB Bor | Bor | 145 | +15 | +30 | - | - | - |
| Portugal | Outokumpu/Quimigal | Sines | - | - | - | +110 | - | - |
| Philippines | Pasar | Isabel | 138 | - | +22 | +13 | - | - |
| Canada | Noranda | Horne | 174 | -12 | - | - | - | - |
| USA | Mitsubishi Metals | Texas City | - | - | - | +100 | +82 | - |
| USA | Asarco | El Paso | 73 | - | - | +18 | - | - |
| Mexico | Cananea | Santa Rosalia | 115 | +5 | +20 | +5 | - | - |
| Brazil | Caraiba Metals | Camacari | 180 | +20 | +20 | 5 | - | - |
| Brazil | Cimquima | Sao Luis | 30 | +30 | +20 | - | - | - |
| Chile | Codelco | Caletones | 400 | +10 | - | - | - | - |
| Chile | Codelco | Chuquicamata | 440 | +80 | - | - | - | - |
| Chile | Enami | Las Ventanas | 115 | +45 | - | - | - | - |
| Chile | Enami | Paipote Herman Videl | 95 | +35 | - | - | - | - |
| Australia | ER&S | Port Kembla | 30 | +30 | +20 | - | - | - |
| | **Grand Total** | | **n.a.** | **+258** | **+132** | **+246** | **82** | **-** |

**Table 4.7** **Major changes to copper refinery capacity ('000 tpy)**

| Country | Company | Location | 1989 Capacity | Additional capacity 1990 | 1991 | 1992 | 1993 | Beyond 1993 |
|---|---|---|---|---|---|---|---|---|
| Portugal | Outokumpu/Quimigal | Sines | - | - | - | +110 | - | - |
| Germany | Norddeutsche Affinerie | Hamburg | 245 | +45 | - | - | - | - |
| Italy | Nuova Samin | Porto Marghera | 45 | - | +25 | - | - | - |
| Zaire | Gecamines | Luilu | - | - | +40 | +40 | +20 | - |
| India | Hindustan Copper | Ghatsila/Moubhandar | 11 | +6 | - | - | - | +20 |
| Korea | Lucky Metals | Changhang | 20 | +25 | - | - | - | - |
| Philippines | Pasar | Isabel | 138 | - | +22 | +13 | - | - |
| India | Hindustan Copper | Khetri | - | - | | - | - | +45 |
| Mexico | Cobre de Mexico | Mexico City | 150 | +40 | - | - | - | - |
| Mexico | Industrias Reunidas | Pasteje | - | - | +60 | - | - | - |
| Mexico | Mexicana de Cobre | La Caridad | - | - | - | - | - | +60 |
| | **Grand Total** | | **n.a.** | **+116** | **+147** | **+163** | **+20** | **+125** |

**Table 4.8: Non-Socialist world copper refined production by country, 1980-1991 ('000 tonnes contained copper)**

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | *Forecast 1990* | *1991* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Germany | 374 | 387 | 394 | 420 | 379 | 414 | 422 | 400 | 426 | 475 | | |
| Belgium | 374 | 429 | 458 | 405 | 396 | 413 | 414 | 408 | 434 | 478 | | |
| France | 47 | 46 | 47 | 45 | 41 | 44 | 42 | 39 | 43 | 45 | | |
| United Kingdom | 161 | 136 | 134 | 144 | 137 | 125 | 126 | 122 | 124 | 119 | | |
| Italy | 12 | 24 | 20 | 31 | 50 | 64 | 65 | 65 | 75 | 76 | | |
| Portugal | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | | |
| Spain | 154 | 152 | 172 | 159 | 156 | 152 | 155 | 151 | 159 | 160 | | |
| Finland | 41 | 34 | 48 | 55 | 57 | 59 | 64 | 60 | 54 | 55 | | |
| Yugoslavia | 131 | 133 | 127 | 124 | 128 | 135 | 140 | 139 | 145 | 151 | | |
| Norway | 27 | 27 | 19 | 23 | 30 | 31 | 31 | 29 | 32 | 33 | | |
| Austria | 31 | 28 | 32 | 33 | 33 | 34 | 33 | 33 | 38 | 46 | | |
| Sweden | 56 | 62 | 62 | 63 | 64 | 65 | 85 | 92 | 90 | 100 | | |
| **Total Western Europe** | **1411** | **1463** | **1516** | **1507** | **1477** | **1540** | **1582** | **1543** | **1627** | **1744** | *1755* | *1780* |
| (% share of total) | 20.1 | 19.9 | 21.2 | 20.6 | 20.5 | 21.0 | 21.2 | 20.1 | 20.2 | 20.7 | *20.3* | *20.3* |
| India | 23 | 23 | 27 | 29 | 34 | 29 | 37 | 31 | 40 | 40 | | |
| Iran | 1 | 1 | 1 | 5 | 5 | 12 | 12 | 30 | 32 | 40 | | |
| Japan | 1014 | 1050 | 1075 | 1092 | 935 | 936 | 943 | 980 | 955 | 990 | | |
| Oman | 0 | 0 | 0 | 4 | 15 | 14 | 15 | 16 | 16 | 15 | | |
| Philippines | 0 | 0 | 0 | 39 | 99 | 130 | 135 | 132 | 132 | 130 | | |
| Korea | 79 | 113 | 116 | 135 | 141 | 150 | 165 | 158 | 171 | 178 | | |
| Taiwan | 20 | 53 | 47 | 38 | 48 | 47 | 50 | 47 | 43 | 41 | | |
| Turkey | 19 | 22 | 34 | 38 | 51 | 61 | 75 | 76 | 68 | 68 | | |
| **Total Asia/Middle East** | **1156** | **1263** | **1300** | **1380** | **1328** | **1379** | **1432** | **1469** | **1458** | **1502** | *1520* | *1540* |
| (% share of total) | 16.4 | 17.2 | 18.2 | 18.8 | 18.5 | 18.8 | 19.2 | 19.1 | 18.1 | 17.8 | *17.6* | *17.5* |
| Egypt | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 4 | 4 | 4 | | |
| South Africa | 148 | 145 | 143 | 158 | 148 | 146 | 143 | 147 | 139 | 146 | | |
| Zambia | 607 | 564 | 587 | 575 | 522 | 510 | 487 | 509 | 448 | 470 | | |
| Zimbabwe | 7 | 17 | 26 | 25 | 23 | 23 | 25 | 23 | 28 | 24 | | |
| Zaire | 144 | 151 | 175 | 227 | 225 | 227 | 218 | 210 | 203 | 185 | | |
| **Total Africa** | **908** | **879** | **933** | **988** | **921** | **907** | **877** | **892** | **822** | **829** | *835* | *855* |
| (% share of total) | 12.9 | 11.9 | 13.0 | 13.5 | 12.8 | 12.4 | 11.7 | 11.6 | 10.2 | 9.8 | *9.7* | *9.7* |
| Argentina | 10 | 10 | 11 | 12 | 11 | 13 | 11 | 13 | 11 | 11 | | |
| Brazil | 39 | 27 | 45 | 89 | 86 | 121 | 147 | 176 | 186 | 208 | | |
| Chile | 811 | 776 | 853 | 834 | 880 | 884 | 942 | 970 | 1013 | 1064 | | |
| Mexico | 103 | 71 | 78 | 80 | 84 | 123 | 90 | 130 | 137 | 130 | | |
| Peru | 225 | 204 | 225 | 194 | 219 | 227 | 226 | 225 | 180 | 220 | | |
| **Total Latin America** | **1187** | **1087** | **1211** | **1209** | **1280** | **1368** | **1415** | **1514** | **1526** | **1633** | *1705* | *1750* |
| (% share of total) | 16.9 | 14.8 | 16.9 | 16.5 | 17.8 | 18.7 | 19.0 | 19.7 | 19.0 | 19.3 | *19.7* | *19.9* |
| Canada | 505 | 477 | 338 | 464 | 504 | 500 | 493 | 491 | 529 | 514 | | |
| USA | 1686 | 1996 | 1683 | 1582 | 1490 | 1435 | 1480 | 1561 | 1857 | 1985 | | |
| **Total North America** | **2191** | **2473** | **2020** | **2046** | **1994** | **1934** | **1973** | **2052** | **2386** | **2499** | *2570* | *2600* |
| (% share of total) | 31.1 | 33.6 | 28.2 | 27.9 | 27.7 | 26.4 | 26.4 | 26.7 | 29.7 | 29.6 | *29.8* | *29.6* |
| Australia | 182 | 191 | 178 | 203 | 197 | 194 | 185 | 208 | 223 | 237 | *250* | *260* |
| (% share of total) | 2.6 | 2.6 | 2.5 | 2.8 | 2.7 | 2.7 | 2.5 | 2.7 | 2.8 | 2.8 | *2.9* | *3.0* |
| **Total Non-Socialist** | **7036** | **7355** | **7158** | **7332** | **7197** | **7323** | **7464** | **7679** | **8042** | **8444** | *8635* | *8785* |
| % change (year-on-year) | | 4.5 | -2.7 | 2.4 | -1.8 | 1.7 | 1.9 | 2.9 | 4.7 | 5.0 | *2.3* | *1.7* |

Figure 4.3 Refined copper production by region 1980 - 1989

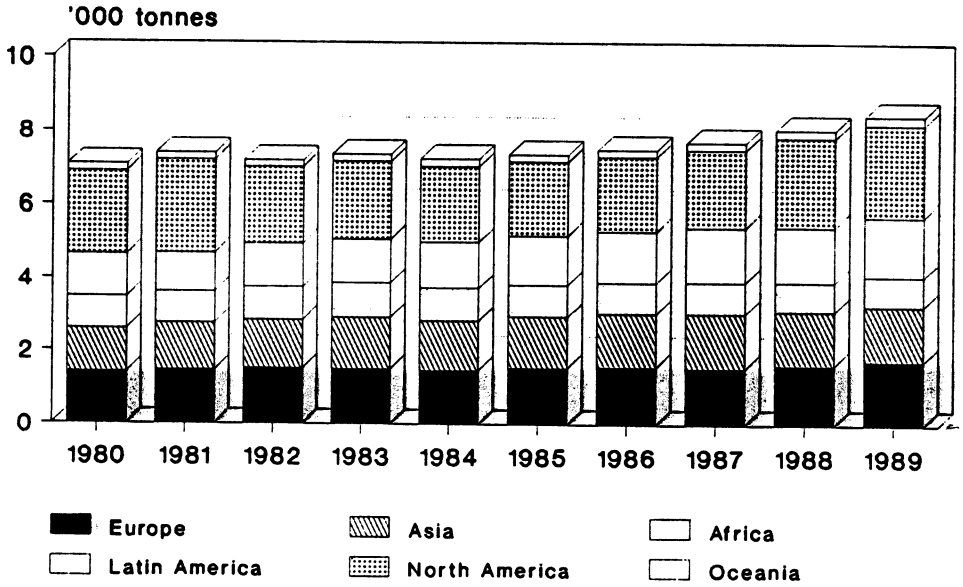
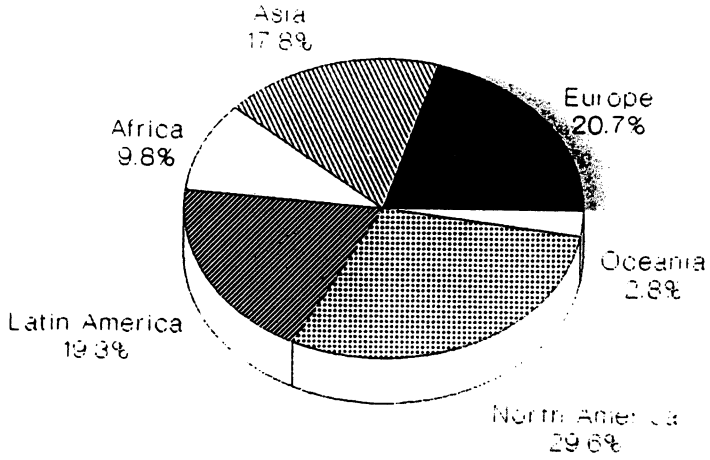



Figure 4.4 Refined copper production by region 1989 (% share)



# MINES BY COMMODITY

RANDOL MINING DIRECTORY

## E

| | | |
|---|---|---|
| TH MINES | Barite | TN |
| A MINE | Barite | NV |
| MTN OPER | Barite | NV |
| GE MINE | Barite | NV |
| SVILLE MILL | Barite | TX |
| ARKANSAS | Barite | AR |
| GRINDING PLANT | Talc Barite | TX |
| N | Barite Fluorspar | IL |
| PLANT | Barite | NY |
| REEK MILL | Barite | NV |
| EEK MINE | Barite | MT |
| AL BARITE | Barite | MO |
| N CITY PLANT | Barite | LA |
| VERSIDE OCHRE | Barite Ochre | GA |
| BARITE | Barite | NV |
| MINE | Barite | GA |

## MINE

| | | |
|---|---|---|
| NSAS CHEMICALS | Br | AR |
| RADA PLANTS | Br | AR |
| TECHNOLOGIES | Br | AR |

## S

| | | |
|---|---|---|
| EEN MILL | Bentonite | MS |
| N COUNTY MINES | Kaolin | SC |
| N KAOLIN | Kaolin | GA |
| OSA PIT | Clays | NV |
| RDAM | Fuller's earth | GA |
| LO-AMERICAN | Kaolin | GA |
| APULGUS | Fuller's earth | GA |
| N COUNTY | Clay | MO |
| ENNIS MINE | Kaolin | GA |
| COLONY MINE | Bentonite | WY |
| H MINE & MILL | Kaolin | SC |
| LE COLONY MINE | Bentonite | SD |
| FOURCHE MILL | Bentonite | SD |
| O #3 | Bentonite | NV |
| MINE | Bentonite | NV |
| ETO 16 MINE | Bentonite | AZ |
| ETO MINE | Bentonite | AZ |
| MINE | Clay | NV |
| Y EAST MILL | Bentonite | WY |
| Y MINE | Bentonite | WY |
| ONY WEST MILL | Bentonite | WY |
| ENSHAW MINE | Clay | MS |
| VILLE PLANT | Kaolin | GA |
| VALLEY MINES | Clay | CA |
| INE | Kaolin | GA |
| BRANCH MINE | Kaolin | GA |
| AR MINE | Kaolin | FL |
| PLANTS | Kaolin | GA |
| MINE | Kaolin | SC |
| A MINE | Fuller's earth | FL |
| ONIA MINES | Bentonite | TX |
| VLKES MINE | Clay | MS |
| EN COUNTY | Clay | FL |
| ER PLANT | Kaolin | GA |
| NADE COUNTY | Clay | MO |
| ALTAR MINE | Kaolin | GA |
| ASON MINE | Clay | TN |
| ON PLANT | Kaolin | GA |
| ULL MINE | Bentonite | WY |
| N MINE | Kaolin | GA |
| DIE | Kaolin | GA |
| TOR MINE | Fuller's earth | CA |
| ER KAOLIN | Kaolin | ID |
| CARROLL MINE | Clay | TN |
| CLAY MINE | Kaolin | GA |
| ER MINE | Kaolin | GA |
| ER WILKINSON | Kaolin | GA |
| ERSONVILLE | Kaolin | GA |
| E MINE & MILL | Bentonite | WY |
| YKE MINE | Kaolin | GA |
| MELIA | Fuller's earth | FL |
| GLEY MINE | Kaolin | SC |
| EBY MINE | Clay | TN |
| MINE | Clay | AZ |
| N COUNTY | Al Kaolin | GA |
| FIELD MINE | Clay | KY |
| GARY MINE | Clay | KY |
| NTYRE MINE | Kaolin | GA |
| MEIGS MINE | Fuller's earth | GA |
| MIDWAY | Fuller's earth | FL |
| MINE #1 TULSA | Clay | OK |
| MINGO MINE | Fuller's earth | SC |
| NATIONAL KAOLIN | Kaolin | SC |
| NEW DISCOVERY MINE | Bentonite | NV |
| NEW IDRIA BENTONITE | Bentonite | CA |
| OIL-DRI MINE | Fuller's earth | GA |
| PALMER MINE | Kaolin | GA |
| PULASKI COUNTY | Al Kaolin | AR |
| REDMOND CLAY & SALT | Bentonite Salt | UT |
| REDMOND PITS | Bentonite | UT |
| REEDY CREEK | Kaolin | GA |
| RICHFIELD QUARRY | Fuller's earth | UT |
| RIPLEY MINE | Fuller's earth | MS |
| SAGE CREEK MINE | Bentonite | WY |
| SANDERSVILLE MINE | Kaolin | GA |
| SCHIRADO MINE | Clay | ND |
| SCOTT MINE | Kaolin | GA |
| SHEPPARD & ROUGHTON | Kaolin | GA |
| SIMS PIT | Kaolin | GA |
| SOUTHEASTERN CLAY | Kaolin | SC |
| SOUTHERN CLAY PLANT | Ball clay | TX |
| STUCCO MINE & MILL | Bentonite | WY |
| TEAGUE MINERALS | Bentonite Zeolite | OR |
| THARPE | Kaolin | GA |
| THIELE KAOLIN | Kaolin | GA |
| THOR MINE | Clay | GA |
| TODDVILLE PLANT | Kaolin | GA |
| UPTON BENTONITE | Bentonite | WY |
| UPTON MINE & MILL | Bentonite | WY |
| WASHINGTON MINE | Kaolin | GA |
| WHITLOCK MINE | Clay | TN |
| WILBURN #2 | Al Kaolin | GA |
| WINNEMUCCA HECTORITE | Clay | NV |
| WRENS MINE | Fuller's earth | GA |
| WRENS MINE | Kaolin | GA |
| YELLOWTAIL MINE | Bentonite | WY |

## COPPER

| | | |
|---|---|---|
| APEX Ga/Ge MINE | Ge Ga Cu | UT |
| BAGDAD MINE | Cu Mo Ag | AZ |
| BINGHAM CANYON | Cu Mo Au Ag Pt | UT |
| BURRO CHIEF COPPER | Cu | NM |
| CAMP BIRD MINE | Au Ag Cu Pb Zn | CO |
| CHINO MINES 258 | Cu Mo | NM |
| COEUR MINE | Ag Cu | ID |
| CONTINENTAL PIT | Cu Mo Ag | MT |
| COPPER CLIFF MINE | Cu Ag | ID |
| COPPER QUEEN | Cu | AZ |
| COPPER RANGE | Cu Ag | MI |
| CYPRUS CASA GRANDE | Cu | AZ |
| CYPRUS MIAMI | Cu Ag | AZ |
| CYPRUS PINOS ALTOS VG | Cu Zn Ag | NM |
| CYPRUS TONOPAH | Mo Cu | NV |
| CYPRUS-SIERRITA | Cu Mo | AZ |
| EMERALD ISLE | Cu | AZ |
| GALENA MINE | Ag Cu | ID |
| GIBSON COPPER MINE | Cu | AZ |
| GOLD HILL MINE | Cu flux | AZ |
| KORN KOB MINE | Cu | AZ |
| LORDSBURG MINE | Au Ag Cu | NM |
| MAGMA MINE SUPERIOR | Cu | AZ |
| MAGMONT MINE | Pb Zn Cu | MO |
| MIAMI TAILINGS | Cu | AZ |
| MIAMI UNIT | Cu | AZ |
| MINERAL PARK MINE | Cu | AZ |
| MISSION COMPLEX | Cu Ag | AZ |
| MORENCI MINE | Cu Mo | AZ |
| PINTO VALLEY UNIT | Cu Mo | AZ |
| RAY UNIT | Cu | AZ |
| SAN MANUEL DIVISION | Cu Mo Au | AZ |
| SILVER BUTTE MINE | Au Ag Cu Zn | OR |
| ST. CLOUD MINES | Ag Cu Au | NM |
| STILLWATER | Pd Pt Cu Ni Au | MT |
| SUNNYSIDE MINE | Au Ag Cu Pb Zn | CO |
| SUNSHINE MINE | Ag Sb Cu | ID |
| TRIXIE MINE | Ag Au Cu | UT |
| TROY MINE | Ag Cu | MT |
| TYRONE MINE & MILL 264 | Cu | NM |
| UNITED VERDE MINE | Cu | AZ |
| VIBURNUM MINES | Pb Zn Cu | MO |
| VULTURE MINE | Cu | AZ |
| WARD MOUNTAIN MINE | Zn Pb Cu Ag | NV |
| WESTERN WORLD PROJECT | Cu Au Ag | CA |

## DIATOMITE

| | | |
|---|---|---|
| BASALT MINE | Diatomite | NV |
| CELATOM MINE | Diatomite | OR |
| CHRISTMAS VALLEY | Diatomite | OR |
| CLARK MINE | Diatomite | NV |
| COLADO MINE | Diatomite | NV |
| DIBBLEE MINE | Diatomite | CA |
| FERNLEY OPERATIONS | Diatomite | NV |
| HAZEN PIT | Diatomite | NV |
| LOMPOC PLANT | Diatomite | CA |
| MOLTAN MINE | Diatomite | NV |
| PLANT #1 WITCO | Diatomite | WA |
| PLANT #2 WITCO | Diatomite | WA |
| TOLBERT MINE | Diatomite | CA |
| WHITECLIFF | Diatomite | AZ |

## FELDSPAR

| | | |
|---|---|---|
| BLAND MINE | Feldspar | SD |
| BUNA MINE | Feldspar | NC |
| CHALK MOUNTAIN | Feldspar Mica | NC |
| CUSTER MILL | Potash Feldspar | SD |
| DELHI MINE | Feldspar | GA |
| FELDSPAR & CRYSTAL | Feldspar | NC |
| FELDSPAR CORPORATION | Feldspar Mica | CT |
| HAWKINS MINE | Feldspar | NC |
| PACOLET MILL | Feldspar Mica | SC |
| PINE MOUNTAIN | Feldspar | NC |
| QUARTZ OPERATIONS | Feldspar | NC |
| SHADY DALE MINE | Feldspar | GA |
| SILOAM MINE | Feldspar | GA |
| SULLINS-WISEMAN | Feldspar Mica | NC |

## GILSONITE

| | | |
|---|---|---|
| BONANZA #12 | Gilsonite | UT |
| BONANZA #3 SHAFT | Gilsonite | UT |
| BONANZA MINE | Gilsonite | UT |
| INDEPENDENT #5 | Gilsonite | UT |

## GOLD/SILVER

| | | |
|---|---|---|
| AJAX PROJECT | Au | CO |
| ALTO/IBEX | Au | UT |
| ANNIE CREEK MINE | Au Ag | SD |
| ANVIL MINE | Au | AK |
| ARAGON HILL MINE | Au | NM |
| ARGENTINE EDELWEISS | Au Ag Pb Zn | MT |
| ASARCO LEADVILLE | Pb Zn Au Ag | CO |
| ASH PEAK MINE | Ag Au | AZ |
| ATLANTIC & PACIFIC | Au | MT |
| ATLAS GOLD BAR MINE | Au Ag | NV |
| AURORA MINE | Au Ag | NV |
| AUSTIN VENTURE | Au | NV |
| B AND B MINING | Au | MT |
| BAGDAD MINE | Cu Mo Ag | AZ |
| BALD MOUNTAIN MINE | Au | NV |
| BARNEYS CANYON MINE | Au | UT |
| BASIN CREEK MINE | Au Ag | MT |
| BATTEST PLACER | Au | AK |
| BATTLE MOUNTAIN GOLD | Au Ag | NV |
| BAYLESS MINING | Au | AK |
| BEAL MOUNTAIN | Au Ag | MT |
| BEAVER STATE MINE | Sn Au | AK |
| BEE HIVE MINE | Au | AK |
| BIG NUGGET MINE | Au | AK |
| BIG NUGGET PLACER | Au | MT |
| BIG SPRINGS MINE | Au | NV |
| BIGHORN MINE | Au Ag | AZ |
| BILLINGS & TRAXLER | Au | AK |
| BINGHAM CANYON | Cu Mo Au Ag Pt | UT |
| BLACKSTONE MINE | Au Ag Pd | ID |
| BLUE JET MINE | Au Ag | CO |
| BLUE STAR MINE | Au | NV |
| BOREALIS MINE | Au | NV |
| BREWER MINE | Au | SC |
| BUCKHORN MINE | Au Ag | NV |
| BUCKSKIN MILL | Au Ag | NV |
| BUFFALO VALLEY MINE | Au | NV |
| BULLFROG PROJECT | Au Ag | NV |
| BUNKER HILL MINE | Zn Pb Ag | ID |
| BUSTER CREEK MINE | Au | AK |
| CABLE PLACER | Au | MT |
| CACHE CREEK | Au Ag Sn | AK |
| CACTUS GOLD MINE | Au Ag | CA |
| CAMP BIRD MINE | Au Ag Cu Pb Zn | CO |
| CANDELARIA MINE | Ag Au | NV |
| CANNON MINE | Au Ag | WA |
| CANYON PLACER | Au | NV |
| CAPE CREEK | Sn W Ag Pt | AK |
| CARGO MUCHACHO MINE | Au | CA |
| CARLIN DEPOSIT | Au | NV |
| CARLO AND SONS MINE | Au | AK |
| CASH MINE | Au Ag | CO |
| CASSILL MINE | Au | CA |
| CHAMPAGNE MINE | Au | ID |
| CHIMNEY CREEK MINE | Au | NV |
| CHRISTY-DESTINY | Au Rare earths | NC |
| COEUR MINE | Ag Cu | ID |
| COEUR-THUNDER MOUNTAIN | Au Ag | ID |
| COLOSSEUM GOLD MINE | Au | CA |
| CONTINENTAL PIT | Cu Mo Ag | MT |
| COPPER CLIFF MINE | Cu Ag | ID |
| COPPER RANGE | Cu Ag | MI |
| COPPERSTONE MINE | Au | AZ |
| CORTEZ GOLD MINES JV | Au Ag | NV |
| CRIPPLE CREEK | Au | CO |
| CROFOOT MINE | Au Ag | NV |
| CROSS MINE | Au Ag | CO |
| CRUSE/BELMONT MINE | Au | MT |
| CYPRUS MIAMI | Cu Ag | AZ |
| CYPRUS PINOS ALTOS | Cu Zn Ag | NM |
| DEE GOLD MINE | Au Ag | NV |
| DELAMAR SILVER MINE | Ag Au | ID |
| DEVILS WASH | Au | AZ |
| DRUM MINE | Au | UT |
| EASY JUNIOR MINE | Au | NV |
| ELDER CREEK MINE | Au | NV |
| ENGSTROM DREDGE | Au | AK |
| ERMA MINE | Au | MT |
| ESTES MOUNTAIN | Au Ag | ID |
| FEATHER FORK MINE | Au | CA |
| FISH CREEK PLACER | Au | AK |
| FLORIDA CANYON MINE | Au Ag | NV |
| FLUMEHOUSE MINE | Au | CA |
| FONDEWAY CANYON | Au | NV |
| FORTUNE COOKIE MINE | Au | NV |
| FOURTH OF JULY MINE | Ag Pb Au W | ID |
| FRIDA MARIE GROUP | Au | MT |
| GALENA MINE | Ag Cu | ID |
| GENERAL CUSTER | Au Ag | ID |
| GENESIS MINE | Au | NV |
| GETCHELL MINE | Au | NV |
| GILT EDGE MINE | Au | SD |
| GLASS MINE | Pb Ag | WA |
| GLISTER PROJECT | Au Ag | NV |
| GOLD BAR MINE | Au Ag | NV |
| GOLD BUG MINE | Au | AZ |
| GOLD KING EXTENSION | Au Ag | CO |
| GOLD LINKS | Au | CO |
| GOLD QUARRY MINE | Au | NV |
| GOLD STAR OPEN PIT | Au | CO |
| GOLDEN BUTTE MINE | Au | NV |
| GOLDEN HORN MINE | Au Ag | AK |
| GOLDEN JUBILEE | Au Ag | MT |
| GOLDEN REWARD MINE | Au Ag | SD |
| GOLDEN SUNLIGHT | Au | MT |
| GOLDSTRIKE MINE | Au | NV |
| GOLDSTRIKE MINE | Au Ag | UT |
| GOLDSTRIPE MINE | Au | CA |
| GOOSEBERRY MINE | Au Ag | NV |
| GRANT MINE | Au Ag | AK |
| GREAT NORTHERN 1 | Ag Au | CA |
| GREEN SPRINGS MINE | Au | NV |
| GREENS CREEK | Au Ag Zn Pb | AK |
| HAILE MINE | Au | SC |
| HART MINE | Au Ag | AK |
| HELEN RAE GROUP | Au | NM |
| HOG RANCH MINE | Au | NV |
| HOMESTAKE MINE | Au | SD |
| HUMMINGBIRD | Au | NM |
| INDEPENDENCE MINE | Au Ag | AK |
| JAMESTOWN MINE | Au Ag | CA |
| JENSEN MINE | Au | AK |
| JERRITT CANYON MINE | Au | NV |

divert the Valdez River in order to continue mining. Open pit placer mine was operated yearround since 1987 with a strip ratio of 20:1. Ore processed 1988: 492,869 cu yd @ 0.092 oz Au/cu yd; 1987: 362,669 cu yd @ 0.089 oz Au/cu yd; 1986: 169,090 cu yd @ 0.079 oz Au/cu yd; 1985: 306,743 cu yd @ 0.0838 oz Au/cu yd. Mining equipment: 11-cu-yd Hitachi 801 loader, two 13-cu-yd shovels, one Cat 992 and three Cat 988 loaders, eight 50-ton trucks, four 85-ton trucks.

**Processing:** Plant at minesite. Gravity (sluice) plant operated year-round with heated water and covered sluices. Gravity concentrates are treated over screens, followed by jigs for coarse gold, Knudsen bowls and final clean-up on a Gold Harvesters Gemini Table. Au recovery 98%.

**Employees:** 180 in 1989

**Personnel:** Richard Hughes, Gen. Mgr.
Greg Archibald, Admin. Super., Treasurer
Larry Jackson, Env. Coord.

**Cap. Costs:** $15 million estimated; $3.3 million in 1988 for plant and mining equipment.

**Oper. Costs:** 1989: $393/oz Au operating cost, $377/oz Au cash cost; 1988: $427/oz Au operating cost, $451/oz Au cash cost.

**Comments:** Valdez Creek Mining Company also holds lease to 50 mining claims owned by Aspen Exploration Corporation. Claims are upstream from the Valdez Creek Mine; estimated 300,000 oz of placer gold reserve.

## VOLCANO CREEK MINE

S Au PL

**Location:** Near Fairbanks, at Volcano Creek, AK
1610 Southern, Fairbanks, AK 99701

**Telephone:** 907/456-6752

**Owners:** Wayne Gibson

**Mine:** Placer operation with recovery by sluice, jigs, trommel.

**Employees:** 4

## WADE CREEK MINE

Au

**Location:** Yukon River County, AK

**Operator:** Alyeska Oil & Exploration, Inc.
P.O. Box 737, Tok, AK 99780

**Contact:** Glenn Couch

**Admin.:** Alyeska Oil & Exploration, Inc.
P.O. Box 74423, Fairbanks, AK 99703

## WAGNER CLAIMS

Au

**Location:** Near Sunrise, Kenai Peninsula, AK

**Operator:** John J. Trautner
Box 909, Girdwood, AK 99587

**Geology:** Greywackie shale with quartz intrusions.

## WALKER FORK MINE

*** Au UG PL

**Location:** Near Fairbanks, AK
P.O. Box 81552, Fairbanks, AK 99708

**Telephone:** 907/479-4927

**Owners:** Dave Heflinger

**Mine:** Seasonal placer operation.

## WILLOW CREEK MINE

**** Au PL

**Location:** Willow Creek, Eagle Quadrangle, AK

**Operator:** Kachemak Mining Corporation
47660 Falls Creek Drive, Homer, AK 99603

**Telephone:** 907/

**Contact:** Mike

**Admin.:** Robe
6419 , CO 80111

**Employees:** 2

## YAKATAGA BEAC..

I Au PL

**Location:** 250 mi W of Juneau, Yakataga Beach at Cape Yakataga, Bering Glacier County, AK

**Reserves:** 1,500,000 cu yd @ 0.027 oz Au/cu yd

**Processing:** 500 cu yd/hr plant used screen, Reichert spirals, shaking tables. Garnet by-product.

**Comments:** Property previously operated by Alaskagold Mines Inc., Vancouver, BC. Claims abandoned in 1989.

## YELLOW PUP MINE

Au

**Location:** Yukon River County, AK

**Operator:** Yellow Pup Mining Company
2920 Monzulla Lane, Fairbanks, AK 99701

## ZERBE MINE

Au PL

**Location:** Iron Creek, AK

**Operator:** Les P. Zerbe
356 Louise Lane, Fairbanks, AK 99709

**Telephone:** 907/479-3779

**Processing:** Screen plant with oversize chutes. Settling and recycling pond system for reclamation of tailings.

# ARIZONA

## AJO MINE

**Alt. Names:** See New Cornelia Mine

## ARABIAN MINE

E Au OP

**Location:** San Francisco Mining District, Mohave County, AZ

**Owners:** Westar Limited and General Partnership; announcement 1/90 of letter of intent signed with Mohave Gold, Inc. for the purchase of the mine through acquisition of Westar.

**Admin.:** Westar Corporation
333 Rancho Drive #825, Las Vegas, NV 89106

**Telephone:** 702/647-6009

**Contact:** Daniel Demers, President

**Reserves:** Drill-indicated reserve of 850,0000based on 100-150 ft centers.

**Mine:** Open pit, heap leach target. Strip ratio 1.9:1.

## ARIZONA 1

*** U UG CCD

**Location:** Arizona Strip area, 45 mi SW of Fredonia, Mohave County, AZ

**Operator:** Energy Fuels Nuclear, Inc.
P.O. Box 36, Fredonia, AZ 86022

**Telephone:** 602/643-7321

**Contact:** Roger B. Smith, Manager Mining Operations

**Owners:** Energy Fuels Nuclear, Inc.

**Admin.:** Energy Fuels Nuclear, Inc.
1200 Seventeenth Street #2500, Denver, CO 80202



**Telephone:** 303/623-8317 **Fax:** 303/595-0930

**Contact:** Muril Vincelette, Vice President Operations

**Geology:** Breccia pipe.

**Reserves:** 3-5 million lb U3O8. Average grade is 0.63% U3O8.

**Start-up:** 1990 (projected)

**Mine:** Mine is under development.

**Processing:** Ore will be processed at the White Mesa Mill at Blanding, UT, which uses acid leach and CCD.

**Employees:** 36

## ASH PEAK MINE

**** Ag, Au UG

**Location:** Near Duncan, 9 mi W on Hwy 70, Greenlee County, AZ

**Operator:** Arizona Flux Mines, Inc.
1630 S. Alvernon Way, Tucson, AZ 85711

**Telephone:** 602/881-2919

**Contact:** Wes Becker, Sr., President

**Owners:** Arizona Flux Mines, Inc., subsidiary of Canamin Resources Limited (100%)

**Start-up:** 1985

**Mine:** Mining rate is 200 stpd. Produces high-silica flux with by-product Au and Ag.

**Employees:** 20

**Personnel:** Les Billingsley, Gen. Mgr.
Wes Becker, Sr., Pres.

**Comments:** Mines Ag- and Au-bearing silica which is sold to the copper smelters as flux.

## B & F MINE

I Au HL CC

**Location:** AZ

**Operator:** B & F Mining Company
1140 Franklin Drive, Kingman, AZ 86401

**Telephone:** 602/769-2303

**Contact:** Hollis Ferguson

## BAGDAD MINE

**** Cu, Mo, Ag OP HL SX-EW

**Location:** Yavapai County, AZ

**Operator:** Cyprus Bagdad Copper Corporation
P.O. Box 245, Bagdad, AZ 86321

**Telephone:** 602/633-2241 **Fax:** 602/633-4290

**Contact:** Harry W. Cosner, Vice President, General Manager

**Owners:** Cyprus Copper Company

**Admin.:** Cyprus Minerals Company
P.O. Box 3299, 9100 E. Mineral Circle, Englewood, CO 80112

**Telephone:** 303/643-5000 **Fax:** 303/643-5049

**Contact:** Donald P. Bellum, Senior Vice President Metals

**Reserves:** 605,600,000 st proven reserves @ 0.43% Cu

**Production:** 1988: 200,600,000 lb Cu, 6,400,000 lb Mo.

**Mine:** Open pit mine with sulfide ore and a small amount of oxide ore. Molybdenum and silver produced as by-products.

**Processing:** 55,000 stpd sulfide ore concentrator produces Cu and Mo concentrates. Current mill capacity is 21 million stpa; throughput will increase from 57,000 stpd to 71,000 stpd upon completion of $21 million expansion in mid-1990, which will add 14,000 stpd to the current grinding capacity. Heap leach system with SX-EW plant produces copper cathode.

**Employees:** 672

**Personnel:** Harry W. Cosner, VP, Gen. Mgr.
R. J. Cunningham, Mgr. Admin.
J. S. Bush, Mgr. Human Res.
T. H. McNamara, Mgr. Mining
Everton Sequeira, Ch. Mine Eng.
Guy Granger, Plant Ops. Mgr.
Joe Mortimer, Safety Dir., Env. Coord.
D. L. Mead, Mgr. Community Serv.

## BIGHORN MINE

**** Au, Ag OP HL CC

**Alt. Names:** U.S. Mine

**Location:** 93 mi WNW of Phoenix, 35 mi from Wickenburg, Bighorn District, Maricopa County, AZ

**Operator:** Roddy Resources (Arizona) Inc.
P.O. Box 2406, 990 Whipple Street, Wickenburg, AZ 85358

**Telephone:** 602/684-2865 **Fax:** 602/684-3256

**Contact:** Walter Cullum, General Manager

**Owners:** Roddy Resources Inc.

**Admin.:** Roddy Resources Inc.
1215, 111 Richmond Street W., Toronto, Ontario Canada M5H 2G4

**Telephone:** 416/364-0444 **Fax:** 416/364-2753

**Contact:** Jack Lovelock, President

**Reserves:** 1,100,000 st @ 0.059 oz Au/st, 0.15 oz Ag/st

**Production:** 12-15,000 oz Au/yr estimated; 1988: 1,907 oz Au.

**Start-up:** 1987

**Mine:** 1500 stpd open pit mine. Mining suspended October, 1989 and will reopen 1/90. Ore is crushed to heap leach size in two-stage crushing system.

**Processing:** Second HL pad with a capacity of 400,000 st ore was completed 2/88, and work had commenced on the third leach pad, which is designed to accommodate over 1,000,000 st ore. Au is recovered using carbon columns. Production capacity is 1,000 oz Au/mo.

**Employees:** 3

**Personnel:** Walter Cullum, Gen. Mgr.
Ken Childers, Proj. Mgr.
Elfie Childers, Purch. Agent

**Cap. Costs:** $3.5-4.0 million

## BISBEE OPERATIONS

**Alt. Names:** See Copper Queen

## BLACK BUTTE PROPERTY

E Au, Cu

**Location:** 65 mi W of Phoenix, Maricopa County, AZ

**Owners:** Rhyolite Resources, Inc. (100%)

**Admin.:** Rhyolite Resources, Inc.
300, 535 Thurlow Street, Vancouver, BC Canada V6F 3L2

**Telephone:** 604/685-6361

**Contact:** John Bissett, President

## BLACK DYKE PROPERTY

E Au OP HL

**Location:** Between the Portland and Tyro Mines, Black Range Mountains, Mohave County, AZ

**Operator:** Western States Minerals Corporation
P.O. Box 6367, Kingman, AZ 86402

**Contact:** Rick Fiddler, Mine Manager

**Owners:** Denys Poyner (lessor)

**Admin.:** Western States Minerals Corporation
4975 Van Gordon Street, Wheat Ridge, CO 80033

**Telephone:** 303/425-7042 **Fax:** 303/233-1525
**Reserves:** 200,000 st @ 0.04 oz Au/st possible reserves.
**Start-up:** Evaluation stage 1987
**Mine:** Open pit, heap leach evaluation, possibly in conjunction with the adjoining Roadside Property which in 1987 was leased to Ivy Minerals, Bullhead City, AZ.

## BLACK PIT

**Pumice**

**Location:** Coconino County, AZ
**Operator:** Flagstaff Cinder Sales Inc.
P.O. Box 2796, Flagstaff, AZ 86003
**Employees:** 7

## BONANAZA

**Au** **OP**

**Location:** Gila County, AZ
**Operator:** Charlie Nichols
P.O. Box 752, Globe, AZ 85502

## BOWIE CHABAZITE OPERATION

**Chabazite** **OP**

**Location:** Graham County, AZ
**Operator:** Union Carbide Molecular Sieves
P.O. Box 1029, Grand Junction, CO 81502
**Telephone:** 303/245-3700
**Owners:** Joint venture: Allied Signal Inc., Union Carbide Corporation, Norton Co., GSA Resources Inc.
**Mine:** Sodium chabazite used in odor control and pollution control products.Mined by contract miners.
**Employees:** 9
**Personnel:** Jim Kirchner, Sr. Mining Eng.

## BURRO CREEK PROJECT

** **Au, Ag** **OP HL**

**Location:** Off Hwy 93, 65 mi SE of Kingman, Mohave County, AZ
**Operator:** Corval Development Inc.
P.O. Box 98, Yucca, AZ 86438
**Telephone:** 602/878-3944
**Contact:** Kevin Hanna, Project Manager
**Owners:** Corval Development Inc., U.S. subsidiary of Arizona Silver Corporation (50%)
**Admin.:** Arizona Silver Corporation
1140, 625 Howe Street, Vancouver, BC Canada V6C 2T6
**Telephone:** 604/689-5588 **Fax:** 604/689-4143
**Contact:** Corwin Coe, Vice President Operations
**Reserves:** 2,600,000 st @ 0.03 oz Au/st, 1.10 oz Ag/st including 1,000,000 st @ 0.04 oz Au/st and 1.5 oz Ag/st; 85% proven reserve category.
**Mine:** Feasibility study recommends production rate of 400,000 stpa mining rate to produce 10,000 oz Au and 150,000 oz Ag annually. Three year mine life projected. Stripping ratio of 1:1.
**Processing:** Bulk sample heap leach column tests yield recoveries of 70% Au and 35% Ag after 45 days on minus 3/8 inch crushed ore. Total cyanide consumption at 1.0 lb/st.
**Cap. Costs:** $2.4 million projected.
**Comments:** Permits approved and haulage road is completed.

## BURRO CREEK SAPONITE

**** **Saponite** **OP**

**Location:** 8 mi SW of Bagdad on Burro Creek, AZ
**Operator:** GSA Resources Inc.
P.O. Box 509, Cortaro, AZ 85652
**Telephone:** 602/297-4330
**Contact:** Ted H. Eyde, President
**Comments:** A major portion of the deposit is located in a wilderness study area.

## CANYON MINE

**S, *** U** **UG**

**Alt. Names:** Red Butte
**Location:** 45 mi N of Williams, Coconino County, AZ
**Operator:** Energy Fuels Nuclear, Inc.
P.O. Box 36, Fredonia, AZ 86022
**Telephone:** 602/643-7321
**Contact:** Roger Smith, Manager Mining Operations
**Owners:** Energy Fuels Nuclear, Inc. (40%), Uranerz U.S.A., Inc. (60%)
**Admin.:** Energy Fuels Nuclear, Inc.
1200 Seventeenth Street #2500, Denver, CO 80202
**Telephone:** 303/623-8317 **Fax:** 303/595-0930
**Contact:** Murll Vincelette, Vice President Operations
**Geology:** Breccia pipe.
**Reserves:** 3 million lb U3O8
**Mine:** Mine is on standby status.
**Processing:** White Mesa Mill at Blanding, UT. 2000 stpd mill uses acid leach.
**Employees:** 5

## CBH LIMITED PARTNERSHIP

**Au** **OP**

**Location:** Mohave County, AZ
**Operator:** C. B. H. Limited Partnership
375 London Bridge Road, Lake Havasu, AZ 86403
**Employees:** 2

## CHETO MINE

**** **Bentonite** **OP**

**Location:** 6 mi SE of Sanders, Apache County, AZ
**Operator:** Filtrol Corporation
P.O. Box 155, Sanders, AZ 86512
**Telephone:** 602/688-2785
**Contact:** Gary McDonald, General Superintendent
**Owners:** Engelhard Corporation
**Admin.:** Engelhard Corporation
Menlo Park, CN 40, Edison, NJ 08818
**Telephone:** 201/632-6000
**Employees:** 6

## CHETO NO. 1

**Bentonite** **OP**

**Location:** 6 mi SE of Sanders, AZ
**Contact:** Robert Deuble, Operations Manager (505/864-6691)
**Owners:** United Catalysts, Inc.
**Admin.:** United Catalysts, Inc.
P.O. Box 32370, Louisville, KY 40232
**Telephone:** 502/634-7200
**Mine:** Seasonal operation.





**Processing:** Processing plant: c/o United Dessicants, P.O. Box 105, Belen, NM 87002, 505/864-6691.

## CHETO SECTION 16 MINE

**** **Bentonite** **OP**

**Location:** 5 mi SE of Sanders, AZ
**Operator:** GSA Resources Inc.
P.O. Box 509, Cortaro, AZ 85652
**Telephone:** 602/297-4330
**Contact:** Ted H. Eyde, President
**Production:** Produces desiccant grade clays.

## CHICAGO PIT

**** **Perlite** **OP**

**Location:** 2 mi SW of Superior, AZ
**Operator:** Nord Perlite Company
Box 127, Superior, AZ 85273
**Telephone:** 602/689-5631
**Contact:** Louis R. Lucero, Plant Manager
**Admin.:** Nord Resources Corporation
8150 Washington Village Drive, Dayton, OH 45458
**Telephone:** 513/433-6307 **Fax:** 513/435-7285
**Contact:** Dr. Edgar F. Cruft, Chairman
**Processing:** Plant is at Superior, on Silver King Mine Road.
**Employees:** 5

## CLARKDALE QUARRY

**** **Limestone** **OP**

**Location:** NW of Clarkdale, AZ
**Operator:** Phoenix Cement Company
P.O. Box 428, Clarkdale, AZ 86324
**Telephone:** 602/634-2261
**Owners:** Phoenix Cement Company, owned by the Salt River Indian Tribe
**Admin.:** Phoenix Cement Company
2505 W. Beryl, Phoenix, AZ 85069
**Telephone:** 602/264-0511
**Contact:** John N. Stoss, President
**Employees:** 107
**Personnel:** John Conway, VP Operations, Plant Mgr.
Frank Contreras, Purch. Agent
Cliff Ayres, Quarry/Crushing Mgr.
Joe D'Avignon, Asst. Plant Mgr., Maint.
Tom Gibbons, Asst, Plant Mgr., Eng.
Richard Huffman, Controller
Richard Gardner, Operations/Shipping

## CLEMENTINE MINE

**S, *** Au**

**Location:** 32 mi NW of Phoenix, AZ
**Owners:** Jefferson Valley Gold Mines Inc. (100%)
**Admin.:** Jefferson Valley Gold Mines Inc.
906, 101 Richmond Street W., Toronto, Ontario Canada M5H 1T1
**Telephone:** 416/364-9126 **Fax:** 416/364-2527
**Contact:** Irwin Singer, President
**Comments:** East-West Resources, Inc., California, terminated its joint venture participation after processing a bulk sample of ore in early 1989.

## COCHISE COPPER PROJECT

* **Cu** **HL**

**Location:** Near Bisbee, Cochise County, AZ
**Operator:** Phelps Dodge Corporation
Highway 92, Bisbee, AZ 85603
**Telephone:** 602/432-3621 **Fax:** 602/432-5252
**Contact:** J. H. Ladd, General Superintendent
**Owners:** Phelps Dodge Corporation (100%)
**Admin.:** Phelps Dodge Corporation
2600 N. Central Avenue, Phoenix, AZ 85004-3014
**Telephone:** 602/234-8100
**Processing:** Heap leach target and recovery by SX-EW. Engineering studies and cost estimates being prepared.

## COD

*** **Au** **UG**

**Location:** 15 mi NW of Kingman, AZ
**Admin.:** Alanco Ltd.
7345 E. Acoma Drive, Scottsdale, AZ 85260
**Telephone:** 602/991-8540
**Employees:** 5
**Personnel:** Chuck Porter, Mgr.
**Comments:** Under development.

## COLUMBIA GOLD MILL

**Au** **Mill**

**Location:** Yavapai County, AZ
**Operator:** Columbia Gold Production Company Inc.
P.O. Box 41773, Phoenix, AZ 85080
**Employees:** 2

## CONGRESS GOLD MINE

*** **Au** **UG**

**Location:** 65 mi NW of Phoenix, 16 mi NW of Wickenburg, Yavapai County, AZ
**Operator:** Malartic Hygrade U.S. Inc.
P.O. Box 361, Congress, AZ 85332
**Telephone:** 602/427-3633
**Contact:** James Sullivan, Vice President Operations
**Owners:** Malartic Hygrade Gold Mines (Canada) Ltd. (100%)
**Admin.:** Malartic Hygrade Gold Mines (Canada) Ltd.
2402, 1 Dundas Street W., Toronto, Ontario Canada M5G 1Z3
**Telephone:** 416/977-4653 **Fax:** 416/977-8335
**Contact:** Marc C. Henderson, President
**Geology:** Quartz and carbonate veins filling two faults in granite rock. Congress vein is mineralized to a depth of at least 3,900 ft and is 3 to 7 ft thick, 1,300 ft long; Niagara vein is 1 to 10 ft thick along 4,000 ft strike length and is open at depth.
**Reserves:** Proven and probable reserves of 462,000 st @ 0.29 oz Au/st. Additional reserve potential to double current 5 year mine life.
**Contained:** 134,000 oz Au
**Production:** 1989: 1369 oz Au; 1988: 16,176 oz Au in first 8 months of production. Mine shut down early 1989. Malartic Hygrade, the new owner, anticipates production of 30,000 oz Au annually.
**Start-up:** 1988
**Mine:** 54,579 st ore @ 0.322 oz Au/st (243 stpd) mined in 1988. Mining is by end slicing stoping method. Sub-levels are developed at 28 ft vertical intervals in the vein. Ore is currently stockpiled on the surface awaiting commissioning of the new 350 stpd mill. Ore was previously trucked to a smelter 350 mi away and used as a siliceous flux. Trucking was discontinued early 1989 due to high trucking costs.

**Processing:** Ore to be crushed and ground in ball mills and Au recovered by direct cyanidation. Estimated Au recovery is 92% using 87% minus 200 mesh, and leaching for 72 hours. A 350 stpd diesel-powered mill is being built on site, capable of expansion to 500 stpd.

**Employees:** 43

**Personnel:** Robert L. Stoughton, Gen. Mgr.
Doug Perkins, Ch. Maint. Super.
Matt Christian, Ch. Eng.

**Cap. Costs:** $8,000,000 development and expansion costs.

**Oper. Costs:** $233/oz Au cash production costs, $300+/oz including transportation costs; construction of mill could lower cash costs to less than $250/oz Au.

**Comments:** Purchased from Echo Bay Mines Ltd. in the second quarter of 1989. The mine produced approximately 388,000 oz Au from 692,000 st between 1888 and 1920, primarily from the Congress vein.

## CONTENTION

**Ag** **OP**

**Location:** Cochise County, AZ

**Operator:** Cochise Silver Mines, Inc.
P.O. Box 158, Tombstone, AZ 85638

## COPPER BASIN DEPOSIT

* **Cu, Mo**

**Location:** SW of Prescott, Yavapai County, AZ

**Owners:** Phelps Dodge Corporation (100%)

**Admin.:** Phelps Dodge Corporation
2600 N. Central Avenue, Phoenix, AZ 85004-3014

**Telephone:** 602/234-8100

**Contact:** Patrick Ryan, Senior Vice President

**Reserves:** Low-grade sulfide deposit containing 175,000,000 st @ 0.55% Cu, 0.021% Mo.

**Comments:** Preparation of EIS continued in 1989 in order to arrange land exchanges with the Forest Service and BLM necessary for development of the property; Forest Service review in its final phase and third party for EIS chosen as of 1/90.

## COPPER HILL MINE

**** **Silica flux** **OP**

**Location:** NW of Globe, AZ

**Operator:** Triple Nichol Inc.
R.R. 1, Box N 123, Globe, AZ 85501

**Telephone:** 602/425-7006

**Contact:** Monty Nichols, President

**Owners:** Triple Nichol Inc.

**Mine:** Mine produces silica flux for copper smelters.

## COPPER QUEEN

**** **Cu** **OP HL**

**Alt. Names:** Bisbee Operations

**Location:** Bisbee, Cochise County, AZ

**Operator:** Phelps Dodge Corporation
Highway 92, Bisbee, AZ 85603

**Telephone:** 602/432-3621 **Fax:** 602/432-5252

**Contact:** J. H. Ladd, General Superintendent

**Owners:** Phelps Dodge Corporation (100%)

**Admin.:** Phelps Dodge Corporation
2600 N. Central Avenue, Phoenix, AZ 85004-3014

**Telephone:** 602/234-8100

**Production:** 1988: 5500 st Cu; 1987: 10,900 st Cu; 1986: 8800 st Cu; 1985: 5400 st Cu.

**Mine:** Pit closed in 1979; heap leach operation only.

**Employees:** 50

## COPPERSTONE MINE

**** **Au** **OP CIP**

**Alt. Names:** Cyprus Copperstone Mine

**Location:** Near Parker, 13 mi N of Quartzite on A295, then 5 mi on plant road, La Paz County, AZ

**Operator:** Cyprus Copperstone Gold Corporation
P.O. Box AI, Parker, AZ 85344

**Telephone:** 619/665-9261 **Fax:** 619/665-8636

**Contact:** Mike L. Schroder, General Manager

**Owners:** Cyprus Gold Company (100%)

**Admin.:** Cyprus Minerals Company
P.O. Box 3299, 9100 E. Mineral Circle, Englewood, CO 80112

**Telephone:** 303/643-5000 **Fax:** 303/643-5049

**Contact:** Donald P. Bellum, Senior Vice President Metals

**Reserves:** 3,553,000 st @ 0.069 oz Au/st; ore contains traces of Cu and Ag. Remaining mine life is 3 years.

**Contained:** 245,400 oz Au

**Production:** 1990e: 75,000 oz Au; 1989: 73,000 oz Au; 1988: 62,800 oz Au.

**Start-up:** October 1987

**Mine:** Open pit: 3000 stpd ore, 28,000 stpd waste; strip ratio 10:1. Ore grade 0.07 oz Au/st 1987-1988. Morrison Knudsen is the contract miner. Underground mine development discontinued due to poor mining conditions, lower grades and environmental factors.

**Processing:** 1 million stpa milled in a conventional ball mill, then leached in cyanide followed by CIP; recovery of Au approximately 88%.

**Employees:** 115 including 60 contract miners

**Personnel:** Mike L. Schroder, Gen. Mgr.
Gary Eastham, Ops. Super.
Marc A. Browning, Admin. Super.
George R. Burns, Mine Super.
Graham Kelsey, Mine Geol.
Joe F. Hatrick, Sr. Mine Eng.
Scott Anderson, Mining Eng.
K. G. Markkola, Mill Super.
Jim A. Cole, Metall. Super., Ch. Assayer
E. P. Sours, Mill Maint. Super.
Susan Fullmer, Human Res., Safety Super., Env. Coord.

**Cap. Costs:** $20 million estimated.

## CROWN CLAIMS

**** **Pumice**

**Location:** 12 mi N of Flagstaff, AZ

**Operator:** Arizona Tufflite, Inc.
2432 W. Peoria #1081, Phoenix, AZ 85029

**Telephone:** 602/931-3682

**Contact:** C. T. Morgan, President

**Mine:** Quarries produce 6000 cu. yd. per month.

**Employees:** 18

**Personnel:** C. T. Morgan, Pres.
Ed Morgan, VP, Mine Mgr.

**Comments:** Glendale yard address: 6856 W. Orangewood, Glendale, AZ.

## CYPRUS BAGDAD COPPER MINE

**Alt. Names:** See Bagdad Mine






**CHILTON** Engineering and Surveying Ltd.

421 COURT ST.
ELKO, NV 89801

(702) 738-2121
FAX (702) 738-7955

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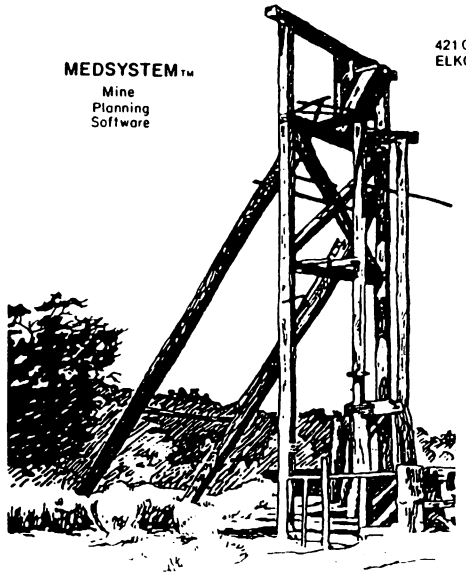


*GENERAL*

- *Professional — Integrity • Registration*
- *Practical — Optimum specifications*
- *Economic — Low overhead • Moderate rates*
- *Available — Headquartered in Elko, Nevada*
- *Continuous — Serving mining since 1899*
- *Diversified — Mining • Civil • Surveying*

*CAPABILITIES*

- *Complete Prospect Feasibility Studies*
- *Manual or Computer Mine Design*
- *Embankment Design*
- *Permitting and Public Agency Coordination*
- *Laboratory and On-site Soils Testing*
- *Construction Quality Control*
- *Professional and Mineral Surveying*
- *Water Rights and Delivery System Design*

*EXPERIENCE*

- *Over 30 Years of Private Mining Industry Experience*
- *Underground • Open Pit • Placer • In Situ*
- *Numerous Commodities:*
  *Au • Ag • Cu • Mo • Co • Pb • Zn • Coal*
  *Colemanite • Limestone • Potash • Sulfur • Uranium*
- *Ore Reserve Calculation:*
  *Polygonal • Inverse Distance*
  *Geostatistical — Kriging*
- *Stream Water Contamination Studies*
- *Gold Mining:*
  - *Complete Mine Design for 2 Million Ounce Operation*
  - *Development of Geological Model for Complex Deposit*
  - *Heap Leach Pad and Ponds Design and Permitting*
  - *Leach Pad and Ponds Construction Quality Control*
  - *Tailings Dam Construction Quality Control*


## CYPRUS CASA GRANDE MINE

**** **Cu** **S F Roast SX-EW**

**Location:** 32 mi S of Casa Grande, Pinal County, AZ

**Operator:** Cyprus Casa Grande Corporation
P.O. Box C-9, Casa Grande, AZ 85222

**Telephone:** 602/623-1539 **Fax:** 602/361-2480

**Contact:** P. K. Medhi, General Manager

**Owners:** Cyprus Copper Company

**Admin.:** Cyprus Minerals Company
P.O. Box 3299, 9100 E. Mineral Cr., Englewood, CO 80112

**Telephone:** 303/643-5000 **Fax:** 303/643-5049

**Contact:** Donald P. Bellum, Senior Vice President Metals

**Reserves:** 15,500,000 st @ 0.79% Cu proven reserves at yearend 1988.

**Production:** 1988: 4.3 million lb Cu

**Start-up:** 1988

**Mine:** Mine is an in situ leaching operation.

**Processing:** 150,000 st of Cu concentrates from Cyprus mines will be treated at the Casa Grande roasting facilities. Roasters have a capacity to treat 150,000 stpa of Cu concentrates. SX-EW plant is on site.

**Employees:** 113

**Personnel:** P. K. Medhi, Gen. Mgr.
Carl McSpadden, Admin. Mgr.
Kermit Behnke, Mine Super.
John Kline, Plant Ops. Mgr.
James Johnson, Ch. Metallurgist

## CYPRUS MIAMI

**** **Cu, Ag** **OP**

**Location:** Near Miami, Gila County, AZ

**Operator:** Cyprus Casa Grande Corporation
P.O. Box 4444, Claypool, AZ 85532

**Telephone:** 602/473-7150 **Fax:** 602/473-7055

**Contact:** Carl Waggoner, Mining Operations Manager

**Owners:** Cyprus Minerals Company (100%)

**Admin.:** Cyprus Minerals Company
P.O. Box 3299, 9100 E. Mineral Circle, Englewood, CO 80112

**Telephone:** 303/643-5000 **Fax:** 303/643-5049

**Contact:** Donald P. Bellum, Senior Vice President Metals

**Geology:** Disseminated porphyry copper of Tertiary age.

**Reserves:** 260,300,000 st @ 0.44% Cu proven reserves as of year-end 1988.

**Production:** 1989e: 125 million lb Cu cathode from leaching and SX-EW operations. 1988: 61.3 million lb Cu from 7/1/88 through 12/31/88; 298,000 oz Ag in 1988.

**Start-up:** 1982

**Mine:** Mine consists of three open pit mines which produce oxide ore for dump leaching operations.

**Processing:** Facilities include a solvent extraction electrowinning plant, refinery, smelter and rod mill. Smelter has a capacity of 450,000 stpa Cu concentrates and rod plant has a capacity of 265 million lb. The Bagdad, Sierrita and Twin Buttes mines will provide up to 325,000 stpa of

concentrates for processing at the smelter. The Miami smelter also processes purchased concentrates or concentrates subject to tolling agreements. Smelter is expected to process 422,000 st Cu sulfide concentrates and to produce 246 million lb Cu cathode in 1989. Cyprus plans to convert all of the Cu cathode production from the Miami Mine, and a portion of other Cyprus Mine production, at the rod mill.

**Employees:** 1006

**Personnel:** Carl Waggoner, Mining Ops. Mgr.
Gerald F. Fountain, Leaching Ops. Super.
Howard Bardwell, Plant Ops. Mgr.
Luis Constandse, Rod Plant Super.
John C. Lorenzen, Plant Serv. Super.
Al Tittes, Smelter Rod Oper.
Kenneth Larson, Plant Tech. Mgr.
Mark Peabody, Tankhouse Super.
Tom Larsen, Env. Services Super.
Denise Danner, Mgr. Accounting
Chuck Rising, Mgr. Human Res.
Craig Patrick, Mgr. Human Res.
Hugo Schriewer, Mgr. Materials Mgmt.

**Comments:** Cyprus Miami was purchased 7/88 from Inspiration Consolidated Copper Company; formerly known as Inspiration. Purchase included the mine, smelter, refinery and rod plant.

## CYPRUS-SIERRITA MINE

**** Cu, Mo OP HL SX-EW

**Alt. Names:** Sierrita Mine, Twin Buttes

**Location:** 32 mi S of Tucson, Pima County, AZ

**Operator:** Cyprus-Sierrita Corporation
P.O. Box 527, Green Valley, AZ 85622

**Telephone:** 602/791-2950 **Fax:** 602/648-8575

**Contact:** Tom O'Neil, General Manager

**Owners:** Cyprus Copper Company (100%)

**Admin.:** Cyprus Minerals Company
P.O. Box 3299, 9100 E. Mineral Circle, Englewood, CO 80112

**Telephone:** 303/643-5000 **Fax:** 303/643-5049

**Contact:** Donald P. Bellum, Senior Vice President Metals

**Reserves:** Proven reserves Cyprus-Sierrita: 343,000,000 st @ 0.29% Cu, 0.037% Mo; Twin Buttes: 39,200,000 st @ 1.00% Cu.

**Production:** 1989: 250 million lb Cu production combined with Twin Buttes production; 1988: 175.2 million lb Cu, 17.4 million lb Mo.

**Mine:** Open pit mine with sulfide and oxide ores. Adjacent Twin Buttes Mine, owned by Cyprus, is operated as part of the Sierrita Mine with sulfide ore conveyed to the Sierrita Mill for processing, and oxide ore leached on site.

**Processing:** Concentrator capacity is 92,000 stpd sulfide ore. Oxide ores are heap leached and processed in SX-EW plant. Mo plant and roasters at minesite process more than half of the Mo concentrates from the Thompson Creek, Tonopah, Bagdad and Cyprus-Sierrita mines owned by Cyprus.

**Employees:** 1133

**Personnel:** Tom O'Neil, Gen. Mgr.
Doug Comer, Jr., Admin. Mgr.
A. J. Murray, Mgr. Human Res.
Donald Prahl, Mine Mgr.
R. R. Dorfler, Mgr. Copper Ops.
M. H. Khan, Mgr. Molybdenum Ops.
Bill Sweetser, Plant Super.
Mike Shinn, Ch. Chem.
Tony Gomez, Env. Coord.

**Comments:** Sierrita Mine was acquired by Cyprus in 1986. Fifteen year lease of Twin Buttes Mine entered into 3/88, and mining by Cyprus began 6/88.

## DEVILS WASH

**** Au PL

**Location:** 1.5 mi SW of Quijotoa, AZ

**Operator:** Arizona Placer
HCR Box 840, Sells, AZ 85634

**Telephone:** 602/361-2391

**Contact:** Don Kilgore, Operator

**Mine:** Placer operation uses wet gravity concentration. Capacity is 500 yards/week.

**Employees:** 2

## DIVES MINE

**Alt. Names:** See Dos Cabezas Project

## DOLAND MINE

E Au, Cu UG

**Location:** 5 mi NE of Wenden, La Paz County, AZ

**Operator:** James Youell
P.O. Box 338, Wenden, AZ 85357

**Telephone:** 602/859-3491

**Owners:** James Youell

**Reserves:** Reserves estimated at 70,000 st @ 0.1 oz Au/st, 2-2.5% Cu.

**Contained:** 3000 oz Au estimated

**Comments:** Exploration by Pacific Mining Corporation ceased 9/87 due to financing problems.

## DON LUIS QUARRY

I Silica flux OP

**Location:** Bisbee, near U.S-Mexico border, Cochise County, AZ

**Operator:** A. J. Gilbert Construction Company
P.O. Box 5288, Bisbee, AZ 85603

**Telephone:** 602/432-2238

**Owners:** A. J. Gilbert, Jr.

## DOS CABEZAS PROJECT

S Au, Ag UG OP

**Alt. Names:** Gold Prince Mine, Dives Mine, Gold Ridge Deposit

**Location:** 2.5 mi NE of Dos Cabezas, 17 mi SE of Willcox, Cochise County, AZ

**Operator:** Queenstake Resources (USA), Inc.
P.O. Box 217, 241 S. Haskell #102, Willcox, AZ 85643

**Telephone:** 602/384-4337 **Fax:** 602/384-4608

**Contact:** Alfred Voirin, Mine Manager

**Owners:** Queenstake Resources (USA), Inc. (100%)

**Admin.:** Queenstake Resources (USA), Inc.
1215 Kleppe Lane, Sparks, NV 89431

**Telephone:** 702/356-3888 **Fax:** 702/356-8543

**Contact:** David R. Hembree, U.S. Exploration Manager

**Reserves:** 106,000 st @ 0.37 oz Au/st mineral inventory in the Gold Prince Mine.

**Contained:** 39,220 oz Au

**Production:** 1989e: 1800 oz Au; 1988: 169 oz Au

**Start-up:** 1988

**Mine:** Current production is from the Gold Prince. 1200 st silica flux @ 0.322 oz Au/st were shipped to the Phelps Dodge Hidalgo Smelter at Playas, NM, first quarter 1989. Three working stopes in production mid-1989, increasing production to 1000 st/mo.





**Processing:** Metallurgical tests in 1988 by Bateman Metallurgical Laboratories, Sparks, NV, yielded a 97.8% Au recovery by a combined gravity-flotation circuit. Feasibility study in progress to determine whether to build a mill on-site.

**Employees:** 2

**Personnel:** Alfred Voirin, Mine Mgr.
Tim Pearson, Geol.

**Comments:** Property also has potential to develop disseminated and veinlet mineralization reserves for open pit mining and heap leach or vat leaching. Exploration continues at depth and along strike of the Gold Prince vein system. Gold Ridge, Dives and Arizona Klondike Mines are adjacent to the Gold Prince Mine.

## DOS POBRES

S Cu UG

**Location:** Near Safford, Graham County, AZ

**Owners:** Phelps Dodge Mining Company (100%)

**Admin.:** Phelps Dodge Corporation
2600 N. Central Avenue, Phoenix, AZ 85004-3014

**Telephone:** 602/234-8100

**Reserves:** 231,600,000 st @ 0.89% Cu. Sulfide copper deposit.

**Cap. Costs:** $90 million for development work between 1969 through 1984.

**Comments:** Development work was suspended in 1982 and is on standby indefinitely.

## EMERALD ISLE

**** Cu S

**Location:** Mohave County, AZ

**Operator:** Arimetco Inc.
P.O. Box 207, Chloride, AZ 86431

**Admin.:** Arimetco Inc.
8835 E. Speedway Boulevard, Tucson, AZ 85710

**Telephone:** 602/290-9200

**Contact:** H. Roy Sipes, President

**Mine:** In situ Cu leach with production of precipitates.

**Employees:** 3

## FELDMAN NO. 2

**** Gypsum OP

**Location:** 12 mi S of Winkelman, Pinal County, AZ

**Operator:** Gold Bond Building Products
Star Route, Box 3990, Winkelman, AZ 85292

**Telephone:** 602/357-7180

**Contact:** Jeff McChesney, Quarry Superintendent

**Owners:** National Gypsum Company, a subsidiary of Aancor Holdings, Inc.

**Admin.:** National Gypsum Company
Gold Bond Building Products Division, 2001 Rexford Road, Charlotte, NC 28211

**Telephone:** 704/365-7300 **Fax:** 704/365-7316

**Contact:** Robert Spitz

**Employees:** 9

## FIRST KNOLL CINDER PIT

**Location:** AZ

**Operator:** Navajo County Roads District 3B
HC62, Box 25001, Pinetop, AZ 85935

## GIBSON COPPER MINE

*** Cu UG

**Location:** W of Miami, Gila County, AZ

**Admin.:** Lodestar Minerals Inc.
2260 University, Mesa, AZ 85203

**Telephone:** 602/833-3355

**Contact:** James Covey

## GLADIATOR-WAR EAGLE MINE

S Au, Ag UG GR F

**Location:** 60 mi N of Phoenix, 4 mi N of Crown King, Yavapai County, AZ

**Reserves:** Previous operator estimated 111,000 st @ 0.58 oz Au/st, 3.72 oz Ag/st in Gladiator and Fairview vein systems.

## GOLD BUG MINE

**** Au UG CIL

**Location:** Between Kingman, AZ, and Las Vegas, W of Dolan Springs, Mohave County, AZ

**Operator:** Ivy Minerals Inc.
P.O. Box 9125, Katherine Station, Bullhead City, AZ 86430

**Telephone:** 602/763-1030

**Contact:** William Vanderwall, Project Manager

**Owners:** Ivy Minerals Inc.

**Geology:** Small, high-angle vein deposit.

**Reserves:** Reserves small – 0.20-0.80 oz Au/st.

**Processing:** Mill at minesite. 2 tph portable mill and CIL plant designed by Kenneth Hall.

**Employees:** 1

## GOLD HILL MINE

**** Cu flux OP

**Location:** 6 mi SW of Oracle, AZ

**Operator:** Little Hill Mines Inc.
P.O. Box 332, Oracle, AZ 85623

**Telephone:** 602/896-2245

**Contact:** Dave McGee, President

**Mine:** Produces silica flux for copper smelter.

**Employees:** 9

## GOLD PRINCE MINE

**Alt. Names:** See Dos Cabezas Project

## GOLD SPRINGS MINE & MILL

Au OP

**Location:** Mohave County, AZ

**Operator:** Gold Springs Mine & Mill
P.O. Box 4324, Kingman, AZ 86402

**Employees:** 3

## GOLDEN HILLSIDE MINE

I Au

**Location:** Maricopa County, AZ

**Operator:** Waltzing Dutchman Mining Company
1630 E. 4th Avenue, Apache Junction, AZ 85219

**Telephone:** 602/982-2149

**Contact:** R. J. Dierking

**Comments:** Inactive for several years; mine has never produced.

## GOLDEN RULE MINE

**Location:** Cochise County, AZ

**Operator:** Goldfort Mine Development Company
P.O. Drawer 1980, Benson, AZ 85637

**Telephone:** 602/826-3837

**Owners:** Goldfort Mine Development Company

## GOLDEN WONDER MINE

**Location:** Gila County, AZ
**Operator:** 85 Venture Company
P.O. Box 2353, Payson, AZ 85541

## GRACE CHABAZITE MINE

**** Chabazite OP
**Location:** 13 mi N of Bowie, AZ
**Operator:** GSA Resources Inc.
P.O. Box 509, Cortaro, AZ 85652
**Telephone:** 602/297-4330
**Contact:** Ted H. Eyde, President; Dan Eyde, Vice President

## H & S CONSTRUCTION

Pumice OP
**Location:** Navajo County, AZ
**Operator:** H & S Construction
P.O. Box 626, Lakeside, AZ 85929

## HACKBERRY MINE

E Ag UG
**Location:** 50 mi E of Kingman, Mohave County, AZ
**Operator:** Combined Metals Reduction Company
Fish Lake Valley Post Office, Tonopah, NV 89049
**Telephone:** 702/572-3331 **Fax:** 702/572-3341
**Contact:** Andrew Lovestedt, Project Mgr, Mine Superintendent
**Owners:** Combined Metals Reduction Company
**Admin.:** Combined Metals Reduction Company
19 W. 94th Street, New York, NY 10025
**Telephone:** 212/864-7177
**Contact:** Lawrence T. Atkinson, President
**Employees:** 3

## HARBORLITE MINE

**** Perlite OP
**Alt. Names:** Superior Perlite
**Location:** 2 mi W of Superior, on Silver King Mine Road, Pinal County, AZ
**Operator:** Harborlite Inc.
P.O. Box 960, Superior, AZ 85273
**Telephone:** 602/689-5723
**Contact:** Bill Smith, Plant Manager
**Admin.:** Harborlite Corporation
P.O. Box 458, Escondido, CA 92025
**Employees:** 7

## HAVASU #1

Ag
**Location:** Mohave County, AZ
**Operator:** Cibola Metals Corporation
P.O. Box 1607, Lake Havasu, AZ 86403
**Employees:** 1

## HELVETIA PROPERTY

** Cu OP
**Location:** 18 mi E of the Mission Complex, Pima County, AZ
**Operator:** Asarco Inc.
P.O. Box 111, Mission Complex, W. Pima Mine Road, Sahuarita, AZ 85629
**Telephone:** 602/791-2920 **Fax:** 602/648-0802
**Owners:** Asarco Inc. (100%)
**Admin.:** Asarco Inc.
180 Maiden Lane, New York, NY 10038
**Telephone:** 212/510-2000 **Fax:** 212/510-1951
**Contact:** Robert Kupsch, Vice President Mining
**Reserves:** 280,000,000 st @ 0.6% Cu sulfide ore and 23,000,000 st @ 0.8% Cu oxide ore.
**Mine:** Mine may be developed by Asarco as a separate mine or as part of the Mission Complex.

## HERMIT MINE

D U UG
**Location:** 30 mi SW of Fredonia, Mohave County, AZ
**Operator:** Energy Fuels Nuclear, Inc.
P.O. Box 36, Fredonia, AZ 86022
**Telephone:** 602/643-7321
**Contact:** Roger Smith, Manager Mining Operations
**Owners:** Energy Fuels Nuclear, Inc.
**Admin.:** Energy Fuels Nuclear, Inc.
1200 Seventeenth Street #2500, Denver, CO 80202
**Telephone:** 303/623-8317 **Fax:** 303/595-0930
**Contact:** Muril Vincelette, Vice President Operations
**Start-up:** 1988
**Employees:** 32
**Personnel:** Roger Smith, Mgr. Mining Ops.
John Stubblefield, Mine Super.

## HOUCK SILICA SAND

**** Hydrafrac sand OP
**Location:** AZ
**Operator:** Arizona Silica Sand Company
P.O. Box 108, Houck, AZ 86506
**Telephone:** 602/688-2602
**Contact:** Robert D. Fisher, President
**Processing:** Plant is south of Houck, AZ.
**Employees:** 15
**Personnel:** Elmer J. Gilstrap, Gen. Mgr.
Ralph Nelson, Frmn.
Jim Burkewitz, Super.
**Comments:** Produces hydrafrac sand for oil well treatment.

## IRON KING MINE

E Au, Ag, Pb, Zn, Cu
**Location:** AZ
**Owners:** Coronado Resources Inc. (can earn 80% interest)
**Admin.:** Coronado Resources Inc.
8065 N. 85th Way #B-100, Scottsdale, AZ 85258
**Telephone:** 602/483-8002 **Fax:** 602/483-8004
**Contact:** George Warnock, President
**Geology:** High grade volcanogenic massive sulfide deposit.
**Reserves:** 850,000 st low-grade ore; 250,000 st medium-grade ore.
**Comments:** Mine produced 693,454 oz Au, 20,626,000 oz Ag, 143,716 st Pb, 419,185 st Zn, 11,328 st Cu from 1906 to 1968.

## IRONITE PRODUCTS COMPANY MINE

**** OP
**Location:** Yavapai County, AZ
**Operator:** Ironite Products Company
P.O. Box 218, Humbolt, AZ 86327
**Employees:** 23

## KANAB NORTH

**** U UG
**Location:** 25 mi Sw of Fredonia, Mohave County, AZ





**Operator:** Energy Fuels Nuclear, Inc.
P.O. Box 36, Fredonia, AZ 86022
**Telephone:** 602/643-7321
**Contact:** Roger B. Smith, Manager, Mining Operations
**Admin.:** Energy Fuels Nuclear, Inc.
1200 Seventeenth Street #2500, Denver, CO 80202
**Telephone:** 303/623-8317 **Fax:** 303/595-0930
**Contact:** Muril Vincelette, Vice President Operations
**Geology:** Breccia pipe.
**Reserves:** 2 million lb U3O8.
**Start-up:** 1985
**Processing:** Ore is processed at the White Mesa Mill at Blanding, UT, which uses acid leach and CCD.
**Employees:** 49
**Personnel:** Roger Smith, Mgr. Mining Ops.
Dan Thebeau, Mine Super.

## KING OF ARIZONA MILL

Au
**Location:** Yuma, AZ
**Operator:** North Continental Energy Ltd.
26406 S. Ribbon Wood Drive, Sun Lakes, AZ 85248
**Employees:** 5

## KORN KOB MINE

*** Cu OP HL
**Location:** Redington Mining District, 10 mi S of San Manuel, Pima County, AZ
**Operator:** Keystone Minerals Inc.
6318 E. Hayne Street, Tucson, AZ 85710
**Telephone:** 602/747-9551 **Fax:** 602/750-9563
**Contact:** Dirk Den-Baars, Project Manager
**Reserves:** 20 million st oxide ore @ 0.5% Cu
**Start-up:** 1991 (projected)
**Mine:** Mine under development, expected to be in production by 1991.
**Processing:** Heap leach with recovery by electrowinning.

## LONE STAR PROPERTY

* Cu
**Location:** Near Safford, Graham County, AZ
**Owners:** Phelps Dodge Mining Company (100%)
**Admin.:** Phelps Dodge Corporation
2600 N. Central Avenue, Phoenix, AZ 85004-3014
**Telephone:** 602/234-8100
**Reserves:** Estimated 1+ billion st @ 0.41% Cu probable reserve.
**Comments:** Phelps Dodge is evaluating feasibility of production. Property acquired from Kennecott Corporation in late 1986.

## LYLES MINE

**** Clay OP
**Location:** W of Kirkland, AZ
**Operator:** GSA Resources Inc.
P.O. Box 509, Cortaro, AZ 85652
**Telephone:** 602/297-4330
**Contact:** Ted H. Eyde, President
**Production:** Hectorite deposit produces premium white clay used in specialty gellant and viscosifier applications.
**Start-up:** 1986

## MAGMA MINE SUPERIOR DIVISION

S, *** Cu UG T
**Location:** 60 mi E of Phoenix, Pinal County, AZ
**Operator:** Magma Copper Company
Box 37, Superior, AZ 85273
**Owners:** Magma Copper Company (100%)
**Admin.:** Magma Copper Company
P.O. Box M, San Manuel, AZ 85631
**Telephone:** 602/385-3100 **Fax:** 602/385-3299
**Reserves:** 4,400,000 st Cu mineralization @ an average grade of 5.7% Cu.
**Start-up:** 3rd Quarter 1990 (projected)
**Mine:** The mine closed in 1982 and has been flooded since 1985. Magma is dewatering the mine which employed 1250 before its closure. When the mine is reopened, it will employ 300 and produce 14,000 st Cu, 6400 oz Au, and 278,000 oz Ag annually.
**Comments:** Magma is considering reopening the mine to recover Cu, and open pit mining of limestone is being studied. Currently, iron pyrite is being recovered from the tailings.

## MAMMOTH MINE

Au OP
**Location:** Pinal County, AZ
**Operator:** Western Labs and Engineering
1385 E. 17th Avenue, Apache Junction, AZ 85219
**Employees:** 7

## MARGARITA MINE

** Au OP HL
**Location:** 10 mi S of Arivaca, 75 mi S of Tucson, Santa Cruz County, AZ
**Operator:** La Teko Resources, Inc.
3131 N. Country Club Rd. #110, Tucson, AZ 85716
**Telephone:** 602/326-2700
**Contact:** Fred Dotterer, Manager
**Owners:** La Teko Resources Ltd. (100%); La Teko will pay Newfields Minerals Inc. 10% of net profit from the operation, increasing to 15% after aggregate Au production reaches 20,000 oz.
**Admin.:** La Teko Resources Ltd.
P.O. Box 49301, Bentall Centre, 3184 Four Bentall Centre, 1055 Dunsmuir St., Vancouver, BC Canada V7X 1L3
**Telephone:** 604/682-2704 **Fax:** 604/682-0559
**Contact:** T. Edmund Babcock, President
**Reserves:** 450,000 st @ 0.055-0.075 oz Au/st proven reserves, with additional potential tonnage of at least 2 million st.
**Contained:** 24,750-33,750 oz Au
**Start-up:** 1989
**Mine:** Projected to be 500 stpd at a strip ratio of 2:1. 7000 st ore drilled and blasted for test heaps in 1989.
**Processing:** Permits to process 500,000 st ore received mid-1989; expect to begin full production of 200,000 st/yr early 1990. Laboratory Au recovery of 88% by column leaching ore crushed to minus 1/2 inch.
**Cap. Costs:** $1.9 million.
**Comments:** Feasibility study carried out for Newfield Minerals Inc. by Davy McKee 1986-87.

## MCCABE MINE

I Au, Ag UG GR F CIP
**Alt. Names:** McCabe-Gladstone

**Location:** Big Bug District, 100 mi N of Phoenix, 20 mi E of Prescott, Yavapai County, AZ
P.O. Box 460, Humboldt, AZ 86329
**Telephone:** 602/632-5165
**Reserves:** 753,000 st @ 0.372 oz Au/st proven and probable reserves; 1,200,000 st @ 0.262 oz Au/st possible reserves.
**Processing:** 500 stpd mill under construction in 1987. Grinding followed by gravity and flotation.
**Comments:** Santa Fe Mining released the property in 1986 after spending over $5 million on exploration. Stan West Mining Corporation, previous owner.

## MCCRACKEN MINE

S — Ag — UG

**Location:** 70 mi S of Kingman, AZ
**Mine:** Former underground Ag mine with 500 tpd mill; mined 500 stpd in 1985. Operation on standby since 1985.
**Processing:** Mill at minesite.
**Comments:** Previous lessee Arizona Silver Corporation returned property to the lessor in 1989, but retained ownership of its 500 stpd flotation mill at Yucca, AZ, which processed the McCracken ore in 1985.

## MCFARLAND & HULLINGER MINE

**** — Silica — OP

**Location:** Hayden, Pinal County, AZ
**Operator:** McFarland & Hullinger
P.O. Box 391, Mammoth, AZ 85618
**Telephone:** 602/487-2752
**Contact:** Gary McFarland, Operations Manager
**Admin.:** McFarland & Hullinger
P.O. Box 238, Tooele, UT 84074
**Telephone:** 801/882-0103
**Contact:** Sid Hullinger
**Production:** 100,000 stpa crushed silica
**Processing:** Crushing at minesite to custom size and sold to area smelters for use as flux.
**Employees:** 10

## MEXICAN HAT PROPERTY

Au

**Location:** Cochise County, AZ
**Operator:** Oneida Resources Inc.
4001 Indian School Road, Albuquerque, NM 87190
**Telephone:** 505/262-2323
**Contact:** William J. Sullivan
**Owners:** Oneida Resources Inc.; Placer Dome U.S. Inc. (option to acquire 60%)
**Admin.:** Oneida Resources Inc.
610, 650 W. Georgia Street, Vancouver, BC Canada V6B 4N7
**Telephone:** 604/681-0977
**Contact:** Albert W. Applegath, President
**Geology:** Mineralized fault zone with high-grade Au potential and a larger bulk deposit to the north. Oxidation extends to 500 ft depth.
**Comments:** Exploration program of trenching, drilling and preliminary leach tests will be followed by engineering studies in mid-1990 if results are favorable.

## MIAMI COPPER OPERATION

**Location:** AZ
**Operator:** Sterling Mining Company
P.O. Box 1598, Apache Junction, AZ 85220

## MIAMI TAILINGS PROJECT

**** — Cu — T SX-EW

**Alt. Names:** See also Pinto Valley Unit
**Location:** Near Miami, 60 mi E of Phoenix, Gila County, AZ
**Operator:** Magma Copper Company, Pinto Valley Division
P.O. Box 100, Miami, AZ 85539
**Telephone:** 602/425-7611 **Fax:** 602/425-3977
**Contact:** W. Glenn Martin, Vice President, General Manager
**Owners:** Magma Copper Company (100%)
**Reserves:** 35,000,000 st @ 0.331% Cu, 54% recovery.
**Production:** Anticipate 8,000 stpa of Cu through 1997.
**Start-up:** 1989
**Mine:** Concentrator tailings from the former Miami underground mine are hydraulically mined and processed at the Miami Unit SX-EW plant.
**Cap. Costs:** $20,000,000 Miami Tailings Project and for expansion of SX-EW plant at the Miami Unit.

## MIAMI UNIT

**** — Cu — S SX-EW

**Alt. Names:** See also Pinto Valley Unit
**Location:** Near Miami, 70 mi N of San Manuel, Gila County, AZ
**Operator:** Magma Copper Company
P.O. Box 100, Miami, AZ 85539
**Telephone:** 602/425-7611 **Fax:** 602/425-3977
**Contact:** William A. Bennett, Miami Leaching Superintendent
**Owners:** Magma Copper Company
**Production:** 1988: 9.8 million lb copper cathode
**Start-up:** 1963
**Mine:** Miami Unit operates over the former underground mine which was depleted by block caving mining methods in 1959. In situ leaching of oxide and sulfide ores has been conducted since 1963; tailing reclamation project began in 1989. The pregnant solution is processed in an SX-EW plant adjacent to the underground mine. In 1986, the leaching area was expanded and the sulfuric acid content in the leach solution was increased. In 1988, leaching of the mill tailings from the underground mine began. The tailings will be processed at the SX-EW plant which will be modified to accommodate the leach solution.
**Processing:** SX-EW plant adjacent to underground mine has a capacity of 13,000,000 lb copper cathode production per year.
**Cap. Costs:** $20,000,000 for expansion of SX-EW plant and Miami Tailings Project.

## MILLER MINING

**** — Pumice — OP

**Location:** Coconino County, AZ
**Operator:** Miller Mining
616 E. Papago Drive, Tempe, AZ 85281
**Employees:** 3

## MINERAL PARK MINE

S, **** — Cu — DL

**Location:** 16 mi N of Kingman, Mohave County, AZ
**Operator:** Cyprus Mineral Park Corporation
P.O. Box 6249, Kingman, AZ 86402
**Telephone:** 602/565-2226 **Fax:** 602/565-2229
**Contact:** George H. Veach, Superintendent
**Owners:** Cyprus Copper Company
**Admin.:** Cyprus Minerals Company
P.O. Box 3299, 9100 E. Mineral Circle, Englewood, CO 80112





**Telephone:** 303/643-5000 **Fax:** 303/643-5049
**Contact:** Donald P. Bellum, Senior Vice President Metals
**Production:** 1988: 4.4 million lb Cu
**Mine:** Mine consists of dump leaching operations and a precipitate plant.
**Processing:** Concentrator with 15,000 stpd capacity on standby; dump leach precipitation plant is operating.
**Employees:** 13
**Personnel:** George H. Veach, Super.
Joey Matthews, Plant Super.
Howard W. Walker, Mill Super.
John Reynolds, Ch. Metallurgist
C. D. Lobley, Ch. Chem.
Pat Maley, Env. Coord. (602/792-3010)
J. B. Lichtenhan, Superintendent, Service
D. J. Hoffman, Ch. Accountant
P. J. Maley, Safety Admin.

## MINNEAPOLIS MINE & MILL

**** — Au, Ag — UG

**Location:** 2 mi S of Oatman, Mohave County, AZ
**Operator:** Grubstake Mining Inc.
P.O. Box 408, Oatman, AZ 86433
**Telephone:** 602/768-3133
**Contact:** John Augustin, Project Manager
**Admin.:** Grubstake Mining Inc.
P.O. Box 2163, Flagstaff, AZ 86003
**Telephone:** 602/526-9464
**Processing:** Recovery by cyanide closed loop, resin.
**Employees:** 14

## MISSION COMPLEX

**** — Cu, Ag — OP F

**Alt. Names:** Includes Eisenhower, Mineral Hill, Mission, Pima and San Xavier Mines
**Location:** Sahuarita, Pima County, AZ
**Operator:** Asarco Inc.
P.O. Box 111, Mission Complex, W. Pima Mine Road, Sahuarita, AZ 85629
**Telephone:** 602/791-2920 **Fax:** 602/648-0802
**Contact:** Tom Scartaccini, Manager SW Mining Department (602/792-3010)
**Owners:** Asarco Inc. (100%)
**Admin.:** Asarco Inc.
180 Maiden Lane, New York, NY 10038
**Telephone:** 212/510-2000 **Fax:** 212/510-1951
**Contact:** Robert Kupsch, Vice President Mining
**Reserves:** 358,138,000 st @ 0.64% Cu, 0.13 oz Ag/st.
**Production:** 1988: 65,200 st Cu, 1,248,000 oz Ag; 1987: 58,600 st Cu, 810,000 oz Ag; 1986: 61,600 st Cu, 1,296,000 oz Ag.
**Mine:** Mining equipment: four 2100BLs with 15 cu. yard dippers, two 1900ALs with 9 cu. yard dippers, three P & H 2300XPA electric mining shovels with 30 cu. yard dippers.
**Processing:** Ores processed at Mission Mill. 87,000 stpa capacity increasing to 124,000 stpa of Cu concentrates through $100 million expansion and reactivation/modernization of Pima mill and concentrator which will treat 19,000 stpd. The Pima mill was purchased from Cyprus Minerals. Ore milled 1988: 10,181,000 st, 86.7% Cu recovery; 1987: 9,926,000 st, 88.6% Cu recovery; 1986: 9,928,000 st, 89.5% Cu recovery.
**Employees:** 600
**Personnel:** Tom Scartaccini, Mgr. SW Mining Dept.
John D. Low, Mgr. Mission Complex
W. B. Manakee, Purch. Agent
J. F. Coxon, Pers. Admin.
S.L. Lakosky, Mine Super.
R. B. Cummings, Geol.
M. A. Melcher, Ch. Eng.
H. E. Hughes, Mech. Super.

## MOHAVE PROJECT

** — Au — OP HL

**Location:** 12 mi N of the Portland Mine, Black Range Mountains, Mohave County, AZ
**Operator:** Combined Metals Reduction Company
Route 264, Fish Lake Valley, via Tonopah, NV 89049
**Telephone:** 702/572-3331 **Fax:** 702/572-3341
**Contact:** Chris Harrison, Project Manager
**Owners:** Combined Metals Reduction Company (60%)
**Admin.:** Combined Metals Reduction Company
19 W. 94th Street, New York, NY 10025
**Telephone:** 212/864-7177
**Contact:** Lawrence T. Atkinson, President
**Start-up:** May or June 1990 (projected)
**Processing:** Heap leach on site.
**Employees:** 25 (projected)
**Personnel:** Chris Harrison, Proj. Mgr.
Jeremy Benezet, Env. Coord.
**Comments:** Group of claims covering 6-7 sections with various claimblock names.

## MORENCI MINE

**** — Cu, Mo — OP SX-EW

**Location:** At Morenci, Greenlee County, AZ
**Operator:** Phelps Dodge Morenci Inc.
P.O. Box 187, Morenci, AZ 85540
**Telephone:** 602/865-4521 **Fax:** 602/865-4117
**Contact:** Jeffrey G. Clevenger, General Manager
**Owners:** Phelps Dodge Corporation (85%), Sumitomo Metal Mining Arizona, Inc. (15%)
**Admin.:** Phelps Dodge Corporation
2600 N. Central Avenue, Phoenix, AZ 85004-3014
**Telephone:** 602/234-8100
**Reserves:** 684,823,520 st @ 0.76% Cu at year end 1988, including recoverable Cu from stockpiled leach material. The adjoining Western Copper and Northwest Extension deposits contain an estimated 225,882,350 st @ 0.70% Cu.
**Production:** 242,709 st Cu concentrates, 4,000 st Cu precipitates, and 50,235 st electrowon Cu. Mine expansion will increase production by 70,000,000 stpa.
**Mine:** Open pit oxide ore presently being mined, with mining of sulfide ore in 7 years. In-pit crushing and conveyor system installed during 1988 to reduce haulage costs; rail haulage being phased out. During 1988, 87,236,470 st ore and waste were mined, and 40,923,529 st ore were mined grading 0.83% Cu. Mine expansion planned to develop ore to the northwest of the present pit.
**Processing:** Produces some Cu precipitates, although the majority of production is of electrowon Cu produced by the SX-EW plant which began operating 9/87. An expansion of the plant to 100,000 stpa is scheduled to begin production in 1990. The plant is producing 50,000 stpa of electrowon Cu. By-product Ag, Au and Mo is produced. Morenci smelter with 650,000 stpa capacity and 2400 stpd acid plant closed 12/84.
**Employees:** 1572
**Personnel:** Jeffrey G. Clevenger, Gen. Mgr.

W. J. Chen, Assist. Mgr.
Jim Johnson, Materials Mgr.
Ralph Burgher, Employment & Benefits Super.
Michael Allen, Super. of Mines
J. B. McBiles, Mech. & Electrical Super.
Fred Menzer, Geol.
E. M. Schern, Dir. Eng. & Geol. Services
Bill Brack, Eng.
Randy Schneider, Super. of Concentrators
T. R. Snider, Gen. Super., Super. SX-EW
Robert E. Johnson, Research
Ted Cogut, Env. Coord.

**Cap. Costs:** $48 million for in-pit crushing/conveyor system installed 1988.

## MYSTIC MINE

* Au UG

**Location:** 8 mi from Sun City, near Phoenix, Maricopa County, AZ
**Operator:** Fischer-Watt Gold Company, Inc.
114 Tucker Avenue #7, Kingman, AZ 86401
**Telephone:** 602/753-1622 **Fax:** 602/753-6396
**Contact:** Frank L. Hillemeyer, Senior Exploration Geologist
**Admin.:** Fischer-Watt Gold Company, Inc.
340 Freeport Boulevard #3, Sparks, NV 89431
**Telephone:** 702/358-0947 **Fax:** 702/358-4026
**Contact:** W. Perry Durning, President
**Contained:** 25,000 oz Au

## NELSON QUARRIES & PLANT

**** Limestone OP

**Location:** Mohave County, AZ
**Operator:** Chemstar Lime
P.O. Box 370, Peach Springs, AZ 86434
**Telephone:** 602/769-2271 **Fax:** 602/769-2305
**Contact:** Ed C. Barry, Plant Manager
**Admin.:** Chemstar Lime
2800 N. 44th Street #400, Phoenix, AZ 85008
**Telephone:** 602/955-5711 **Fax:** 602/468-0488
**Mine:** Mining rate 1800 stpd.
**Employees:** 73
**Personnel:** Danny Roberts, Purch. Agent
Ed C. Barry, Plant Mgr., Personnel Mgr.
Rick Schneider, Lab
Perry Curley, Lab
Jerry Yound, Plant Super.

## NEW CORNELIA MINE

I Cu, Mo OP

**Alt. Names:** Ajo Mine
**Location:** AZ
**Operator:** Phelps Dodge Corporation, New Cornelia Branch
Ajo, AZ 85321
**Telephone:** 602/387-7451 **Fax:** 602/387-7454
**Contact:** J. L. Armstrong, Plant Superintendent
**Owners:** Phelps Dodge Corporation (100%)
**Admin.:** Phelps Dodge Corporation
2600 N. Central Avenue, Phoenix, AZ 85004-3014
**Telephone:** 602/234-8100
**Reserves:** 209,200,000 st @ 0.50% Cu.
**Mine:** Mine was shut down 8/84. Phelps Dodge does not plan to resume operations at the mine until market conditions warrant reopening the mine.
**Processing:** 30,000 stpd concentrator with Mo circuit and 190,000 stpd smelter with acid plant on site.
**Employees:** 24

## NORTH STAR MINE

E Au

**Location:** Kofa Mining District, Yuma County, AZ
**Admin.:** Fargo Resources Ltd.
10th Floor, 900 W. Hastings, Vancouver, BC Canada V6C 1E5
**Telephone:** 604/684-4246 **Fax:** 604/684-9959
**Geology:** Epithermal system; gold occurs as finely disseminated flakes in a breccia zone contained in Tertiary volcanics. Breccia can be traced for several thousand feet along the surface and is open at depth.
**Comments:** Fargo Resources is considering joint venture participation for further exploration.

## NORTH STAR TAILINGS

**** Au T HL CC

**Location:** 85 mi W of Scottsdale, Yuma County, AZ
**Operator:** Gold & Minerals Company Inc.
9709 E. Mountain View #1622, Scottsdale, AZ 85258
**Owners:** Robert Langguth Limited Partner, Gold & Minerals Company Inc., Superintendent, General Manager
**Reserves:** Tailings with 0.035 oz Au/st.
**Start-up:** 1987
**Processing:** Plant at minesite. Tailings are reclaimed for heap leaching with carbon column Au recovery.
**Employees:** 2-3, all subcontractors

## ORACLE RIDGE PROJECT

** Cu, Ag

**Location:** 15 mi N of Tucson, AZ
**Operator:** Oracle Ridge Mining Partners
**Owners:** Union Copper Inc. (55%; Union Copper formed by the merger of subsidiaries of South Atlantic Ventures Ltd. and Union Mines Inc.), Continental Catalina Inc. (45%)
**Admin.:** South Atlantic Ventures Ltd.
405, 750 W. Pender Street, Vancouver, BC Canada V6C 2T7
**Telephone:** 604/682-8896
**Reserves:** Approximately 4,000,000 st @ 2.33% Cu, 0.67 oz Ag/st at a cutoff grade of 1.5% Cu, proven and probable, and 4,400,000 st @ 2.25% Cu possible.
**Start-up:** Mid-1990 (projected)
**Mine:** Construction of a 285,000 stpa facility to begin early 1990.
**Processing:** Column flotation mill to be built on site.
**Cap. Costs:** $23 million from purchase in 1977 to mid-1983.

## PHENIX MINE

**** Au, Ag

**Location:** AZ
**Operator:** Phenix Mining Corporation
P.O. Box 21180, 5 Wellik Road, Wickenburg, AZ 85358
**Telephone:** 602/684-3157
**Contact:** G. B. Stone, President
**Reserves:** Grade is 0.034 to 0.08 oz Au/st.
**Mine:** 1300 stpd mine.
**Processing:** Uses thiourea leach process.

## PIGEON MINE

D U UG

**Location:** 20 mi S of Fredonia, Coconino County, AZ





**Owners:** Energy Fuels Nuclear, Inc.
**Admin.:** Energy Fuels Nuclear, Inc.
1200 Seventeenth Street #2500, Denver, CO 80202
**Telephone:** 303/623-8317 **Fax:** 303/595-0930
**Contact:** Muril Vincelette, Vice President Operations

## PILGRIM MINE

* Au OP UG HL

**Location:** 21 mi NW of Kingman, Black Mountains, Mohave County, AZ
**Owners:** Mohave Gold Inc. (100%)
**Admin.:** Mohave Gold Inc.
600, 550 11th Avenue S.W., Calgary, Alberta Canada T2R 1M7
**Telephone:** 403/237-5100 **Fax:** 403/262-1127
**Contact:** Robin W. Pearson, President
**Reserves:** 550,000 st @ 0.06 oz Au/st.
**Mine:** Former producer was mined to 1942. 1987 drilling results show zones of 0.167 oz Au/st over 25 ft.
**Processing:** Pilot production at 50-100 stpd planned as part of feasibility study.

## PINE NUT

S U UG

**Location:** 45 mi SW of Fredonia, Mohave County, AZ
**Operator:** Energy Fuels Nuclear, Inc.
P.O. Box 36, Fredonia, AZ 86022
**Telephone:** 602/643-7321
**Contact:** Roger B. Smith, Manager, Mining Operations
**Owners:** Energy Fuels Nuclear, Inc.
**Admin.:** Energy Fuels Nuclear, Inc.
1200 Seventeenth Street #2500, Denver, CO 80202
**Telephone:** 303/623-8317 **Fax:** 303/595-0930
**Contact:** Muril Vincelette, Vice President Operations
**Geology:** Breccia pipe.
**Reserves:** 2 million lb $U_3O_8$.
**Start-up:** 1985
**Mine:** Development completed. Mine is on standby and is ready for production.
**Processing:** Mine will use the White Mesa Mill at Blanding, UT for processing.

## PINTO VALLEY UNIT

**** Cu, Mo OP S SX-EW

**Alt. Names:** See also Miami Unit, Miami Tailing Project
**Location:** Near Miami, 70 mi N of San Manuel, Gila and Pinal Counties, AZ
**Operator:** Magma Copper Company, Pinto Valley Division
P.O. Box 100, Miami, AZ 85539
**Telephone:** 602/425-7611 **Fax:** 602/425-3977
**Contact:** W. Glenn Martin, Vice President, General Manager
**Owners:** Magma Copper Company
**Geology:** Disseminated deposit of sulfide mineralization in fractures and mineral boundaries forming an oblong deposit with a core of low grade mineralization.
**Reserves:** Proven and probable reserves: open pit: 404,443,000 st @ an average grade of 0.395% Cu, a cutoff grade of 0.26% Cu and 85.5% Cu recovery; sulfide dump material: 376,660,000 st @ an average grade of 0.114% Cu and 10% Cu recovery. Total reserves, including 35,000,000 st oxide tailings @ 0.331% Cu and 54% recovery, are 816,103,000 st @ 0.262% Cu.
**Mine:** Pinto Valley Unit mines 61,000 stpd of copper sulfide ore. In 1988 total material mined was 146,300 stpd and total ore production was 22,400,000 st; in 1987, total material mined was 136,000 stpd and total ore production was 21,500,000 st. In 1988, Cu content averaged 0.374%. Stripping ratio is currently 1.39:1, and will fall to 0.22:1 in the early 2000s.
**Processing:** Concentrator produces a concentrate containing approximately 30% Cu and a molybdenum disulfide byproduct. Concentrate is trucked to San Manuel Division for smelting, refining and casting. In 1988, 22,400,000 st sulfide ore was processed by the concentrator. Low grade waste material that is leachable is trucked to sulfide ore dumps and sprayed with water, which forms a sulfuric acid leach solution. The leach solution is treated in the SX-EW plant adjacent to the dumps, which has a capacity to produce 17,000,000 lb of copper cathode per year; in 1988, 13,600,000 lb of copper cathode were produced from the dump leaching operations.
**Employees:** 547
**Personnel:** W. Glenn Martin, VP, Gen. Mgr.
B. L. Beydler, Purchasing Mgr.
D. L. Goar, Mine Super.
Loren Hallin, Concentrator Ops. Super., Lab Mgr.
W. G. Slack, Concentrator Ops. Mgr.
William A. Bennett, Miami Leaching Super.
Chuck Taylor, Ch. Env. Eng.

## PORTLAND MINE

E Au OP HL CC

**Location:** 45 mi NNW of Kingman, in Black Range Mountains, Mohave County, AZ
**Operator:** Western States Minerals Corporation
P.O. Box 6367, Kingman, AZ 86402
**Owners:** W. S. Minerals Holdings Inc. (100%)
**Admin.:** Western States Minerals Corporation
4975 Van Gordon Street, Wheat Ridge, CO 80033
**Telephone:** 303/425-7042 **Fax:** 303/233-1525
**Contact:** Arden Morrow, President
**Reserves:** Original deposit had 1,000,000 st @ 0.065 oz Au/st.
**Start-up:** 1984
**Mine:** Mine closed in late 1987 until additional ore reserve drilled out; existing heaps continue to produce Au.
**Processing:** Carbon columns on site to recover Au from heap leach solutions. Mineral Economics Group reports construction of 750-1000 stpd mill in 1985, which shut down due to metallurgical problems.
**Personnel:** Rick Fiddler, Proj. Mgr.
Michael Campbell, Mine Frmn.

## RAY UNIT

**** Cu OP

**Location:** 70 mi N of Tucson, Pinal County, AZ
**Operator:** Asarco Inc.
P.O. Box 8, Hayden, AZ 85235
**Telephone:** 602/356-7811 **Fax:** 602/356-6080
**Contact:** Bruce K. Malone, General Manager
**Owners:** Asarco Inc. (100%), BP Minerals America (25% of revenue from Cu prices greater than $0.68/lb)
**Admin.:** Asarco Inc.
180 Maiden Lane, New York, NY 10038
**Telephone:** 212/510-2000 **Fax:** 212/510-1951
**Contact:** Robert Kupsch, Vice President Mining
**Reserves:** 660,057,000 st @ 0.70% Cu. Additional reserves at the Copper Butte property.

**Production:** 1988: 117,100 st Cu, 439,000 oz Ag; 1987: 107,700 st Cu, 378,000 oz Ag; 1986: 10,600 st Cu, 37,000 oz Ag (production after Asarco's purchase of the mine 11/86). Production includes Cu in electrowon cathodes, 1988: 38,500 st; 1987: 32,000 st; 1986: 2000 st; and precipitates in 1988: 0 st; 1987: 2600 st; 1986: 900 st. On completion of expansion project, will produce 112,000 stpa of Cu concentrates.

**Mine:** Open pit mine; will install a new 60,000 stpd in-pit crusher and conveying system which will be completed in 1992.

**Processing:** $12 million expansion of mining and concentrating capacity planned in order to offset increasing hardness of ore and maintain level of production. New mill and concentrator will have 20,000 stpd capacity with SAG mills and flotation cells, in addition to the 30,000 stpd concentrator at Hayden, AZ. Slurry of tailings will go by rail to the smelter at Hayden.

**Employees:** Mine – 542; concentrator – 228

**Personnel:** Bruce K. Malone, Gen. Mgr.
Roger L. Gagliano, Op. Mgr.
Bob Henry, Purch. Agent
Joyce L. Morris, Pers. Admin.
R. E. Thompson, Mining Super.
Bill Pyle, Maint. Super.
Edward John, Div. Geol.
S. F. Johnson, Mining Eng.
George Self, Ch. Chem.
Gary Lubers, Conc. Super.
Bryon G. Brumbaugh, Dir. Safety & Env.
Rulon Ellett, Human Res. Dir.
N. A. Gambell, Tech. Services Admin.

## RED BUTTE

**Alt. Names:** See Canyon Mine

## REYMERT SILVER MINE

**S** **Silica flux**

**Location:** 5 mi W of Superior, Pinal County, AZ

**Operator:** Cyprus Miami Mining Corporaiton
P.O. Box 4444, Claypool, AZ 85532

**Telephone:** 602/473-7150 **Fax:** 602/473-7055

**Contact:** Carl Waggoner, Mine Manager

**Owners:** Cyprus Minerals Company, lease with option to purchase from Georesources Inc. (Cyprus Miami acquired the lease from Inspiration Consolidated Copper.)

**Admin.:** Cyprus Minerals Company
P.O. Box 3299, 9100 E. Mineral Circle, Englewood, CO 80112

**Telephone:** 303/643-5000 **Fax:** 303/643-5049

**Contact:** Donald P. Bellum, Senior Vice President Metals

**Geology:** Fracture-filling vein occuring in Precambrian schist.

**Reserves:** 400,000 st @ 4.02 oz Ag/st

**Contained:** 1.6 million oz Ag

**Production:** 1988-1989: 300,000 oz Ag

**Mine:** Mine produces Ag-bearing silica flux for copper smelters. Mining rate 1988-1989: 75,000 st/yr. Production by mining contractor, Triple Nichol Inc., Globe, AZ.

**Personnel:** Carl Waggoner, Mine Mgr.
James Lundy, Mine Super.

## ROADSIDE DEPOSIT

**E** **Au** **OP HL**

**Location:** Between Tyro Mine and Portland Mine, Black Mountain Range District, near Kingman, Mohave County, AZ

**Operator:** Ivy Minerals Inc.
P.O. Box 9125, Katherine Station, Bullhead City, AZ 86430

**Telephone:** 602/763-1030

**Owners:** Ivy Minerals Inc., Onenon Corporation of Bullhead City, AZ

**Geology:** Possible detachment fault rubble zone host for mineralization.

**Mine:** Open pit, heap leach target. May be mined and treated in conjunction with adjacent similar deposit belonging to different owners.

## SAN MANUEL DIVISION

******** **Cu, Mo, Au** **UG OP S**

**Location:** Near San Manuel, 45 mi NE of Tucson, Pinal County, AZ

**Owners:** Magma Copper Company (100%)

**Admin.:** Magma Copper Company
P.O. Box M, San Manuel, AZ 85631

**Telephone:** 602/385-3100 **Fax:** 602/385-3299

**Contact:** Harry C. Smith, Operations Manager Sulfide & Oxide Mining

**Geology:** San Manuel and Kalamazoo orebodies are faulted segments of a single cylindrical shell of disseminated copper mineralization around a core of waste. The shell is from 100 to 1,000 ft thick, 7,700 ft long and 2,500 to 5,000 ft in diameter. San Manuel orebody contains underground sulfide ores and open-pittable oxide ores. The Kalamazoo orebody has not been put into production, but is accessed through the San Manuel mine shafts.

**Reserves:** Kalamazoo orebody adjacent to UG sulfide mine has gold reserves; development in joint venture with Cyprus is currently suspended during expansion of San Manuel copper orebody.

**Production:** 1988: 184,000,000 lb Cu from sulfide ore from underground mine.

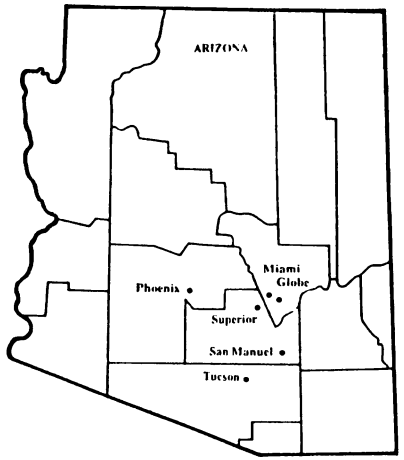
**Start-up:** 1956

**Mine** Mine includes underground sulfide ore mine, open pit mining of oxide ore which is treated by dump leaching and an in situ leaching area. Underground mining rate with block caving method is 45,000 stpd sulfide ore. In 1988, 44,577 stpd of sulfide ore averaging 0.628% net sulfide Cu content were produced and processed at the San Manuel Division. Ore is transported to the concentrator by train. The open pit mine has a stripping ratio of 2.32:1, with an overall stripping ratio of 1.09:1 projected by the mine plan. In 1988, 7.9 million st Cu oxide ore were mined using open pit methods. The ore from the open pit mine is trucked to adjacent leach pads, sprayed with water and sulfuric acid, and the pregnant solution is pumped to the San Manuel SX-EW plant. The in situ leaching is conducted in areas adjacent to depleted portions of the underground mine. The sulfuric acid leach solution is injected to a depth of 600 to 1200 ft and the leach solution is pumped to the SX-EW plant. Magma projects that in situ production of 70 million lb per year will be achieved by yearend 1991.

**Processing:** Concentrator, smelter, sulfuric acid plant, refinery, SX-EW plant and cast rod mill are located 7 mi SE of mine area. Concentrator crushes and grinds ore and recovers concentrates in 40 ft flotation columns. Concentrator capacity is 62,500 stpd of ore; in 1988 the concentrator processed an average of 48,400 stpd. Molybdenum disulfide is processed through flotation and a molybdenum recovery plant where it is packaged for delivery. 1988 expansion included construction of SX-EW plant with 50,000 stpa capacity which processes both open pit and in situ leach solutions; during 1988 the SX-EW plant produced approximately 63 million lb of copper cathode. New flash furnace replacing three reverberatory furnaces will be operating at design capacity of 3000 stpd








Source: Magma Copper Company, Annual Report 1988

(300,000 stpa) in 1990; it is the world's largest copper smelting furnace. The three reverberatory furnaces at San Manuel were permanently shut down 8/88. Sulfuric acid produced by smelter is used in the leaching operations.

**Employees:** 3800

**Personnel:** Fred Hays, Purchasing Mgr.
Harry C. Smith, Ops. Mgr. Sulfide & Oxide Mining

## SANCHEZ COPPER DEPOSIT

****** **Cu** **OP HL SX-EW**

**Location:** 10 mi NE of Safford, Graham County, AZ

**Operator:** AZCO Mining Inc.
30 Bowie Avenue, Solomon, AZ 85546

**Admin.:** AZCO Mining Inc.
165 S. Union Boulevard #350, Lakewood, CO 80228

**Telephone:** 303/969-0591 **Fax:** 303/969-0596

**Contact:** Anthony R. Harvey, President

**Reserves:** 168,000,000 st oxide ore @ 0.34% Cu, 0.01 oz Au/st at a cutoff grade of 0.2% Cu, strip ratio 1.3:1, plus 60,000,000 st oxide ore @ 0.1-0.2% Cu at a cutoff grade of 0.1% Cu.

**Production:** 50-60 million lbs cathode copper per year projected.

**Start-up:** 1991 (projected)

**Processing:** Ore will be crushed and leached. Cu will be recovered by SX-EW.

**Cap. Costs:** $1.5 million spent to date on feasibility studies, preliminary engineering, geotechnical surveys, etc. Project will require a total of $75 million to production stage.

**Comments:** Feasibility study by Fluor Daniel, 1989. Basic engineering by Wright Engineers underway.

## SANTA CRUZ PROJECT

**E** **Cu** **S**

**Location:** 7 mi W of Casa Grande, Pinal County, AZ

**Operator:** Santa Cruz Joint Venture
P.O. Box 5747, Tucson, AZ 85703

**Telephone:** 602/792-3010 **Fax:** 602/792-3934

**Contact:** Albert Raihl, Project Manager (602/836-6249)

**Owners:** Asarco Santa Cruz Inc. (50%), Freeport Copper Company (50%); M. A. Hanna and Getty Oil are royalty holders.

**Admin.:** Asarco Inc.
180 Maiden Lane, New York, NY 10038

**Telephone:** 212/510-2000 **Fax:** 212/510-1951

**Contact:** Robert Kupsch, Vice President Mining

**Reserves:** 800,000,000 st @ 0.4% Cu, 640,000,000 st @ 0.7% Cu. Top of the orebody is 1500-ft below the surface.

**Mine:** Evaluating in situ solution mining of large oxidized porphyry deposits. Currently, water injections are used to obtain information for permit applications for injection of a dilute acid solution. Five-point well pattern with injection into center wells.

**Processing:** Plan to construct a small-scale conventional SX-EW plant on site.

**Personnel:** Albert Raihl, Proj. Mgr.
Henry G. Kreis, Field Mgr., Geol.

**Comments:** Research project funded by the Bureau of Mines (75%) and the Santa Cruz Joint Venture (25%). Five-year budget is approximately $20 million.

## SECRET PASS

**Au**

**Location:** Mohave County, AZ

**Operator:** Fischer-Watt Gold Company, Inc.
114 Tucker Avenue #7, Kingman, AZ 86401

**Telephone:** 602/753-1622 **Fax:** 602/753-6396

**Contact:** Frank L. Hillemeyer, Senior Exploration Geologist

**Owners:** Joint venture Fischer-Watt Gold Company, Inc., International Prospector, Inc.

**Admin.:** Fischer-Watt Gold Company, Inc.
340 Freeport Boulevard #3, Sparks, NV 89431

**Telephone:** 702/358-0947 **Fax:** 702/358-4026

**Contact:** W. Perry Durning, President

**Reserves:** 250,000 st @ 0.15 oz Au/st estimated. Drilling to confirm reserves in 1987.

## SHEEPHILL MINE & MILL

******** **Au, Ag**

**Location:** Flagstaff, Coconino County, AZ

**Operator:** Mariah-Guildmark Joint Venture
5000 Trails End, Flagstaff, AZ 86004

**Contact:** Richard Baker, Project Manager

**Owners:** Mariah International Inc. (50%), Guild-Mark Industries Inc. (50%)

**Admin.:** Mariah International Inc.
5617 N. Scottsdale Road #202, Scottsdale, AZ 85253

**Telephone:** 602/483-2303

**Contact:** Rod Groen, Controller

**Geology:** Above-ground cinder cone. Research and development project to establish mineral content in progress 2/90.

## SIERRITA MINE

**Alt. Names:** See Cyprus-Sierrita Mine

## SILVER BELL UNIT

**S** **Cu, Ag** **OP**

**Location:** Pima County, AZ

**Operator:** Asarco Inc.
General Delivery, Marana, AZ 85653

**Telephone:** 602/622-6751
**Contact:** D. J. Duncan, Mill Superintendent
**Owners:** Asarco Inc. (100%)
**Admin.:** Asarco Inc.
180 Maiden Lane, New York, NY 10038
**Telephone:** 212/510-2000 **Fax:** 212/510-1951
**Contact:** Robert Kupsch, Vice President Mining
**Reserves:** 20,955,000 st @ 0.68% Cu, 0.07 oz Ag/st.
**Production:** 1988: 4300 st Cu; 1987: 6400 st Cu; 1986: 3600 st Cu. Currently producing only copper precipitates. Mine could produce 18,000 stpa contained Cu if restarted, for a 6.5-yr mine life.
**Processing:** 11,000 stpd concentrator on standby. Dump leach and precipitation plant are operating.
**Employees:** 20
**Personnel:** D. J. Shea, Maint. Super.
D. J. Duncan, Mill Super.
A. J. Robles, Ch. Accountant

## SILVER CROSS MINE

I Au, Ag, Cu OP HL CC

**Location:** 30 mi N of Phoenix, at Cave Creek, Maricopa County, AZ
**Operator:** Anica Industries Inc.
P.O. Box 189, Cave Creek, AZ 85331
**Owners:** Amca Resources Ltd. (option 60.35%), Flow Resources Ltd. (39.65%)
**Admin.:** Amca Resources Ltd.
402, 807 W. Pender Street, Vancouver, BC V6B 1T5
**Telephone:** 604/688-6521
**Contact:** Charlie Martin
**Reserves:** High-grade zone: 100,000 st @ 0.7 oz Au/st, 7-10 oz Ag/st, 5-7% Cu.
**Production:** 8000-10,000 oz Au/yr.
**Start-up:** 1987
**Processing:** In 1985, constructed crushing and agglomeration plant on site and secured permits for heap leaching.
**Cap. Costs:** $2.0 million estimated.

## SOUTHWEST SALT MINE

**** Salt S

**Location:** AZ
**Operator:** Morton Salt Division
13000 W. Glendale Avenue, Glendale, AZ 85307-2408
**Telephone:** 602/247-3000 **Fax:** 602/247-3016
**Contact:** Gary McFarlin, Facility Manager
**Admin.:** Morton International, Inc., Morton Salt Division
110 N. Wacker Drive, Chicago, IL 60606-1560
**Telephone:** 312/807-2000 **Fax:** 312/807-2241
**Mine:** Solution mining by wells with evaporation of brines. Underground cavities used for storage of propane and butane.
**Employees:** 27

## ST. CHRISTOPHER GOLD MINE

*** Au UG

**Location:** 9 mi S of Arivaca, Santa Cruz County, AZ
**Operator:** Santa Cruz Mining & Milling Company
P.O. Box 101, Arivaca, AZ 85601
**Telephone:** 602/398-2389
**Contact:** G. F. Delgado, General Manager
**Owners:** Santa Cruz Mining & Milling Company (100%)
**Employees:** 2

## ST. JOHNS LIMESTONE

**** Limestone OP

**Location:** 5 mi SE of St. Johns, AZ
**Operator:** Superior Companies
P.O. Box 2777, St. Johns, AZ 85936
**Telephone:** 602/337-4529
**Contact:** Ed Bishop, Superintendent
**Owners:** Superior Companies
**Admin.:** Superior Companies
100 W. Coolidge, Phoenix, AZ 85013
**Telephone:** 602/230-9300 **Fax:** 602/230-0189
**Contact:** Archer V. Shelton, President; Lester Hall, Vice President Operations
**Employees:** 5

## STATE OF MAINE MINE

I Ag UG OP

**Location:** Tombstone, Cochise County, AZ
**Operator:** State of Maine Mining Company
P.O. Box 1016, Tombstone, AZ 85638
**Telephone:** 602/457-3601
**Contact:** Bailey Escapule
**Owners:** Charles Escapule, Louis Escapule
**Comments:** Mine operated until 1985. Recovery by Merrill-Crowe precipitation process; 12 stpd mill on site.

## STRONG AND HARRIS COPPER DEPOSIT

* Cu OP

**Location:** Johnson Camp, Cochise County, AZ
**Admin.:** AZCO Mining Inc.
165 S. Union Boulevard #350, Lakewood, CO 80228
**Telephone:** 303/969-0591 **Fax:** 303/969-0596
**Contact:** Anthony R. Harvey, President
**Geology:** Manto type replacement. 50% sulfide, 50% oxide ore.
**Reserves:** Based on 130 drill holes: 60 million st @ 0.6% Cu, 0.8% Zn, 0.2 oz Ag/st. Includes two high-grade zones, all open-ended: 1) 1.7 million st @ 4.4% Cu, 8.5% Zn, 0.3 oz Ag/st; 2) 750,000 st @ 1.8% Cu, 1.4% Zn, 0.75 oz Ag/st.

## SUPERIOR GYPSUM PIT

**** Gypsum OP

**Alt. Names:** Camp Verde Gypsum
**Location:** 4 mi SE of Camp Verde, Yavapai County, AZ
**Operator:** Superior Companies
P.O. Box 308, Cottonwood, AZ 86326
**Telephone:** 602/253-5590
**Contact:** H. Boyd Snoddy, General Manager Verde Valley Operations (602/567-3854)
**Owners:** Superior Companies
**Admin.:** Superior Companies
100 W. Coolidge, Phoenix, AZ 85013
**Telephone:** 602/230-9300 **Fax:** 602/230-0189
**Contact:** Archer V. Shelton, President; Lester Hall, Vice President Operations
**Mine:** Gypsum produced for Phoenix Cement Plant.
**Employees:** 40
**Personnel:** H. Boyd Snoddy, Gen. Mgr.
Alvin Hazelwood, Maint. Super.
Danny Parker, Prod. Mgr.

## SUPERIOR PERLITE

**Alt. Names:** See Harborlite Mine





## TREASURE KING GOLD PROJECT

** Au

**Alt. Names:** Treasure King/Mayer Area Project
**Location:** Near Prescott, Yavapai County, AZ
**Owners:** Royal Gold, Inc. (51%); States Exploration Ltd. (49%). Royal Gold, Inc. exchanged a 49% interest in the property for 23% ownership and warrants for additional shares of States Exploration Ltd. 8/88.
**Admin.:** Royal Gold, Inc.
1660 Wynkoop Street #1000, Denver, CO 80202-1132
**Telephone:** 303/573-1660 **Fax:** 303/595-9385
**Contact:** Edwin W. Peiker, Jr., President
**Reserves:** 175,000 st @ 0.063 oz Au/st.
**Mine:** Mine is fully permitted and ready for production when gold prices increase.

## TWIN BUTTES

**Alt. Names:** See Cyprus-Sierrita Mine

## TYRO MINE

S Au, Ag UG OP CIP

**Location:** Black Range Mountains, 30 mi W of Kingman, 6 mi from Bullhead City, Mohave County, AZ
**Operator:** Gold Standard Mines Inc.
P.O. Box 9006KS, Bullhead City, AZ 86430
**Telephone:** 602/754-3132
**Reserves:** 500,000 st estimated; based on weighted average of past production records, grade is extrapolated at 0.135 oz Au/st and 0.50 oz Ag/st.
**Processing:** Mill at minesite has 300 stpd capacity.
**Comments:** Property is owned by Denys Poyner, 3011 Van Marter Court, Kingman, AZ 86401-4262, 602/753-3838.

## U.S. MINE

**Alt. Names:** See Bighorn Mine

## UNITED VERDE EXTENSION (EDITH)

Au, Ag UG

**Location:** At Jerome, Yavapai County, AZ
**Operator:** A. F. Budge (Mining) Limited
P.O. Box 938, Jerome, AZ 86331
**Telephone:** 602/634-9034
**Contact:** Ronald R. Short, General Manager
**Owners:** A. F. Budge (Mining) Ltd.
**Admin.:** A. F. Budge (Mining) Ltd.
4301 N. 75th Street #101, Scottsdale, AZ 85251
**Employees:** 16
**Personnel:** Ronald R. Short, Gen. Mgr.
Pete Flores, Mine Mgr.
John McKenny, Geol.

## UNITED VERDE MINE

**** Cu OP

**Location:** At Jerome, Yavapai County, AZ
**Operator:** Phelps Dodge Corporation
P.O. Box 215, Jerome, AZ 86331
**Telephone:** 602/634-2622
**Contact:** Andrew Peterson, Agent
**Owners:** Phelps Dodge Corporation
**Admin.:** Phelps Dodge Corporation
2600 N. Central Avenue, Phoenix, AZ 85004-3014
**Telephone:** 602/234-8100
**Employees:** 2

## UNITED WESTERN MINE

*** Au UG

**Location:** Near Oatman, San Francisco Mining District, Mohave County, AZ
**Owners:** Joint venture Sun River Gold Corporation, Fischer-Watt Gold Company, Inc.
**Admin.:** Sun River Gold Corporation
110, 12761 16th Avenue, White Rock, BC Canada V4A 1N2
**Telephone:** 604/538-6601 **Fax:** 604/538-5223
**Contact:** Thomas R. Tough, President
**Reserves:** 1,384,095 st @ 0.221 oz Au/st, including 734,095 st @ 0.201 oz Au/st considered to be mineable reserves across a mining width of 15.7 ft. Deposit is open along strike in both directions and at depth.
**Contained:** 305,885 oz Au
**Production:** 25,000 oz Au annually projected.
**Start-up:** 1990 (projected)
**Mine:** 400 stpd mining and milling rate planned, with reserves adequate for 13 years. Shrinkage stoping to long-hole mining methods. EIS undertaken second half 1989. Rehabilitation of shaft collar and erection of headframe in progress 1/90, and dewatering of underground workings planned.
**Cap. Costs:** Estimated $5 million to place deposit into production.
**Oper. Costs:** $235/oz Au projected.
**Comments:** Sun River also owns the United Eastern and Big Jim Mines in the area, which formerly produced 550,000 st @ 1.10 oz Au/st over 45-ft mining widths and 220,552 st @ 0.834 oz Au/st at an overall cutoff grade of 0.40 oz Au/st.

## VAN DEEMEN PROPERTY

*, E Au OP HL

**Location:** 50 mi NW of Kingman, in the Black Range Mountains, Mohave County, AZ
**Operator:** Arizona Star Resources Corporation
114 Tucker #2, Kingman, AZ 86401
**Telephone:** 602/753-1100
**Contact:** Peter Drobeeck, Project Manager
**Owners:** Arizona Star Resources Corporation; Bema Gold Corporation (40%)
**Admin.:** Arizona Star Resources Corporation
1450, 625 Howe Street, Vancouver, BC Canada V6C 2T6
**Telephone:** 604/685-8844
**Contact:** K. W. Geigler, President
**Geology:** Detachment hosted deposit.
**Reserves:** 2,052,000 st @ 0.042 oz Au/st indicated and inferred reserves. Independent source mention proven reserves at 970,000 st @ 0.035 oz Au/st.
**Mine:** OP, HL potential. Possible feasibility decision anticipated 1989.
**Processing:** Plant at minesite.

## VAN DYKE MINE

S Cu UG S

**Location:** Gila County, AZ
**Operator:** Kocide Mining Corporation
Drawer D, Miami, AZ 85539
**Telephone:** 602/473-2421
**Contact:** Jimmy Whatley, Vice President Mining; Paul Musgrove, Consultant
**Owners:** Kocide Mining Corporation

**Production:** 4,000,000 lb contained Cu annually.
**Mine:** In situ leach.
**Processing:** Copper is refined at Cyprus' Casa Grande facility to produce copper sulfate.
**Employees:** 1

## VULTURE MINE

**** Cu T HL M-C

**Location:** 12 mi SW of Wickenburg, Maricopa County, AZ
**Operator:** A. F. Budge (Mining) Ltd.
P.O. Box 20878, Wickenburg, AZ 85358
**Telephone:** 602/376-9894
**Contact:** Dale H. Allen, Production Manager
**Admin.:** A. F. Budge (Mining) Ltd.
4301 N. 75th Street #101, Scottsdale, AZ 85251
**Contact:** Carole O'Brien
**Reserves:** 220,460 st @ 0.04 oz Au/st tailings and near-surface reserves with additional hard rock reserves mineable by open pit methods at a similar grade.
**Processing:** Tailings are agglomerated and leached using cyanide followed by Merrill-Crowe recovery. 1000 stpd is processed.
**Employees:** 9
**Comments:** The mine produced about 350,000 oz Au and 250,000 oz Ag with minor Cu and Pb from 1863 to 1942.

## WHITE CROSS MINE

Gypsum OP

**Location:** 4 mi N of Mammoth, Pinal County, AZ
**Operator:** Pinal Gypsum Corporation
P.O. Box 99, Coolidge, AZ 85228
**Telephone:** 602/723-3131
**Contact:** James Bechtel, Vice President Operations
**Admin.:** Pinal Gypsum Corporation
3 Park Central #900, Denver, CO 80202
**Contact:** Orin Benton, President
**Employees:** 7

## WHITE GOLD PROJECT

**, E Au OP

**Location:** NW of Nogales, Santa Cruz County, AZ
**Owners:** NCA Minerals Corp. via Goldstar Mining Company (20% to payback, then 50%), Zephyr Resources Inc. (80% to payback)
**Admin.:** Zephyr Resources Inc.
5400 Equity Avenue #B, Reno, NV 89502
**Telephone:** 702/322-5501 **Fax:** 702/322-5549
**Contact:** Dan W. Martin, President; Andy Markos, Manager
**Contained:** 35,000 oz Au
**Comments:** In exploration phase. Feasibility study by Zephyr Resources completed in 1989.

## WHITE HILL PROPERTY

Au, Ag UG

**Alt. Names:** GAR Shaft
**Location:** White Hills, AZ
**Reserves:** 350,000 st @ 0.25 oz Au/st, 10 oz Ag/st estimated 1987; additional dump material in other workings.
**Mine:** In 1987, rehabilitation of the GAR shaft on the property to 480 ft by previous lessee, Corval Development Corporation, U.S. subsidiary of Arizona Silver Corporation.
**Comments:** Corval Development Corporation terminated its lease of the property in 1989.

## WHITECLIFF DIATOMITE MINE

**** Diatomite OP

**Location:** 10 mi SE of Mammoth, 45 mi NE of Tucson, Pinal County, AZ
**Owners:** Whitecliff Industries, Inc. (100%)
**Admin.:** Whitecliff Industries, Inc.
7400 N. Oracle Road #371, Tucson, AZ 85704
**Telephone:** 602/797-0990
**Contact:** Gilbert Mott, President
**Production:** 20,000 stpa
**Processing:** Dry air cyclone plant on site with 75 stpd capacity. Product marketed throughout the U.S. to the functional filler market.
**Employees:** 7
**Personnel:** Peter Forsyth, Gen. Mgr.
Daniel Buelna, Plant Mgr.
Kim Howell, Technical Dir.
Graham Mott, Marketing/Sales Dir.

## WILLIAMS CINDERS

Pumice OP

**Location:** Coconino County, AZ
**Operator:** Olson Brothers
131 E. Railroad Avenue, Williams, AZ 86046
**Employees:** 2

## WINKELMAN GYPSUM

**** Gypsum OP

**Location:** Pinal County, AZ
**Operator:** Superior Companies
P.O. Box 327, Winkelman, AZ 85292
**Telephone:** 602/357-7002
**Contact:** John Nevitt, Superintendent
**Owners:** Superior Companies
**Admin.:** Superior Companies
100 W. Coolidge, Phoenix, AZ 85013
**Telephone:** 602/230-9300 **Fax:** 602/230-0189
**Contact:** Archer V. Shelton, President; Lester Hall, Vice Presdident Operations
**Mine:** Gypsum produced for Arizona Portland Cement Plant, Rillito, AZ.
**Employees:** 3

## YARNELL GOLD PROJECT

E Au, Ag OP

**Location:** S of Yarnell, 16 mi NE of Wickenburg, 72 mi NW of Phoenix, Yavapai County, AZ
**Owners:** Norgold Resources Inc. (100%); Asarco Inc. (right to acquire 51% for certain obligations, including a bankable feasibility study by July, 1991)
**Admin.:** Norgold Resources Inc.
210, 475 Howe Street, Vancouver, BC Canada V6C 2B3
**Telephone:** 604/681-5566 **Fax:** 604/687-8789
**Contact:** Michael D. Philpot, President
**Geology:** Mineralization is structurally controlled in an altered and strongly jointed Precambrian granite.
**Reserves:** 8,400,000 st @ 0.042 oz Au/st estimated geological reserve. The deposit is open in both strike directions and down dip.
**Start-up:** Mid-1991 (projected)
**Mine:** Low-grade bulk tonnage deposit associated with the Yarnell fault system. Anticipated overall stripping ratio 2:1. Prefeasibility study early 1990.





**Processing:** Heap leach target. 20,000 lb bulk sample being tested to determine optimum crushing size. Preliminary metallurgical tests indicate Au recovery of up to 80% with cyanide and lime consumption of 0.4 and 4.0 lb/st respectively.
**Personnel:** Mark Miller, Project Mgr.

## YARNELL NO. 1 MINE

Au

**Location:** Yavapai County, AZ
**Operator:** Jade Mining Company, Inc.
8014 W. Osborn, Phoenix, AZ 85033

## ZULU MINE

**Location:** Gila, AZ
**Operator:** Zulu Mining Company
4241 Winfield Scott Plaza #1, Scottsdale, AZ 85251

# ARKANSAS

## ARKANSAS CHEMICALS INC.

**** Bromine S

**Location:** Union County, AR
**Operator:** Arkansas Chemicals Inc.
Route 6, Box 98, El Dorado, AR 71730
**Telephone:** 501/862-4973
**Contact:** Dennis Venters, Vice President Operations
**Owners:** Great Lakes Chemical Corporation
**Admin.:** Great Lakes Chemical Corporation
P.O. Box 2200, W. Lafayette, IN 47906
**Telephone:** 317/497-6100
**Personnel:** Dennis Venters, VP Operations
George Hogg, Plant Mgr., Pers. Mgr.
Derry Hiett, Tech.

## ARKANSAS OPERATIONS MINE & MILL

**** Bauxite OP

**Location:** Saline County, AR
**Operator:** Aluminum Company of America
P.O. Box 300, Bauxite, AR 72011
**Telephone:** 501/776-4725
**Contact:** Hiram Cooper, Operations Manager
**Owners:** Aluminum Company of America
**Admin.:** Aluminum Company of America
1501 Alcoa Building #1064, Pittsburgh, PA 15219
**Employees:** Mine – 23, mill – 920
**Comments:** Mine will close 6/90 due to poor economic conditions. Jamaican bauxite shipped to the Point Comfort, TX, operations will continue to supply feed stock to the Arkansas mill after mid-1990.

## BERGER PLANT

**** Bauxite Plant

**Location:** Pulaski County, AR
**Operator:** Porocel Corporation
P.O. Box 9910, Little Rock, AR 72219
**Telephone:** 501/888-1357 **Fax:** 501/888-7050
**Contact:** Bill Evans, General Plant Manager
**Owners:** Porocel Corporation
**Admin.:** Engelhard Corporation
Menlo Park, CN 40, Edison, NJ 08818
**Telephone:** 201/632-6000
**Employees:** 18

## BRIAR PITS & PLANT

**** Gypsum OP

**Location:** Howard County, AR
**Operator:** Briar Gypsum
Route 4, Box 78, Nashville, AR 71852
**Telephone:** 501/845-4951 **Fax:** 501/642-1451
**Contact:** Larry Renard, Plant Manager
**Owners:** Boral Industries Inc.
**Admin.:** Boral Industries Inc.
800 N. Haven Avenue #240, Ontario, CA 91764
**Telephone:** 714/944-1700
**Employees:** 224
**Personnel:** Larry Renard, Plant Mgr.
Jim Foltz, Personnel Mgr.

## BRYANT ARKANSAS PLANT

**** Barite

**Location:** Saline County, AR
**Operator:** Milwhite Co., Inc.
P.O. Box 7, Bryant, AR 72022
**Owners:** Milwhite Co., Inc. (100%)
**Admin.:** Milwhite Co., Inc.
P.O. Box 15038, 5801 Lyons Avenue, Houston, TX 77020
**Telephone:** 713/675-0961

## CHRISTY MINE

I V OP

**Location:** Hot Springs County, AR
**Operator:** U.S. Vanadium Corporation
Route 6, Box 943, Hot Springs, AR 71901
**Telephone:** 501/262-1270 **Fax:** 501/262-2793
**Contact:** Dan Harris, General Manager
**Owners:** Umetco Minerals Corporation, a wholly owned subsidiary of Union Carbide (100%)
**Admin.:** Umetco Minerals Corporation
P.O. Box 1029, Grand Junction, CO 81502
**Telephone:** 303/245-3700 **Fax:** 303/245-7543
**Contact:** Niels Haubold, General Manager
**Mine:** Currently inactive.
**Personnel:** Dan Harris, Gen. Mgr.
Jim Morrissey, Purch. Agent
Sue Stone, Pers. Mgr.
Dave Lechak, Lab Mgr.
Clayton Quackenbush, Env. Coord.

## CONGO PIT

Talc OP

**Location:** Pulaski County, AR
**Operator:** Warner Trucking Company
P.O. Box 474, Bryant, AR 72022
**Owners:** Milwhite, Inc. (100%)
**Admin.:** Milwhite, Inc.
P.O. Box 15038, 5801 Lyons Avenue, Houston, TX 77020
**Telephone:** 713/675-0961

## EL DORADA PLANTS

**** Bromine

**Alt. Names:** Includes Marysville Plant (West Plant)
**Location:** Union County, AR