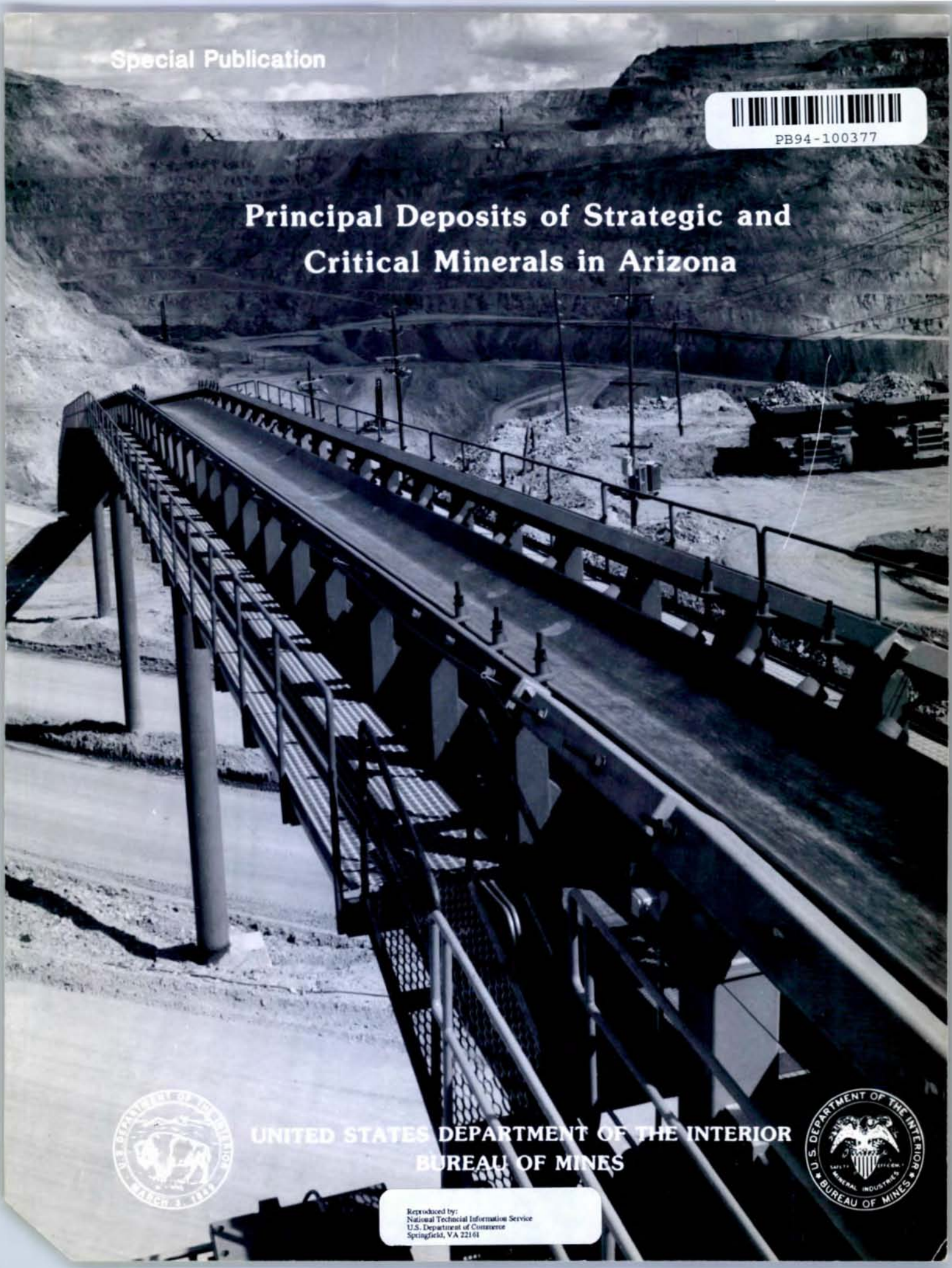
Special Publication

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# Principal Deposits of Strategic and Critical Minerals in Arizona



UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

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# PRINCIPAL DEPOSITS OF STRATEGIC AND CRITICAL MINERALS IN ARIZONA

by

Michael B. Sawyer, Alfredo C. Gurmendi, Michael R. Daley,
and Susan B. Howell

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

| | |
|---|---|
| acre-ft | acre-foot |
| acre-ft/yr | acre-foot per year |
| d/wk | day per week |
| ft | foot |
| g | gram |
| gpm | gallon per minute |
| in | inch |
| kg | kilogram |
| km | kilometer |
| kV•A | kilovolt ampere |
| kW | kilowatt |
| kW•h | kilowatt hour |
| lb | pound |
| lb/d | pound per day |
| $lb/ft^3$ | pound per cubic foot |
| lb/mo | pound per month |
| lb/yr | pound per year |
| lt | long ton |
| m | meter |
| $m^3$ | cubic meter |
| $m^3/yr$ | cubic meter per year |
| mi | mile |
| mo | month |
| mt | metric ton |
| ppm | part per million |
| st | short ton |
| st/d | short ton per day |
| st/h | short ton per hour |
| st/mo | short ton per month |
| st/yr | short ton per year |
| st unit | short ton unit |
| tr oz | troy ounce |
| tr oz/st | troy ounce per short ton |
| tr oz/yr | troy ounce per year |
| wt % | weight percent |

# PRINCIPAL DEPOSITS OF STRATEGIC AND CRITICAL MINERALS IN ARIZONA

By M. B. Sawyer,[1] A. C. Gurmendi,[1] M. R. Daley,[2]

and S. B. Howell[3]

## ABSTRACT

This Bureau of Mines publication provides locational, geological, and operational data in abstracted format for about 200 mineral deposits representing 16 commodities that are considered to be important to the economies of the United States and Arizona. Each of these commodities is discussed in terms of its history, physical and chemical properties, uses, and occurrence in Arizona. Institutional and infrastructural factors that affect mineral development in Arizona are also presented. These factors include regulation, taxation, and availability of utilities, transportation, and mineral processing facilities.

## INTRODUCTION

The purpose of this report is to present locational, geological, and operational data on 189 selected principal deposits of strategic and critical

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minerals in the State of Arizona. The important institutional and infrastructural factors that affect mineral development in the State are also discussed. The units given in this report are those reported in sources cited. No attempt was made to convert them.

This publication consists of a narrative description of background information on the minerals industry of Arizona including the existing infrastructural-institutional factors that affect Arizona's minerals industries, followed by a commodity review and information abstracts on 138 important mineral deposits.

The infrastructure subsection explains the transportation (highway and railroad) and utility (electricity, natural gas, and water) networks in the State. It also contains general information on milling, smelting, and refining facilities as well as permitting and taxation procedures and policies with respect to mineral development in Arizona.

The commodity reviews present an overview of the principal mineral commodities of Arizona. The reviews also list the principal deposits in the State, most of which are described in greater detail in the deposit abstract section. Descriptions of deposit size reflect the authors' professional judgment of the total resource contained in the individual deposit. The terms "small," "medium," and "large" are based on the size categories published by the U.S. Geological Survey (USGS) (*225*);[4] definitions of the terms are provided for each commodity. A commodity location map shows the principal deposits as well as mineral occurrences. The terms "reserve" and "resource"

[4]Italic numbers in parentheses refer to items in the list of references at the end of this report.

are used according to the mineral resource classification system of the Bureau and the USGS (667).

The largest segment of the publication is the deposit abstract section. It contains single-page summaries of information on 138 important mineral properties in Arizona. The abstracted information includes deposit name and commodity(ies), location and ownership, geology, development, published reserves and resources, and references. The format of these abstracts is loosely based on the Bureau's Minerals Availability System (MAS) data base (661). In order to avoid conversion errors, all data are reported in terms and units of the cited publication unless otherwise specified.

An extensive reference section follows the deposit abstracts. Although an individual reference cited in an abstract may not specifically mention the deposit in question, the reference contains geological, mining, metallurgical, statistical, economic, or other data pertinent to the deposit.

## ACKNOWLEDGMENTS

The authors wish to thank the State of Arizona for its assistance and information and for graciously allowing the use of State base maps and other illustrations in the preparation of this publication.

Special gratitude is extended to the Arizona Department of Mines and Mineral Resources (ADMMR), with particular thanks to J. H. Jett, former director; L. E. Kissinger, director; K. A. Phillips, chief engineer; N. J. Niemuth, mineral resource specialist; and R. R. Beard, mining engineer, for their contributions during the preparation of this report. Also, the cooperation of R. A. McColly and N. T. Lowe (Bureau of Mines) is especially noted and appreciated.

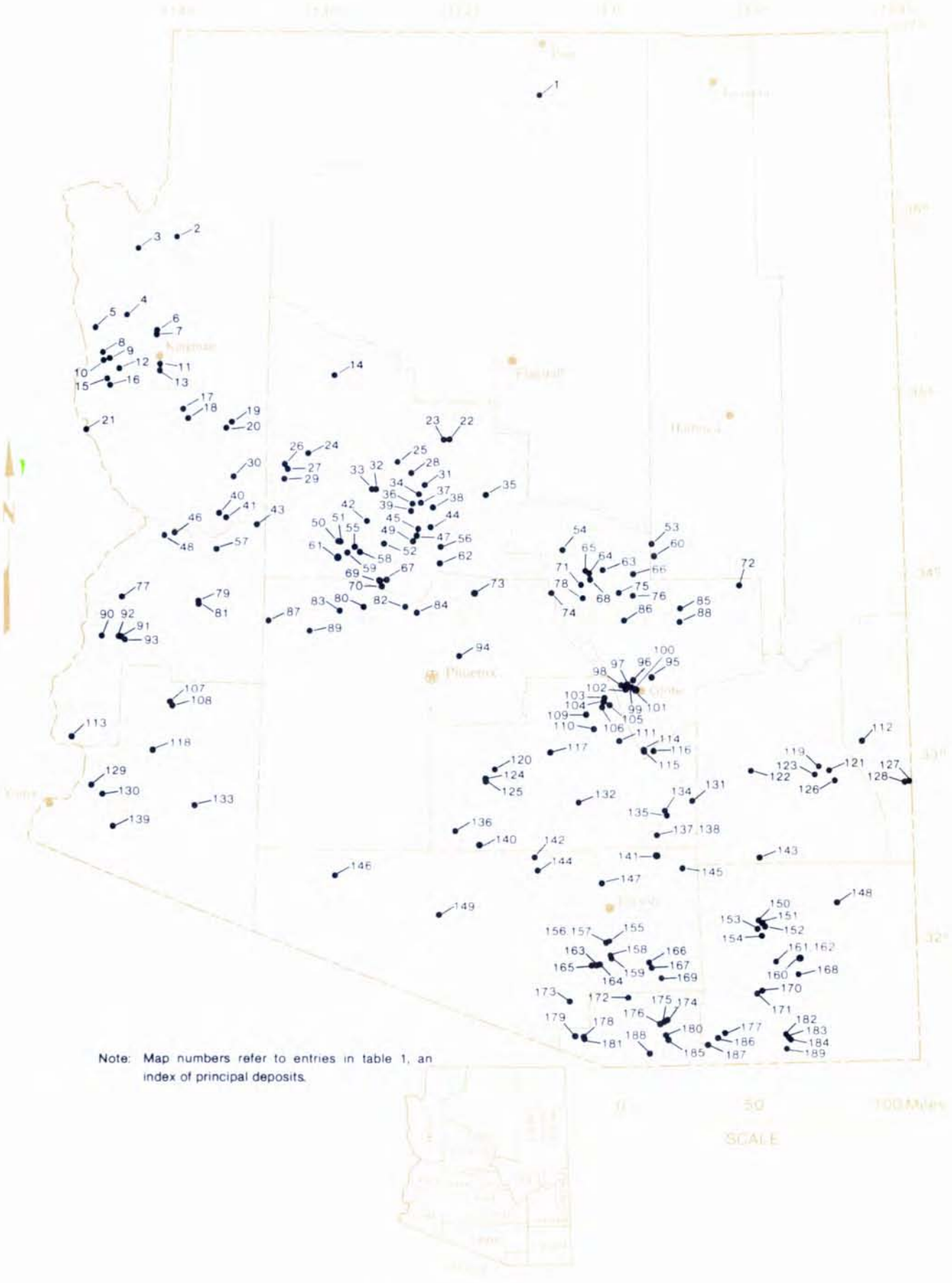
## COMMODITY AND DEPOSIT SELECTION

The mineral deposits described in this report comprise 16 mineral commodities of interest to the Bureau because of their significance to the economy, critical and/or strategic nature, environmental problems, etc. The commodities are aluminum, asbestos, barite, columbium-tantalum, copper, fluorspar, gold, iron, lead, manganese, mercury, molybdenum, silver, tungsten, and zinc. A much larger number of commodities is reported in the State, but these are either negligible in quantity or are ubiquitous and significant in quantity. The latter category includes mainly industrial minerals such as sand and gravel, perlite, pyrites, gypsum, and pumice.

Deposit selection was completed after consultation with individuals and agencies familiar with the Arizona mining industry and was generally based on meeting one or more of the following criteria:

1. The deposit has been evaluated by the Bureau.
2. The deposit contains significant known reserves-resources or may, in the judgment of the authors, contain significant reserves-resources.
3. The deposit is a producing mine.
4. The deposit is presently uneconomic, but because of its size alone (irrespective of location, grade, and metallurgical complexities), is significant from an academic perspective and could be a commodity source dependent upon future recovery technologies.

Figure 1 and table 1 show the locations and names of the 189 principal deposits selected for this report; deposit abstracts have been prepared for 138 of the principal deposits. Table 2 shows the distribution of the 189 principal deposits by commodity and county.



Note: Map numbers refer to entries in table 1, an index of principal deposits.

**Figure 1. Location of selected principal deposits in Arizona.**

Table 1.--Selected principal deposit index

(Refer to figure 1)

| Map no. | Deposit name | Primary commodity |
|---|---|---|
| 1 | White Mesa District | Cu |
| 2 | Quartz Mountain[1] | Cb-Ta |
| 3 | Cyclopic | Au |
| 4 | Mineral Park | Cu-Mo |
| 5 | Portland | Au |
| 6 | C.O.D. | Ag |
| 7 | Fountain Head | Ag |
| 8 | Roadside | Au |
| 9 | Frisco | Au |
| 10 | Arabian | Au |
| 11 | Bi-Metal | Au |
| 12 | Secret Pass | Au |
| 13 | Mineral X[1] | Cb-Ta |
| 14 | Seligman-Cowden Area[1] | Fe |
| 15 | Moss | Au |
| 16 | United Western | Au |
| 17 | Boriana | W |
| 18 | Antler | Zn |
| 19 | Rare Metals | Cb-Ta |
| 20 | Williams | W |
| 21 | Van Deemen | Au |
| 22 | United Verde Extension. | Cu |
| 23 | United Verde | Cu |
| 24 | Black Pearl | W |
| 25 | Black Hills Area[1] | Fe |
| 26 | Boulder Cr.-Milholland Cr. Area[1]. | Fe |
| 27 | Bagdad | Cu-Mo |
| 28 | Lynx Creek Drainage Area[1]. | Au |
| 29 | Bruce | Zn |
| 30 | Signal District[1] | Cb-Ta |
| 31 | Iron King | Pb |
| 32 | Copper Basin | Cu-Mo |
| 33 | Copper Basin[1] | Au |
| 34 | McCabe | Au-Ag |
| 35 | Squaw Peak | Mo |
| 36 | Transcendent | Au |
| 37 | Big Bug Creek Drainage Area[1]. | Au |
| 38 | Mayer Area[1] | Fe |
| 39 | Goodwin-Crown King Area[1]. | Fe |
| 40 | Maggie | Mn |
| 41 | Artillery Mountains District[1]. | Mn |
| 42 | Zonia | Cu |
| 43 | Spring[1] | Mn |
| 44 | Cleator Area[1] | Fe |
| 45 | North Star | W |
| 46 | New Planet | Fe |
| 47 | Gladiator-War Eagle[1] | Au |
| 48 | Mineral Hill | Fe |
| 49 | Wildflower | Ag |
| 50 | New Congress | Au |
| 51 | Congress | Au |
| 52 | Hassayampa River Drainage Area[1]. | Au |
| 53 | Apache | Fe |
| 54 | Oxbow | Au |
| 55 | Stanton Area[1] | Fe |
| 56 | Rock Springs-Cordes Area[1]. | Fe |
| 57 | Doyle[1] | Mn |
| 58 | Octave | Au |
| 59 | Weaver District[1] | Au |
| 60 | Chedlski | Fe |
| 61 | Santa Margarita District[1]. | Fe |
| 62 | Kay | Cu |
| 63 | Rose | W |
| 64 | Iron King[1] | Fe |
| 65 | Pig Iron[1] | Fe |
| 66 | American | Asb |
| 67 | Midnight Owl | Cb-Ta |
| 68 | Top Hat Group | $BaSO_4$ |
| 69 | Outpost[1] | Cb-Ta |
| 70 | Picacho View | Cb-Ta |
| 71 | Quartz Ledge | $CaF_2$ |
| 72 | Red Rock | $CaF_2$ |
| 73 | Silver Cross | Au |
| 74 | Mazatzal Mountains Area. | Hg |
| 75 | McFadden Peak | $CaF_2$ |
| 76 | Samsel | W |
| 77 | Copperstone | Au |
| 78 | Packard | $CaF_2$ |
| 79 | Yuma | Cu |
| 80 | Newsboy | Au |
| 81 | Three Musketeers | W |
| 82 | Pikes Peak District | Fe |
| 83 | Vulture | Au |
| 84 | Clementine | Au |
| 85 | Canadian | Asb |
| 86 | Zimmerman-Asbestos Points Area[1]. | Fe |
| 87 | Snowball | $CaF_2$ |
| 88 | El Dorado | Asb |
| 89 | Big Horn | Au |
| 90 | La Paz[1] | Au |
| 91 | La Cholla-Middle Camp-Oro Fino[1]. | Au |
| 92 | Sugarloaf Butte | Al |
| 93 | Plomosa[1] | Au |
| 94 | Rico Group | Hg |
| 95 | Globe District[1] | Mn |
| 96 | Copper Cities | Cu |
| 97 | Bluebird | Cu |
| 98 | Pinto Valley | Cu-Mo |
| 99 | Inspiration | Cu |
| 100 | Miami Unit | Cu |
| 101 | Van Dyke | Cu |
| 102 | Ox Hide | Cu |
| 103 | Silver King | Ag |
| 104 | Superior District[1] | Mn |
| 105 | Magma-Superior | Cu |
| 106 | L. S. and A. | Au |
| 107 | North Star | Au |
| 108 | King of Arizona | Au |
| 109 | Reymert | Ag |
| 110 | Silverbell-Martinez | Ag |
| 111 | Ray | Cu-Mo |
| 112 | Morenci-Metcalf | Cu-Mo |
| 113 | Silver-Eureka District. | Ag |
| 114 | Seventy-Nine | Pb |
| 115 | Chilito[1] | Cu-Mo |
| 116 | Christmas | Cu |
| 117 | Florence | Cu |
| 118 | Castle Dome[1] | Au |
| 119 | Dos Pobres | Cu |
| 120 | Sacaton | Cu |
| 121 | Peacock | Cu |
| 122 | Mt. Jackson | $CaF_2$ |
| 123 | Lone Star | Cu-Mo |
| 124 | Casa Grande | Cu |
| 125 | Santa Cruz | Cu-Mo |
| 126 | Sanchez | Cu |
| 127 | Fourth of July | $CaF_2$ |
| 128 | Daniels Camp 1 & 2 | $CaF_2$ |
| 129 | Laguna[1] | Au |
| 130 | Gila City[1] | Au |
| 131 | Old Reliable | Cu |
| 132 | Florence-Oracle Jct.-Red Rock Area[1]. | Fe |
| 133 | Renner | $BaSO_4$ |
| 134 | Mammoth-Tiger | Au |
| 135 | San Manuel-Kalamazoo | Cu-Mo |
| 136 | Vekol Hills | Cu-Mo |
| 137 | Pure Gold | W |
| 138 | Morning Star | W |
| 139 | La Fortuna | Au |
| 140 | Lakeshore | Cu |
| 141 | Oracle Ridge | Cu |
| 142 | Atlas[1] | Cu |
| 143 | Strong & Harris[1] | Cu |
| 144 | Silver Bell | Cu |
| 145 | Korn Kob[1] | Cu |
| 146 | New Cornelia | Cu-Mo |
| 147 | Old Yuma | Pb |
| 148 | Gold Prince | Au |
| 149 | Quijotoa[1] | Au |
| 150 | Cyprus Johnson | Cu |
| 151 | Keystone | Cu |
| 152 | I-10[1] | Cu-Mo |
| 153 | Primos Group | W |
| 154 | Dragoon[1] | Cu |
| 155 | Eisenhower | Cu-Mo |
| 156 | Mission-San Xavier | Cu-Mo |
| 157 | Pima | Cu-Mo |
| 158 | Dynamite[1] | Cu |
| 159 | Twin Buttes | Cu-Mo |
| 160 | Commonwealth | Ag |
| 161 | San Juan | Zn |
| 162 | Cochise[1] | Cu |
| 163 | Sierrita | Cu-Mo |
| 164 | Esperanza | Cu-Mo |
| 165 | Sierrita Mountains[1] | Au |
| 166 | Helvetia West | Cu |
| 167 | Helvetia East | Cu-Mo |
| 168 | Turquoise[1] | Cu |
| 169 | Greaterville[1] | Au |
| 170 | Contention-Grand Central. | Ag |
| 171 | Tombstone District[1] | Mn |
| 172 | Glove Group | Pb |
| 173 | Arivaca[1] | Au |
| 174 | Treasure King | Au |
| 175 | Pat Alunite | Al |
| 176 | Red Mountain | Cu |
| 177 | Lucky Strike | W |
| 178 | Montana | Ag-Au |
| 179 | Ventura[1] | Mo |
| 180 | Hardshell | Mn |
| 181 | Margarita Group | Au |
| 182 | Dubacher Canyon | Cu |
| 183 | Bisbee District[1] | Mn |
| 184 | Denn | Cu |
| 185 | Mowry[1] | Mn |
| 186 | Reef | W |
| 187 | Wakefield Group | W |
| 188 | Edna Group | W |
| 189 | Copper Queen | Cu |

[1]Deposit abstract not prepared.

Table 1.--Selected principal deposit index--Continued

(Refer to figure 1)

| Deposit name (alphabetical) | Primary commodity | Map no. | Deposit name (alphabetical) | Primary commodity | Map no. | Deposit name (alphabetical) | Primary commodity | Map no. |
|---|---|---|---|---|---|---|---|---|
| American | Asb | 66 | Hassayampa River Drainage Area[1] | Au | 52 | Pure Gold | W | 137 |
| Antler | Zn | 18 | Helvetia East | Cu-Mo | 167 | Quartz Ledge | $CaF_2$ | 71 |
| Apache | Fe | 53 | Helvetia West | Cu | 166 | Quartz Mountain[1] | Cb-Ta | 2 |
| Arabian | Au | 10 | I-10[1] | Cu-Mo | 152 | Quijotoa[1] | Au | 149 |
| Arivaca[1] | Au | 173 | Inspiration | Cu | 99 | Rare Metals | Cb-Ta | 19 |
| Artillery Mountains District[1] | Mn | 41 | Iron King[1] | Fe | 64 | Ray | Cu-Mo | 111 |
| Atlas[1] | Cu | 142 | Iron King | Pb | 31 | Red Mountain | Cu | 176 |
| Bagdad | Cu-Mo | 27 | Kay | Cu | 62 | Red Rock | $CaF_2$ | 72 |
| Big Bug Creek Drainage Area[1] | Au | 37 | Keystone | Cu | 151 | Reef | W | 186 |
| Big Horn | Au | 89 | King of Arizona | Au | 108 | Renner | $BaSO_4$ | 133 |
| Bi-Metal | Au | 11 | Korn Kob[1] | Cu | 145 | Reymert | Ag | 109 |
| Bisbee District[1] | Mn | 183 | La Cholla-Middle Camp-Oro Fino[1] | Au | 91 | Rico Group | Hg | 94 |
| Black Hills Area[1] | Fe | 25 | La Fortuna | Au | 139 | Roadside | Au | 8 |
| Black Pearl | W | 24 | Laguna[1] | Au | 129 | Rock Springs-Cordes Area[1] | Fe | 56 |
| Bluebird | Cu | 97 | Lakeshore | Cu | 140 | Rose | W | 63 |
| Boriana | W | 17 | La Paz[1] | Au | 90 | Sacaton | Cu | 120 |
| Boulder Cr.-Milholland Cr. Area[1] | Fe | 26 | Lone Star | Cu-Mo | 123 | Samsel | W | 76 |
| Bruce | Zn | 29 | L. S. and A | Au | 106 | Sanchez | Cu | 126 |
| Canadian | Asb | 85 | Lucky Strike | W | 177 | San Juan | Zn | 161 |
| Casa Grande | Cu | 124 | Lynx Creek Drainage Area[1] | Au | 28 | San Manuel-Kalamazoo | Cu-Mo | 135 |
| Castle Dome[1] | Au | 118 | Maggie | Mn | 40 | Santa Cruz | Cu-Mo | 125 |
| Chedlski | Fe | 60 | Magma-Superior | Cu | 105 | Santa Margarita District[1] | Fe | 61 |
| Chilito[1] | Cu-Mo | 115 | Mammoth-Tiger | Au | 134 | Secret Pass | Au | 12 |
| Christmas | Cu | 116 | Margarita Group | Au | 181 | Seligman-Cowden Area[1] | Fe | 14 |
| Cleator Area[1] | Fe | 44 | Mayer Area[1] | Fe | 38 | Seventy-Nine | Pb | 114 |
| Clementine | Au | 84 | Mazatzal Mountains Area | Hg | 74 | Sierrita | Cu-Mo | 163 |
| Cochise[1] | Cu | 162 | McCabe | Au-Ag | 34 | Sierrita Mountains[1] | Au | 165 |
| C.O.D. | Ag | 6 | McFadden Peak | $CaF_2$ | 75 | Signal District[1] | Cb-Ta | 30 |
| Commonwealth | Ag | 160 | Miami Unit | Cu | 100 | Silver Bell | Cu | 144 |
| Congress | Au | 51 | Midnight Owl | Cb-Ta | 67 | Silverbell-Martinez | Ag | 110 |
| Contention-Grand Central | Ag | 170 | Mineral Hill | Fe | 48 | Silver Cross | Au | 73 |
| Copper Basin | Cu-Mo | 32 | Mineral Park | Cu-Mo | 4 | Silver-Eureka District | Ag | 113 |
| Copper Basin[1] | Au | 33 | Mineral X[1] | Cb-Ta | 13 | Silver King | Ag | 103 |
| Copper Cities | Cu | 96 | Mission-San Xavier | Cu-Mo | 156 | Snowball | $CaF_2$ | 87 |
| Copper Queen | Cu | 189 | Montana | Ag-Au | 178 | Spring[1] | Mn | 43 |
| Copperstone | Au | 77 | Morenci-Metcalf | Cu-Mo | 112 | Squaw Peak | Mo | 35 |
| Cyclopic | Au | 3 | Morning Star | W | 138 | Stanton Area[1] | Fe | 55 |
| Cyprus Johnson | Cu | 150 | Moss | Au | 15 | Strong & Harris[1] | Cu | 143 |
| Daniels Camp 1 & 2 | $CaF_2$ | 128 | Mt. Jackson | $CaF_2$ | 122 | Sugarloaf Butte | Al | 92 |
| Denn | Cu | 184 | Mowry[1] | Mn | 185 | Superior District[1] | Mn | 104 |
| Dos Pobres | Cu | 119 | New Congress | Au | 50 | Three Musketeers | W | 81 |
| Doyle[1] | Mn | 57 | New Cornelia | Cu-Mo | 146 | Tombstone District[1] | Mn | 171 |
| Dragoon[1] | Cu | 154 | New Planet | Fe | 46 | Top Hat Group | $BaSO_4$ | 68 |
| Dubacher Canyon | Cu | 182 | Newsboy | Au | 80 | Transcendent | Au | 36 |
| Dynamite[1] | Cu | 158 | North Star | Au | 107 | Treasure King | Au | 174 |
| Edna Group | W | 188 | North Star | W | 45 | Turquoise[1] | Cu | 168 |
| Eisenhower | Cu-Mo | 155 | Octave | Au | 58 | Twin Buttes | Cu-Mo | 159 |
| El Dorado | Asb | 88 | Old Reliable | Cu | 131 | United Verde | Cu | 23 |
| Esperanza | Cu-Mo | 164 | Old Yuma | Pb | 147 | United Verde Extension | Cu | 22 |
| Florence | Cu | 117 | Oracle Ridge | Cu | 141 | United Western | Au | 16 |
| Florence-Oracle Jct.-Red Rock Area[1] | Fe | 132 | Outpost[1] | Cb-Ta | 69 | Van Deemen | Au | 21 |
| Fountain Head | Ag | 7 | Oxbow | Au | 54 | Van Dyke | Cu | 101 |
| Fourth of July | $CaF_2$ | 127 | Ox Hide | Cu | 102 | Vekol Hills | Cu-Mo | 136 |
| Frisco | Au | 9 | Packard | $CaF_2$ | 78 | Ventura[1] | Mo | 179 |
| Gila City[1] | Au | 130 | Pat Alunite | Al | 175 | Vulture | Au | 83 |
| Gladiator-War Eagle[1] | Au | 47 | Peacock | Cu | 121 | Wakefield Group | W | 187 |
| Globe District[1] | Mn | 95 | Picacho View | Cb-Ta | 70 | Weaver District[1] | Au | 59 |
| Glove Group | Pb | 172 | Pig Iron[1] | Fe | 65 | White Mesa District | Cu | 1 |
| Gold Prince | Au | 148 | Pikes Peak District | Fe | 82 | Wildflower | Ag | 49 |
| Goodwin-Crown King Area[1] | Fe | 39 | Pima | Cu-Mo | 157 | Williams | W | 20 |
| Greaterville[1] | Au | 169 | Pinto Valley | Cu-Mo | 98 | Yuma | Cu | 79 |
| Hardshell | Mn | 180 | Plomosa[1] | Au | 93 | Zimmerman-Asbestos Points Area[1] | Fe | 86 |
| | | | Portland | Au | 5 | Zonia | Cu | 42 |
| | | | Primos Group | W | 153 | | | |

[1]Deposit abstract not prepared.

Table 2.--Distribution of principal deposits of selected commodities in Arizona, by county

| County | Aluminum | | Asbestos | | Barite | | Columbium-Tantalum | | Copper | | Fluorspar | | Gold | | Iron | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dep | Abs | Dep | Abs | Dep | Abs | Dep | Abs | Dep | Abs | Dep | Abs | Dep | Abs | Dep | Abs |
| Apache..... | | | | | | | | | | | | | | | | |
| Cochise..... | | | | | | | | | 10 | 5 | | | 1 | 1 | | |
| Coconino.... | | | | | | | | | 1 | 1 | | | | | | |
| Gila..... | | | 3 | 3 | 1 | 1 | | | 9 | 8 | 4 | 4 | 2 | 2 | 3 | 0 |
| Graham..... | | | | | | | | | 5 | 5 | 1 | 1 | 3 | 3 | | |
| Greenlee.... | | | | | | | | | 1 | 1 | 2 | 2 | 1 | 1 | | |
| La Paz..... | 1 | 1 | | | | | | | 1 | 1 | | | 4 | 1 | | |
| Maricopa.... | | | | | | | | | | | 1 | 1 | 5 | 5 | 1 | 1 |
| Mohave..... | | | | | | | 5 | 1 | 1 | 1 | | | 10 | 10 | | |
| Navajo..... | | | | | | | | | | | | | | | 2 | 2 |
| Pima..... | | | | | | | | | 14 | 11 | | | 9 | 5 | | |
| Pinal..... | | | | | | | | | 9 | 9 | | | 3 | 3 | 1 | 0 |
| Santa Cruz.. | 1 | 1 | | | | | | | 1 | 1 | | | 2 | 2 | | |
| Yavapai..... | | | | | | | 2 | 2 | 6 | 6 | | | 13 | 7 | 9 | 0 |
| Yuma..... | | | | | 1 | 1 | | | | | | | 6 | 3 | 2 | 2 |
| Total..... | 2 | 2 | 3 | 3 | 2 | 2 | 7 | 3 | 58 | 49 | 8 | 8 | 59 | 43 | 18 | 5 |

| | Lead | | Manganese | | Mercury | | Molybdenum | | Silver | | Tungsten | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dep | Abs | Dep | Abs | Dep | Abs | Dep | Abs | Dep | Abs | Dep | Abs | Dep | Abs |
| Apache..... | | | | | | | | | | | | | | |
| Cochise..... | | | 2 | 0 | | | 1 | 0 | 2 | 2 | 4 | 4 | 1 | 1 |
| Coconino.... | | | | | | | | | | | | | | |
| Gila..... | 1 | 1 | 1 | 0 | | | 2 | 1 | 1 | 1 | 2 | 2 | | |
| Graham..... | | | | | | | 2 | 2 | 2 | 2 | | | | |
| Greenlee.... | | | | | | | 1 | 1 | 1 | 1 | | | | |
| La Paz..... | | | 2 | 0 | | | | | | | 1 | 1 | | |
| Maricopa.... | | | | | 2 | 2 | | | | | | | | |
| Mohave..... | | | 2 | 1 | | | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 |
| Navajo..... | | | | | | | | | | | | | | |
| Pima..... | 1 | 1 | | | | | 8 | 8 | 7 | 7 | | | | |
| Pinal..... | | | 1 | 0 | | | 3 | 3 | 4 | 4 | 2 | 2 | | |
| Santa Cruz.. | 1 | 1 | 2 | 1 | | | 1 | 0 | 1 | 1 | 1 | 1 | | |
| Yavapai..... | 1 | 1 | | | | | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 |
| Yuma..... | | | | | | | | | 1 | 1 | | | | |
| Total..... | 4 | 4 | 10 | 2 | 2 | 2 | 22 | 19 | 24 | 24 | 14 | 14 | 3 | 3 |

Dep Number of principal deposits. Abs Number of deposit abstracts.
NOTE.--No entry in a column indicates that no principal deposits were identified or no abstract was prepared.

## HISTORY OF MINING IN ARIZONA[5]

Mining has long driven the history and economy of Arizona. Through television and movies, Americans are aware, albeit vaguely, of the wealth created from mining of the State's gold and silver deposits during the mid-19th through late 20th century. Few people, however, are aware of the true significance of mining to the State's economy. Although ranked fourth nationally in the value of its nonfuel mineral production for 1986, Arizona has led the nation in the output of copper for more than 75 years. Since 1961, Arizona has annually produced over one-half of all domestic copper. In addition, in 1986, Arizona was second in mine production of molybdenum; third in output of perlite, pyrites, sand and gravel, and silver; fifth in output of gypsum, lead, and pumice; and seventh in output of gold.

The first mining in Arizona was conducted by Indians in search of turquoise (for decoration and trade), salt (for food and for curing of hides), and deep colored iron and copper minerals (for cosmetics). Evidence indicates that Spanish explorers first entered Arizona in the 1540's in search of the Seven Cities of Cibola, which were thought to have streets paved with gold and treasure troves of wrought gold artifacts. The first "true" ore body discovered by non-Indians in Arizona is believed to be the copper ore body at the United Verde Mine, discovered along the Verde River by Don Antonio de Espejo in 1582. This discovery was apparently of no interest to the gold-seeking Spaniards. The second discovery was probably made at Ajo in 1750, but the early prospectors mistook copper glance (chalcocite) for silver

[5]See references 56, 158-159, 293-294, 345, 658-659.

glance (argentite). When the small amounts of ore that were taken to Mexico did not yield the expected silver, the deposit was forgotten. It was rediscovered 100 years later after Arizona had become a U.S. Territory.

With the exception of small amounts of placer gold and of copper from Ajo, almost all mining in Arizona until the 1850's was for silver. Arizona's modern mining era began in late 1854 when Captain Peter R. Brady of the Texas & Pacific Railroad survey team was sent to relocate the Ajo ore body. The initial copper ore grade was so rich that the miners were able to make a profit even after paying $105/st for transportation of the ore by pack mules to the Colorado River where it could be shipped downriver to the Gulf of California and then to the copper smelter in Swansea, Wales.

The true impetus for mining in Arizona is more generally attributed to Charles D. Poston, a writer. In 1854 Poston traveled to Arizona in the company of Herman Ehrenberg, a mining engineer and metallurgist. Ehrenberg pointed out the silver mineralization in the hills surrounding Tubac to Poston before continuing on to the Colorado River for additional prospecting. Poston then returned to San Francisco for the purpose of raising venture capital. In 1856, with a $100,000 purse and the promise of up to $1 million more if needed, Poston returned to Tubac to develop the silver deposits. Although the high-grade silver ores were mined out early, Poston was never discouraged. Traveling to Washington, DC, he was instrumental in gaining Territorial status for Arizona, and he returned in 1864 as the newly appointed Indian Commissioner attached to the Territorial government.

Although Arizona is now known for its copper production, numerous silver deposits supplied the majority of mine income during the four decades

following 1854. Silver began a remarkable climb in both production and unit price in the 1850's that continued through the 1870's. In 1878 passage of the Bland-Allison Silver Purchase Act required the Secretary of the Treasury to buy a minimum of $2 million in silver every month at prevailing market prices. This requirement led to increased production and the beginning of a drop in price because of oversupply. As the price of silver fell, political pressure was building to help the producers. The result was the Sherman Silver Purchase Act of 1890 that required the Secretary of the Treasury to buy 4.5 million tr oz of silver every month at prevailing market prices. The quantity was an estimate of the total national silver production. In June 1893 the British stopped production of the silver rupee in India, precipitating a price drop of 20% for silver in only a few hours on the world markets. By the time the Sherman Silver Purchase Act was repealed in November 1893, silver had fallen from its preeminent position as the major commodity in Arizona. Its value had dropped from a high of $1.29/tr oz to only $0.64/tr oz. Copper was thus left as Arizona's dominant commodity. There were two primary roadblocks to the rise of copper's importance in Arizona. The first was the lack of adequate transport facilities. Although there was an existing infrastructure in place for the silver market, it was designed for a product that was measured in ounces, in sharp contrast to copper, which was measured in tons. The second was the inability to handle lower grade copper ores.

The arrival of the railroads in Arizona (Southern Pacific by September 1880 and Atlantic and Pacific by May 1883), coupled with improved milling methods, not only allowed copper mining to continue, but, more importantly, stimulated its growth. This occurred even though copper prices had fallen

from $0.21/lb to $0.10/lb. In 1886, two copper concentrators were built, the first by William Church for the Detroit Copper Company at Joy's Camp (present-day Morenci), and the second by James Colquhoun for the Arizona Copper Company at Clifton.

Arizona's copper output peaked in 1981 when the ore mined yielded more than 1,146,000 st of copper valued at more than $1.953 billion or about three-fourths of the State's total nonfuel mineral production. Mine output dropped more than 25% the following year, and the production rate has been relatively constant since then, averaging more than 827,000 st/yr and reaching a high of almost 882,000 st/yr in 1985 and 1986.

Arizona is currently experiencing a modern day "gold rush," and gold has replaced copper as the most sought after mineral in the State. By 1989, Arizona gold production was expected to be triple the early 1980's level, but because of recovery problems at the McCabe Mine, production has not reached the expected level.

The resurgence of gold mining stems from two unrelated factors. First was the development of large, low-grade, disseminated gold resources in northern La Paz and central Yavapai counties. The development of and subsequent production from the Copperstone Mine in 1987 at 60,000 tr oz/yr has doubled production of gold in the State. It is expected that future discovery of additional large, low-grade deposits will lead to more increases in gold production. Second was the dramatic increase in domestic gold prices caused by the establishment of the two-tier pricing system in March 1968, which created an open market price for gold that could fluctuate with supply and demand, and the removal of restrictions on private ownership of gold in

December 1974.

Because of these actions, the price of gold rose from $35/tr oz in 1967 to more than $600/tr oz in 1980, which provided the economic incentive that allowed domestic producers to explore for and even develop the low-grade gold deposits. As a consequence, Arizona has seen a large increase in gold exploration activities over the past decade.

Base metal prices have generally increased in recent years. Copper prices have fluctuated over the past 15 years from a low of about $0.60/lb in 1973 to about $1.20/lb in the early 1980's; in December 1988 the price had risen to about $1.60/lb. The price of lead fluctuated from a low of $0.16/lb in 1973 to $0.53/lb in 1979; after dropping to a low of $0.19/lb in 1985, the lead market started to recover, reaching a price of about $0.42/lb in December 1988. The zinc price was $0.21/lb in 1973 and has steadily risen to about $0.93/lb in March 1989. Molybdenum is the only base metal that has not shown a recovery trend. Although it is now at a price almost double that of 1973 ($1.72/lb Mo in concentrate in 1973; $3.30/lb Mo in concentrate in 1988), it is still well below the high of $9.70/lb Mo in concentrate reached in 1980.

Arizona's base and precious metal operations, boosted by stronger commodity prices, achieved a major turnaround in 1987. This turnaround, however, has been deceptive, for although there has been a resurgence in production, it is not solely attributable to the increase in prices. Labor has made major concessions that streamlined various production methodologies and lowered unit costs because of the increased use of leaching technology.

## INFRASTRUCTURAL AND INSTITUTIONAL FACTORS AFFECTING MINING OPERATIONS IN ARIZONA

Because most mining operations initially require large capital expenditures and have relatively low profit margins, existing infrastructure is very important to the economics of these operations. The infrastructural items having the largest impact on mining are utilities and transportation. Availability of electrical power sources, natural gas pipelines, sources of water, highways, and rail lines is critical to most operations because of the high cost of creating these items when they do not already exist. Arizona is fortunate in having a relatively well-developed infrastructural base.

In addition, institutional factors can have a significant economic impact. Federal, State, and local taxes impose an economic burden on mining, and the costs of complying with environmental and safety regulations have drastically increased over the past several decades. Finally, the availability of post-mill processing facilities is vital to those operations that do not produce a product that is directly marketable.

All of the above factors have economic impacts that can be significant and that must be carefully considered when planning a mining operation. The infrastructural base must be capable of not only meeting the demands of today's mining industry for utilities and transportation, but also must be flexible enough to meet future demands. Likewise, taxation and regulation must be carefully monitored to maintain the delicate balance between economic progress on the one hand and the demands of government and the environment on the other. The following sections briefly summarize the status of these infrastructural and institutional factors in Arizona.

## UTILITIES

### Electricity[6]

Mining and milling are activities that tend to consume large amounts of energy, primarily in the form of electricity and natural gas. Energy usage varies widely from operation to operation because of differences in such factors as operation size, mining method, and milling method. These variations make it impossible to generalize about a typical mining operation, but it is clear that mining is one of the largest energy-consuming industries in Arizona. Recent years have seen a shift throughout the mining industry away from the labor- and energy-intensive technologies of the past toward more efficient methods. In Arizona, this change can best be seen in the copper industry in which conventional methods of underground or open pit mining, flotation milling, and smelting-refining have frequently yielded to in situ, dump, or heap leaching and solvent extraction-electrowinning technologies. These newer methods have not only cut labor and energy requirements, but have also resulted in the ability to mine lower grade ores than in the past. In addition, leaching has become the method of choice for precious-metal operations because of its low cost and ability to treat very low-grade ores.

Arizona has several sources of electrical energy. According to data collected through telephone conversations with 15 different utilities operating in Arizona as of January 1988, two vendors provide almost 60% of the energy for public, industrial, agricultural, and mining needs. These are the Arizona Public Service Company (APS), the largest utility operating in

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[6]See references 3, 35, 37, 173, 216, 326, 369, 417, 554, 561, 573-574, 622, and 690.

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Arizona, and the Salt River Agricultural Improvement and Power District (SRP), the second largest utility. Both have multiple methods of supplying consumers:

| Source of electricity | Amount supplied, percent | |
|---|---|---|
| | APS | SRP |
| Gas- and oil-fired generating plants.. | 13.0 | 8.6 |
| Oil-fired generating plants..... | .8 | 0 |
| Hydroelectric generating plants..... | .1 | 10.1 |
| Coal-fired generating plants..... | 45.6 | 60.1 |
| Nuclear-fueled generating plants..... | 40.5 | 12.7 |
| Purchases from connecting power grids. | 0 | 8.5 |
| Totals..... | 100.0 | 100.0 |

It is apparent from the figures that the main sources of electricity are generating plants using coal, nuclear fuels, and gas-oil; however, future environmental concerns and regulations could cause the amount of power produced by hydroelectric plants to be increased at the expense of plants using other fuels.

The turbines at Hoover Dam generate and supply about 4.5 billion kW·h of energy annually, enough to support 500,000 homes in Nevada, Arizona, and California. The Arizona legislature created the Arizona Power Authority (APA) in 1944. As of May 1987, it received and marketed 165,000 kW of the Hoover power plant output (35). Effective June 1, 1987, the APA entered into a new 30-year power sales contract with the United States acting through the Western Area Power Administration (WAPA). The contract stipulates that the energy produced at the Hoover power plant in excess of 4.5 billion kW·h in any given year must first be offered to the authority for use in Arizona.

The result is an increase in APA's allocation to about 1.1 billion kW·h of total energy per year delivered by the Federal System (Parker-Davis Project and the Pacific Northwest-Pacific Southwest Intertie) to WAPA's allottees (35).

Also, Arizona is provided with electricity by smaller, privately owned electric utility systems. Figure 2 depicts the distribution of major electrical transmission lines, principal substations, in-State generating facilities, and ownership. Figure 3 displays the major certificated electricity service areas as well as the areas now unassigned. Utilities having a certificated service area have exclusive rights to market electricity in the area and are obliged to provide power to all new consumers. Service in the uncertificated areas is competitive subject to the regulations of the Arizona Corporation Commission. The electric companies regulated by the commission are listed in table 3, and representative industrial power rates in Arizona are presented in table 4.

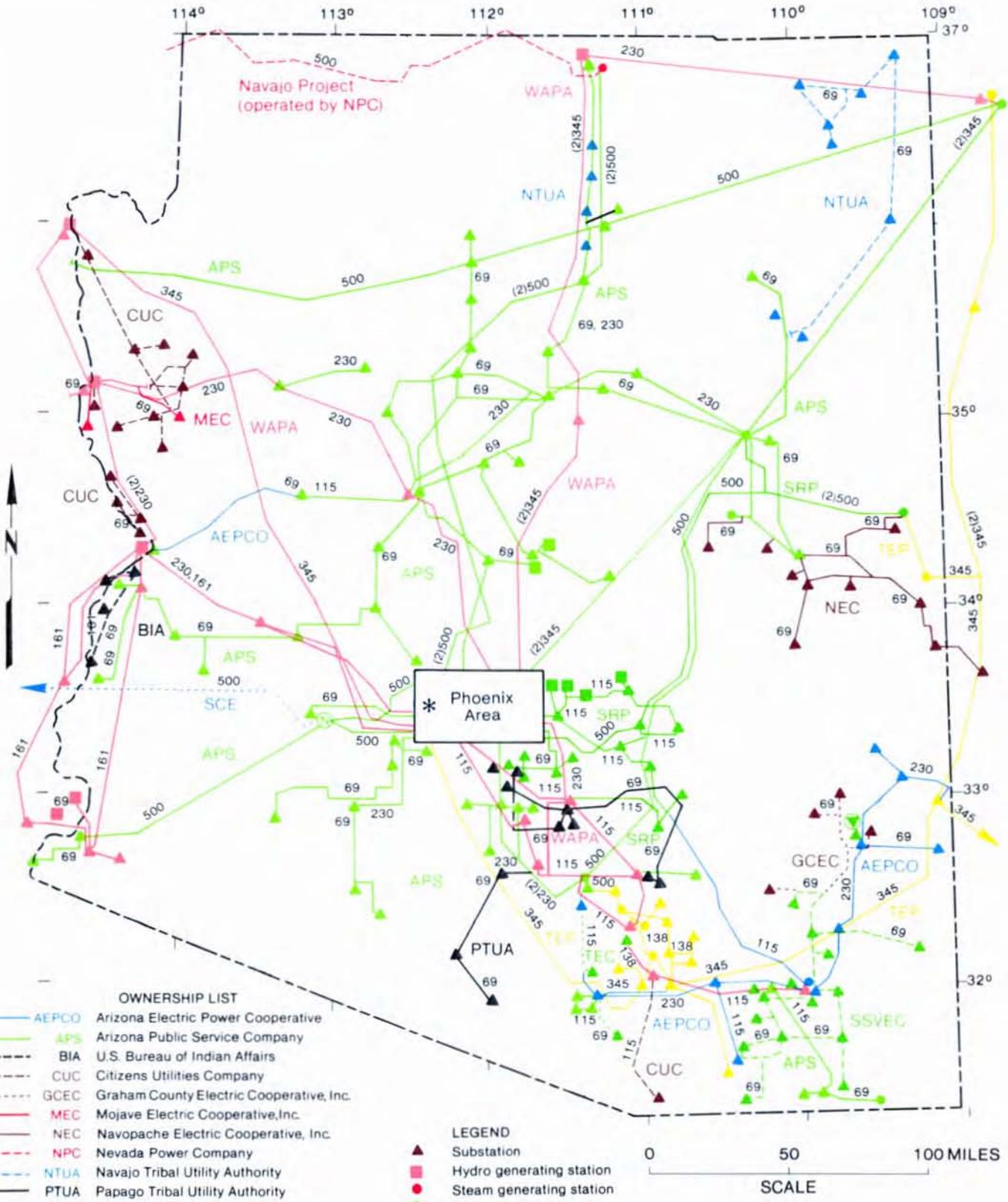
As of December 1986, most of the major utilities in Arizona indicated that electrical supplies are adequate and that they foresee no problems serving future power needs of the mining industry in Arizona.

## Natural Gas[7]

Supplies of natural gas to Arizona are delivered by Southern Union Gas Company, Southwest Gas Corporation, and several smaller distributors (table 5).

Customers are supplied by two interstate pipelines, the San Juan Mainline and the California Mainline (fig. 4). The first services the northern portion of the State, crossing from east to west following the route of Interstate

[7] See references 37 and 216.




OWNERSHIP LIST

| | |
|---|---|
| AEPCO | Arizona Electric Power Cooperative |
| APS | Arizona Public Service Company |
| BIA | U.S. Bureau of Indian Affairs |
| CUC | Citizens Utilities Company |
| GCEC | Graham County Electric Cooperative, Inc. |
| MEC | Mojave Electric Cooperative, Inc. |
| NEC | Navopache Electric Cooperative, Inc. |
| NPC | Nevada Power Company |
| NTUA | Navajo Tribal Utility Authority |
| PTUA | Papago Tribal Utility Authority |
| SCE | Southern California Edison |
| SRP | Salt River Project Agricultural Improvement And Power District |
| SSVEC | Sulphur Springs Valley Electric Cooperative, Inc. |
| TEC | Trico Electric Cooperative |
| TEP | Tucson Electric Power Company |
| WAPA | Western Area Power Administration |

*NOTE: The Phoenix Area is Serviced By: WAPA, APS, SRP.

LEGEND

| | |
|---|---|
| ▲ | Substation |
| ■ | Hydro generating station |
| ● | Steam generating station |
| ▼ | Diesel generating station |
| (N) | Nuclear generating station |
| —\|\|— | Interconnection between companies |
| (2)500 | Number and voltage of transmission lines (kV) |

Figure 2. Major electrical transmission lines, principal substations, and in-state generating facilities in Arizona.

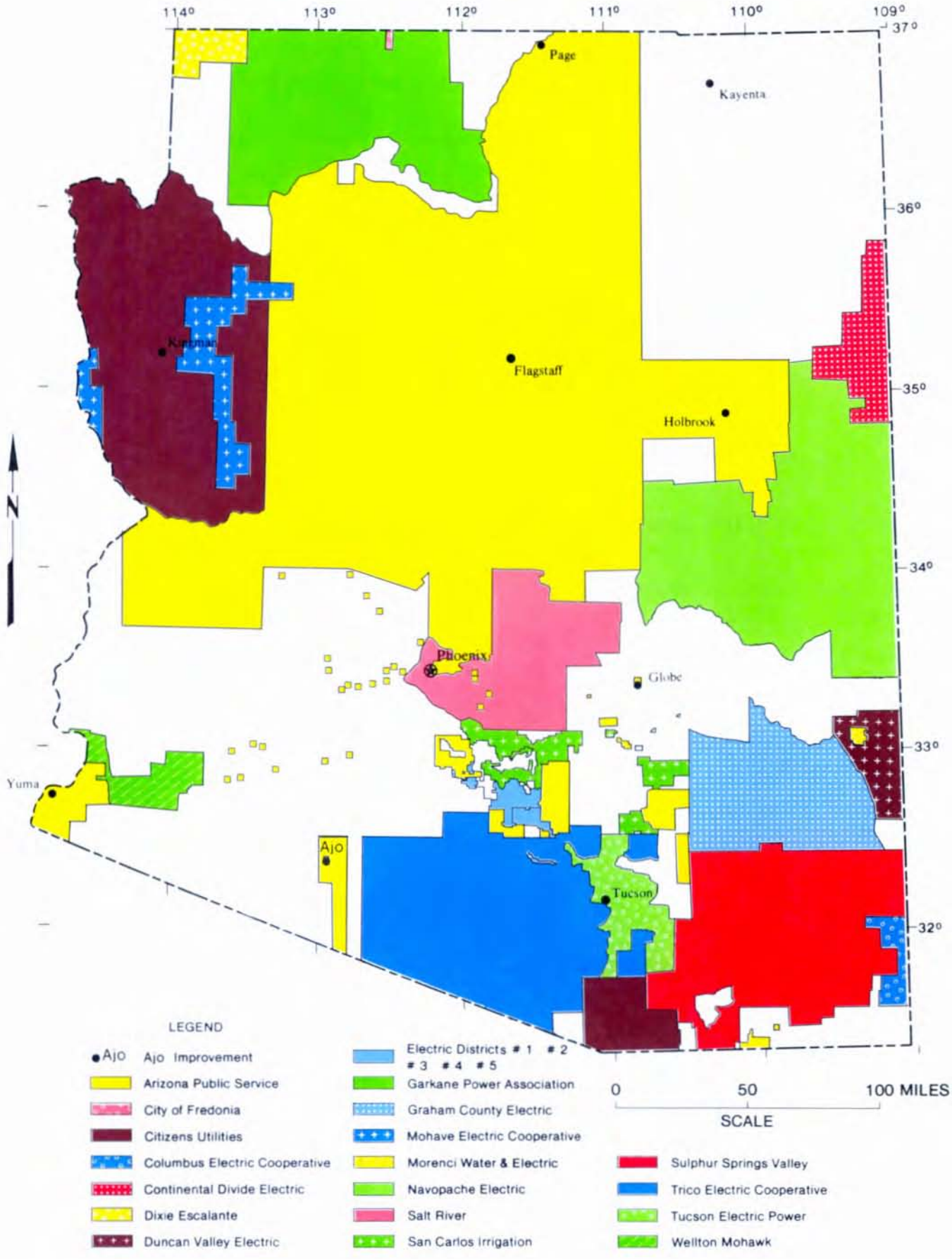



Figure 3. Major certificated electricity service areas in Arizona.

Table 3.--Regulated electric companies in Arizona

| Company | Address |
|---|---|
| Ajo Improvement Company..... | P.O. Drawer 9<br>Ajo, AZ 85321 |
| Arizona Electric Power Cooperative, Inc. | P.O. Box 670<br>Benson, AZ 85602 |
| Arizona Public Service Company..... | P.O. Box 53999 Sta. 1840<br>411 N. Central Ave.<br>Phoenix, AZ 85072 |
| C P National Corporation..... | 2121 N. California Blvd., Suite 400<br>Walnut Creek, CA 94596 |
| Citizens Utilities Company..... | P.O. Box 3099<br>Kingman, AZ 86402 |
| Columbus Electric Cooperative, Inc.. | P.O. Box 631<br>Deming, NM 88030 |
| Continental Divide Electric Cooperative, Inc. | P.O. Box 1087<br>200 E. High St.<br>Grants, NM 87020 |
| Dixie Escalante Rural Electric Association. | Beryl, UT 84714 |
| Duncan Valley Electric Cooperative, Inc. | P.O. Box 0<br>Duncan, AZ 85534 |
| Garkane Power Association, Inc..... | P.O. Box 790<br>56 Center St.<br>Richfield, UT 84701 |
| Graham County Electric Cooperative, Inc. | P.O. Drawer B<br>Pima, AZ 85543 |
| Mohave Electric Cooperative, Inc.... | P.O. Box 1045<br>1999 Arena Dr.<br>Bullhead City, AZ 86430 |
| Morenci Water & Electric Company.... | Box 68<br>Morenci, AZ 85540 |
| Navopache Electric Cooperative, Inc. | P.O. Box 308<br>Lakeside, AZ 85929 |

Table 3.--Regulated electric companies in Arizona--Continued

| Company | Address |
|---|---|
| Sulphur Springs Valley Electric Cooperative, Inc. | P.O. Box 820<br>Willcox, AZ 85644 |
| Trico Electric Cooperative, Inc..... | P.O. Box 35970<br>Tucson, AZ 85740 |
| Tucson Electric Power Company..... | 220 W. Sixth St.<br>Tucson, AZ 85701 |

Source: Correspondence with electrical utilities operating in the State and the Arizona Corporation Commission.

Table 4.--Representative industrial power rates in Arizona, January 1987

| Utility | Customer monthly meter charge | Demand charge per kW per mo | Energy charge per kW·h used |
|---|---|---|---|
| Arizona Public Service Company[1]..... | $12.50 | $3.36 | [2]$0.094798 |
| | | | [3].066598 |
| | | | [4].043898 |
| Citizens Utilities Company..... | NAp | 4.50 | [5].079924 |
| | | | [6].074164 |
| | | | [7].070604 |
| Columbus Electric Cooperative, Inc.[1] (Deming, NM). | NAp | 8.00 | .047900 |
| Continental Divide Electric Cooperative, Inc.[10] (Grants, NM). | NAp | [8]8.25 | [9].017730 |
| | | [11]8.00 | [12].018250 |
| Garkane Power Association, Inc.[13] | [14]10.00 | | |
| (Richfield, UT). | [9]50.00 | 2.25 | .042500 |
| Mohave Electric Cooperative, Inc.[9]..... | 62.00 | 9.00 | .042500 |
| Navopache Electric Cooperative, Inc..... | NAp | [15]17.00 | [15].039071 |
| | NAp | [16]14.00 | [16].036660 |
| | NAp | [14]12.75 | [14].091400 |
| Trico Electric Cooperative, Inc.[17]..... | NAp | 15.25 | .046710 |
| Tucson Electric Power Company[1]..... | NAp | 10.98 | [18].0876569 |
| | | | [19].0711569 |
| | | | [20].0681569 |

NAp Not applicable.

[1]Single- or three-phase service.

[2]For the first 2,500 kW·h, add 100 kW·h per kW for each kW over 5 kW.

Table 4.--Representative industrial power rates
in Arizona, January 1987--Continued

[3] For the next 42,000 kW·h.
[4] For all additional kW·h.
[5] First 180 kW·h per kW of demand.
[6] Second 180 kW·h per kW of demand.
[7] More than 360 kW·h per kW of demand.
[8] Utility-owned substation.
[9] More than 50 kV·A transformer capacity.
[10] Services public lands and Indian reservation. Operates from Grants, New Mexico.
[11] Consumer-owned substation.
[12] Industrial service more than 3,000 kW capacity and 115,000 volts delivered.
[13] Serves uranium industry. Operates from Richfield, Utah.
[14] For less than 50 kV·A of demand.
[15] On-peak rate from 6 a.m. to 9 p.m. more than 50 kV·A transformer capacity.
[16] Off-peak rate from 9 p.m. to 6 a.m. more than 50 kV·A transformer capacity.
[17] More than 10 kW up to 11,999 kW of demand.
[18] More than 100 kW·h and less than 3,400 kW·h, summer or winter rate.
[19] More than 3,400 kW·h as additional during summer.
[20] More than 3,400 kW·h as additional during winter.

Source: References 3, 173, 216, 326, 369, 554, 561, 573-574, 622.

Table 5.--Regulated gas companies in Arizona

| Company | Address |
|---|---|
| Ajo Improvement Company..... | 1 Plaza Way<br>Ajo, AZ 85321 |
| Black Mountain Gas Company..... | P.O. Box 427<br>6015 E. Cave Creek Rd.<br>Cave Creek, AZ 85331 |
| Broken Bow Gas Company..... | P.O. Box Drawer H<br>200 W. Overland<br>Payson, AZ 85541 |
| Citizens Utilities Company..... | P.O. Box 3099<br>Kingman, AZ 86402 |
| Copper Market, Inc..... | 102 Main St.<br>P.O. Box 245<br>Bagdad, AZ 86321 |
| General Utilities, Inc..... | P.O. Box 428<br>22 W. Center St.<br>Pima, AZ 85543 |
| Southern Union Gas Company..... | P.O. Box 1448<br>Flagstaff, AZ 86002 |
| Southwest Gas Corporation..... | P.O. Box 15015<br>5241 Spring Mountain Rd.<br>Las Vegas, NV 89114 |

Source: Arizona Corporation Commission.

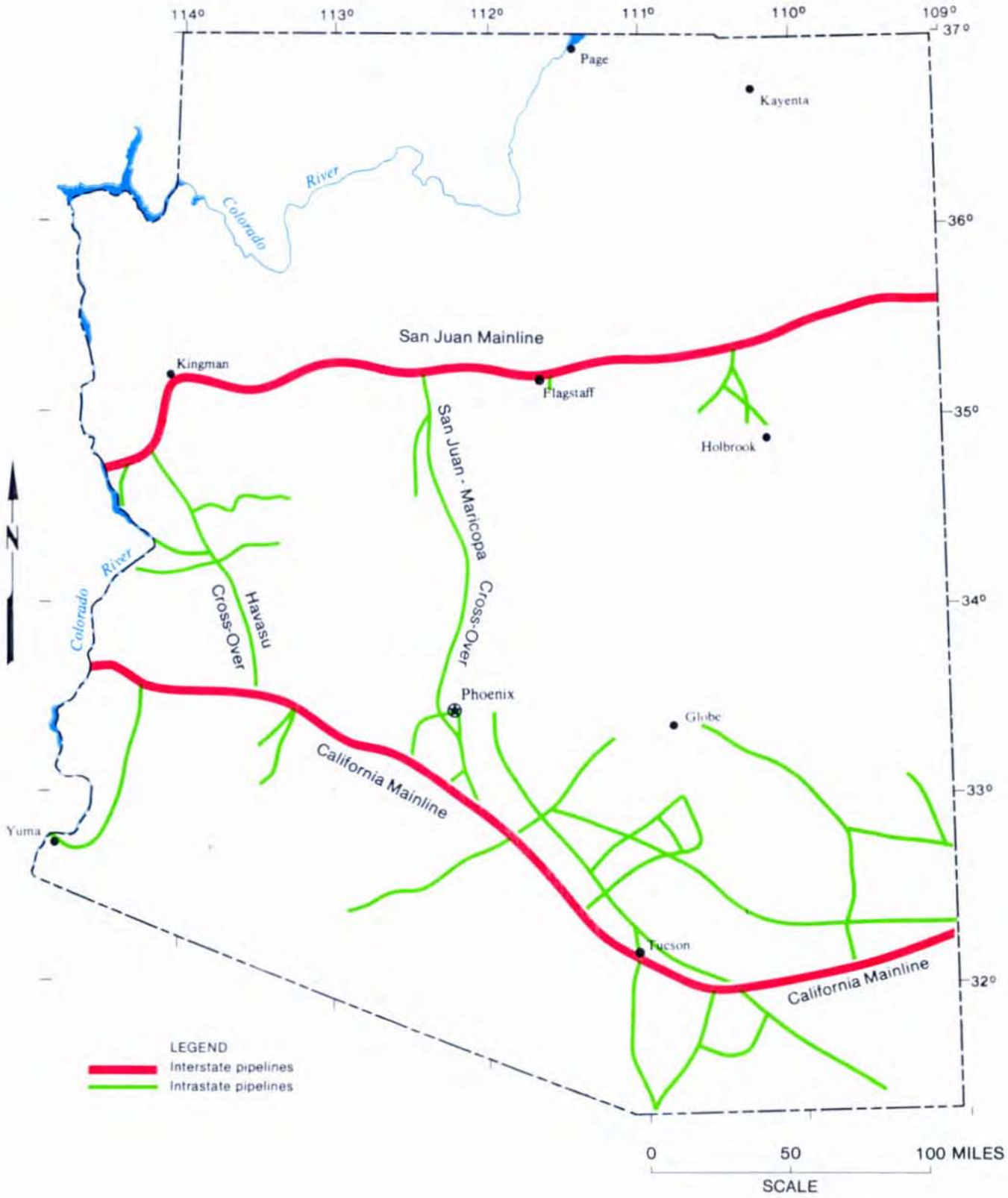



Figure 4. Natural gas distribution system in Arizona.

Highway 40, connecting the Window Rock, Navajo, Dilkon, Leupp, Flagstaff, Williams, Seligman, Hackberry, and Topock stations. This line has important laterals serving Holbrook, Winslow, Prescott, Bagdad, and Lake Havasu City.

The California Mainline services the southern portion of Arizona, crossing from east to west following Interstate Highway 10, connecting the San Simon, Willcox, Benson, Vail, Tucson, Casa Grande, Gila, and Wenden stations. This line has laterals supplying Bisbee, Sonoita, Nogales, Ajo, Phoenix, and Yuma.

There are also two main intrastate pipelines, the San Juan-Maricopa Cross-Over and the Havasu Cross-Over (fig. 4). The first connects the two mainlines just described between the Williams and Casa Grande stations passing through Phoenix; the latter unites both mainlines between the Topock and Wenden stations.

Figure 4 also depicts pipelines owned by other smaller suppliers that supply gas to various other parts of the State. Figure 5 shows the certificated service areas for each of the gas companies serving Arizona; the white areas are presently unassigned. Table 5 lists the gas distributors in Arizona regulated, as of April 30, 1986, by the Arizona Corporation Commission, Utilities Division (1200 W. Washington, Phoenix, AZ 85007, 602-255-3316).

As of December 1986, natural gas distribution and availability on demand is adequate; serving the mining industry in the future should not be a problem.

## Water[8]

As with electricity and natural gas, water usage by mines varies greatly

[8]See references 21, 100, 324, 668-669, and 691-692.

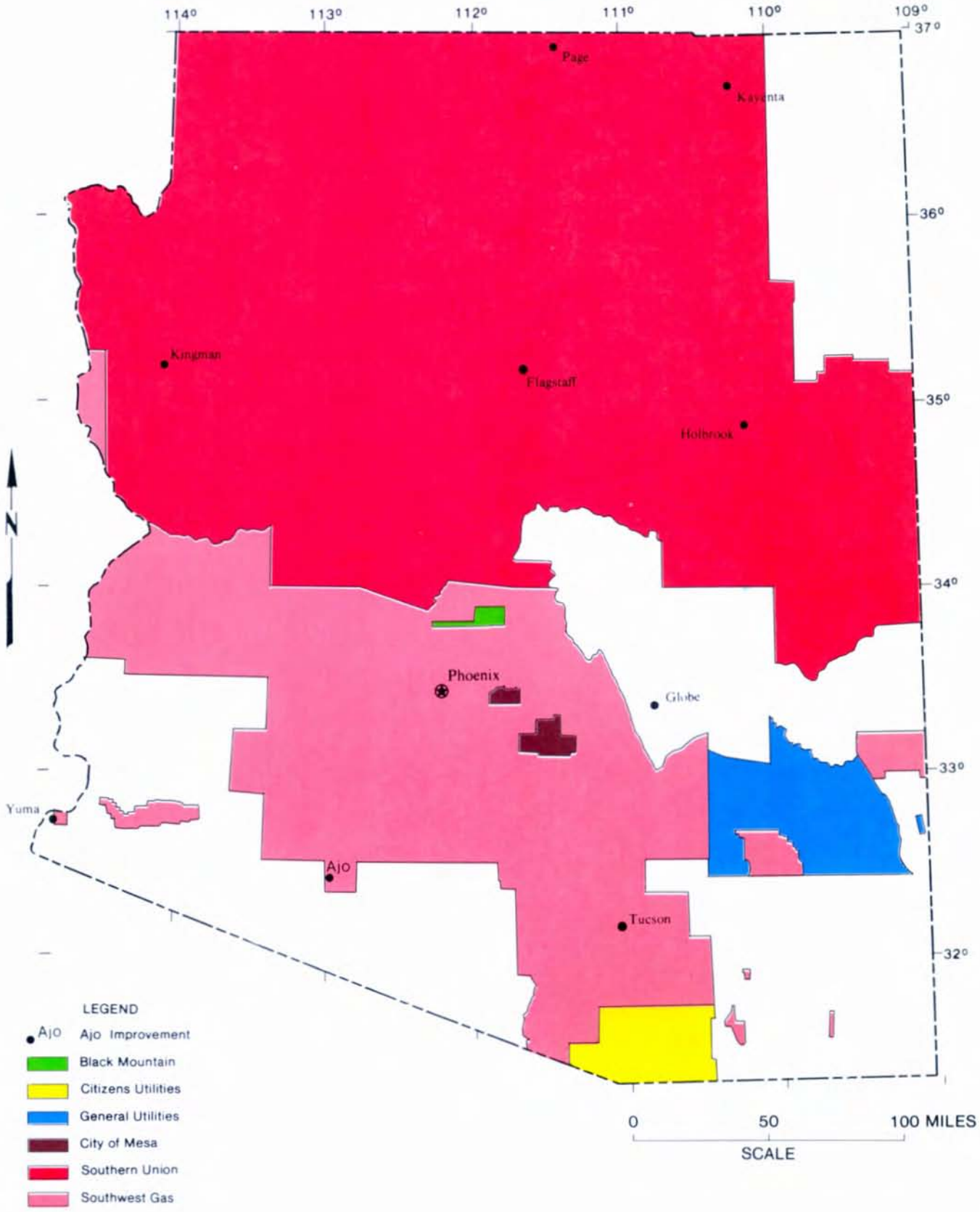



Figure 5. Natural gas service areas in Arizona.

from one operation to another. Most of the water is consumed by leaching or milling processes but also is used in mining for such purposes as drilling and dust control. Both surface- and ground-water resources are used by mining operations, and, in some cases, water must be transported a significant distance to the mine-mill site. Although water should generally continue to be available for mining use in the future, the cost of obtaining it could be high in some areas. With expected increases in water usage by agriculture, industry, and municipalities, the competition for existing water supplies may have a significant economic impact on some mining operations.

The climate in most of Arizona is classified as arid or semiarid with annual precipitation varying from a low of about 4 in to a high of about 25 in. Of this precipitation, about 95% evaporates or is transpired by vegetation leaving only a limited amount to run off or enter the ground-water system (21). This high evaporation rate also has a marked effect on storage reservoirs in the area; Lake Mead, for example, lost 787,600 acre-ft to evaporation during 1982 (21).

Arizona has three water provinces that are closely related to the State's physiography. These are the Plateau Uplands, Central Highlands, and Basin and Range Lowlands. Water conditions in these three provinces differ markedly because of differences in geology and climate. Flat-lying sedimentary rocks and volcanic peaks rising to over 8,000 ft above sea level characterize the Plateau Uplands. Annual precipitation in this area varies from about 10 to 25 in. The Basin and Range Lowlands province is typified by mountain ranges that bound broad, alluvium-filled valleys and by annual precipitation of 4 to 12 in. The Central Highlands province, which is transitional between the other

two provinces, is generally mountainous and consists of a mixture of igneous, metamorphic, and sedimentary rocks. Annual precipitation ranges from 15 to 25 in (21, 691).

About 58% of Arizona's water supply comes from ground-water reservoirs with the remaining 42% from surface-water supplies (21). The geographic distribution of the principal aquifers is shown in figure 6, and the locations of the principal river basins and dams are shown in figure 7. Ground-water reservoirs are of great significance as a source of water because virtually all surface water has been appropriated. Any future increases in water demand will have to be met by ground water.

## Surface Water

The USGS formally defines for the United States a number of water-resources regions, which are further divided into subregions and river basins (21). Most of Arizona falls within the Lower Colorado Region except for the northeastern corner of the State, which lies within the Upper Colorado Region. These regions and their subregions are shown in figure 7. The major rivers that drain these areas are the Colorado, Little Colorado, Bill Williams, Gila, and Salt (21).

The Colorado River enters northern Arizona at Glen Canyon, flows through the Grand Canyon into Lake Mead, and then forms the western border of the State before entering the Republic of Mexico (fig. 7). All of the other rivers in the State eventually flow into the Colorado River.

The Little Colorado River, which is mostly fed by ephemeral streams, drains most of the northeastern corner of the State and joins the Colorado River upstream from the Grand Canyon. The Bill Williams River drains the

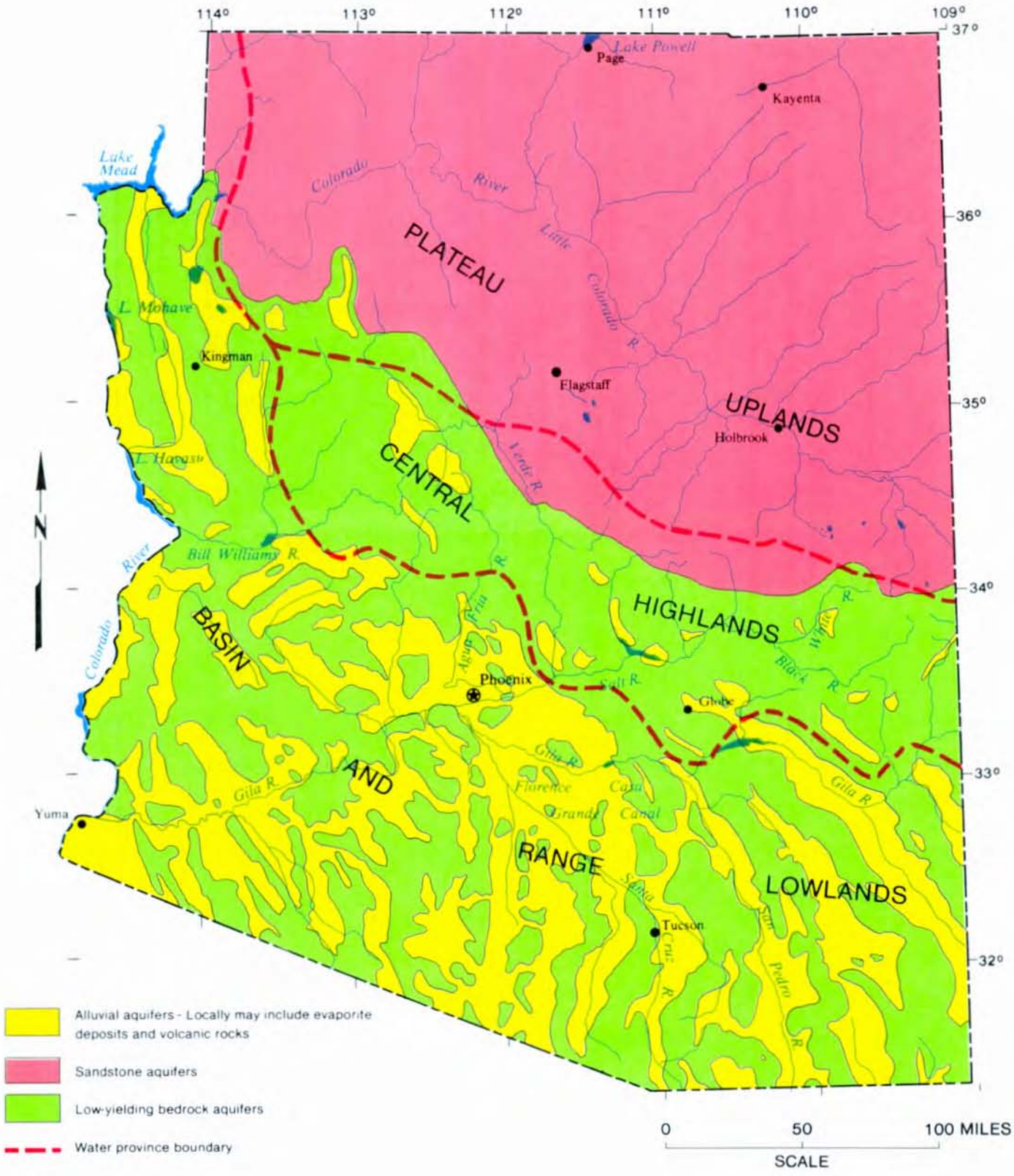



Figure 6. Geographic distribution of principal aquifers in Arizona.

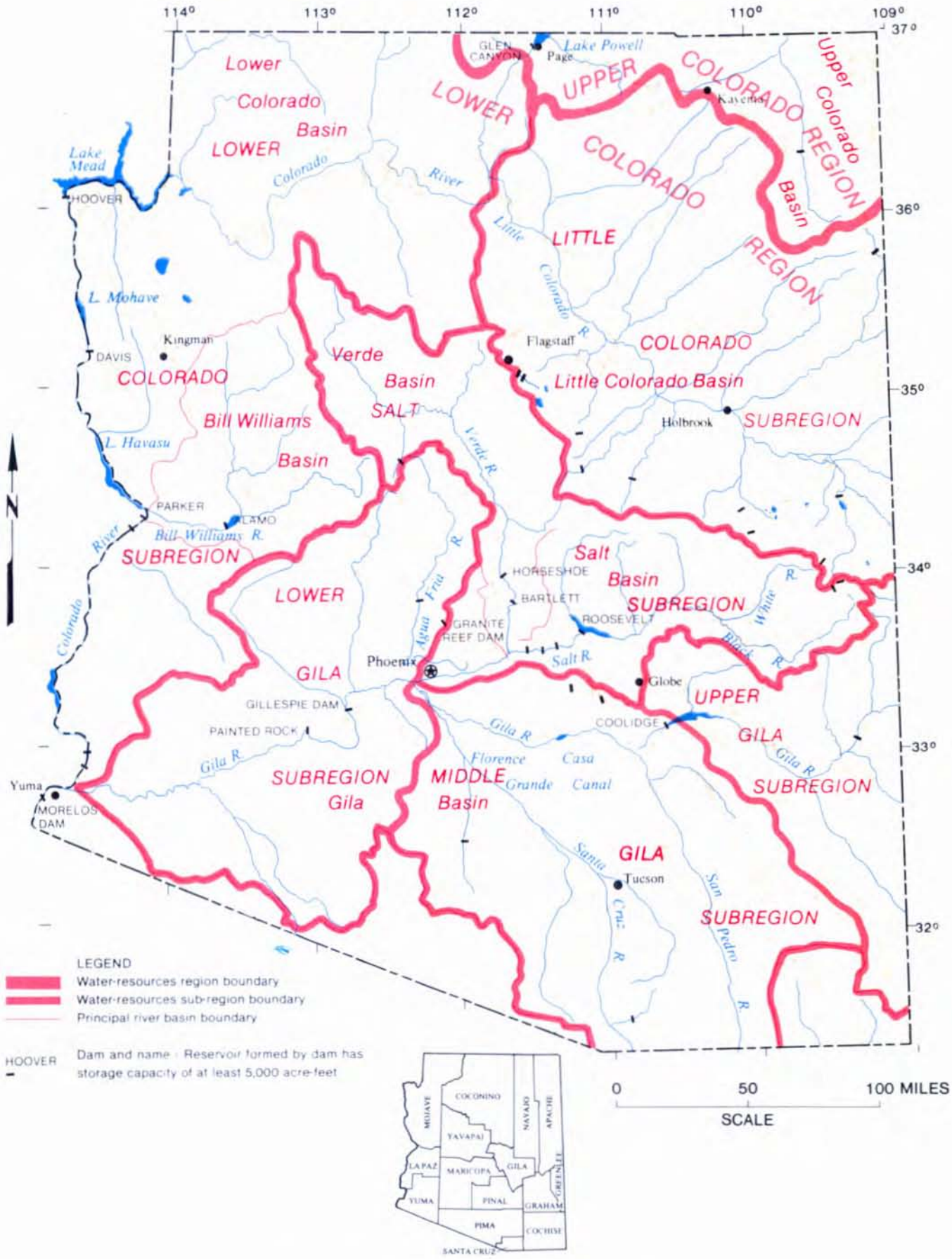



Figure 7. Principal river basins and related surface-water resources in Arizona.

west-central portion of Arizona and joins the Colorado River on the western border of the State.

The Salt River and its major tributaries, the Black, White, and Verde Rivers, do not flow directly into the Colorado River, but rather join the Gila River near Phoenix. The area drained by these rivers includes the central and east-central portions of the State.

The Gila River drains most of the southern half of the State. In addition to the Salt River, tributaries to the Gila River include the Santa Cruz and San Pedro Rivers entering from the southeast and the Agua Fria River from the north. The Gila River joins the Colorado River in the southwestern corner of the State near Yuma.

Storage reservoirs are used both to regulate the flow of perennial streams and to store surface water for eventual use. Arizona has water rights to large amounts of water stored in major reservoirs located on the State's borders. These reservoirs include Lakes Mead, Mohave, Havasu, and Powell. In addition, significant quantities of water are stored in Roosevelt Lake (Roosevelt Dam in figure 7), San Carlos Lake (Coolidge Dam in figure 7), and other smaller reservoirs.

Table 6 presents some summary statistics regarding surface water in Arizona. Note that about 89% of the surface-water withdrawals in Arizona are for irrigation and that about 9% are for public supply. Industrial withdrawals, including those for mining, only account for about 2% of total withdrawals. Mining, therefore, can be seen to have a fairly negligible effect on surface water supplies. However, because virtually all surface water in Arizona is appropriated, most, if not all, future mining activity

Table 6.--Arizona surface-water summary

| Item | $10^6$ $m^3$/yr | $10^3$ acre-ft/yr |
|---|---|---|
| Precipitation: | | |
| Estimated annual average precipitation..... | 84,000 | 68,000 |
| Budget: | | |
| Estimated runoff from mountains..... | 4,900 | 4,000 |
| Estimated inflow crossing state line (excluding Colorado River). | 2,000 | 1,600 |
| Colorado River inflow (1965-83)..... | 11,500 | 9,300 |
| Estimated outflow crossing state line (excluding Colorado River). | 1,100 | 900 |
| Colorado River outflow (1983 water year)..... | 8,500 | 6,900 |
| Withdrawals: | | |
| Public supply..... | 359 | 291 |
| Rural supply, domestic..... | 0 | 0 |
| Rural supply, livestock..... | 2.5 | 2.0 |
| Industrial self-supplied..... | 95 | 77 |
| Irrigation..... | 3,730 | 3,024 |

Source: References 21, 691-692.

will have to rely on supplies of ground water.

Rights to surface waters in Arizona are based upon prior appropriations that put the water to a beneficial use. State laws require that an application be filed to obtain a permit to apply such water to beneficial use. Strict compliance with these laws is mandatory to acquire surface-water rights.

## Ground Water

Ground water in Arizona is found in three types of aquifers: alluvial, sandstone, and low-yielding bedrock. The alluvial aquifers are the most significant, consist mainly of unconsolidated sands and other sediments, and are found in the Basin and Range Lowlands and parts of the Central Highlands. These aquifers commonly are found at depths between 100 and 2,000 ft and have a typical yield of about 1,000 gpm but may exceed 2,500 gpm. The thickness of these units varies from a few hundred to about 10,000 ft. Most of the cities and irrigated areas in the southern half of the State rely on this type of aquifer (691).

The sandstone aquifers consist mainly of fine-grained sandstone beds whose permeability may be enhanced by faulting and fracturing. These aquifers are found only in the Plateau Uplands and along the northern edge of the Central Highlands. Depths commonly range from 50 to 2,000 ft, and yields are typically between 0 and 50 gpm but may exceed 500 gpm. Individual aquifers vary from about 200 to 500 ft in thickness and are separated by thick layers of impervious sediments. Most water in the northern part of the State comes from this type of aquifer, and, most notably, from the Coconino and Navajo Sandstones (691).

The least important aquifers are the bedrock type, which are composed of relatively impermeable crystalline and sedimentary rocks. They are found at depths of about 50 to 1,000 ft and have typical yields of 0.5 to 2 gpm but may exceed 200 gpm. These aquifers supply only individual domestic users in rural areas (691).

Table 7 presents some summary statistics regarding ground water in Arizona. About 88% of ground-water withdrawals are for irrigation, 7% are for public use, and only about 4% are for industrial use, including mining. These figures closely parallel those for surface water (21, 691).

The USGS, in cooperation with the Arizona Department of Water Resources, has conducted a program of ground-water studies in the State since 1939. These studies define the amount, location, and quality of ground-water resources in Arizona and monitor the effects of their usage (691-692). Since 1974, a major thrust of this program has been to inventory the ground-water conditions in each of the 68 ground-water areas of the State (figure 8 and table 8). Several selected ground-water areas are studied each year, water levels are measured annually in a statewide observation-well network, many ground-water samples are collected and analyzed annually, and ground-water pumpage is computed for most of the areas (668-669).

Ground-water rights in Arizona are based on a comprehensive and complex ground-water code that was enacted in 1980. This statute created four Active Management Areas (AMA), shown in figure 9, within which there are severe limitations on uses of ground water. Within these AMA's, ground water can be obtained for mining purposes only through acquisition from the Arizona Department of Water Resources of a mineral extraction and metallurgical

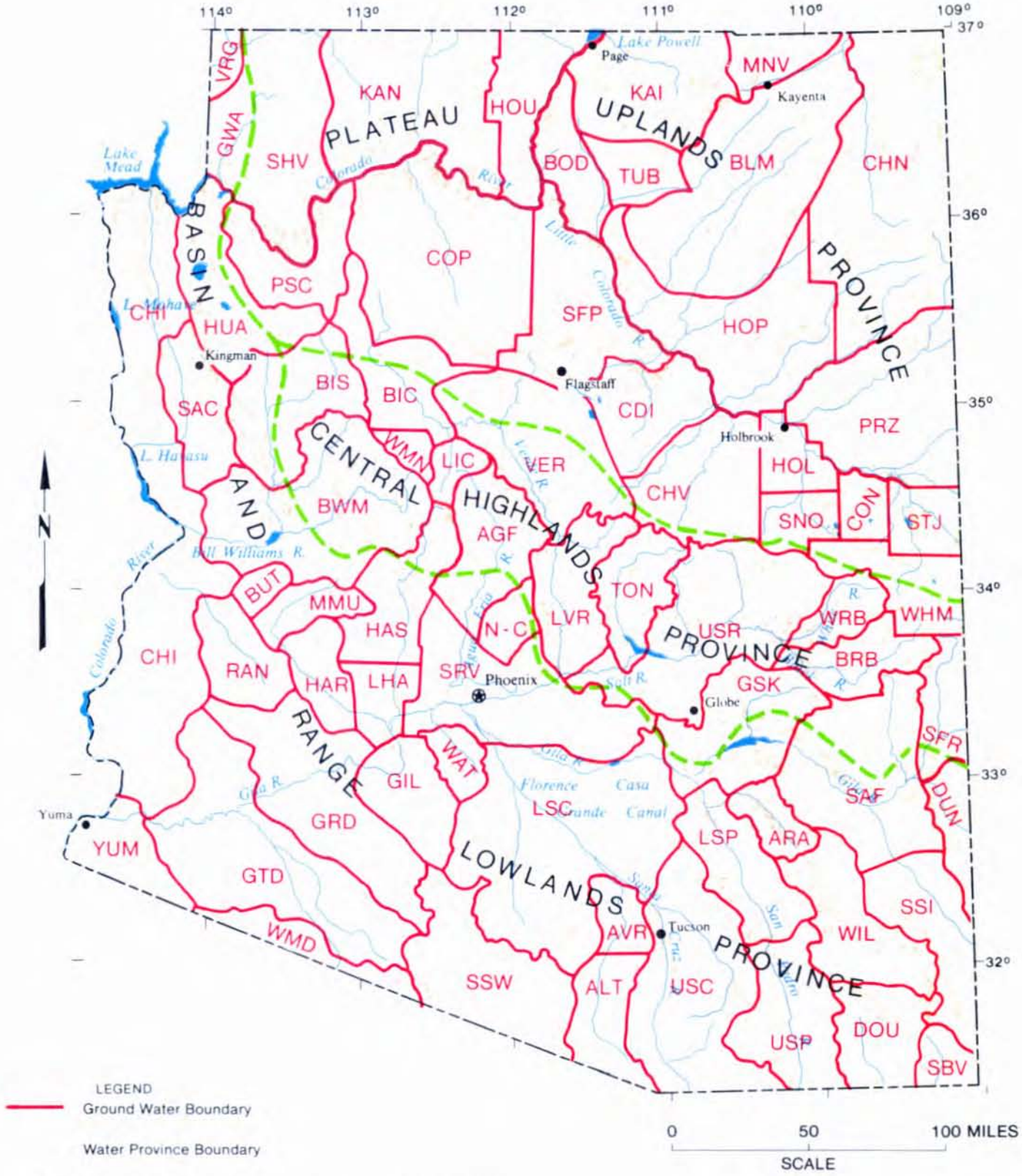
Table 7.--Arizona ground-water summary

| Item | $10^6$ $m^3$/yr | $10^3$ acre-ft/yr |
|---|---|---|
| Budget for valley fill reservoirs: | | |
| Estimated inflow | 4,600 | 3,700 |
| Estimated outflow | 4,600 | 3,700 |
| Recharge from precipitation | 3,400 | 2,800 |
| Perennial yield of valley fill reservoirs | 2,600 | 2,100 |
| Estimated inflow crossing state line | 5 | 4 |
| Estimated outflow crossing state line | 220 | 180 |
| Withdrawals: | | |
| Public supply | 414 | 336 |
| Rural supply, domestic | 44 | 36 |
| Rural supply, livestock | 14 | 11 |
| Industrial self-supplied | 249 | 202 |
| Irrigation | 5,112 | 4,144 |
| Storage: | | |
| Stored in upper 100 ft of saturated valley fill. | [1]385 | [2]313 |
| Estimated transitional storage reserve | [1]130 | [2]105 |

[1]Billion cubic meters.

[2]Million acre-ft.

Source: References 21, 691-692.




*Note: Definitions of ground-water area abbreviations are given in table 8.

Figure 8. Index map of the 68 ground-water areas in Arizona.

Table 8.--Abbreviations of the 68 ground-water areas in Arizona (692)

(Refer to figure 8)

| | | | |
|---|---|---|---|
| AGF | Agua Fria basin | LIC | Little Chino Valley |
| ALT | Altar Valley | LHA | Lower Hassayampa |
| ARA | Aravaipa Valley | LSP | Lower San Pedro basin |
| AVR | Avra Valley | LSC | Lower Santa Cruz basin |
| BIC | Big Chino Valley | LVR | Lower Verde River |
| BIS | Big Sandy Valley | MMU | McMullen Valley |
| BWM | Bill Williams | MNV | Monument Valley |
| BLM | Black Mesa | N-C | New River-Cave Creek |
| BRB | Black River basin | PSC | Peach Springs Canyon |
| BOD | Bodaway Mesa | PRZ | Puerco-Zuni |
| BUT | Butler Valley | RAN | Ranegras Plain |
| CDI | Canyon Diablo | SAC | Sacramento Valley |
| CHV | Chevelon | SAF | Safford basin |
| CHN | Chinle | SRV | Salt River Valley |
| COP | Coconino Plateau | SBV | San Bernardino Valley |
| CHI | Colorado River, Hoover Dam to Imperial Dam | SFP | San Francisco Peaks |
| | | SFR | San Francisco River basin |
| CON | Concho | | |
| DOU | Douglas basin | SSI | San Simon basin |
| DUN | Duncan basin | SSW | San Simon Wash |
| GIL | Gila Bend basin | SHV | Shivwits |
| GRD | Gila River from Painted Rock Dam to Texas Hill | SNO | Snowflake |
| | | STJ | St. Johns |
| GSK | Gila River from head of San Carlos Reservoir to Kelvin | TON | Tonto basin |
| | | TUB | Tuba City |
| | | USR | Upper Salt River basin |
| GTD | Gila River from Texas Hill to Dome | USP | Upper San Pedro basin |
| | | USC | Upper Santa Cruz basin |
| GWA | Grand Wash | VER | Upper Verde River |
| HAR | Harquahala Plains | VRG | Virgin River |
| HAS | Hassayampa basin | WAT | Waterman Wash |
| HOL | Holbrook | WMD | Western Mexican drainage |
| HOP | Hopi | WHM | White Mountains |
| HOU | House Rock | WRB | White River basin |
| HUA | Hualapai Valley | WIL | Willcox basin |
| KAI | Kaibito | WMN | Williamson Valley |
| KAN | Kanab | YUM | Yuma |

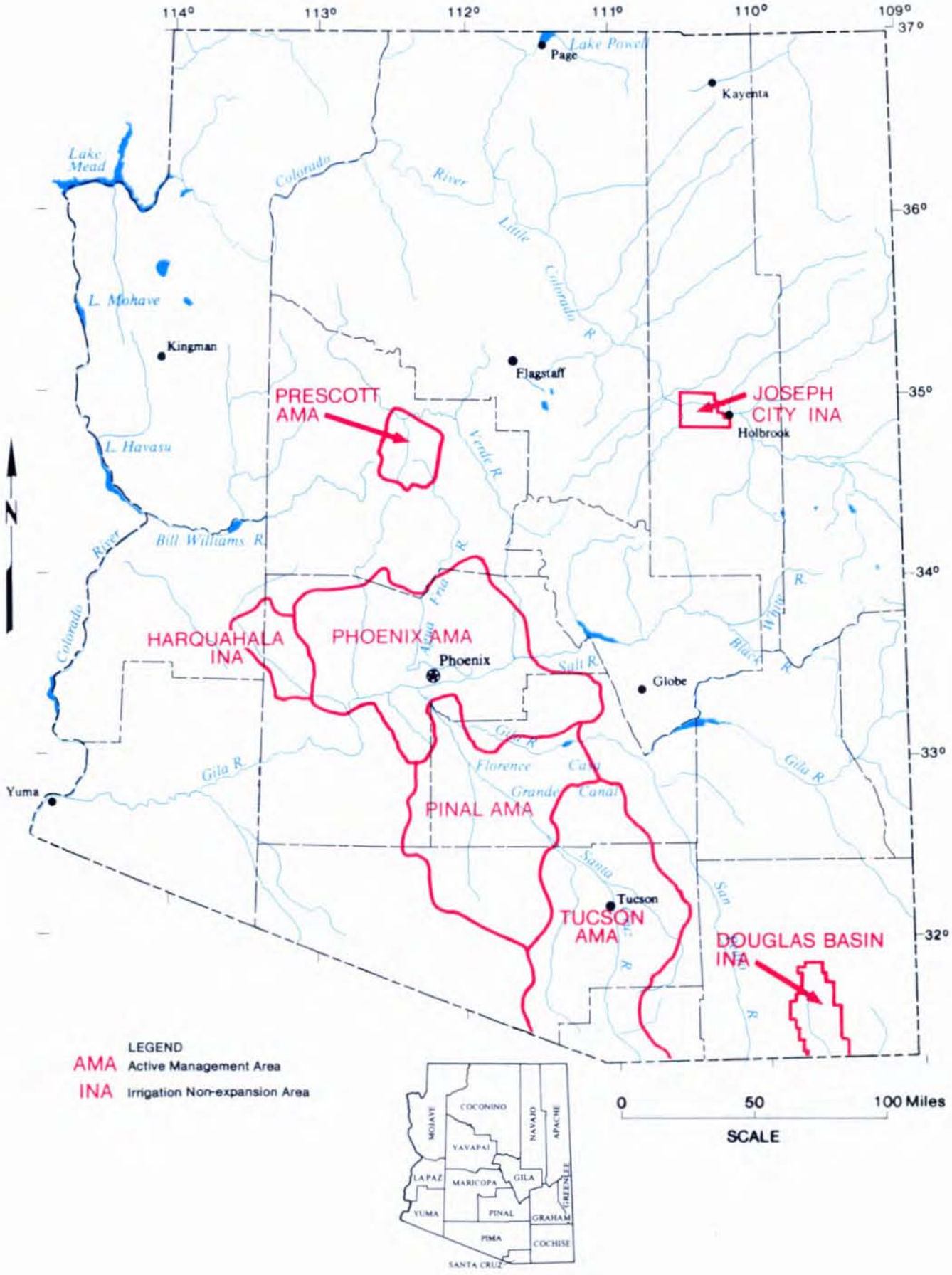



Figure 9. Managed ground-water use areas in Arizona.

processing permit or a dewatering permit (100). In addition, certain grandfathered ground-water rights exist as specified in the code. Outside AMA's, ground water may be pumped and used as long as it is used reasonably and beneficially (324). All wells, including exploration wells, however, require a permit issued by the Department of Water Resources (324). The code also created three Irrigation Non-expansion Areas (INA), also shown in figure 9, within which ground-water users must file annual withdrawal reports (324). Although these areas do not currently have any special restrictions on water withdrawals for mining use, the very fact that ground-water use in these areas needs to be regulated suggests that additional restrictions could be imposed in the future.

## TRANSPORTATION

Transportation systems in Arizona, both road and rail, are well developed and provide access to most areas of the State. Rail routes in Arizona were built in large part to transport mine products to smelters and refineries. Highways were developed in response to growth of commerce and the need to communicate between communities and the rest of the Nation. Regional transportation systems are linked to the statewide system in Arizona, thus providing transportation services to destinations outside the State (29, 34, 629).

### Rail

Arizona's railway system comprises 2,027 mi of track consisting of 1,542 mi of mainlines and 485 mi of branch lines. Table 9 and figure 10 summarize the State's rail carriers and rail system.

Two major railways provide transportation services within the State of

Table 9.--Rail carriers and railage, km (mi)

| Carrier | Mainline | | Branchline | | Total | | Percent |
|---|---|---|---|---|---|---|---|
| Apache Railway Co..... | 121.6 | (76) | 0 | (0) | 121.6 | (76) | 3.7 |
| Atchison, Topeka, and Santa Fe Railway Co. | 1,070.9 | (665) | 284.9 | (177) | 1,355.8 | (842) | 41.6 |
| Black Mesa and Lake Powell Railroad.. | 134.6 | (84) | 0 | (0) | 134.6 | (84) | 4.1 |
| Magma Arizona Railroad..... | 43.4 | (27) | 0 | (0) | 43.4 | (27) | 1.3 |
| San Manuel Arizona Railroad..... | 60.8 | (38) | 0 | (0) | 60.8 | (38) | 1.9 |
| Southern Pacific Railroad..... | 980.6 | (609) | 495.1 | (308) | 1,475.7 | (917) | 45.3 |
| Tucson, Cornelia, and Gila Bend Railroad. | 69.5 | (43) | 0 | (0) | 69.5 | (43) | 2.1 |
| Total..... | 2,481.4 | (1,542) | 780.0 | (485) | 3,261.4 | (2,027) | 100.0 |

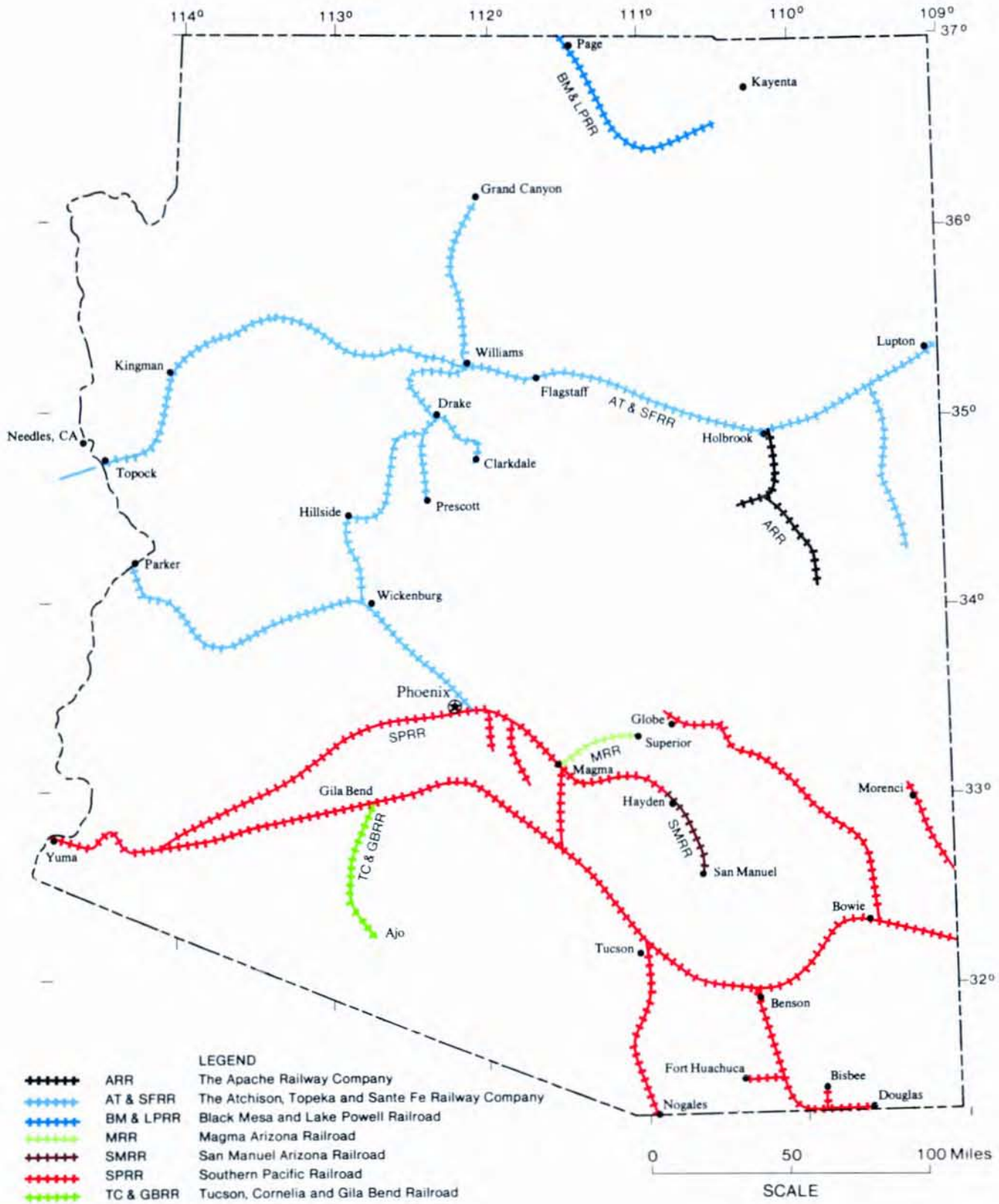



Figure 10. Rail network of Arizona.

Arizona: the Atchison, Topeka, and Santa Fe Railway Company (AT & SFRR); and the Southern Pacific Transportation Company (SPRR). Both companies provide transcontinental connections. The State is also served by five intrastate railroads: the Apache Railway Company (ARR), the Black Mesa and Lake Powell Railroad (BM & LPRR), the Magma Arizona Railroad (MRR), the San Manuel Arizona Railroad (SMRR), and the Tucson, Cornelia, and Gila Bend Railroad (TC & GBRR) (29, 629).

The SPRR is the largest carrier that serves Arizona with 917 mi of track (fig. 10). SPRR's transportation services include rail, truck, piggyback, and pipeline systems (629).

The SPRR links markets in 12 States in the West and Southwest, and offers direct mainline service to major markets in Oregon, California, Utah, Nevada, Texas, New Mexico, and Arizona. Additionally, through service is offered to points in the Pacific Northwest, Midwest, and Eastern United States (629).

Extending east-west across the southern portion of Arizona, the SPRR operates between El Paso, TX, and Niland, CA. Connections are made with the AT & SFRR at Vaughn, NM, El Paso, TX, and Phoenix, AZ. Connections are also made with the TC & GBRR at Gila Bend, servicing Ajo in Pima County; with the MRR at Magma, servicing Superior in Pinal County; and with the SMRR at Hayden, servicing San Manuel in Pinal County (fig. 10). Also, the SPRR has about 308 mi of branch lines in Arizona (table 9). These lines serve such mining communities as Hayden, Magma, Morenci, Globe, Douglas, and Bisbee (fig. 10).

The AT & SFRR is the second largest carrier with 842 mi of track, servicing the upper northern and north-central areas of Arizona. The AT & SFRR mainline crosses the State from the eastern border (near Lupton), passing

through Navajo, Holbrook, Flagstaff, Williams, Kingman, and Topock, to Needles in California. This mainline links with the ARR at Holbrook (table 9 and figure 10).

Arizona is also served by an AT & SFRR line of approximately 250 mi running from its connection point with the SPRR at Phoenix through Wickenburg, Hillside, Drake, and Williams to the Grand Canyon (fig. 10). Connecting to this mainline are two shorter branch lines serving Clarkdale and Prescott. Another branch line links Wickenburg to Parker in the west-central part of the State and continues on into California. The mainline of the AT & SFRR that runs from east (Gallup, NM) to west (Needles, CA) through the northern portion of the State is part of an interstate network serving the States of California, Arizona, New Mexico, Colorado, Texas, and Kansas.

The five smaller rail carriers are important to the mining industry because they provide the final links to such mining centers as Superior, San Manuel, and Ajo (fig. 10). Their railage is summarized in table 9.

Road

The State of Arizona stretches about 460 mi north-south and approximately 350 mi east-west. A well-developed network of interstate, Federal, State, County, and Indian highways provides access to most parts of the State and serves the interstate and intrastate transportation needs of Arizona's people and industries (fig. 11). This highway system is important to the mining industry of Arizona both for bringing in supplies and equipment and for shipment of mine, mill, smelter, and refinery products.

Segments of six interstate highways service the State. Interstate 40 (I-40), across northern Arizona, and I-10, across the southern part of the

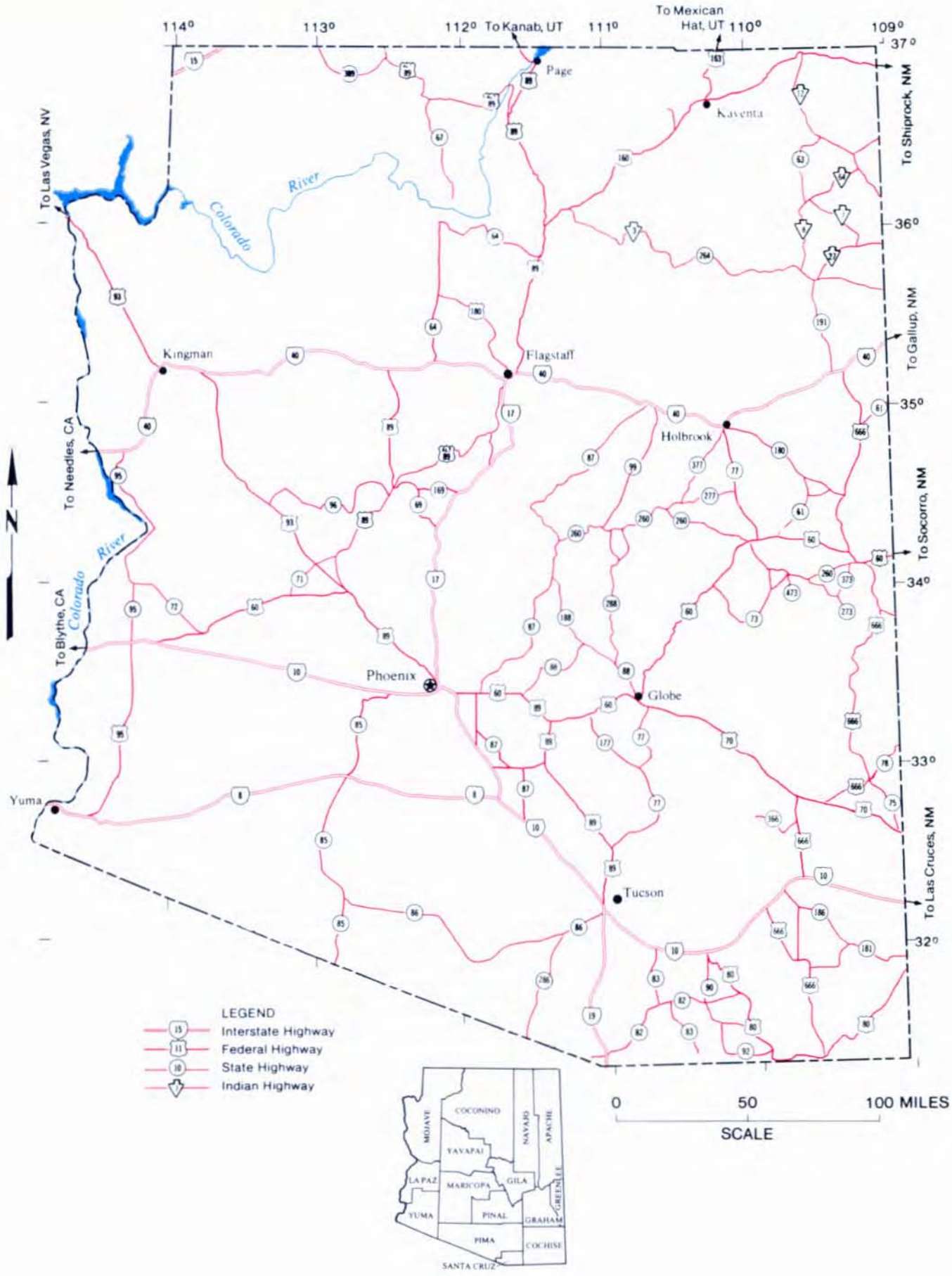



Figure 11. Highway system and classification in Arizona.

State, provide the two major east-west routes with lengths of 373 mi and 402 mi, respectively. Interstate 8 extends eastward from Yuma to its junction with I-10 southeast of Phoenix, a distance of 178 mi. The major north-south routes are I-17 from Flagstaff to Phoenix (146 mi) and I-19 from Tucson to the Mexican border (63 mi). Finally, I-15 crosses the extreme northwestern corner of the State. These roads form the core of the highway system in Arizona but would be of limited use without the Federal, State, County, and Indian roads that form the remainder of the network.

Various restrictions on highway use in Arizona are imposed by regulation, and these regulations often impact the mining industry. Vehicles that do not exceed 102 in. in width are exempt from permits and may operate on all Interstate and State highways shown in figure 12. However, there are certain rules and regulations that apply to the movement of any vehicle, material, or commodity load in excess of the legal size or weight permitted on highways under the jurisdiction of the Arizona Department of Transportation (34). For example, Class A permits allow loads up to 14 ft in width, 16 ft in height, 120 ft overall length, and 250,000 lb gross combined weight (34). Loads requiring Class A permits must be escorted if traveling on any of the restricted highways shown in figure 13. Other classes of permits may be required, depending on the load, and the Department of Transportation should be consulted for further information.

Intrastate movement of mine and mill products is commonly accomplished by truck, often by contract carrier. Long-distance interstate movement of mine or mill products is most often accomplished by rail after the products are trucked to railheads. Figure 14 shows mileages between principal Arizona

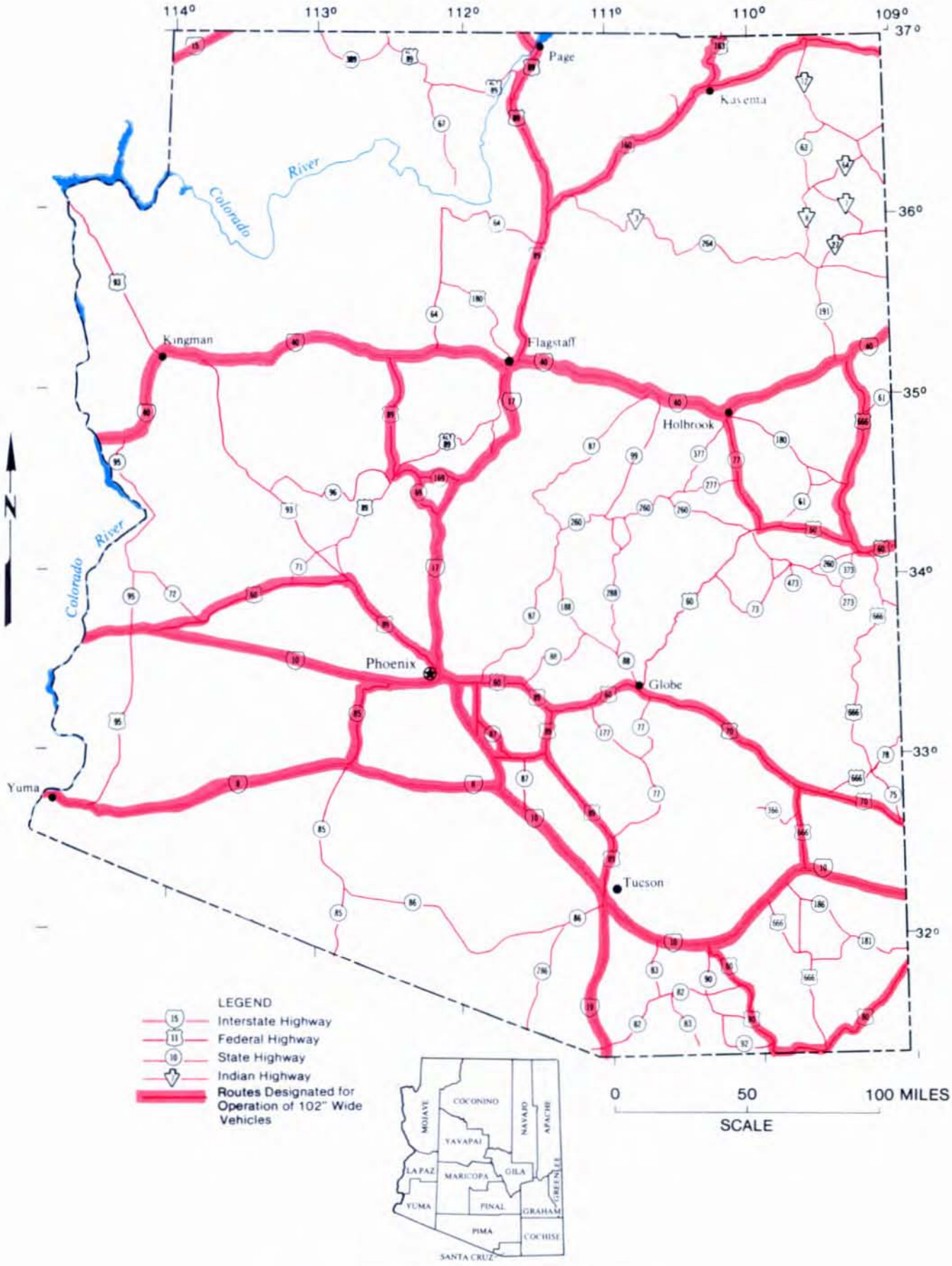



Figure 12. Interstate highways and State routes designated for operation of 102-inch-width vehicles and loads.

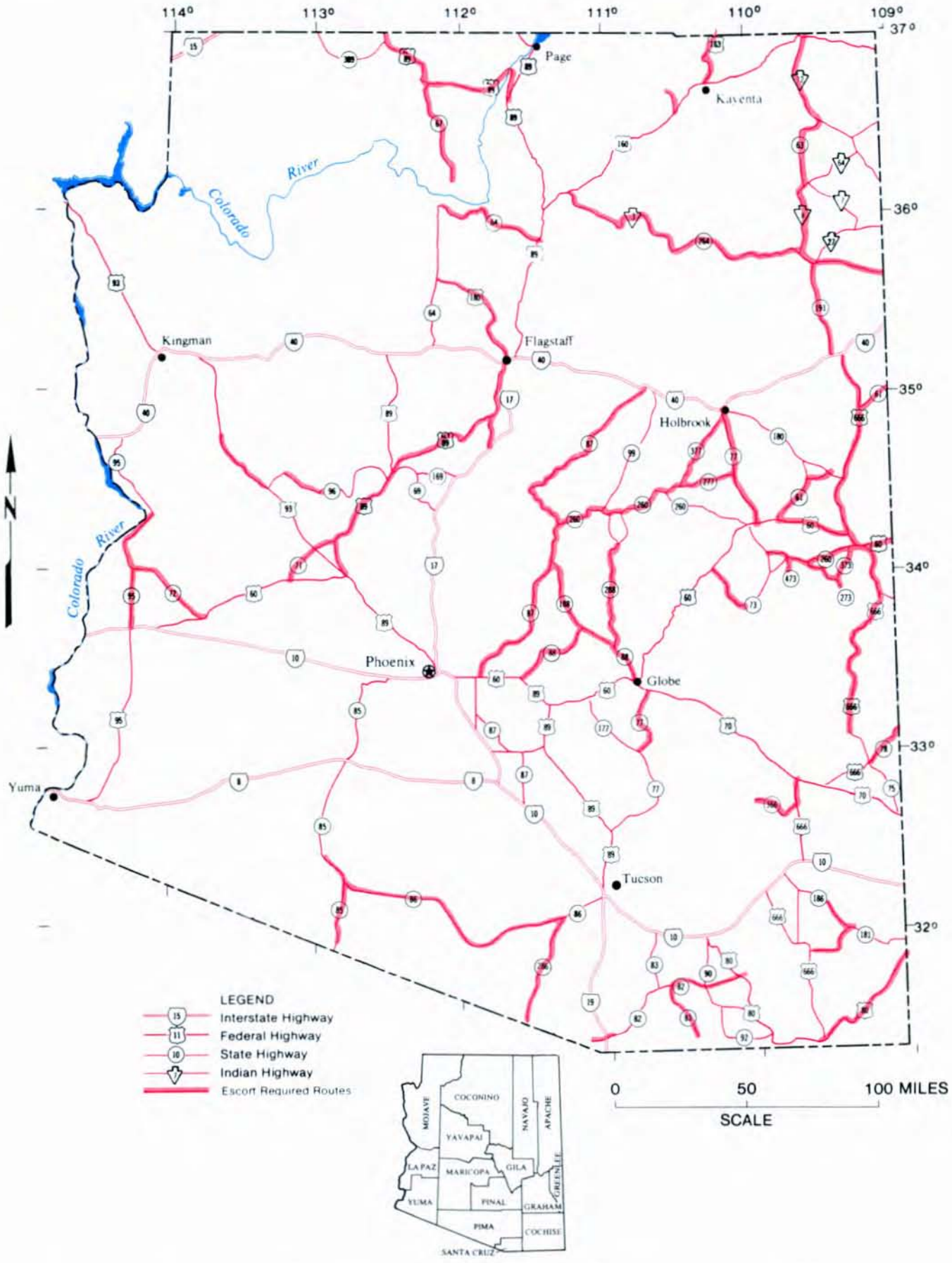



Figure 13. Highways in Arizona requiring escort for overdimensional and overweight loads.

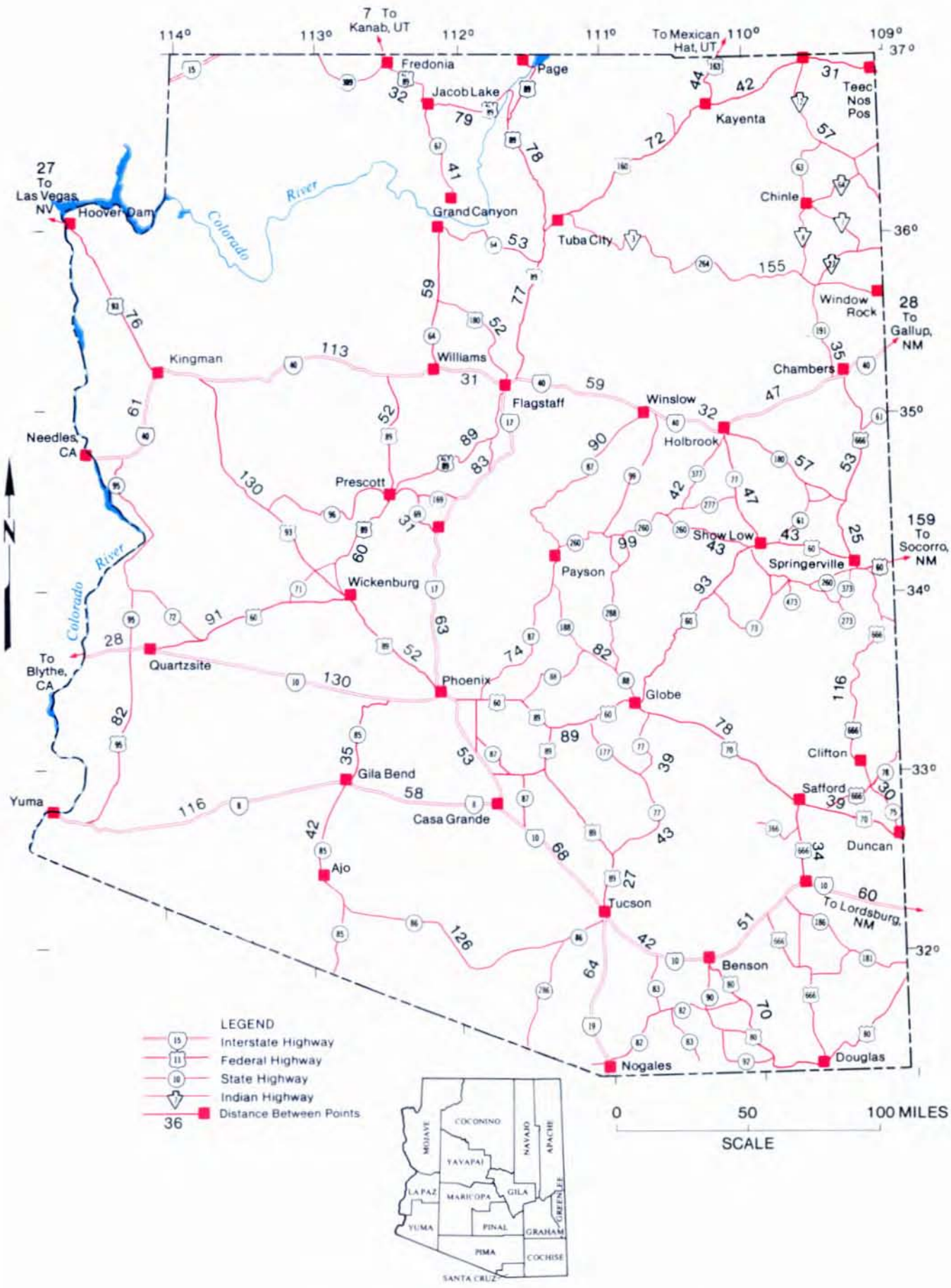



Figure 14. Mileage diagram between principal communities in Arizona.

communities and may be used to determine intrastate trucking distances or may be used, in conjunction with figure 10, to determine trucking distance to railheads.

## REGULATION AND TAXATION

Exploration for and development of mineral commodities and sources of energy as well as production, milling, smelting, and refining are essential to the economy of Arizona as well as individual communities. Mining contributes to economic growth by providing jobs and a source of income through taxes, freight revenues, and support of subsidiary industries. Regulations governing the mining industry in Arizona are thus generally favorable. The services of the ADMMR and the Office of Economic Planning and Development are available to assist investors (30, 91). The impact of taxation on a particular mineral deposit in Arizona depends both on the physical characteristics of the deposit and on its economics (33, 137).

### Mining Regulations

Regulations governing exploration and development of mineral resources in Arizona exist at both the Federal and State levels. About 72% of the land in the State (including Indian reservations) is owned or controlled by the Federal Government and is subject to the provisions of Federal laws. Pursuant to the Indian Mineral Development Act of 1982 and with the approval of the Secretary of the Interior, tribes may enter into agreements with third parties for the exploration, extraction, processing, or other development of mineral resources on Indian tribal lands and lands allotted to Indians in severalty (100). The State of Arizona owns about 15% of the land, and mining rights on that land are subject to a complex set of State laws. The remaining land

in Arizona, about 13%, is privately owned. Mining claims are locatable on private land, pursuant to Federal laws, providing that the Federal Government has retained the mineral rights (table 10, figure 15) (36, 356).

The availability of Federal lands in Arizona for mineral exploration and development varies according to land use classification. Under this system, many Federal lands have been withdrawn from mineral entry for a variety of reasons. Interested parties seeking information on the status and specifics of Federal tracts, parcels, and mineral ownership, should refer to the official records of the U.S. Bureau of Land Management (BLM), the corresponding managing agency, or the State's Office of Economic Planning and Development (1700 W. Washington, Executive Tower, Room 400, Phoenix, AZ 85007). Rights to mineral commodities on Federal lands are obtained by claim location, lease, or sale, depending on the mineral(s) and type of Federal lands (356). Locatable minerals include all metallic and most nonmetallic commodities. Leasable minerals include oil and gas, phosphate, sodium, potassium, and coal. Federal laws determine the leasing terms and limit extraction rates. The sale of sand, gravel, stone, clay, pumice, and cinders is at the discretion and control of the managing agency.

Table 10 shows ownership or assignment of lands. Specific laws, regulations, and management practices determine the availability of lands under the particular jurisdiction. If a landowner has obtained the mineral rights, then acquisition by third parties of those rights is not governed by Federal or State laws, but rather is determined by the concerned parties through negotiation. If the Federal Government has reserved the mineral rights, either on State or private lands, then the same may be obtained

Table 10.--Land ownership or control in Arizona

| Distribution | Acreage | Percent |
|---|---|---|
| Federal: | | |
| Bureau of Land Management | 13,899,000 | 19.1 |
| Forest Service | 10,807,000 | 14.9 |
| Department of Defense | 3,574,000 | 4.9 |
| National Park Service | 2,414,000 | 3.3 |
| Fish and Wildlife Service | 723,000[1] | 1.0 |
| Bureau of Reclamation | 480,000 | .7 |
| Other Federal agencies | 92,000 | .1 |
| Total Federal control | 31,989,000 | 44.0 |
| Bureau of Indian Affairs/Indian Reservations: | | |
| Navajo[2] | 9,874,899 | 13.6 |
| Papago | 2,855,874 | 3.9 |
| Hopi | 2,472,254 | 3.4 |
| San Carlos | 1,877,216 | 2.6 |
| Fort Apache | 1,664,872 | 2.3 |
| Hualapai | 992,463 | 1.4 |
| Gila River | 371,929 | .5 |
| Colorado River[2] | 225,996 | .3 |
| Others | 222,097 | .3 |
| Total Indian lands | 20,557,600 | 28.3 |
| State: Total State lands | 10,903,000 | 15.0 |
| Private: Total private lands | 9,238,400 | 12.7 |
| Grand total | 72,688,000 | 100.0 |

[1]Includes 825,000 acres of the Cabeza Prieta Game Range at the Barry M. Goldwater Air Force Range and shown in the Department of Defense total.
[2]Includes only that part of the reservation located in Arizona.

Source: References 356, 656.

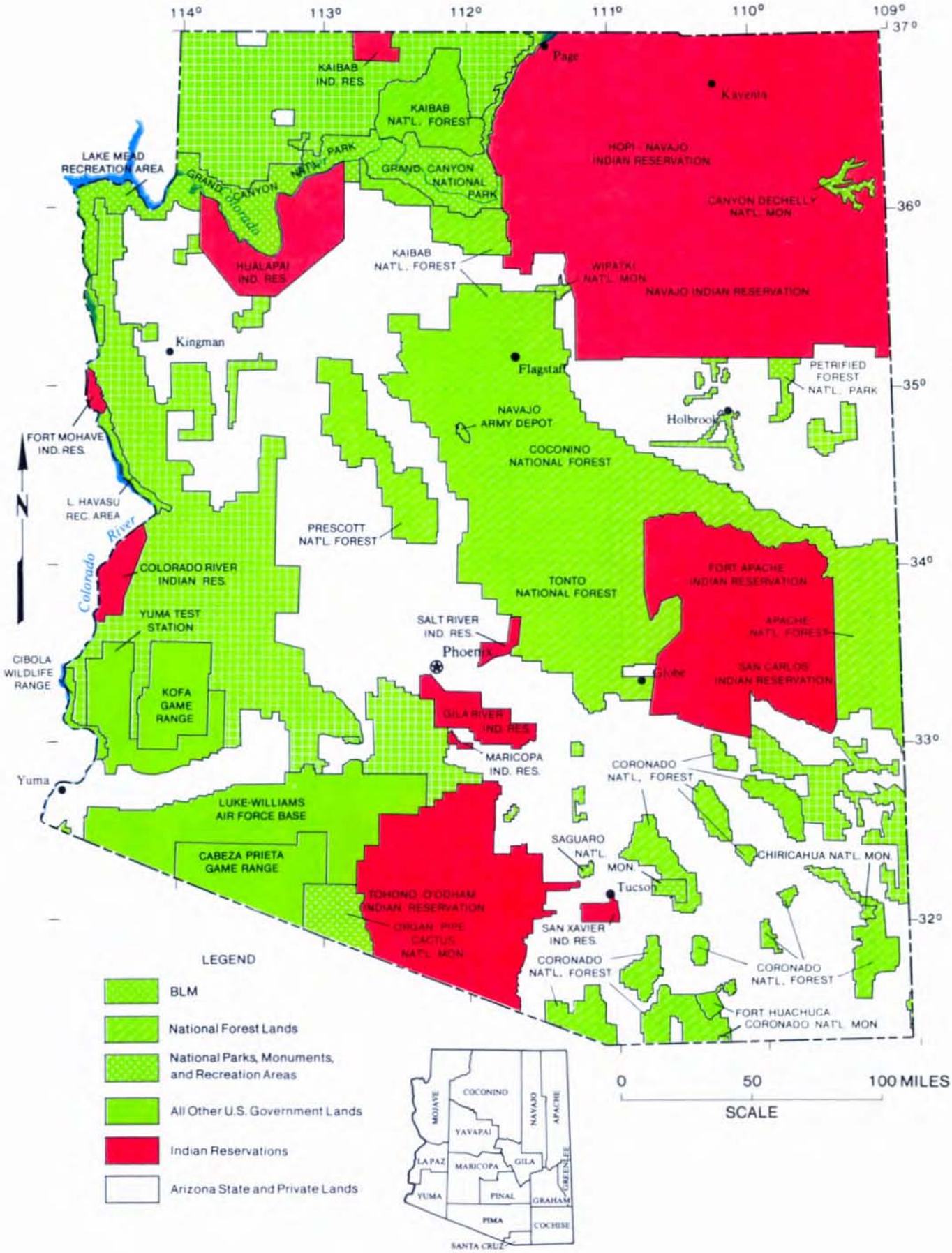



Figure 15. Federal and State lands in Arizona.

pursuant to Federal laws (36, 356).

If information beyond an initial determination that the land is subject to Indian ownership rights is desired, it is advisable to consult the Phoenix Area Office of the Bureau of Indian Affairs (BIA) (3030 North Central Ave., Phoenix, AZ 85012, 602-241-2285). Also, table 11 provides a list of offices and officials of the reservations in Arizona (563).

Mineral entry and mining locations on public lands, Federal mineral leasing laws, mineral materials disposal, multiple use of Federal lands, acquisition of mineral rights on State lands, permits, environmental protection, taxes, water and water rights, roads, rails, rights-of-way, waste disposal, mining partnerships, and grubstake agreements on Federal and State lands are covered by an ADMMR booklet, "Laws and Regulations Governing Mineral Rights in Arizona" (100), and by ADMMR Circular No. 13 (30). Both are recommended reading and are available from the ADMMR (Mineral Bldg., State Fairgrounds, Phoenix, AZ 85007, 602-255-3791 and 416 W. Congress, Suite 161, Tucson, AZ 85701, 602-628-5399). Similar information is available from the BLM and U.S. Forest Service (USFS) offices.

The most restrictive regulatory compliance State laws relate to mining safety and health, air, and water controls. Arizona has adopted all mandatory Federal health and safety standards of the Mine Safety and Health Administration (MSHA) and the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor. The State Mine Inspector is responsible for enforcing and administering the Arizona Mining Code, and thereby protecting the life, safety, health, and welfare of employees in Arizona mines, mills, smelters, refineries, and mine-related operations

Table 11.--Arizona offices and officials of the Bureau of Indian Affairs (BIA) and offices and officials of Indian Tribal Councils

(BIA offices, officials, and addresses are shown in italic)

| BIA Agency or Indian Tribal Council | Official's name and title | Address | Telephone |
|---|---|---|---|
| *Colorado River Agency* | *C. L. Henson, Superintendent* | *Rt. 1, Box 9-C, Parker, AZ 85344* | 602-669-6121 |
| Chemehuevi Tribal Council | Richard Alvarez, Chairman | P.O. Box 1976, Chemehuevi Valley, CA 92363 | 619-858-4531 |
| Colorado River Tribal Council | Anthony Drennan, Sr., Chairman | Rt. 1, Box 23-B, Parker, AZ 85344 | 602-669-9211 |
| Fort Mojave Tribal Council | Nora Garcia, Chairperson | 500 Merriman Ave., Needles, CA 92363 | 619-326-4591 |
| *Fort Apache Agency* | *Benjamin Nuzamsa, Superintendent* | *P.O. Box 560, Whiteriver, AZ 85941* | 602-338-4364 |
| White Mountain Apache Tribal Council | Rena Johnson, Sr., Chairman | P.O. Box 700, Whiteriver, AZ 85941 | 602-338-4346 |
| *Fort Yuma Agency* | *Felix Montague, Superintendent* | *P.O. Box 1591, Yuma, AZ 85364* | 619-572-0248 |
| Cocopah Tribal Council | Fred Miller, Sr., Chairman | Bin G, Somerton, AZ 85350 | 602-627-2102 |
| Quechan Tribal Council | Lorraine White, President | P.O. Box 1352, Yuma, AZ 85364 | 619-572-0213 |
| *Hopi Agency* | *Alph Secakuku, Superintendent* | *P.O. Box 158, Keams Canyon, AZ 86034* | 602-738-2228 |
| Hopi Tribal Council | Ivan Sidney, Chairman | P.O. Box 123, Kykotsmovi, AZ 86039 | 602-734-2445 |
| *Papago Agency* | *James Barber, Superintendent* | *P.O. Box 578, Sells, AZ 85634* | 602-383-7286 |
| Tohono O'odham Nation | Josiah N. Moore, Chairman | P.O. Box 837, Sells, AZ 85634 | 602-383-2221 |
| *Pima Agency* | *Denise Homer, Superintendent* | *P.O. Box 8, Sacaton, AZ 85247* | 602-562-3326 |
| Ak-Chin Indian Community Council | Leona Kaker, Chairperson | Rt. 2, Box 27, Maricopa, AZ 85239 | 602-568-2227 |
| Gila River Indian Community Council | Donald R. Antone, Sr., Governor | P.O. Box 97, Sacaton, AZ 85247 | 602-562-3311 |
| *Salt River Agency* | *Ray Albert, Actg., Superintendent* | *Rt. 1, Box 117, Scottsdale, AZ 85256* | 602-241-2842 |
| Mohave-Apache Community Council | Louis Hood, President | P.O. Box 17779, Fountain Hills, AZ 85268 | 602-990-0995 |
| Pascua Yaqui Tribal Council | David Ramirez, Chairman | 7474 S. Camino De Oeste, Tucson, AZ 85746 | 602-883-2838 |
| Salt River Pima-Maricopa Indian Community Council | Gerald Anton, President | Rt. 1, Box 216, Scottsdale, AZ 85256 | 602-941-7277 |
| *San Carlos Agency* | *Allen J. Anspach, Superintendent* | *P.O. Box 209, San Carlos, AZ 85550* | 602-475-2321 |
| San Carlos Council | Buck Kitcheyan, Chairman | P.O. Box 0, San Carlos, AZ 85550 | 602-475-2361 |
| *Truxton Canon Agency* | *George Keller, Superintendent* | *P.O. Box 37, Valentie, AZ 86437* | 602-769-2286 |
| Havasupai Tribal Council | Wayne Sinyella, Chairman | P.O. Box 10, Supai, AZ 86435 | 602-448-2961 |
| Hualapai Tribal Council | Edgar Walema, Chairman | P.O. Box 168, Peach Springs, AZ 86434 | 602-769-2216 |
| Tonto Apache Tribal Council | Jeri Johnson, Chairperson | Tonto Reservation #30, Payson, AZ 85541 | 602-474-5000 |
| Yavapai-Apache Community Council | Theodore Smith, Sr., Chairman | P.O. Box 1188, Camp Verde, AZ 86322 | 602-567-3649 |
| Yavapai-Prescott Board of Directors | Patricia McGee, President | P.O. Box 348, Prescott, AZ 86301 | 602-445-8790 |
| *San Carlos Irrigation Project* | *Ralph Esquerra, Project Engineer* | *P.O. Box 250, Coolidge, AZ 85228* | 602-723-5439 |
| *Phoenix Hopi Partitioned Lands Office* | *Ray Smith, Natural Resource Manager* | *P.O. Box 10, Phoenix, AZ 85001* | 602-241-5190 |

(357). Information pertaining to laws and regulations of mine activities and mine labor are available from the State Mine Inspector (705 West Wing, Capitol Tower, Phoenix, AZ 85007-2859, 602-255-5971) and from the Industrial Commission of Arizona (800 West Washington, Phoenix, AZ 85007, 602-255-4411).

Most permitting required in Arizona for development of its mineral resources occurs at the State level; however, there are also local and Federal agencies that have jurisdiction. Table 12 outlines State and Federal permits, with agency contacts, required for planning, development, and construction. This table is based on ADMMR Circular No. 13, "Pertinent Data for New or Prospective Mining Operations in Arizona" (30); on the ADMMR publication entitled "Laws and Regulations Governing Mineral Rights in Arizona" (100); and on "Permit Requirements for Development of Energy and Other Selected Natural Resources for the State of Arizona," prepared for the Four Corners Regional Commission and the USGS (91). The first two documents are obtainable from the ADMMR and the last from the USGS, Environmental Affairs Office, 760 National Center, Reston, VA 22092. The ADMMR and the Office of Economic Planning and Development should be contacted for information regarding amendments or additions to regulations and permitting processes for the mining industry in Arizona. Furthermore, the interpretation of the laws and regulations and the process of permitting frequently require legal determinations; consequently, consultation is suggested.

## Taxation

The Arizona Department of Revenue compiles, reviews, and updates annually an appraisal manual for producing mines, nonproducing mines, and oil, gas, and geothermal interests for the taxing year.

Table 12.--Permits required in Arizona before initiation of mining or milling

| Requirement | Granting agency or agency to contact |
|---|---|
| State: | |
| Starting business in Arizona..... | Arizona Corporation Commission<br>1200 W. Washington St.<br>Phoenix, AZ 85007<br>602-255-3931 |
| License to do business..... | Arizona Tax Commission, Sales and Use Tax Division, Department of Revenue<br>West Wing, Capitol Bldg.<br>Phoenix, AZ 85007<br>602-255-3594 |
| Permit to construct campsite..... | Arizona Department of Health Services<br>Engineering Services Section<br>2005 N. Central<br>Phoenix, AZ 85004<br>602-257-2285 |
| Air quality permit to construct..... | Arizona Department of Health Services<br>Bureau of Air Quality Control<br>2005 N. Central<br>Phoenix, AZ 85004<br>602-257-2285 |
| Air quality permit to operate..... | Do. |
| Arizona water pollution control permit. | Arizona Department of Health Services<br>Bureau of Water Quality Control<br>2005 N. Central<br>Phoenix, AZ 85004<br>602-257-2305 |
| Authorization for disposal of solid wastes. | Do. |
| Hazardous waste..... | Arizona Department of Health Services<br>Bureau of Water Quality Control<br>2005 N. Central<br>Phoenix, AZ 85004<br>602-257-2305 |

Table 12.--Permits required in Arizona before initiation of mining or milling--Continued

| Requirement | Granting agency or agency to contact |
|---|---|
| State--Continued: | |
| Permits for uranium mills..... | Arizona Radiation Regulatory Commission<br>4814 S. 40th St.<br>Phoenix, AZ 85040<br>602-255-4845 |
| Endangered wildlife..... | Arizona Game and Fish Commission<br>Bureau of Land Management, State Office<br>3707 N. 7th St.<br>Phoenix, AZ 85014<br>602-241-5547 |
| Endangered plants..... | Arizona Commission of Agriculture and Horticulture<br>1688 W. Adams, Room 421<br>Phoenix, AZ 85007<br>602-255-4373 |
| Prospecting permits and mineral leases on state lands. | Arizona State Land Department<br>1624 W. Adams<br>Phoenix, AZ 85007<br>602-255-4061 |
| Permit to appropriate the public waters. | Arizona Department of Water Resources<br>99 E. Virginia Ave.<br>Phoenix, AZ 85004<br>602-255-1550 |
| Permit to construct tailings dam. | Do. |
| Commencement or suspension of an operation. | Arizona State Mine Inspector<br>705 West Wing, Capitol Tower<br>Phoenix, AZ 85007-2859<br>602-255-5971 |
| Explosives Regulation Compliance. | Do. |
| Labor laws..... | Industrial Commission of Arizona<br>800 W. Washington<br>Phoenix, AZ 85007<br>602-255-4411 |

Table 12.--Permits required in Arizona before initiation of mining or milling--Continued

| Requirement | Granting agency or agency to contact |
|---|---|
| State--Continued: | |
| State Clearinghouse..... | Office of Economic Planning and Development, Development Division<br>1700 W. Washington<br>Executive Tower, Room 400<br>Phoenix, AZ 85007<br>602-255-5705 |
| Federal: | |
| Use of BLM-administered land..... | Bureau of Land Management, State Office<br>3707 N. 7th St.<br>Phoenix, AZ 85014<br>602-241-5547 |
| Use of BLM-administered land under wilderness review. | Do. |
| Temporary use of BLM-administered land. | Do. |
| Right-of-way for transmission corridor. | Do. |
| Road access (Right-of-way)..... | Do. |
| Prevention of significant deterioration. | Environmental Protection Agency<br>Division of New Source Section<br>Air Management<br>215 Fremont St.<br>San Francisco, CA 94105<br>415-974-8110 |
| Mining in National Forest..... | U.S. Forest Service, Arizona Zone Office--Minerals<br>2324 E. McDowell Rd.<br>Phoenix, AZ 85006<br>602-225-5200 |
| Flora and fauna..... | U.S. Forest Service, Arizona Zone Office--Minerals<br>2324 E. McDowell Rd.<br>Phoenix, AZ 85006<br>602-225-5200 |

Table 12.--Permits required in Arizona before initiation of mining or milling--Continued

| Requirement | Granting agency or agency to contact |
|---|---|
| Federal--Continued: | |
| Notification of commencement or suspension of an operation. | Mine Safety & Health Administration<br>3221 N. 16th St., Suite 300<br>Phoenix, AZ 85016<br>602-241-2030 |
| Patenting mining claims..... | Bureau of Land Management, State Office<br>3707 N. 7th St.<br>Phoenix, AZ 85014<br>602-241-5547 |
| Labor laws..... | U.S. Department of Labor<br>Wage and Hour Division<br>3221 N. 16th St., Room 301<br>Phoenix, AZ 85016<br>602-241-2990 |
| Purchase, transport, or storage of explosives. | Bureau of Alcohol, Tobacco, and Firearms<br>201 E. Indianola Ave., Suite 375<br>Phoenix, AZ 85012<br>602-241-2025 |
| City and county: | |
| General plan, building permit, special-use permit, zoning change, business license, taxation. | Contact respective city or county government affected by a proposed operation for information on what permits may be required and taxes imposed. |

Source: References 30, 91, 100.

The techniques and methods discussed in the document (137) are designed to assist the investor in assessing the impact of taxation, which depends on the physical and economic characteristics of the individual mineral deposits. Physical characteristics include geology, ore reserves, production rates, metal content of ore, mining methods, etc.; economic characteristics include commodity prices, profit margins, discount rates, etc., of the mineral commodity relative to its costs of production (33).

According to the Arizona Department of Revenue, the value of taxable producing mine property includes land, supplies inventories, ore reserves, construction work in progress, personal property, and improvements. Nonproducing mines are valued for 3 years after the mine is shut down, considering salvage. Land is valued at market based on data from the local county assessors. The 1987 assessment ratio is 30% of full cash value for producing mines, which will decrease to 25% in 1990. Nonproducing mines have an assessment ratio of 16%. The property tax for producing oil, gas, and geothermal interests is based on gross yield from the well. This assessed value is then multiplied by the combined property tax rate for State, county, city, and local school districts to determine the tax amount (33).

Severance tax in Arizona is calculated from values after milling. Tax equals the rate times margins (commodity revenues less sum of smelter and refinery operating costs and transportation costs from mills to smelters and refineries). The current rate is 2.5%.

Arizona's property tax is calculated by using Hoskold's formula (298). Reserves in place are valued using the following taxation percentages: mill levy rate (11%), assessment rate (52%), redemption rate (19%), and interest

rate (8%). The investment property tax is calculated at the mill levy rate of 11% and at the assessment rate of 52%.

Arizona's sliding-scale state income tax is calculated from gross revenues, less the following deductions:

1. All operating costs.
2. All transportation costs.
3. All amortization and depreciation.
4. Previous year's Federal taxes.
5. Present year's severance taxes.
6. Present year's property taxes.
7. Royalty payments.
8. Loan interest payments.
9. Any and all depletion used.

The rate scale for gross revenue is as follows, in percent (137): $0 to $2,000, 0; $2,000 to $3,000, 5; $3,000 to $4,000, 6.5; $4,000 to $5,000, 8; $5,000 to $6,000, 9; greater than $6,000, 10.5.

A comparative analysis of mine tax impact in Arizona and the States of Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wisconsin is provided in appendix A of a paper written by Davidoff and Hurdelbrink (137).

## MINERAL PROCESSING FACILITIES SIGNIFICANT TO ARIZONA

### Milling Facilities

Ore beneficiation facilities in Arizona are shown in figure 16 and listed in tables 13 and 14. The information pertinent to 16 strategic or critical mineral commodities vital to the U.S. and Arizona economies was compiled as of the end of 1987 and beginning of 1988.

Mill capacities and types of operational data were compiled from the ADMMR publication, "Directory of Active Mines in Arizona, 1987-88" (31) and from the "Annual Report of the State Mine Inspector" (357-358), in conjunction with data obtained from technical journals, newspapers, field visits, and

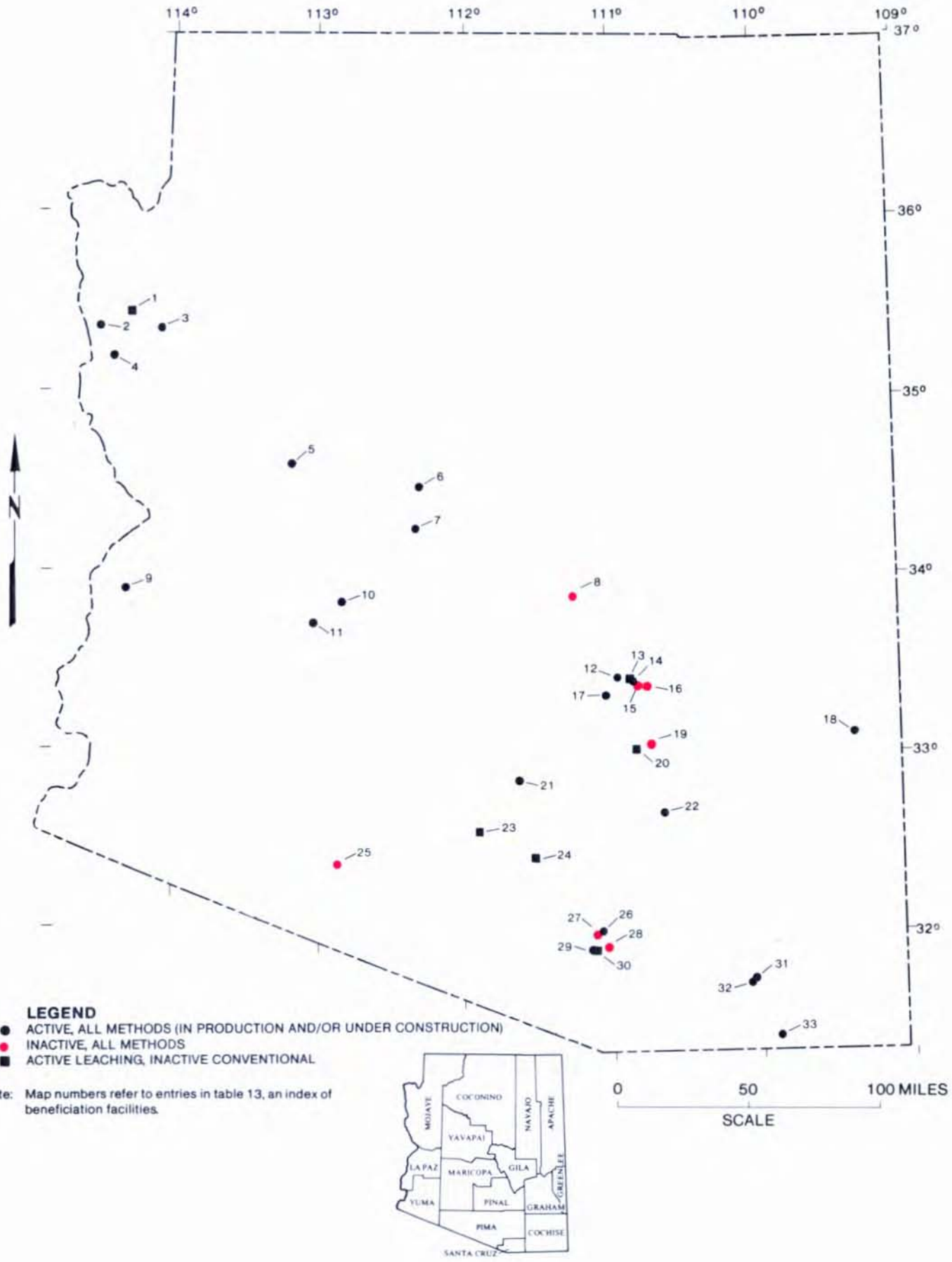



Figure 16. Selected beneficiation facilities in Arizona.

Table 13.--Numerical index of selected beneficiation facilities in Arizona

(Refer to figure 16)

| Map No. | Name | Principal commodity |
|---|---|---|
| 1 | Mineral Park | Cu |
| 2 | Portland | Au |
| 3 | C.O.D. | Au |
| 4 | Frisco | Au |
| 5 | Bagdad | Cu |
| 6 | McCabe | Au |
| 7 | Gladiator | Au |
| 8 | Tonto Basin | $CaF_2$ |
| 9 | Copperstone | Au |
| 10 | Vulture | Au |
| 11 | Big Horn | Au |
| 12 | Pinto Valley | Cu |
| 13 | Inspiration | Cu |
| 14 | Miami Unit | Cu |
| 15 | Van Dyke | Cu |
| 16 | Jaquays | Asb |
| 17 | Magma-Superior | Cu |
| 18 | Morenci-Metcalf | Cu |
| 19 | Christmas | Cu |
| 20 | Ray | Cu |
| 21 | Stutenroth | Au |
| 22 | San Manuel-Kalamazoo | Cu |
| 23 | Lakeshore | Cu |
| 24 | Silver Bell | Cu |
| 25 | New Cornelia | Cu |
| 26 | Mission Complex | Cu |
| 27 | Pima | Cu |
| 28 | Twin Buttes | Cu |
| 29 | Sierrita | Cu |
| 30 | Esperanza | Cu |
| 31 | Contention | Au |
| 32 | Armco Custom | Au |
| 33 | Copper Queen | Cu |

Table 14.--Selected beneficiation facilities

| Name and operator | County | Status | Map No.[1] | Method[2] | Capacity[3] | Type | Comments |
|---|---|---|---|---|---|---|---|
| | | | | ASBESTOS | | | |
| Jaquays, Jaquays Mining Corp. | Gila..... | Inactive.... | 16 | Crushing, screening, and air classifying. | 25 st/d ore..... | M | Products are AAA, 3Z, 4T, and 7MF fiber. |
| | | | | COPPER | | | |
| Bagdad, Cyprus Metals Co. | Yavapai..... | Active..... | 5 | Mill, dump leach, SX-EW. | 54,000 st/d ore, 12,500 gpm solution. | M | Products are Cu and Mo concentrates and cathode Cu from SX-EW. |
| Christmas, Cyprus Metals Co. | Gila..... | Inactive | 19 | Mill..... | 5,500 st/d ore.... | M | Cu concentrate product. |
| Copper Queen, Phelps Dodge Corp. | Cochise..... | Mill, active. Dump leach, inactive. | 33 | Mill, dump leach, precipitation. | 20,000 st/d ore, 1,500 st/yr leach feed. | M | Cement Cu produced. |
| Esperanza, Cyprus Metals Co. | Pima..... | Mill, inactive. Dump leach, active. | 30 | Mill, dump leach..... | 17,500 st/d ore, 3,500 gpm of solution. | M | Cu and Mo concentrates produced. Dump leach solution processed by Sierrita SX-EW plant. Crushing facilities supplement Sierrita. |
| Inspiration, Cyprus Metals Co. | Gila..... | Mill, inactive. Heap leach, active. | 13 | Mill, heap leach, ferric cure leach, precipitation, SX-EW. | 24,000 st/d ore, 8,000-9,000 gpm of solution. | M | Products are Cu concentrate, Mo concentrate, cement Cu, and cathode Cu. The SX-EW plant, called Cyprus Miami, serves all Cyprus leach operations in the area and produces 125,000,000 lb/yr of Cu. |

See explanatory notes at end of table.

Table 14.--Selected beneficiation facilities--Continued

| Name and operator | County | Status | Map No.[1] | Method[2] | Capacity[3] | Type | Comments |
|---|---|---|---|---|---|---|---|
| | | | | COPPER--Continued | | | |
| Lakeshore, Cyprus Metals Co. | Pinal..... | Mill, inactive. Vat leach, active. | 23 | Mill, in situ leach, concentrate from Sierrita is fed to roaster, vat leach, SX-EW. | 10,000 st/d ore, 6,500 st/d Cu oxides to leaching and SX-EW. | M | 75,000 st/yr cathode Cu output from SX-EW. Cooperative study with U.S. Bureau of Mines involving in situ leaching. |
| Magma-Superior, Magma Copper Co. | ..do..... | Active..... | 17 | Mill..... | 3,500 st/d ore.... | M | Mill is for sale. Presently reprocessing tailings for pyrite for local market. |
| Miami Unit, Magma Copper Co. | Gila..... | ..do..... | 14 | In situ leach, SX-EW.. | 3,000 gpm solution. | M | In situ leach of old block cave operation. Tailings leach scheduled to begin Nov. 1988 with SX-EW expansion to 6,000 gpm of solution. |
| Mineral Park, Cyprus Metals Co. | Mohave..... | Mill, inactive. In situ leach, active. | 1 | Mill, in situ leach, precipitation. | 15,000 st/d ore, leach produces 4,500,000 lb/yr Cu in cement Cu. | M | Products are Cu and Mo concentrates and cement Cu. |
| Mission Complex, ASARCO Incorporated. | Pima..... | Active..... | 26 | Mill..... | 29,000 st/d ore... | M | Cu concentrate produced. |
| Morenci-Metcalf, Phelps Dodge Corp. | Greenlee.... | ..do..... | 18 | Two mills, dump leach, SX-EW. | Morenci mill, 60,000 st/d ore. Metcalf mill, 40,000 st/d ore. SX-EW, 30,000 gpm solution. | M | Metcalf concentrator has a Mo circuit. SX-EW started in September, 1987. |
| New Cornelia, Phelps Dodge Corp. | Pima..... | Inactive.... | 25 | Mill, dump leach, precipitation. | 30,000 st/d ore. | M | Concentrator has a Mo circuit. |

See explanatory notes at end of table.

Table 14.--Selected beneficiation facilities--Continued

| Name and operator | County | Status | Map No.[1] | Method[2] | Capacity[3] | Type | Comments |
|---|---|---|---|---|---|---|---|
| | | | | COPPER--Continued | | | |
| Pima, Cyprus Metals Co. | ..do..... | ..do..... | 27 | Mill..... | 15,000 st/d ore... | M | Old mill has been scavenged. New mill is intact. Products are Cu and Mo concentrates. |
| Pinto Valley, Magma Copper Co. | Gila..... | Active..... | 12 | Mill, dump leach, SX-EW. | 60,000 st/d ore, 6,000 gpm of solution. | M | |
| Ray, ASARCO Incorporated | Gila..... | ..do..... | 20 | Mill, dump leach, heap leach, SX-EW. | 27,000 st/d sulfide ore; 14,000 st/d oxide ore. | M | Products are Cu and Mo concentrates and Cu from SX-EW. |
| San Manuel-Kalamazoo, Magma Copper Co. | ..do..... | ..do..... | 22 | Mill, heap leach, in situ leach, SX-EW. | 62,000 st/d ore, 14,400 gpm of solution. | M | Products are Cu and Mo concentrates and 50,000 st/yr Cu from SX-EW. |
| Sierrita, Cyprus Metals Co. | Pima..... | ..do..... | 29 | Mill, dump leach, ferromolybdenum roaster, SX-EW. | 100,000 st/d ore, 4,000 gpm of solution. | M | Johnson Camp SX-EW plant was moved to Sierrita. SX-EW plant handles solutions from both Sierrita and Esperanza pits. Ferromolybdenum roaster produces a rhenium byproduct from flue dust. |
| Silver Bell, ASARCO Incorporated. | ..do..... | Mill, inactive. Dump leach, active. | 24 | Mill, dump leach, precipitation. | 11,000 st/d ore, 2,500 gpm of solution. | M | |

See explanatory notes at end of table.

Table 14.--Selected beneficiation facilities--Continued

| Name and operator | County | Status | Map No.[1] | Method[2] | Capacity[3] | Type | Comments |
|---|---|---|---|---|---|---|---|
| | | | | COPPER--Continued | | | |
| Twin Buttes, Cyprus Metals Co. | ..do..... | Inactive.... | 28 | Heap leach, agitation leach, SX-EW. | 10,000-20,000 st/d ore in future. | M | Cyprus is shipping sulfide ore to Sierrita and stockpiling oxide ore at Twin Buttes. Plans are to open the oxide plant by the end of 1988, and heap leach by late 1989. Cyprus has a 15-year lease on the property from Park Corp. |
| Van Dyke, Kocide Chemical Co. | Gila..... | ..do..... | 15 | In situ leach, precipitation. | 500 gpm of solution planned capacity. | M | In situ leach and precipitation plant under construction. Planned output is 600,000 lb/mo contained Cu in cement Cu. |
| | | | | FLUORSPAR | | | |
| Tonto Basin, Pro-Met of Arizona, Inc. | Gila..... | Inactive.... | 8 | Mill..... | 125 st/d ore..... | M | Conventional flotation mill. |
| | | | | GOLD | | | |
| Armco Custom Mill, Alanco, Ltd. | Cochise..... | Active..... | 32 | Mill..... | Undetermined..... | C | Facility includes metallurgical laboratory. Mill has flotation, gravity, and cyanide circuits. Located 4 mi east of Tombstone. |
| Big Horn, Roddy Resources Arizona, Inc. | Maricopa.... | ..do..... | 11 | Cyanide heap leach, carbon adsorption. | 30,000 st/mo ore.. | M | Open pit gold mine. |
| C.O.D., Alanco, Ltd..... | Mohave..... | ..do..... | 3 | Mill..... | 60 st/d ore..... | M | Underground base and precious metal mine. Gravity mill. Under development. |

See explanatory notes at end of table.

Table 14.--Selected beneficiation facilities--Continued

| Name and operator | County | Status | Map No.[1] | Method[2] | Capacity[3] | Type | Comments |
|---|---|---|---|---|---|---|---|
| | | | | GOLD--Continued | | | |
| Contention, PBR Minerals, Inc. | Cochise..... | ..do..... | 31 | Cyanidation..... | Undetermined..... | M | Wash and cleanup of old Ag and Au tailings with no additional cyanide required. |
| Copperstone, Cyprus Gold Co. | La Paz..... | ..do..... | 9 | Cyanide agitation leach, CIP-EW, furnace. | 2,700 st/d ore.... | M | Produces gold bullion. |
| Frisco, Frisco Land and Mining Co. | Mohave..... | ..do..... | 4 | Cyanide heap leach.... | Undetermined..... | M | Underground gold mine. Heap leach production intermittent. |
| Gladiator, Nor-Quest Arizona, Inc. | Yavapai..... | ..do..... | 7 | Mill..... | 100 st/d ore..... | M | Underground Au mine with gravity and flotation mill. Located 25 mi south of Prescott. |
| McCabe, Stan West Mining Corp. | ..do..... | ..do..... | 6 | Mill..... | 500 st/d ore..... | M | Gravity, copper flotation, and CIP cyanide mill. Underground precious and base metal mine. Production anticipated 3rd quarter, 1988. |
| Portland, Western States Minerals Corp. | Mohave..... | ..do..... | 2 | Cyanide heap leach, carbon adsorption. | Undetermined..... | M | Open pit gold mine. |
| Stutenroth, Stutenroth Milling Co. | Pinal..... | ..do..... | 21 | Mill..... | 50 st/d ore..... | C | Custom gravity mill. Located 8 mi southeast of Casa Grande. |
| Vulture, A.F. Budge (Mining), Ltd. | Maricopa.... | ..do..... | 10 | Cyanide heap leach, Merrill-Crowe system. | 95-125 gpm of solution. | M | Mill tailings are agglomerated prior to leaching. Merrill-Crowe Zn precipitate system producing dore gold. |

C Custom mill. M Captive mill.

[1] Refers to figure 16.

[2] An entry of "Mill" indicates a conventional flotation mill.

[3] Approximate mill feed unless otherwise noted.

personal communications with vendors, owners, and operators. The information in neither the figure nor the tables is intended to be exhaustive; rather, the information shows the 1987-88 status of critical and strategic minerals processing in Arizona.

While some large-scale copper-molybdenum facilities are still inactive, the volume of copper recovered by precipitation or leaching with solvent extraction and electrowinning processes at reduced costs increased. The trend toward these recovery methods was caused originally by low copper prices and related foreign competition (imports were less expensive than domestic production). In 1988, however, the copper and gold industries in the State were spurred by an increase in the copper price and a continuation of relatively high gold prices. The copper price increased to a level ranging from about $1.00/lb to $1.60/lb after hovering for several years near $0.60/lb; the gold price ranged from about $395/tr oz to $485/tr oz.

Gold continued to be recovered as a byproduct of base metals. Nine additional gold mines and mills were operating by the end of 1987, and three more units had come into production by fall of 1988. Molybdenum continued to be recovered as a coproduct and/or byproduct of copper production at the Bagdad, Mineral Park, San Manuel, Pinto Valley, Morenci, and New Cornelia mining operations (31). Arizona remained first in copper with 72%, second in molybdenum with 18%, third in silver with 12%, and seventh in gold with 2% of the total value of domestic production (659).

During 1987-88, gold, copper, and molybdenum were actively recovered using the following processing methods (31):

Gold.--wet gravity; cyanide heap leach with carbon-in-pulp (CIP) and

electrowinning; agitation leach, gravity, and flotation; and wash and cleanup of old silver and gold tailings with no additional cyanide.

Copper and molybdenum.--flotation; dump and in situ leaching with precipitation; heap, dump, and in situ leaching with solvent extraction and electrowinning with ferromolybdenum and rhenium recovery; and ferric-cure dump leach.

Copper and gold.--gravity copper flotation and CIP cyanide process for gold.

Most industrial and fuel minerals and mineral products produced in Arizona, such as cement, clays, gem stones, gypsum, lime, perlite, pumice, pyrite, salt, sand and gravel, stone, sulfuric acid, vermiculite (exfoliated), zeolites, coal, and uranium are not part of the strategic or critical minerals listing.

The weakening of the Arizona mining industry from 1970 to 1985 impacted employment as shutdowns and layoffs took place in the State's copper industry. Employment dropped from 21,900 workers in 1981 to 9,000 by the end of 1985, but rebounded to 9,900 in the first half of 1988 (31, 358).

Smelting, Refining, and Solvent Extraction-Electrowinning Facilities

Arizona hosts four smelting facilities that have purchased outside concentrates or conducted toll smelting in the past. All four smelters process copper concentrates and two have attendant refineries.

The ASARCO Incorporated smelters at Hayden have the capacity to produce up to 300,000 st/yr of anode copper. The Hayden plant can produce between 180,000 and 200,000 st/yr, and the Ray Mines smelter can produce between 95,000 and 100,000 st/yr of anode copper. The Hayden plant processes feed

materials from the Mission and Ray concentrators. When Asarco bought the Ray Mines Division from Kennecott, there was not enough copper concentrate available to keep both smelter facilities operating, so the Ray smelter was placed on standby. At the time of sale to Asarco, the Ray smelter was in full environmental compliance and could, therefore, be brought back on-line very quickly. The Silver Bell and Mission concentrators are in a standby maintenance mode. The Sacaton Mine has been permanently closed, the mill facility has been partially dismantled, and the parts have been used by other Asarco facilities.

The Cyprus operations include three solvent extraction-electrowin (SX-EW) operations. Sierrita, at 5,000 st/yr of cathode copper, has the smallest SX-EW capacity. Next in size is Bagdad, at a capacity of 9,000 st/yr of cathode copper. Cyprus Casa Grande (formerly Lakeshore), with current production of 50,000 st/yr of cathode copper, is the largest Cyprus operation. In January 1988, the rated capacity of this SX-EW operation was 75,000 st/yr of cathode copper. The unique feature of the Cyprus Casa Grande operation is that it is an SX-EW facility with a sulfide roaster that uses sulfide concentrates. The sulfide roaster prepares the standard sulfide concentrates for leaching. Currently, Cyprus does not purchase concentrates or toll refine, but company officials have not ruled out that possibility.

The Cyprus smelter at Miami has the capacity to produce 140,000 st/yr of anode copper. It processes feed materials from the Cyprus Miami mill and from the Christmas and Ox Hide concentrators when the latter two are operating. Cyprus acquired Inspiration Consolidated Copper Company on July 1, 1988. All anode copper produced from former Inspiration properties is sent to the old

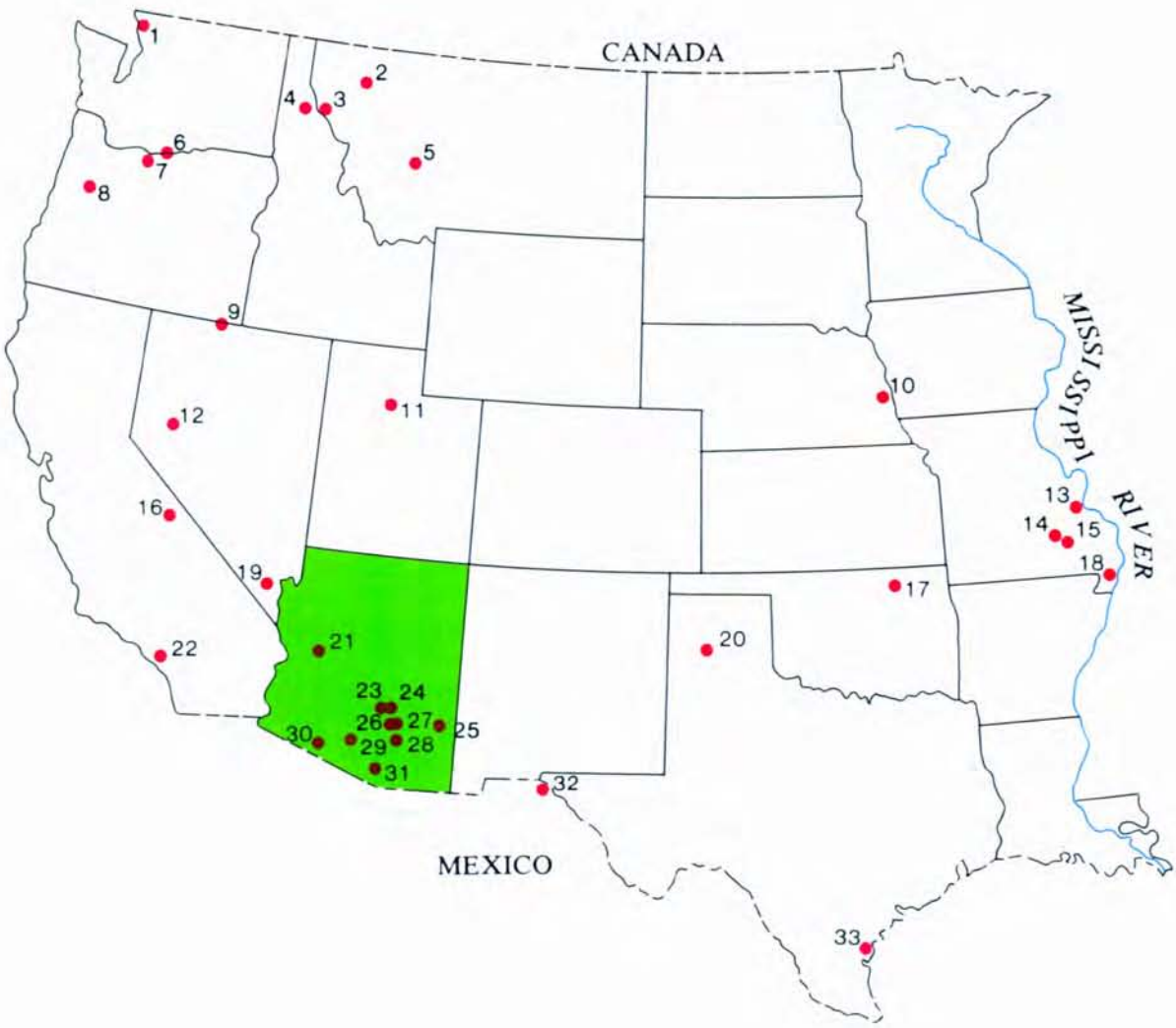
Inspiration refinery, which has the capacity to produce 130,000 st/yr of continuous cast rod.

The Magma Copper smelter at San Manuel has the capacity to produce 275,000 st/yr of blister copper. It processes feed materials from the San Manuel mill. It also processed material from the Superior mill until it closed and the mine was placed on caretaker status pending sale or permanent closure. All of the blister copper produced is then sent to the San Manuel refinery. The refinery has a capacity of 250,000 st/yr of continuous cast redraw rod. The SX-EW plant at Pinto Valley has the capacity to produce 36,000 st/yr of cathode copper from its dump leach operations.

The Phelps Dodge smelter at Douglas was closed in January 1985. The Morenci and the New Cornelia smelters are captive to such an extent that there is no excess capacity available to process material not produced by their respective concentrators.

Although there are a number of smelting facilities in Arizona, they are not normally interested in buying other companies' concentrates or in processing other companies' concentrates on a toll basis. The reason for this situation is that most of the companies have enough feed from their own mills to keep their smelters operating.

Figure 17 shows and lists principal smelting and refining facilities in the continental U.S., west of the Mississippi River, that either accept toll smelting materials or buy concentrates, and that may be significant to Arizona. Because of the closures of smelters and refineries for a multitude of reasons, the list of smelter-refinery facilities given in figure 17 is much smaller today than it would have been one or two decades ago. Availability of




| NO. | PLANT NAME | COMPANY NAME | COMMODITY | TYPE | STATUS | NO. | PLANT NAME | COMPANY NAME | COMMODITY | TYPE | STATUS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Ferndale | Intalco Aluminum Corp. | Al | A | a | 18. | New Madrid | Noranda Aluminum, Inc. | Al | A | a |
| 2. | Columbia Falls | Columbia Falls Aluminum Co. | Al | A | a | 19. | Henderson | Kerr-McGee Chem. Corp. | Mn | C | a |
| 3. | Babbitt | U.S. Antimony Corp. | Sb | B | a | 20. | Amarillo | ASARCO, Inc. | Cu,Ag,Au | B | a |
| 4. | Bunker Hill | Bunker Ltd. Part. | Ag,Au | B | b | 21. | Bagdad | Cyprus Minerals | Cu | D | a |
| | Bunker Hill | Bunker Ltd. Part. | Cd | B | b | 22. | Los Angeles | Engelhard Corp. | Au,Ag | C | a |
| 5. | East Helena | ASARCO, Inc. | Pb,Cu,Ag,Au | A | a | 23. | Pinto Valley | Magma Copper | Cu | D | a |
| 6. | Goldendale | Columbia Aluminum Corp. | Al | A | a | 24. | Miami | Cyprus Minerals | Cu | A,B,D | a |
| 7. | Northwest | Martin Marietta Aluminum | Al | A | a | 25. | Morenci | Phelps Dodge | Cu | A,D | a |
| 8. | Albany | Oregon Metallurgical Corp. | Ti,Zr | A | a | 26. | Ray Mines | ASARCO, Inc. | Cu | A,D | b |
| 9. | McDermitt | McDermitt Mine JV | Hg | B | a | 27. | Hayden | ASARCO, Inc. | Cu | A | a |
| 10. | Omaha | ASARCO, Inc. | Pb,Bi,Sb | B | a | 28. | San Manuel | MAGMA Copper | Cu | A,B,D | a |
| 11. | Salt Lake City | Johnson Matthey Refining | Au,Ag | B | a | 29. | Casa Grande | Cyprus Minerals | Cu | D | a |
| 12. | Fallon | Kennametal Inc. | W | C | a | 30. | New Cornelia | Phelps Dodge | Cu | A | b |
| 13. | Herculaneum | Doe Run Company | Pb,Ag | A,B | a | 31. | Sierrita | Cyprus Minerals | Cu | D | a |
| 14. | Buick | Doe Run Company | Pb | A | b | 32. | El Paso | ASARCO, Inc. | Cu,Pb,Sb | A | a |
| 15. | Glover | ASARCO, Inc. | Pb | A,B | a | 33. | Sherwin | Reynolds Metals Co. | Al | B | a |
| 16. | Pine Creek | Strategic Minerals Corp. | W | C | a | Type: | A, smelter; B, refinery; C, chemical; D, solvent extraction-electrowin | | | | |
| 17. | Bartlesville | National Zinc Co. | Zn,Cd | A,B | a | Status: | a, active; b, idle | | | | |

Figure 17. Principal smelting, refining, and solvent extraction-electrowinning facilities significant to Arizona.

appropriate facilities to process concentrates and/or impure metals has become a serious problem for many operations. In some cases the materials must even be shipped for processing to countries such as Belgium, the Federal Republic of Germany, South Korea, Japan, etc.

# REVIEW OF SELECTED MINERAL COMMODITIES IN ARIZONA

## ALUMINUM

Aluminum is a silvery-white, light metal that is nontoxic, nonmagnetic, nonsparking, and highly reflective. Its density is approximately one-third that of copper or steel. In addition to being corrosion-resistant and durable, aluminum is malleable, ductile, and easily machined and cast. It also has high electrical and thermal conductivity (231, 355).

Alum ($K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$) was used by the Greeks and Romans as a medicine, astringent, and a mordant in dyeing (231). Alunite ($KAl_3(OH)_6(SO_4)_2$) was mined at Tolfa, Italy from 1462 until the middle of this century, and it was used to make Roman alum (cubic crystalline alum) (652), which was used in the production of paper, tanning of leather, and in fabric dyeing. Alunite was produced in the United States during World War I as an emergency source of potassium sulfate fertilizer. Aluminum metal was first isolated in 1825 by Oerstad (355). It was regarded as an exotic metal, was very expensive (price comparable to precious metals), and was used in jewelry and art. After the discovery of the Bayer and Hall-Héroult processes and the development of cheap hydroelectric power, approximately 100 years ago, aluminum came into common use (223).

Aluminum is the second most abundant metallic element in the earth's crust (8%) and also the second most used common metal, exceeded only by iron. The high strength-to-weight ratio of aluminum alloys makes them particularly well suited for use in aircraft, missiles, high-speed surface vehicles, and marine vessels. Aluminum has virtually replaced copper in high-voltage

overhead powerlines and has become an important substitute in power cable. Aluminum films are used for corrosion-resistant mirrors in optical systems. The oxide is used for laser crystals and jeweled bearings. Calcined bauxite is divided into two grades: refractory and abrasive. The refractory grade is used to line furnaces and ladles of the steel-, copper-, aluminum-, and glass-producing industries. The abrasive grade is the predominant ingredient in products used for precision grinding, surfacing, and polishing of metals (229, 231, 241, 299, 355, 570, 662).

Because aluminum is important in virtually all segments of the world economy, aluminum oxide and ore have considerable strategic importance. The United States is the world's largest producer of aluminum metal and has accounted for approximately 30% of world smelter output over the past 5 years. This level of output has required, however, that the United States import 97% of the bauxite consumed (662). The major suppliers of the imported bauxite are Guinea, Jamaica, and Brazil; thus, the probability of simultaneous disruption of supply is slight, but the transportation routes are generally long (241). At present, the only economically viable smelter feed for the production of aluminum metal is alumina ($Al_2O_3$), derived from bauxite. It is technically feasible to extract aluminum from large domestic reserves of clay, anorthosite, alunite, dawsonite in spent oil shale, coal wastes, and ferruginous laterite; however, it is not economically attractive at present (355, 424).

Alunite deposits are known to occur in Arizona at Red Mountain and Sugarloaf Butte in association with hypogene ore deposits. Alunitization appears to be a near-surface phenomenon, caused by hot sulfuric acid-charged

fluids in the late stages of volcanism. Volcanic settings in which the rock is pervasively altered, bleached, and iron-stained may contain alunite. The presence of alunite may also serve as a marker for the exploration of metalliferous deposits (228, 424). Alunite could theoretically be mined for alumina with coproducts of potash and sulfuric acid (229, 421, 424). Future development of these resources is dependent on their economic ability to compete with bauxitic sources of supply (299).

Mineral Occurrences and Principal Deposits in the State of Arizona--Aluminum

| | |
|---|---|
| Total properties | 25 |
| Known principal deposits | 2 |
| Deposit abstracts in directory | 2 |

Reported Bauxite Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | [2]$10^3$ st | $10^3$ mt | Value, $10^3$ | st | mt | Value |
| 1981 | 1,664 | 1,510 | $26,489 | NRP | NRP | NRP |
| 1982 | 807 | 732 | 12,334 | NRP | NRP | NRP |
| 1983 | 748 | 679 | 11,309 | NRP | NRP | NRP |
| 1984 | 944 | 856 | 15,643 | NRP | NRP | NRP |
| 1985 | 743 | 674 | 12,855 | NRP | NRP | NRP |
| 1986 | 562 | 510 | 10,366 | NRP | NRP | NRP |

NRP No reported production.

[1]As crude ore (dry equivalent).

[2]Converted from metric tons.

Source: Reference 659.

Principal Known Aluminum Deposits in Arizona

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^3$ st | wt % | Year | Class[3] | Reference |
| Pat Alunite[4] | Santa Cruz | I-EP | Al, $K_2SO_4$, S | M[5] | 97,000 | 30[6] | 1974 | Ind | 163 |
| Sugarloaf Butte[4] | La Paz | I-EP | Al | U[7] | 256 | 55[6] | 1941 | NRIR | 649 |

EP Explored prospect. I Inactive. NAp Not applicable. U Undetermined.

[1] Commodities are listed in order of decreasing importance.

[2] Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. In this case, the U.S. Geological Survey defines the contained commodity as bauxite, which has about twice the alumina content of alunite. The following abbreviations and size ranges are used: S, small, less than 1 million; M, medium, 1 million to 100 million; L, large, greater than 100 million.

[3] Class of reserve-resource is reported as described in the reference. The following abbreviations are used: Ind, Indicated; NRIR, not reported in reference.

[4] Deposit abstract in directory.

[5] Based only on current resources.

[6] Contained alunite. Alunite contains about 37% alumina.

[7] Because the size of the Sugarloaf Butte deposit may be greater than indicated by the reserve figure, the size is shown as undetermined.




Figure 18. Aluminum in Arizona.

# ASBESTOS

Asbestos is the generic name applied to a particular mode of occurrence of six naturally fibrous silicate minerals mined for their desirable physical properties, primarily their fibrous structure, noncombustibility, weavability, low thermal conductance, high tensile strength, and resistance to chemical attack (101, 266, 354).

Asbestos was well known to ancient man and is first referred to by Theophrastus (third century B.C.) in the following statement: "There is also found in the mines of Scaptesylae a stone, in its external appearance somewhat resembling wood, on which, if oil be poured, it burns; but when the oil is burnt away, the burning of the stone ceases, as if it were in itself not liable to such accidents." Cloth woven of asbestos was found in pre-Augustinian Roman tombs (261), and Marco Polo told of seeing nonflammable fabric in China. The first industrial use of asbestos was in early steam engines (101).

The only asbestos known to have been mined in Arizona is chrysotile, the most common of the asbestos minerals (578, 695). The end use of chrysotile is determined by its chemical and physical properties, including iron content, harshness, and fiber length. The most important property, for most end uses, is fiber length. The longest fibers have been used for manufacturing fireproof textiles, packings, woven brake linings, clutch facings, electrical insulation materials, and high-pressure and marine insulation (101, 354). Somewhat shorter fibers have been used for fabricating asbestos cement pipe (water transport) and sheets, molded paper products and wrappings (such as

pipe insulation), and brake linings and gaskets. Still shorter fibers have been used in asbestos cement products, gaskets, brake linings, vinyl sheet backing, and millboard. The shortest fibers have been used in molded brake linings, clutch facings, vinyl and asphalt floor tiles (as a filler), asphalt compounds, joint and insulation cements, roof coatings, plastics, and caulking compounds. Because of their high tensile strength and temperature resistance, asbestos fibers have also found applications in rockets and missiles (101, 354).

Asbestos is considered a strategic and critical mineral because of its unique properties and more than 2,000 uses. The United States is dependent on foreign supply for more than 50% of its consumption (662). Asbestos has been declared by the Department of State to be a strategic mineral for which the quantities essential for the economy and defense of the United States are unavailable from reliable and secure sources; this declaration allows the United States to continue to import asbestos from South Africa (662). The majority of this commodity is imported from Canada, but some crocidolite is imported from the Republic of South Africa. Thus, the majority of imported asbestos is from supplies that would not easily be interrupted. Although its usage at present is being sharply reduced because of environmental and health fears, no substitutes are currently able to duplicate the strength, chemical inertness, durability or low cost of asbestos.

Chrysotile has been sporadically recovered in Arizona since 1903. Asbestos occurs along the Colorado River in north-central Arizona and in east-central Arizona near Globe. The latter area, in Gila County, is 60 mi long and 25 mi wide and was the major source of past production in the State

(73). Asbestos has been mined from about 160 deposits associated with diabase intrusives in the Mescal Limestone. These small tabular zones 6 to 8 in thick are localized in cherty or siliceous magnesian limestone (578-579). Major production during the World Wars was actually surpassed during the period following World War II (101, 354). Chrysotile was last produced in Arizona in January 1982 (565). Undiscovered minable resources of asbestos in the State probably equal past production (75,000-100,000 st) (578-579).

Mineral Occurrences and Principal Deposits in the State of Arizona--Asbestos

| | |
|---|---|
| Total properties | 131 |
| Known principal deposits | 3 |
| Deposit abstracts in directory | 3 |

Reported Asbestos Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | [2]st | mt | Value, $10^3$ | st | mt | Value |
| 1981 | 83,355 | 75,618 | $30,685 | W | W | W |
| 1982 | 70,013 | 63,515 | 24,917 | W | W | W |
| 1983 | 77,058 | 69,906 | 27,866 | NRP | NRP | NRP |
| 1984 | 63,297 | 57,422 | 24,238 | NRP | NRP | NRP |
| 1985 | 63,335 | 57,457 | 20,485 | NRP | NRP | NRP |
| 1986 | 56,700 | 51,437 | 17,367 | NRP | NRP | NRP |

NRP No reported production.
W Withheld to avoid disclosing company proprietary data.
[1]Measured as shipments or sales.
[2]Converted from metric tons.

Source: Reference 659.

| Deposit | County | Status | Commodity | Size[1] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^3$ st | wt % Asb | Year | Class | Reference |
| American[2] | Gila | I-PP | Asb | M | ([3]) | ([3]) | NAp | NAp | NAp |
| Canadian[2] | ...do... | I-PP | Asb | S[4] | ([3]) | ([3]) | NAp | NAp | NAp |
| El Dorado[2] | ...do... | I-PP | Asb | S[4] | ([3]) | ([3]) | NAp | NAp | NAp |

I Inactive. NAp Not applicable. PP Past producer.

[1]Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 100,000; M, medium, 100,000 to 10,000,000; L, large, greater than 10,000,000.

[2]Deposit abstract in directory.

[3]No published data have been located.

[4]Based only on current resources.

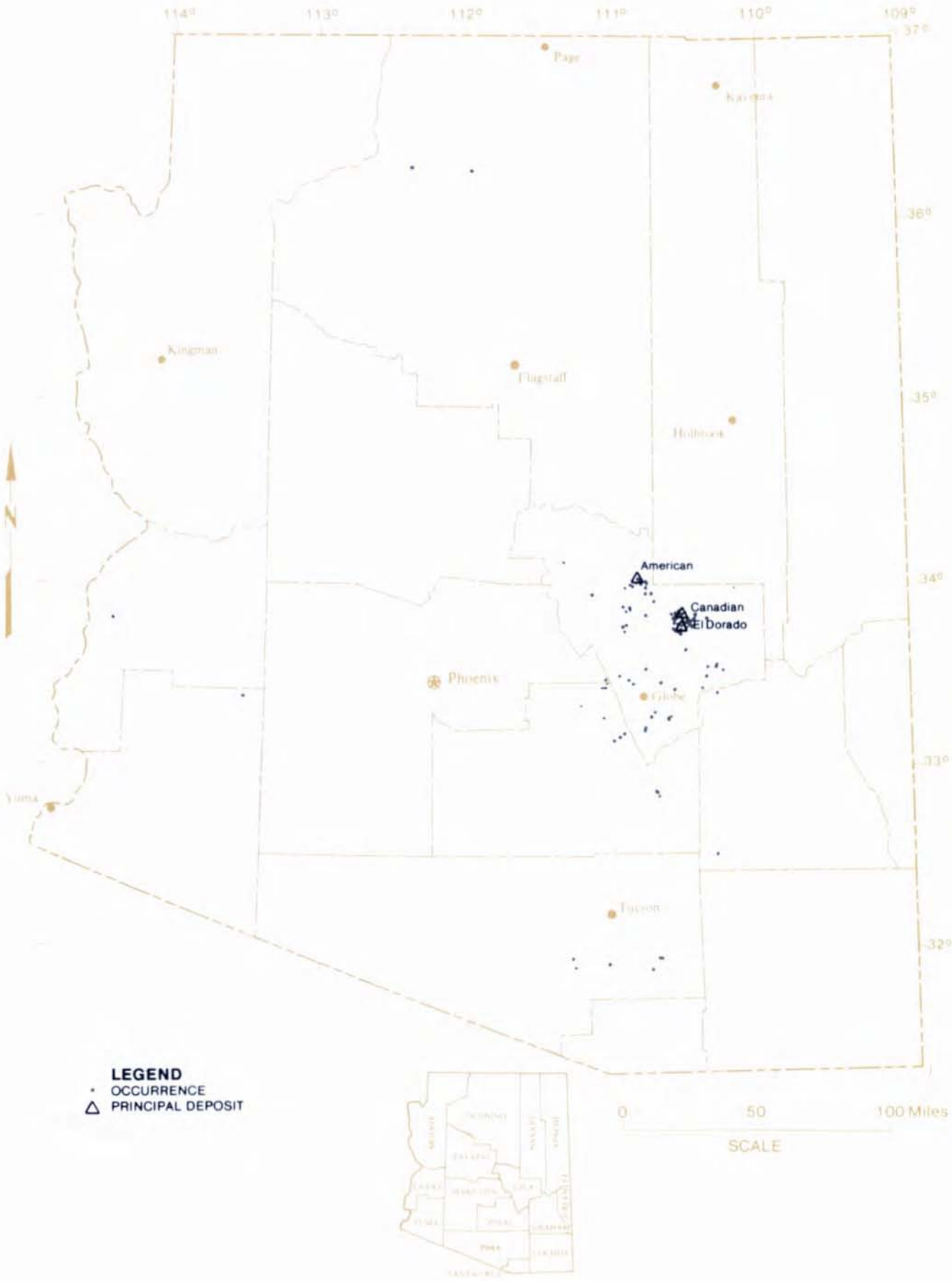



Figure 19. Asbestos in Arizona.

# BARITE

Barite ($BaSO_4$) is a dense, soft, and chemically inert mineral also known as barytes, tiff, cawk, or heavy spar (78). It is a common mineral occuring in tabular crystals that can be colorless, white, blue, yellow, red, or black. It has perfect cleavage and a luster that ranges from vitreous to resinous or pearly (266). The mineral has low oil absorption, a high specific gravity, and easy wettability by oil. Barite contains 58.8% barium, which is a silvery-white, soft, dense metal (14, 266).

The element barium was first identified by Sir Humphrey Davy in 1808. Barite was first mined in the United States in Fauquier County, VA, in 1845. Barite was initially used as a filler in white paint. It was later used to produce lithopone, a pigment and filler used in the manufacture or processing of paint, ink, leather, paper, linoleum, and face powders (14, 231).

Barite is primarily used in the United States in the production of weighted muds used in drilling oil and gas wells. This use accounts for approximately 65% of total U.S. barite consumption (14, 76-77). Another 2% of U.S. consumption is as a filler or extender in paper, cloth, paint, ink, plastic, and rubber products. A smaller amount is used in the production of glass. Barite is the source of barium for chemical production. The major compound, barium carbonate, is used in making brick, tile, television picture tubes, ceramic glazes, optical glass, porcelain enamel, ferrite, and other assorted ceramic products (14, 76, 78, 662). Barium chloride is used for case-hardening and heattreating baths, producing magnesium and barium metal, producing cloth and leather, manufacturing brick, and treating water. Other

barium compounds are used for pyrotechnics, ferrous metallurgy, and prevention of scumming in ceramic manufacturing (14, 77-78, 662). Barium metal is used as a "getter" to remove small amounts of gas from vacuum tubes (14, 266). Barium is an important component in the new high-temperature electrical superconductors (249).

Neither barite nor barium is considered a strategic or critical mineral or element (14), but barite is being considered in this report because imported barite accounted for 66% of domestic consumption in 1986 (266). Overall domestic use has continued to decline since 1982, primarily because of decreased oil well drilling activities. Currently, the United States imports barite primarily from China, Morocco, and India; if imports from these sources were disrupted, they could be replaced by domestic production at higher cost.

Barite from Arizona has accounted for only 1% of national production since 1882. Significant production from the State has been limited primarily to Cochise and Maricopa Counties. The last reported production was in 1955 (76). In practically all the deposits, the barite was limited to veins associated with faults, breccias, and fracture zones (643). In nearly one-half of the locations, a significant amount of fluorspar ranging from a few tenths of a percent to 30% was found with the barite. Also commonly associated with barite are calcite, silica, and base and/or precious ore minerals (76). Barite in Arizona could be mined as a byproduct under current market conditions.

## Mineral Occurrences and Principal Deposits in the State of Arizona--Barite

| | |
|---|---|
| Total properties | 127 |
| Known principal deposits | 2 |
| Deposit abstracts in directory | 2 |

## Reported Barite Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | $10^3$ st | [2] $10^3$ mt | Value, $10^3$ | st | mt | Value |
| 1981 | 2,849 | 2,585 | $102,439 | NRP | NRP | NRP |
| 1982 | 1,845 | 1,674 | 69,522 | NRP | NRP | NRP |
| 1983 | 754 | 684 | 29,203 | NRP | NRP | NRP |
| 1984 | 775 | 703 | 25,445 | NRP | NRP | NRP |
| 1985 | 739 | 670 | 21,501 | NRP | NRP | NRP |
| 1986 | 297 | 269 | 12,326 | NRP | NRP | NRP |

NRP No reported production.

[1] As sold or used by producers.

[2] Converted from short tons.

Source: Reference 659.

Principal Known Barite Deposits in Arizona

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^6$ st | wt % | Year | Class | Reference |
| Renner[3] | Yuma | I-PP | $BaSO_4$, Ag | S | ([4]) | ([4]) | NAp | NAp | NAp |
| Top Hat Group[3] | Gila | I-PP | $BaSO_4$ | S | ([4]) | ([4]) | NAp | NAp | NAp |

I Inactive. NAp Not applicable. PP Past producer.

[1]Commodities are listed in order of decreasing importance.

[2]Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 50,000; M, medium, 50,000 to 5,000,000; L, large, greater than 5,000,000.

[3]Deposit abstract in directory.

[4]No published data have been located.

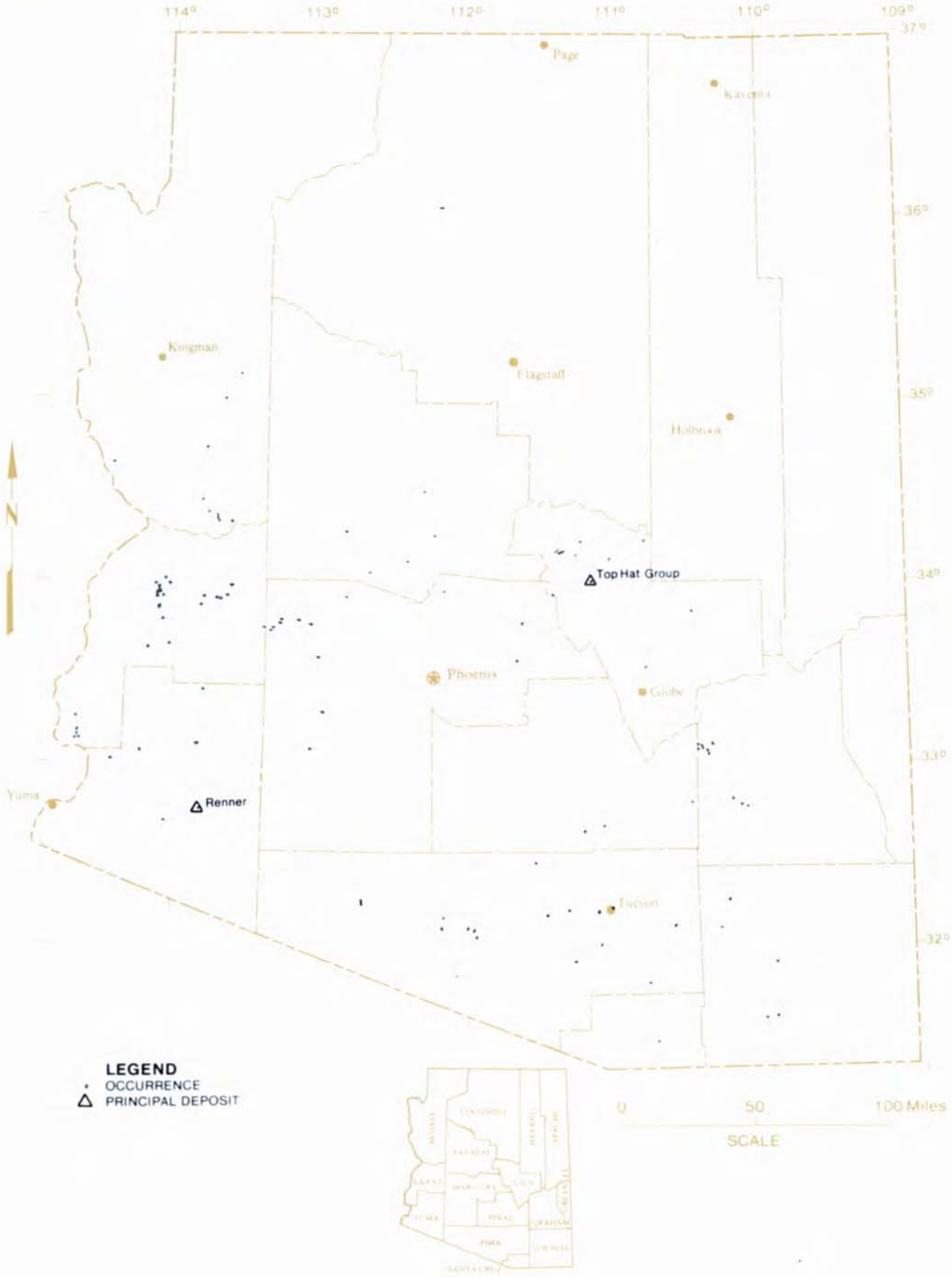



**Figure 20. Barite in Arizona.**

# COLUMBIUM AND TANTALUM

Columbium (niobium) and tantalum are discussed together because they have a high degree of geochemical affinity for each other. Both are relatively common elements in the Earth's crust (columbium more so than tantalum), but concentrated deposits are rare (119-120, 420).

Columbium, when pure, is soft, shiny, and ductile with a color similar to steel, but when polished resembles platinum. It develops a bluish cast when exposed to air for long periods of time. The metal oxidizes at 200° C unless placed in a protective atmosphere, and there are at present no usable protective coatings. It resembles copper in both density and hardness. The metal is an electrical superconductor at very low temperatures (231).

Tantalum is a very hard, silver-gray metal with a high density and melting point. It exceeds most refractory metals in workability and weldability and is tough and durable. The metal is ductile and easily fabricated; it melds readily with other refractory metals and forms alloys having high-temperature strength and stability. The stable oxide films have good rectifying and dielectrical properties (231).

Columbium was discovered in 1801 by the English chemist Hackett in an "ore sample" shipped from Connecticut 76 years earlier by John Winthrop the Younger, the first Governor of the State (59). Tantalum was discovered in 1802 by Ekeberg, in similar specimens from Sweden. There existed an element of confusion between the two, until in 1844, the oxides, and in 1866, the metals, were proved to be distinct from each other. In 1866, Marignac developed the basis for the current commercial separation technique. The

first relatively pure tantalum was produced in Germany by the Polish scientist von Bolton, in 1903. He also produced the first pure columbium in 1907. Tantalum was used commercially for filament material in light bulbs and for penpoints and surgical and dental instruments shortly thereafter (59). Columbium did not come into use until the 1920's, when it was used in high-speed cutting steels (119-120, 231).

Both elements are highly resistant to corrosion and are used in electronic, nuclear, chemical, and high-temperature metallurgical applications. They are also used in vacuum tube elements, superconductors, and as components of high-temperature nonferrous alloys. The carbides of both elements are used as binders in cemented carbide tools (59, 119-120, 419-420).

Columbium is used principally as an element in alloying steel and in the superalloys of nickel, cobalt, and iron. These metals are used in turbine engine components, rocket subassemblies, nuclear reactor hardware, and in heat-resistant and combustion equipment. Columbium metal is of great value in superconductors and advanced airframe systems (59, 119, 420).

Tantalum is used principally to produce electronic components, mainly capacitors. The tantalum capacitor is the industry standard. Refractory superalloys with cobalt, iron, and nickel are used in aerospace structures, jet engines, and gas turbine parts. Tantalum is used in chemical process equipment, where its stability and ability to serve as an excellent interstitial absorber of common gases are extremely useful. Other minor uses are in prosthetic devices, optical glass, and electroplating devices (119-120, 419-420).

Both elements are classified as strategic and critical: columbium,

because of its usage in the aerospace, energy, and transportation industries; and tantalum and its alloys, because of their usage in aerospace, communication, machine tool, and nuclear applications. All substitutes have performance, cost, or effectiveness penalties (59, 119, 231, 419-420). There has been no significant domestic columbium or tantalum mining since 1959 (119-120).

In the past, pegmatite ore bodies have been the only source of columbium-tantalum in Arizona. The best known columbium- and tantalum-bearing pegmatites are located in the White Picacho and Aquarius Cliffs districts. The pegmatites with the most columbium and tantalum are generally complexly zoned and have abundant albite with strongly developed lithium and beryllium minerals (420). In Arizona, columbium and tantalum have been recovered as byproducts or coproducts of other pegmatitic minerals (beryl, feldspar, and mica).

Mineral Occurrences and Principal Deposits in the State of Arizona--Columbium-Tantalum

| | |
|---|---|
| Total properties | 14 |
| Known principal deposits | 7 |
| Deposit abstracts in directory | 3 |

Reported Columbium Production--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | lb | kg | Value | lb | kg | Value |
| 1981 | ([1]) | ([1]) | ([2]) | NRP | NRP | NRP |
| 1982 | ([1]) | ([1]) | ([2]) | NRP | NRP | NRP |
| 1983 | NRP | NRP | NRP | NRP | NRP | NRP |
| 1984 | NRP | NRP | NRP | NRP | NRP | NRP |
| 1985 | NRP | NRP | NRP | NRP | NRP | NRP |
| 1986 | NRP | NRP | NRP | NRP | NRP | NRP |

NRP No reported production.

[1]A small unreported quantity was produced.

[2]Value unreported.

Source: Reference 659.

Reported Tantalum Production--United States and Arizona, 1981-86 (659)

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | lb | kg | Value | lb | kg | Value |
| 1981 | ([1]) | ([1]) | ([2]) | NRP | NRP | NRP |
| 1982 | ([1]) | ([1]) | ([2]) | NRP | NRP | NRP |
| 1983 | NRP | NRP | NRP | NRP | NRP | NRP |
| 1984 | NRP | NRP | NRP | NRP | NRP | NRP |
| 1985 | NRP | NRP | NRP | NRP | NRP | NRP |
| 1986 | NRP | NRP | NRP | NRP | NRP | NRP |

NRP No reported production.

[1]A small unreported quantity was produced.

[2]Value unreported.

Principal Known Columbium-Tantalum Deposits in Arizona

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^3$ st | wt % | Year | Class | Reference |
| Midnight Owl[3] | Yavapai | A-PP | Feldspar, Li, Be, Cb-Ta, Bi | S[4] | (5) | (5) | NAp | NAp | NAp |
| Mineral X | Mohave | I-RP | Cb-Ta, RAE, feldspar | S[6] | (5) | (5) | NAp | NAp | NAp |
| Outpost | do | I-RP | Cb-Ta, RAE, feldspar | S[6] | (5) | (5) | NAp | NAp | NAp |
| Picacho View[3] | Yavapai | I-PP | Feldspar, Be, Cb-Ta, Li, mica, W | S[4] | (5) | (5) | NAp | NAp | NAp |
| Quartz Mountain | Mohave | I-RP | Cb-Ta, RAE | S[6] | (5) | (5) | NAp | NAp | NAp |
| Rare Metals[3] | do | I-PP | RAE, Cb-Ta, Bi, Th, $U_3O_8$ | S[4] | (5) | (5) | NAp | NAp | NAp |
| Signal District | do | I-RP | Cb-Ta, RAE | S[6] | (5) | (5) | NAp | NAp | NAp |

A Active. I Inactive. NAp Not applicable. PP Past producer. RP Raw prospect.

[1] Commodities are listed in order of decreasing importance.

[2] Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 1,000; M, medium, 1,000 to 100,000; L, large, greater than 100,000.

[3] Deposit abstract in directory.

[4] Based only on past production.

[5] No published data have been located.

[6] Based only on current resources.




**Figure 21. Columbium and tantalum in Arizona.**

# COPPER

Copper is a reddish-orange, brightly lustrous, dense metal. It is ductile, malleable, and an excellent conductor of heat and electricity. Copper work-hardens and anneals well, is strong, and has high resistance to fatigue and creep. The metal and its alloys are resistant to both corrosion and biofouling (231, 266, 288, 361).

Native copper and copper minerals were originally used for neolithic ornaments, makeup, and the glazing of pottery. The earliest Old World metal artifact is a copper pendant, dated at 9500 B.C., found in the Shanidar Cave, northern Iraq (195). The Copper Age started in approximately 5500 B.C. with the first organized mining of copper deposits. Initially, native copper was beaten into shape and used in making tools, utensils, weapons, and art objects (223, 288, 293).

Copper use was expanded in about 3000 B.C. with the discovery that the addition of a small amount of tin to copper produced bronze. Bronze was a much harder metal than copper and was easier to cast because it had a more fluid melt. By alloying copper and zinc, the Romans produced brass, which they used extensively for coins, ornaments, and other decorative purposes (195, 223, 288, 293). The modern use of copper began with the discovery of electricity in 1831 and the creation of a diversity of electrical inventions that required copper (288, 361).

Copper's principal properties of high electrical and thermal conductivity, ability to be drawn into fine wires, malleability, high corrosion resistance, and appearance make it an important material for industrial uses. It can be combined readily with many other metals to form

many useful alloys, most importantly the commercial brasses, bronzes, and copper-nickels.

In the electrical industry, copper is the metal of choice because of its high electrical conductivity, and it appears unlikely that any other material could seriously compete with copper for this type of use.

In the telecommunications industry, fiber optics may be expected to have a negative impact on future copper usage. Because of its low cost and resistance to tampering, electromagnetic pulse, and interference, fiber optics are being used increasingly for military and aerospace communications, telephone systems, and computer communications (288, 662).

In the construction industry, plastics have already taken most of the market for drainage and water supply piping away from copper. On the other hand, other technologies such as solar energy may increase future use of copper (288, 662).

In vehicles, copper is used extensively for heating and cooling systems and for electrical components. If the technology for electrically powered vehicles can be improved to a practical level, a substantial increase in copper usage may be expected (288, 662).

In the machinery and equipment sector, which includes such items as valves and fittings, condensors and heat exchangers, pumps, bearings, and small components, the use of copper may be expected to remain relatively stable (288, 662).

Continued growth in the consumer durables market, which includes domestic appliances, radios and televisions, motor windings, refrigeration equipment, and other assorted items, is expected to be a positive factor in future copper

consumption.

In Arizona, copper was originally mined by the Indians for use in cosmetics and as a dye for blankets. Turquoise was mined and used for decoration and trade. The Spaniards and Mexicans mined copper at Ajo as early as 1750, but, because there was very little precious metal in the ore, production was low (158).

In 1855, shortly after the Gadsden Purchase, 10 st of selected ore were shipped from Ajo to Swansea, Wales. This operation probably represented the first modern mining of copper ore in Arizona (16, 158, 293). The search for silver in the early 1870's resulted in the discovery of the copper deposits of Clifton-Morenci, Ray, Globe, United Verde, and Bisbee (16, 158). With the arrival of transcontinental railroads in Arizona in 1876 and 1882, these copper discoveries of the 1870's became mines. The first copper furnace was built in 1872 at the Longfellow Mine near Clifton; it treated 1 st of ore per day. By 1893, copper had become the primary commodity produced in the State. At the end of the century, the annual production of copper in Arizona had reached 60,000 st/yr with a dollar value more than three times greater than that of gold and silver (16, 158, 422).

During World War I, several rich copper deposits were found and developed, including United Verde Extension and Magma. Ajo became the first large opencut mine. Block caving was introduced to Arizona in 1922 in order to mine lower grade ore. During the Depression, production fell dramatically, and many mines shut down not to reopen until the beginning of World War II. Bagdad went into production during the 1930's and, during World War II, financed by Government loans, built a concentrator with a capacity of 2,500

st/d of ore. Many mines that had closed during the 1930's reopened, thus requiring the enlargement or construction of concentrators and smelters. During this period, Morenci became the largest copper producer in the State (16, 158, 361, 422).

During the early 1940's, initiatives provided by the U.S. Government allowed millions of tons of marginal copper ore to be produced that would otherwise have been lost. Many of these mines continued operations into the 1950's (16, 158, 361, 422).

The advent of the Korean Conflict in 1950 caused concern that the United States was not meeting the domestic consumption of copper with corresponding production. The Government instituted a price support system through the Defense Materials Administration. San Manuel was explored with Government assistance and began production in 1956. It is currently the second largest mining operation in the State (16, 158, 361, 423).

Since the 1950's, the copper market has been cyclic in nature, typically going through periods of "boom and bust." The problems that have plagued the industry have been the same ones that have plagued all mining to some degree, namely, increased costs for labor, energy, and environmental compliance coupled with a shrinking market and increased foreign competition. Wage concessions by the labor unions, a shift toward the use of leaching technology with its lower operating costs, and an increase in the selling price of copper have resulted in a recent resurgence of the industry.

Because of its many large, low-grade porphyry copper deposits, Arizona is the largest copper producer in the United States and will continue to be so in the foreseeable future (16, 111). Arizona's copper resources probably total

about 9.3 billion st of ore at an average grade of 0.59% copper or 55 million st of metallic copper. This figure reflects currently known and published reserves (64). Arizona has undiscovered resources of copper, the quantity of which is difficult to estimate. Much of the Basin and Range province of Arizona has potential for the discovery of new copper deposits, with this potential greatest in the southern part of the State, where the largest concentration of known deposits occurs. The northwestern and southwestern corners of this province also contain copper deposits and probably also contain hidden intrusive igneous rocks of Laramide age, which are frequently associated with commercial copper deposits (16, 111).

Mineral Occurrences and Principal Deposits in the State of Arizona--Copper

| | |
|---|---|
| Total properties | 3,038 |
| Known principal deposits | 58 |
| Deposit abstracts in directory | 49 |

Reported Copper Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | [2]$10^3$ st | $10^3$ mt | Value, $10^6$ | [2]$10^3$ st | $10^3$ mt | Value, $10^6$ |
| 1981 | 1,695 | 1,538 | $2,886 | 1,148 | 1,041 | $1,953 |
| 1982 | 1,264 | 1,147 | 1,841 | 849 | 770 | 1,235 |
| 1983 | 1,144 | 1,038 | 1,751 | 747 | 678 | 1,144 |
| 1984 | 1,216 | 1,103 | 1,625 | 822 | 746 | 1,100 |
| 1985 | 1,219 | 1,106 | 1,632 | 879 | 797 | 1,176 |
| 1986 | 1,264 | 1,147 | 1,671 | 870 | 789 | 1,149 |

[1]Contained copper as reported by producing mines.
[2]Converted from metric tons.

Source: Reference 659.

Principal Known Copper Deposits in Arizona

| Deposit | County | Status | Commodity[1] | Size[2] | X-Ref[3] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $10^6$ st | wt % Cu | Year | Class[4] | Reference(s) |
| Atlas | Pima | A-PP | Cu, Pb, Zn, Ag | S[5] | NAp | [6]5 | 0.64 | 1987 | Demo | 64 |
| | | | | | | [7]5 | .37 | 1987 | Demo | 64 |
| Bagdad[8] | Yavapai | A-P | Cu, Mo, Ag, Au | L[5] | Mo, Ag, Au | 397.3 | .44 | 1986 | Prov | 126 |
| Bluebird[8] | Gila | A-P | Cu | M[5] | NAp | 20 | .6 | 1984 | Meas | 275 |
| Casa Grande[8] | Pinal | I-EP | Cu | L[5] | NAp | [9]352 | 1 | 1980 | NRIR | 64 |
| Chilito | Gila | I-PP | Cu, Mo, Ag, Au | M[5] | Mo | 74 | .51 | 1970 | NRIR | 32 |
| Christmas[8] | ...do | I-TS | Cu, Au, Ag, Mo | M[5] | NAp | [10]7.567 | .63 | 1983 | Prov | 274 |
| | | | | | | [11]12.862 | 1.78 | 1983 | Prov | 274 |
| | | | | | | [11]7.269 | 1.94 | 1983 | Prob | 274 |
| Cochise | Cochise | I-PP | Cu, Pb, Zn, Ag, Bi | L[5] | NAp | 170 | .50 | 1987 | Demo | 64 |
| Copper Basin[8] | Yavapai | I-PP | Cu, Mo, Au | L[5] | Mo | 175 | .55 | 1981 | NRIR | 484 |
| Copper Cities[8] | Gila | I-PP | Cu, Mo, Ag, Au, Pb, Zn | M[5] | NAp | ([12]) | ([12]) | NAp | NAp | NAp |
| Copper Queen[8] | Cochise | A-P | Cu, Ag, Au, Pb, Zn | L[5] | NAp | ([12]) | ([12]) | NAp | NAp | NAp |
| Cyprus Johnson[8] | ...do | I-PP | Cu, Ag, Au, Zn, Pb | L[5] | NAp | 3.9268 | .40 | 1985 | Prov | 203 |
| Denn[8] | ...do | I-PP | Cu, Pb, Zn, Au, Ag, Bi | L[13] | NAp | ([12]) | ([12]) | NAp | NAp | NAp |
| Dos Pobres[8] | Graham | I-EP | Cu | L[5] | NAp | [9]231.6 | .89 | 1986 | Meas | 535 |
| Dragoon | Cochise | I-PP | Cu, Ag | M[5] | NAp | 25 | .5- .6 | 1979 | NRIR | 32 |
| Dubacher Canyon[8] | ...do | I-EP | Cu | M[5] | NAp | [7]20 | .8 | 1977 | NRIR | 463 |
| Dynamite | Pima | I-EP | Cu | M[5] | NAp | [9]100 | .53 | 1987 | Demo | 64 |
| Eisenhower[8] | ...do | A-P | Cu, Ag, Mo, Au | M[5] | Ag, Mo, Au | 99.276 | .68 | 1986 | Demo | 49 |
| Esperanza[8] | ...do | A-P | Cu, Mo, Ag | M[5] | Mo, Ag | 48.783 | .27 | 1981 | NRIR | 513 |
| Florence[8] | Pinal | I-EP | Cu | L[5] | NAp | [6]500 | .39 | 1977 | NRIR | 620 |
| | | | | | | [7]250 | .32 | 1977 | NRIR | 620 |
| Helvetia East[8] | Pima | I-PP | Cu, Ag, Mo, Au | L[5] | Mo, Ag | [6]280 | .62 | 1988 | NRIR | 12 |
| | | | | | | [7]23 | .78 | 1988 | NRIR | 12 |
| Helvetia West[8] | ...do | I-PP | Cu, Ag, Au, Mo | M[5] | NAp | 24 | .75 | 1977 | NRIR | 722 |
| I-10 | Cochise | I-EP | Cu, Mo | M[5] | Mo | 100 | .52 | 1987 | Demo | 64 |
| Inspiration[8] | Gila | A-P | Cu, Ag, Au, Mo, Se | L[5] | NAp | [6]129.2 | .53 | 1986 | Demo | 276 |
| | | | | | | [7]122.7 | .57 | 1986 | Demo | 276 |
| Kay[8] | Yavapai | I-PP | Cu, Pb, Zn, Au, Ag | S-M | NAp | ([12]) | ([12]) | NAp | NAp | NAp |
| Keystone[8] | Cochise | I-PP | Cu, Zn, Ag, Mo, Au, W | S[13] | NAp | ([12]) | ([12]) | NAp | NAp | NAp |
| Korn Kob | Pima | I-EP | Cu | S[5] | NAp | [7]8 | .5 | 1973 | NRIR | 64 |
| Lakeshore[8] | Pinal | A-P | Cu, Au, Ag | M[5] | NAp | [14]41 | .65 | 1983 | NRIR | 413 |
| | | | | | | [15]8.9 | 1.35 | 1983 | NRIR | 413 |
| | | | | | | [7]13.1 | 1.16 | 1983 | NRIR | 413 |
| | | | | | | [7]50 | ([12]) | 1986 | NRIR | 383 |
| Lone Star[8] | Graham | I-OD | Cu, Mo | L[5] | Mo | 1,065 | .58 | 1981 | NRIR | 25 |
| Magma-Superior[8] | Pinal | I-PP | Cu, Ag, Au, Zn, Pb | M[5] | NAp | 4.439 | 5.69 | 1984 | Ind | 404 |
| Miami Unit[8] | Gila | A-P | Cu, Au, Ag, Mo | L[5] | NAp | 5.976 | 3.14 | 1985 | NRIR | 64, 405 |
| | | | | | | [16]35 | .331 | 1988 | Meas | 680 |
| Mineral Park[8] | Mohave | A-P | Cu, Mo, Ag | M[5] | NAp | 35 | .17 | 1986 | NRIR | 63 |
| Mission-San Xavier[8] | Pima | A-P | Cu, Mo, Ag, Au | L[5] | Mo, Ag, Au | 367.5 | .64 | 1987 | NRIR | 143 |
| Morenci-Metcalf[8] | Greenlee | A-P | Cu, Mo, Au, Ag, Zn | L[5] | Mo, Au, Ag | 794.235 | .77 | 1986 | Meas | 535 |
| | | | | | | 183.529 | .64 | 1986 | Meas | 535 |
| New Cornelia[8] | Pima | A-TS | Cu, Mo, Au, Ag, Re | L[5] | Mo, Au, Ag | 209.2 | .50 | 1986 | Meas | 535 |
| Old Reliable[8] | Pinal | I-PP | Cu, Ag, Au, Mo | S[5] | NAp | 4 | .74 | 1971 | Meas | 543 |

See explanatory notes at end of table.

Principal Known Copper Deposits in Arizona--Continued

| Deposit | County | Status | Commodity[1] | Size[2] | X-Ref[3] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $10^6$ st | wt % Cu | Year | Class[4] | Reference(s) |
| Oracle Ridge[8] | Pima | I-DD | Cu, Ag | M[5] | NAp | 11.3 | 2.28 | 1975 | Meas | 373 |
| Ox Hide[8] | Gila | I-PP | Cu, Mo, Ag | M[5] | NAp | 28.573 | .30 | 1981 | Prov | 273, 274 |
| Peacock[8] | Graham | I-PP | Cu, Au, Ag, Mo | S[5] | Au | 20 | .50 | 1976 | Ind | 718 |
| Pima[8] | Pima | A-P | Cu, Ag, Mo, Au | L[5] | Ag, Mo, Au | 120.767 | .482 | 1984 | NRIR | 254 |
| Pinto Valley[8] | Gila | A-P | Cu, Mo, Au, Ag, Pb, Zn, $U_3O_8$ | L[5] | Mo, Au, Ag | 229.3 | .400 | 1987 | NRIR | 353 |
| | | | | | | 251.2 | .411 | 1987 | NRIR | 353 |
| Ray[8] | Pinal | A-P | Cu, Mo, Au, Ag, Pb, Zn | L[5] | Mo, Au, Ag | 677 | .7 | 1988 | NRIR | 143 |
| Red Mountain[8] | Santa Cruz | I-EP | Cu, Mo | L[5] | NAp | 100 | .71 | 1975 | NRIR | 372, 445 |
| Sacaton[8] | Pinal | I-PP | Cu, Mo, Ag, Au | M[5] | NAp | [11] 15.96 | 1.20 | 1983 | Demo | 46 |
| Sanchez[8] | Graham | A-DD | Cu, Au, Ag, Mo | L[5] | Au, Ag | [6,9] 100 | .30 | 1988 | NRIR | 51 |
| | | | | | | [7] 250 | .28 | 1988 | NRIR | 51 |
| San Manuel-Kalamazoo[8] | Pinal | A-P | Cu, Mo, Au, Ag | L[5] | Mo, Au, Ag | [6] 155.846 | .771 | 1987 | Demo | 353 |
| | | | | | | [7] 255.365 | .388 | 1987 | Demo | 353 |
| Santa Cruz[8] | ...do | A-EP | Cu, Mo, Au, Ag | L[5] | Mo | [9] 350 | 1.0 | 1984 | NRIR | 32, 485, 496 |
| Sierrita[8] | Pima | A-P | Cu, Mo, Ag, Re, Au | L[5] | Mo, Ag, Au | 343.3 | .31 | 1986 | Prov | 126 |
| Silver Bell[8] | ...do | A-P | Cu, Mo, Ag | M[5] | NAp | 20.955 | .68 | 1986 | Demo | 49 |
| Strong & Harris | Cochise | I-EP | Cu, Zn | M[5] | NAp | [9] 60 | .6 | 1987 | Demo | 64 |
| Turquoise | ...do | I-EP | Cu | S[5] | NAp | [7] 10 | .5 | 1975 | Demo | 64, 283 |
| Twin Buttes[8] | Pima | A-TS | Cu, Mo, Ag, Au, Zn, Pb, $U_3O_8$ | L[5] | Mo | [6] 37 | .92 | 1988 | NRIR | 507 |
| | | | | | | [7] 10.6 | .73 | 1988 | NRIR | 507 |
| United Verde[8] | Yavapai | I-PP | Cu, Au, Ag, Zn, Pb | L | NAp | 11 | .6 | 1931 | NRIR | 268 |
| United Verde Extension[8] | ...do | I-PP | Cu, Ag, Au | M[5] | NAp | ([12]) | ([12]) | NAp | NAp | NAp |
| Van Dyke[8] | Gila | A-DD | Cu | M[5] | NAp | 100 | .5 | 1980 | NRIR | 471 |
| Vekol Hills[8] | Pinal | I-EP | Cu, Mo, Au, Ag | M[5] | Mo | 104.651 | .543 | 1981 | Prov | 201 |
| White Mesa District[8] | Coconino | I-PP | Cu, Ag | M[5] | NAp | .260 | 1 -4 | 1943 | Ind | 551 |
| | | | | | | 2 | .1-1 | 1943 | Ind | 551 |
| | | | | | | 14 | .1-4 | 1943 | Infr | 551 |
| Yuma[8] | La Paz | I-PP | Cu, Au, Ag, Fe | S | NAp | ([12]) | ([12]) | NAp | NAp | NAp |
| Zonia[8] | Yavapai | I-PP | Cu, Ag, Au | S[5] | NAp | [7] 35 | .31 | 1987 | Demo | 64 |

A Active. DD Developed deposit. EP Explored prospect. I Inactive. NAp Not applicable. P Producer. PP Past producer. RP Raw prospect. TS Temporary shutdown. X-Ref Cross reference.

[1] Commodities are listed in order of decreasing importance.

[2] Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 50,000; M, medium, 50,000 to 5 million; L, large, greater than 5 million.

[3] Indicates other commodities for which this deposit has been judged to be a principal deposit. Additional data may be found in the tables of principal deposits for these other commodities.

[4] Class of reserve-resource is reported as described in the reference. The following abbreviations are used: Meas, measured; Ind, indicated; Infr, inferred; Prov, proven; Prob, probable; Demo demonstrated; NRIR, not reported in reference.

[5] Based only on current resources.

[6] Sulfide ore.

[7] Oxide ore.

[8] Deposit abstract in directory.

[9] Mixed sulfide and oxide ore.

[10] Surface.

[11] Underground.

[12] No published data have been located.

[13] Based only on past production.

[14] Sulfide (porphyry) ore.

[15] Sulfide (tactite) ore.

[16] Tailings.

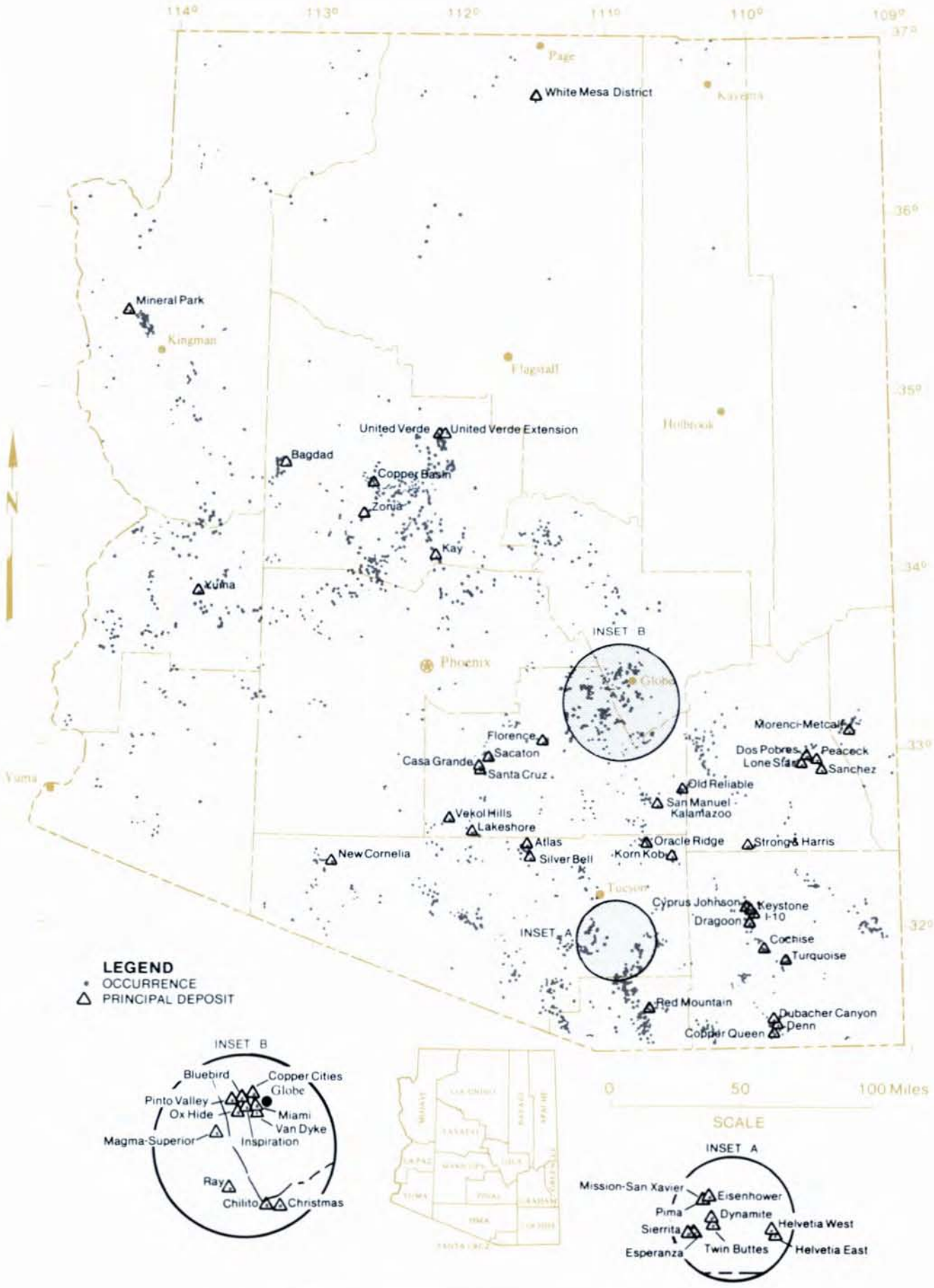



**Figure 22. Copper in Arizona.**

# FLUORSPAR

Fluorspar is the name commercially applied to the mineral fluorite ($CaF_2$, calcium fluoride). It commonly occurs in vitreous cubes and octahedra, but can also occur in massive and earthy forms and as an incrusting globular aggregate with a radial fibrous texture (266). Relatively high concentrations of europium, lanthanum, cerium, and yttrium may be indicated by strong fluorescence. The crystalline mineral is isotropic and is able to transmit ultraviolet light (508). Fluorite is the most important source of the element fluorine, the most reactive and electronegative element (231, 508). Fluorine is a pale yellow, corrosive gas that reacts with practically all substances and is the lightest of the halogens (231).

Fluorspar was carved by the early Greeks and Romans and used for ornamental vases, drinking cups, and table tops. The Chinese and Amerindians were some of the various peoples who carved ornaments and figurines from large crystalline masses (214). Agricola mentions its use as a metallurgic flux in the 1556 edition of "De Re Metallica" (2). The production and use of fluorspar grew with the invention of open-hearth steelmaking in 1856, although the first production of fluorspar in the United States was in the early 19th century.

The principal users of fluorspar are now the aluminum, chemical, and steel industries. There are basically three primary grades of fluorspar readily available: acid, ceramic, and metallurgical (508, 707). The metallurgical applications are derived from fluorspar's ability to form lower melting eutectics with refractory materials. The metallurgical grade is utilized as a flux in the manufacture of iron, steel, aluminum, and several

other metals. The ceramic grade is used in the production of glass and enamel. The acid grade, which represents the vast majority of fluorspar usage (approximately 70%), is used to make hydrogen fluoride (662). This chemical is used in the production of fluorocarbons, other chemicals, synthetic cryolite (used in the manufacture of aluminum), and fluorine. Alkylate, which also uses hydrogen fluoride in its production, is used in high-octane aircraft and automobile fuel. Hydrogen fluoride is also used in electroplating operations, steel pickling, enamel stripping, and glass etching and polishing. Fluorocarbons are quite chemically stable and nontoxic and are used as refrigerants, foam blowing agents, sterilent gases, and food freezants (508, 707). Some of these uses are under review, because of the increasing concern about the "ozone hole" in the upper atmosphere over Antarctica and to the related regulations limiting the further use of chlorofluorocarbons (662). Fluoropolymers have low coefficients of friction and are inert. They are used for the manufacture of parts that cannot be lubricated. Large quantities of elemental fluorine were initially produced for the atomic bomb project and nuclear energy applications during World War II (508). Anhydrous hydrogen fluoride and uranium hexafluoride are currently used in the isotopic separation of uranium.

Fluorspar is a critical raw material in the aluminum and steel industries and is therefore strategic for defense, which requires these metals. The United States imported approximately 88% of fluorspar used during 1986 (662). Currently, fluorite is imported from Mexico, the Republic of South Africa, and China. The domestic industry is unable to compete at current market prices, but could be brought into production if the supply were interrupted. Olivine

and/or dolomitic limestone have been tested as possible substitutes for fluorspar as a flux, but their use seems limited to low- and medium-carbon steels from open-hearth furnaces (508, 662).

Fluorspar is widely distributed over the southern half of Arizona. The deposits are primarily epithermal veins that fill fissures and brecciated zones along faults. Cumulative production in the State has probably been less than 50,000 st (214). Potential fluorspar deposits might be found around known centers of fluorspar mineralization and in the vicinity of metalliferous ore bodies, particularly lead and manganese deposits. Other possible sources of interest are barite-fluorspar deposits.

Mineral Occurrences and Principal Deposits in the State of Arizona--Fluorspar

| | |
|---|---|
| Total properties | 193 |
| Known principal deposits | 8 |
| Deposit abstracts in directory | 8 |

Reported Fluorspar Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | st | [2]mt | Value, $10^3$ | st | mt | Value |
| 1981 | 115,404 | 104,693 | $18,412 | NRP | NRP | NRP |
| 1982 | 77,017 | 69,869 | 13,293 | NRP | NRP | NRP |
| 1983 | e61,000 | e55,000 | e10,000 | NRP | NRP | NRP |
| 1984 | e72,000 | e65,000 | W | NRP | NRP | NRP |
| 1985 | e66,000 | e60,000 | W | NRP | NRP | NRP |
| 1986 | e78,000 | e71,000 | W | NRP | NRP | NRP |

eEstimated.
NRP No reported production.
W Withheld to avoid disclosing company proprietary data.
[1]As measured by finished shipments.
[2]Converted from short tons.

Source: Reference 659.

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^6$ st | wt % | Year | Class | Reference |
| Daniels Camp 1 & 2[3] | Greenlee. | I-EP | $CaF_2$, Mn, Be | U | ([4]) | ([4]) | NAp | NAp | NAp |
| Fourth of July[3] | ...do.... | I-PP | $CaF_2$, Mn, W, Be, Cu, Au, Ag | S[5] | ([4]) | ([4]) | NAp | NAp | NAp |
| McFadden Peak[3] | Gila..... | I-EP | $CaF_2$ | M[6] | ([4]) | ([4]) | NAp | NAp | NAp |
| Mt. Jackson[3] | Graham... | I-PP | $CaF_2$, Cu, Pb, Ag | S | ([4]) | ([4]) | NAp | NAp | NAp |
| Packard[3] | Gila..... | I-PP | $CaF_2$ | S | ([4]) | ([4]) | NAp | NAp | NAp |
| Quartz Ledge[3] | ...do.... | I-PP | $CaF_2$, Au, Ag | S | ([4]) | ([4]) | NAp | NAp | NAp |
| Red Rock[3] | ...do.... | I-PP | $CaF_2$, Au, Ag | S | ([4]) | ([4]) | NAp | NAp | NAp |
| Snowball[3] | Maricopa. | I-PP | $CaF_2$ | S | ([4]) | ([4]) | NAp | NAp | NAp |

EP Explored prospect. I Inactive. NAp Not applicable. PP Past producer. U Undetermined.

[1] Commodities are listed in order of decreasing importance.

[2] Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 50,000; M, medium, 50,000 to 5,000,000; L, large, greater than 5,000,000.

[3] Deposit abstract in directory.

[4] No published data have been located.

[5] Based only on past production.

[6] Based only on current resources.

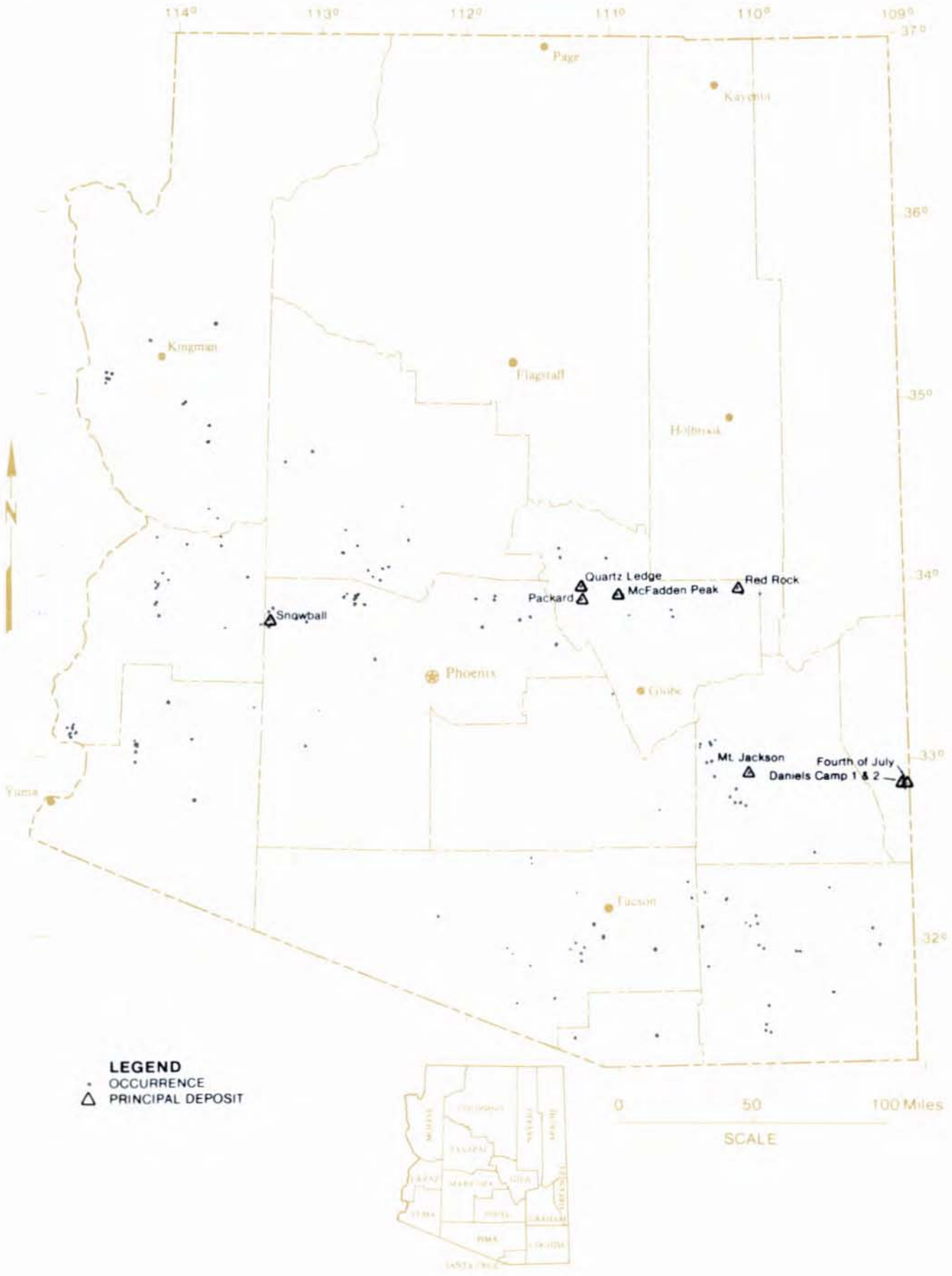



Figure 23. Fluorspar in Arizona.

# GOLD

Gold is a heavy yellow metal, that, when finely divided, may appear black, ruby, or purple (231). This most malleable and ductile of all metals is an excellent conductor of heat and electricity and is highly corrosion resistant (231). It is also highly reflective to light, both visible and infrared (231, 241, 266, 348, 662).

Gold is categorized as a precious metal and has been considered so since ancient times. Probably the first metal used by man, it was valued for its beauty, charm, and the ease with which it could be found and worked, although it was too soft for tools (223, 260). The oldest vessel made of gold dates from 3500 B.C. and was found at the site of Ur in Ancient Mesopotamia (702). The search for this metal has lead man to explore the world and develop trade for more than 60 centuries (348). Early coins were made of gold, and the metal has long been used as a monetary standard in addition to being important to industry and the arts (195, 223, 231, 348).

In 1987, 59% of domestic gold consumption was used in the production of jewelry and artworks, 8% for dentistry, and 33% for modern industrial applications (662). The industrial applications include solid-state electronic devices, corrosion-resistant chemical process equipment, and industrial control and monitoring instruments (662). Modern solid-state electronic devices use gold for conductive paths on printed circuit boards, connectors, dopant in some semiconductors, keyboard contactors, and miniaturized circuitry (348). These uses require components that remain totally free of high-resistance tarnish films and that are metallurgically and

chemically stable for the life of the device. Research on alternate materials, done in the mid-1970's when gold reached record prices, and the recent sharp price increase have led to a reduction in the amount of gold being used in these devices (241, 348, 662). Alloys of the metal are used in electrical instruments and thermocouples, and brazing alloys are important in jet turbines and high-performance rocket engines. The element is used as a reflective coating for infrared radiation in radiant heating and drying devices and in heat-insulating windows (231, 348, 662).

Gold is strategic because no other metal or alloy substitute has all of the desirable properties of gold. Although palladium, platinum, and silver may sometimes be used as substitutes for gold, decreased performance, increased price, and consumer resistance often result. In 1986, the United States imported 21 percent of all gold used with 50 percent of this amount coming from Canada. Fifty percent of the world's known reserves are located in the Republic of South Africa. Disruption of South African production or exports would have little effect on domestic industrial uses because of the small amount of gold indirectly imported to the United States from this source, less than 3% of total consumption (241). Although there is no strategic stockpile, the U.S. Treasury maintains stocks of gold, and, in addition, the Government instituted a secondary precious-metals recovery program in 1984 (231, 241, 662).

In Arizona, 42 mining districts in 10 counties have had gold production in excess of 10,000 tr oz (319). Nearly 80% of the lode gold produced in Arizona and much of the placer gold has come from a northwest-trending belt, which Ransome called the "mountain region," and which is shown as the "Central

Highlands" in figure 6. This belt is approximately 65 mi wide and abuts on the southwest margin of the Colorado plateau. It is characterized by deformed Precambrian rocks which have been tilted, severely faulted, and intruded by bodies of igneous rock (545, 702).

Gold occurs in the State in six types of deposits (339, 390, 582). The first type consists of epithermal quartz veins containing gold and silver, which are best developed in Tertiary volcanic rocks. The veins are irregularly shaped, tabular, or lenticular masses of greenish-yellow quartz, which are finely crystalline with banding or crustiform layering. The gold is typically found alloyed with silver in small pale-yellow specks (223, 319, 582).

In the second type of deposit, gold occurs in mesothermal siliceous base metal veins, which are persistent, straight, and narrow, with well-defined walls. The gangue is massive to drusy milk-white quartz, and ore shoots located below the oxidation zone contain plentiful sulfides, primarily pyrite, galena, sphalerite, chalcopyrite, arsenopyrite, and tetrahedrite. Ankeritic carbonates and abundant native silver may also occur in these ore shoots. The majority of the gold is submicroscopic and intergrown with the sulfides (319, 339, 390, 702).

The third type of deposit is the base metal sulfide replacement body. This type is characterized by galena, sphalerite, chalcopyrite, and/or pyrite in varying amounts with the free gold intergrown with one or more of these minerals. These deposits occur as irregular tabular or lenticular bodies in limestones or other host rocks, as pipelike masses at structural intersections, or as ore shoots in vein material (319, 390, 702).

The fourth type is large, low-grade disseminated copper deposits from which the gold is recovered as a byproduct. The largest producers of gold in Arizona have been the porphyry (disseminated) copper deposits, some of which were mentioned previously in the Copper section (319, 390, 702).

The first gold produced in Arizona came from the fifth type of deposit, a placer. The placers generally occur in the southwestern half of the State, although they may be derived from practically any lode gold deposit. The larger producers in Arizona, and those in which the larger nuggets are found, are derived from upper oxidized portions of the deeper seated, mesothermal vein deposits (319, 390, 702).

The last, and perhaps the least well-defined type, is the multiepisodic hydrothermal breccia deposit, possibly genetically associated with detachment faulting. This type of deposit has a hematite-specularite matrix containing fragments of quartz vein material, host rock, and earlier breccia. The deposit is roughly tabular in shape with associated mineralized quartz-amethyst veins cutting the surrounding rock. The gangue is composed primarily of hematite and chrysocolla with minor amounts of malachite and barite and even lesser amounts of calcite, siderite, manganese oxide, fluorite, adularia, magnetite, chalcopyrite, and pyrite. The majority of the gold occurs as free particles that vary from 4 to 40 microns in size (124, 156). Cyprus Mineral Company's Copperstone deposit, which was discovered in 1985 by bulldozer trenching, is fairly typical of this deposit type. Cyprus discovered the ore body at the north end of the Dome Rock Mountains near Parker in La Paz County. When the Copperstone deposit went into production in late 1987, gold production in Arizona approximately doubled. The proven

reserves are currently estimated at 6 million st at a grade of 0.085 tr oz/st of gold (564). The current rate of production is 60,000 tr oz/yr from surface mining and vat leaching, making Copperstone the largest primary gold producer in the State. In 1985, the State was seventh in production of gold, at 2% of national production (659, 662). Gold will continue to be produced as a byproduct of copper mining in the foreseeable future, and deposits of the other types may be found, particularly those associated with detachment faults.

Mineral Occurrences and Principal Deposits in the State of Arizona--Gold

| | |
|---|---|
| Total properties | 3,379 |
| Known principal deposits: | |
| Placer | 15 |
| Lode | 44 |
| Deposit abstracts in directory | 43 |

Reported Gold Production--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | $10^3$ tr oz | [1] $10^3$ kg | Value, $10^3$ | tr oz | [1] kg | Value, $10^3$ |
| 1981 | 1,379 | 43 | $633,918 | 100,339 | 3,121 | $46,120 |
| 1982 | 1,466 | 46 | 550,968 | 61,050 | 1,899 | 22,949 |
| 1983 | 2,003 | 62 | 849,071 | 61,991 | 1,928 | 26,284 |
| 1984 | 2,085 | 65 | 751,833 | 54,897 | 1,707 | 19,799 |
| 1985 | 2,427 | 75 | 786,345 | 52,053 | 1,619 | 16,535 |
| 1986 | 3,733 | 116 | 1,374,710 | W | W | W |

W Withheld to avoid disclosing company proprietary data.
[1] Converted from troy ounces.

Source: Reference 659.

## Gold Placers with Past Production of at Least 5,000 tr oz of Gold Through 1968[1]

| Placer or drainage name | County | Estimated past production, tr oz |
|---|---|---|
| Arivaca | Pima | 40,000 |
| Big Bug Creek drainage area | Yavapai | 10,000 |
| Castle Dome | Yuma | GT7,000 |
| Copper Basin | Yavapai | 8,000 |
| Gila City | Yuma | GT26,000 |
| Greaterville | Pima | 40,000 |
| Hassayampa River drainage area[2] | Yavapai | 30,000 |
| La Cholla-Middle Camp-Oro Fino | La Paz | 18,000 |
| Laguna | Yuma | 5,000 |
| La Paz | La Paz | GT100,000 |
| Lynx Creek drainage area[3] | Yavapai | 80,000 |
| Plomosa | La Paz | 18,000 |
| Quijotoa | Pima | 15,000 |
| Sierrita Mountains | ...do.... | 12,500 |
| Weaver district[4] | Yavapai | 110,000 |

GT Greater than.

[1]Arizona placer gold production since 1968 has been very small and was not included in this table. Because of the difficulties in obtaining any data relating to placers, deposit abstracts were not prepared for any gold placer deposits.

[2]Includes Upper, Central, and Lower Hassayampa River, Walnut Grove, Minnehaha Creek, Cherry Creek, and Oak Creek.

[3]Includes both Upper and Lower Lynx Creek.

[4]Includes both Weaver and Martinez placers.

Source: Reference 285.

| Deposit | County | Status | Commodity[1] | Size[2] | X-Ref[3] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $10^6$ st | Grade[4] | Year | Class[5] | Reference(s) |
| Arablan[6] | Mohave... | A-PP | Au, Ag, Ba | S | NAp | 0.5 | 0.06 | 1987 | NRIR | 409 |
| Bagdad[6] | Yavapai.. | A-P | Cu, Mo, Ag, Au | U | Cu, Mo, Ag | 397.3 | (7) | 1986 | Prov | 126 |
| Big Horn[6] | Maricopa. | A-P | Au, Ag | S[8] | NAp | 1 | .059 | 1988 | Infr | 366 |
| Bi-Metal[6] | Mohave... | A-PP | Au | S | NAp | .06 | .1 | 1987 | NRIR | 409 |
| Clementine[6] | Maricopa. | A-PP | Au, Ag | S | NAp | .1 | 05 | 1987 | NRIR | 409 |
| Congress[6] | Yavapai.. | I-PP | Au, Ag, Pb, Cu, $U_3O_8$ | S[9] | NAp | (7) | (7) | NAp | NAp | NAp |
| Copperstone[6] | La Paz... | A-P | Au | S | NAp | [10]6 | .085 | 1987 | Prov | 564 |
| | | | | | | [11]1.1 | .18 | 1988 | NRIR | 227 |
| Cyclopic[6] | Mohave... | I-PP | Au, Ag, Pb, Mo | S[8] | NAp | .07 | .28 | 1987 | NRIR | 409 |
| | | | | | | [12].05 | .06 | 1987 | NRIR | 409 |
| Eisenhower[6] | Pima..... | A-P | Cu, Ag, Mo, Au | U | Cu, Ag, Mo | 99.276 | (7) | 1986 | Demo | 49 |
| Frisco[6] | Mohave... | A-PP | Au, Ag | S[7] | NAp | .15 | .03 | 1987 | NRIR | 409 |
| Gladiator-War Eagle | Yavapai.. | A-P | Au, Ag, Pb, Zn, Cu | S[8] | NAp | .12 | .4 | 1987 | NRIR | 409 |
| Gold Prince[6] | Cochise.. | A-P | Au, Pb, Ag, Cu, Zn | S | NAp | .2 | .5 | 1987 | NRIR | 409 |
| King of Arizona[6] | Yuma..... | A-P | Au, Ag, Mn | S | NAp | 1 | .1 | 1987 | NRIR | 409 |
| La Fortuna[6] | ...do.... | I-PP | Au, Ag, Cu, Fe | S[9] | NAp | (7) | (7) | NAp | NAp | NAp |
| L. S. and A.[6] | Pinal.... | A-PP | Au, Cu, Pb, Ag, Mn | S[8] | NAp | (7) | (7) | NAp | NAp | NAp |
| Mammoth-Tiger[6] | ...do.... | A-P | Au, Pb, Zn, Y, Ag, Cu, Mo, $CaF_2$, $BaSO_4$, W | S[8] | NAp | 10 | .04 | 1987 | NRIR | 409 |
| Margarita Group[6] | Santa Cruz | A-PP | Au, Ag, Pb, Cu, Zn | S[8] | NAp | .6 | .07 | 1988 | Ind | 32 |
| McCabe[6] | Yavapai.. | A-P | Au, Ag, Pb, Cu, Zn | M | Ag | .7537 | .332 | 1989 | Demo | 681 |
| Mission-San Xavier[6] | Pima..... | A-P | Cu, Mo, Ag, Au | U | Cu, Mo, Ag | 367.5 | (7) | 1987 | NRIR | 143 |
| Montana[6] | Santa Cruz | A-DD | Ag, Au, Pb, Zn, Cu | S | Ag | [12].7 | [13].011 | 1987 | NRIR | 409 |
| Morenci-Metcalf[6] | Greenlee. | A-P | Cu, Mo, Au, Ag, Zn | U | Cu, Mo, Ag | .977764 | (7) | 1986 | Meas | 535 |
| Moss[6] | Mohave... | A-PP | Au, Ag | S | NAp | .25 | .25 | 1987 | NRIR | 409 |
| New Cornelia[6] | Pima..... | A-TS | Cu, Mo, Au, Ag, Re | U | Cu, Mo, Ag | 209.2 | (7) | 1986 | Meas | 535 |
| New Congress[6] | Yavapai.. | A-P | Au | S[8] | NAp | .4 | .4 | 1988 | Prov | 370 |
| Newsboy[6] | Maricopa. | A-PP | Au, Ag, Mn, Cu, Fe | S[8] | NAp | 1 | .045 | 1989 | Prob | 157 |
| North Star[6] | Yuma..... | I-PP | Au, Ag | S | NAp | (7) | (7) | NAp | NAp | NAp |
| Octave[6] | Yavapai.. | I-PP | Au, Ag, Pb, Cu | S[9] | NAp | (7) | (7) | NAp | NAp | NAp |
| Oxbow[6] | Gila..... | I-PP | Au, Cu, Pb, Mo, $CaF_2$, Ag | S[9] | NAp | (7) | (7) | NAp | NAp | NAp |
| Peacock[6] | Graham... | I-PP | Cu, Au, Ag, Mo | U | Cu | 20 | (7) | 1976 | Ind | 718 |
| Pima[6] | Pima..... | A-P | Cu, Ag, Mo, Au | U | Cu, Ag, Mo | 120.767 | (7) | 1984 | NRIR | 254 |
| Pinto Valley[6] | Gila..... | A-P | Cu, Mo, Au, Ag, Pb, Zn, $U_3O_8$ | U | Cu, Mo, Ag | 480.5 | (7) | 1987 | NRIR | 353 |
| Portland[6] | Mohave... | A-P | Au, Ag | S[8] | NAp | (14) | (7) | 1985 | NRIR | 409 |
| Ray[6] | Pinal.... | A-P | Cu, Mo, Au, Ag, Pb, Zn | U | Cu, Mo, Ag | 677 | (7) | 1988 | NRIR | 143 |
| Roadside[6] | Mohave... | A-P | Au, Ag | S[8] | NAp | .3 | .03 | 1986 | NRIR | 161, 409 |
| Sanchez[6] | Graham... | A-DD | Cu, Au, Ag, Mo | M[8] | Cu, Ag | 100 | .01 | 1988 | NRIR | 51 |
| San Manuel-Kalamazoo[6] | Pinal.... | A-P | Cu, Mo, Au, Ag | S[8] | Cu, Mo, Ag | 155.846 | .00158 | 1987 | Demo | 353 |
| Secret Pass[6] | Mohave... | A-EP | Au, Ag | S | NAp | .5 | .1 | 1988 | Meas | 160 |
| Sierrita[6] | Pima..... | A-P | Cu, Mo, Ag, Re, Au | U | Cu, Mo, Ag | 343.3 | (7) | 1986 | Prov | 126 |

See explanatory notes at end of table.

| Deposit | County | Status | Commodity[1] | Size[2] | X-Ref[3] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $10^6$ st | Grade[4] | Year | Class[5] | Reference(s) |
| Silver Cross[6] | Maricopa. | I-PP | Au, Ag, Cu | S | NAp | (7) | (7) | NAp | NAp | NAp |
| Transcendent[6,15] | Yavapai.. | I-PP | Au, Ag, Cu | S[8] | U | .025 | (7) | 1975 | NRIR | 444 |
| Treasure King[6] | ...do.... | A-EP | Au, Cu, Ag | S[8] | NAp | .15 | .5 | 1987 | NRIR | 409 |
| United Western[6] | Mohave... | A-PP | Au, Ag | S[8] | NAp | .118054 | .259 | 1987 | Ind | 506 |
| | | | | | | .107608 | .266 | 1987 | Infr | 506 |
| Van Deemen[6] | ...do.... | A-EP | Au, Ag | S[8] | NAp | 1 | .055 | 1987 | Prob | 255 |
| Vulture[6] | Maricopa. | A-P | Au, Pb, Ag, Cu, V, | S[9] | NAp | [10].25 | .507 | 1987 | NRIR | 409 |
| | | | Zn, Mo, Li | | | [11].5 | .25 | 1987 | NRIR | 409 |
| | | | | | | [12].25 | .402 | 1987 | NRIR | 409 |

A Active. DD Developed deposit. EP Explored prospect. I Inactive. NAp Not applicable. P Producer. PP Past producer. RP Raw prospect. TS Temporary shutdown. U Undetermined. X-Ref Cross reference.

[1] Commodities are listed in order of decreasing importance.

[2] Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 25; M, medium, 25 to 500; L, large, greater than 500.

[3] Indicates other commodities for which this deposit has been judged to be a principal deposit. Additional data may be found in the tables of principal deposits for these other commodities.

[4] Tr oz/st Au.

[5] Class of reserve-resource is reported as described in the reference. The following abbreviations are used: Meas, measured; Ind, Indicated; Infr, Inferred; Prov, proven; Prob, probable; Demo, demonstrated; NRIR, not reported in reference.

[6] Deposit abstract in directory.

[7] No published data have been located.

[8] Based only on current resources.

[9] Based only on past production.

[10] Surface.

[11] Underground.

[12] Tailings.

[13] Author's estimate from published material. See the deposit abstract for details.

[14] 42,000 tr oz contained Au.

[15] This deposit is included in this table because it has traditionally been considered a gold deposit. Its true significance, however, may lie in the fact that the 1975 owners (Last Chance Mining Company) stated that there are "indications" of an underlying porphyry copper deposit at this locality (444).

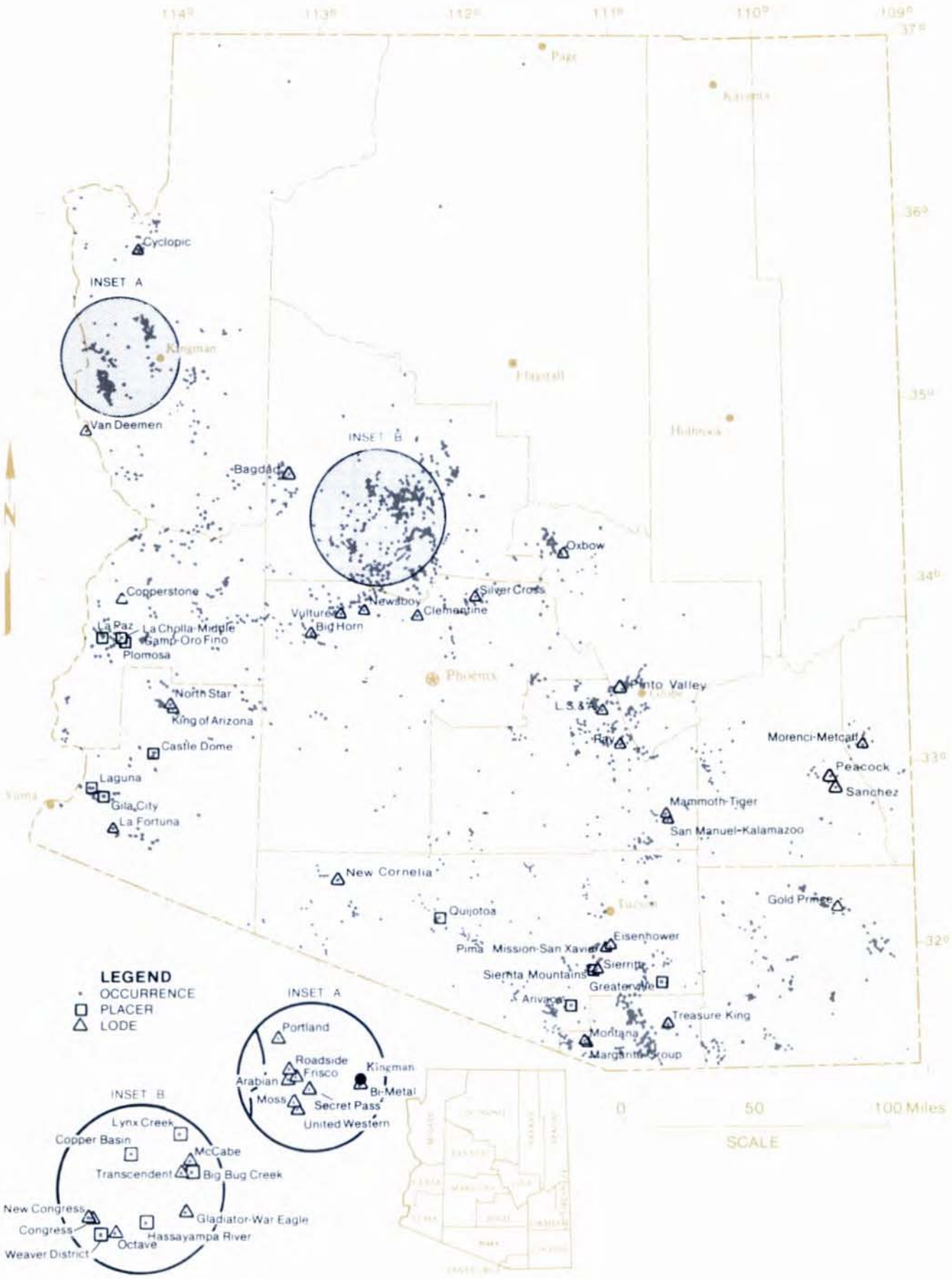



**Figure 24. Gold in Arizona.**

# IRON

Iron is a ductile, malleable, silver-white metal (231). The fourth most abundant element by weight (241) in the Earth's crust, it is the cheapest and most commonly used metal. The metal is lustrous, tenacious, and can be tempered (223). It has good weldability, malleability, and strength and is strongly magnetic (266, 316). Iron has the ability to form a wide range of alloys with other metallic and nonmetallic elements such as carbon, oxygen, nitrogen, and phosphorus (241, 316).

Hematite was discovered and mined approximately 50,000 B.C. at Bomvu Ridge, Swaziland, for use as ceremonial paint and to represent life's blood in graves. This area has been mined up to the present day. The earliest form of metallic iron used was celestial in origin. Meteoritic iron was used to make daggers and swords, but the supply was extremely limited (223). Terrestrial iron was probably discovered during the bronze age when fires were built on outcroppings of red iron ore, and sponge iron was found in the ashes of the fire. Iron ore was first smelted about 1400 B.C. by the Hittites who were able to conquer much of western Asia with their superior iron weapons (223). Throughout the 3,000 years of the iron age, the technology of mining advanced with many forests felled to provide fuel for the smelting of metals until wood was replaced by coal (223). Iron became the most important of all metals. Iron ore was first mined in the United States in 1608. An attempt to build an ironworks in Virginia in 1622 was not successful because of an Indian raid (223).

Approximately 99% of the iron ore mined in the United States is used in

the production of iron and steel. The remainder is used in cement, iron oxide pigments, ferrites, heavy-medium materials, concrete aggregate, metallurgical fluxes, and sponge iron (314, 316, 566, 662). Iron and steel are essential to maintain a strong industrial base. They are the primary metals for vehicles and mobile equipment, machinery, and ships. Of domestic iron consumption (662), transportation accounts for 24%, and machinery uses 16%. Practically all large structures are either framed with steel or are composed of concrete reinforced with steel; construction accounts for 35 percent of domestic iron consumption (662). The tanks, pressure vessels, and piping used in the production of petroleum, natural gas, and other chemicals are typically made of steel. Lesser amounts of steel are used in essential parts of aerospace applications, and varietal steels are used in electrical equipment for their electrical and magnetic properties. The major reason for the widespread usage of steel is its low cost. In addition, it can be alloyed, heattreated, and processed to produce a large degree of variation in the properties of hardness, strength, and corrosion resistance (566, 662).

Iron ore is essential for maintaining domestic production of iron and steel. An adequate and dependable supply requires a blend of developed domestic resources and dependable sources of imports. In 1987, foreign ore supplied 15% of domestic consumption. In 1988, it is estimated that the United States will produce 39 million st and consume 55 million st of iron ore. Similarly, the estimated 1988 production of raw steel will be 82 million st, and the consumption will be 100 million st, leaving the net import reliance at 37% for iron ore and 18% for iron and steel. The majority, 59%, of the imported iron ore is from Canada (316, 662). Although classified as

strategic, the Government is not stockpiling iron ore (316).

Arizona is estimated to have less than one percent of the iron ore resources of the United States, and its total past production has been small. The State has potentially large resources, but they currently can be considered only potential ores (314). These deposits are located in a band that trends roughly east-west across the center of the State (243).

Because so little detailed exploration and development of Arizona iron deposits has occurred in the past, very little firm data are available concerning most individual deposits. Published information often tends to deal with small discrete deposits by grouping them together into areas that can be more easily discussed. Although these areas may appear to have significant resources, these resources are, in reality, composed of small discrete deposits that are individually of much less interest than the area as a whole. For this reason, abstracts of these areas were not prepared. Instead, the resources of these areas are summarized in the table. For those properties that were clearly identifiable as discrete deposits with more significant resources, abstracts were prepared.

There are three types of iron ore deposits in Arizona. The first of these is the bedded deposit. These range from Lake Superior type deposits composed of siliceous taconites, jaspilites, and schists to deposits composed of stratiform hematite or magnetite, possibly of contact metamorphic or metasomatic replacement origin (93, 314). The second type of deposit is alluvial. These deposits are magnetite-bearing or titaniferous magnetite-bearing sands that have been mined as recently as the 1960's in Pinal County. The last type of deposit is massive. These deposits are

generally hydrothermal replacement bodies with occasional associated copper mineralization, but they also include low-grade manganiferous hematite-limonite deposits at several sites in the State. Small residual deposits of goethite or jarosite, formed by weathering or leaching of iron minerals from other types of iron deposits, are known to exist (314). Iron sulfides were produced at several of the larger copper mines in the State and were used for the production of sulfuric acid and of sponge iron for the precipitation of copper. A large percentage of the tailings from several of the copper mines are composed of pyrite that could be exploited. The possibility of iron ore development in the State is slight considering the shipping cost involved and the current worldwide surplus of iron ore (93, 243, 314-315).

Mineral Occurrences and Principal Deposits in the State of Arizona--Iron

| | |
|---|---|
| Total properties | 453 |
| Known principal deposits | 18 |
| Deposit abstracts in directory | 5 |

Reported Iron Ore Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | $10^3$ lt | [2]$10^3$ mt | Value, $10^6$ | lt | mt | Value |
| 1981 | 72,181 | 73,339 | $2,915 | NRP | NRP | NRP |
| 1982 | 35,756 | 36,330 | 1,492 | NRP | NRP | NRP |
| 1983 | 44,596 | 45,312 | 1,945 | NRP | NRP | NRP |
| 1984 | 50,883 | 51,700 | 2,248 | NRP | NRP | NRP |
| 1985 | 49,411 | 50,204 | 2,077 | NRP | NRP | NRP |
| 1986 | 41,327 | 41,990 | 1,473 | NRP | NRP | NRP |

NRP No reported production.

[1]As direct-shipping ore, concentrates, agglomerates, and byproduct ore.

[2]Converted from long tons.

Source: Reference 659.

Principal Known Iron Deposits, Areas, and Districts in Arizona

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^6$ lt | wt % Fe | Year | Class[3] | Reference |
| Apache[4] | Navajo... | I-EP | Fe[5] | M[6] | 15 | 43-66 | 1931 | Rsrv | 314 |
| Black Hills Area | Yavapai.. | I-RP | Fe[5] | S[6] | Several | 27-37 | 1969 | Pot | 314 |
| Boulder Creek-Millholland Area | ...do.... | I-RP | Fe, Ti[7] | ([8]) | ([8]) | 60-62 | 1969 | NAp | 314 |
| Chediski[4] | Navajo... | I-RP | Fe[5] | M[6] | 10- 15 | 23-62 | 1969 | Pot | 314 |
| Cleator Area | Yavapai.. | I-RP | Fe[5] | M[6] | GT10 | 21-39 | 1969 | Pot | 314 |
| Florence-Oracle Jct.-Red Rock Area. | Pinal.... | I-PP | Fe, Ti[9] | L[6] | 100- 500 | 3 | 1969 | Pot | 314 |
| Goodwin-Crown King Area | Yavapai.. | I-RP | Fe[5] | M[6] | GT10 | 21-39 | 1969 | Pot | 314 |
| Iron King | Gila..... | I-RP | Fe, Ti[5] | L[6] | GT1000 | 39-42 | 1969 | Infr Rsrc | 243 |
| Mayer Area | Yavapai.. | I-RP | Fe, Ti[5] | L[6] | GT10 | 21-39 | 1969 | Pot | 314 |
| Mineral Hill[4] | Yuma..... | I-PP | Fe, Cu[7] | S[6] | 3.356 | 48.3 | 1961 | Rsrv | 243 |
| | | | | | 1 | 38.1 | 1961 | Rsrv | 243 |
| New Planet[4] | ...do.... | I-PP | Fe, Cu[7] | M[6] | 1.25 | 60 | 1945 | Rsrv | 314 |
| | | | | | 21 | 35 | 1945 | Infr Rsrc | 314 |
| Pig Iron | Gila..... | I-RP | Fe, Ti[5] | L[6] | 1000 | 19-37 | 1969 | Infr Rsrc | 243 |
| Pikes Peak District[4] | Maricopa. | I-RP | Fe[5] | L[6] | 100 | 30 | 1957 | Infr Rsrv | 314 |
| Rock Springs-Cordes Area | Yavapai.. | I-RP | Fe[5] | M[6] | GT10 | 21-39 | 1969 | Pot | 314 |
| Santa Margarita District | ...do.... | I-RP | Fe[9] | L[6] | ([8]) | [10]5.5 | 1969 | Infr Rsrc | 243 |
| Seligman-Cowden Area | ...do.... | I-PP | Fe[7] | S[6] | 1 | 55-68 | 1969 | Infr Rsrc | 243 |
| Stanton Area | ...do.... | I-RP | Fe[5] | M[6] | GT10 | 21-31 | 1969 | Pot | 314 |
| Zimmerman-Asbestos Points Area | Gila..... | I-RP | Fe[7] | S[6] | Several | 30-68 | 1961 | Infr Rsrc | 243 |

EP Explored prospect. GT Greater than. I Inactive. NAp Not applicable. PP Past producer. RP Raw prospect.

[1] Commodities are listed in order of decreasing importance.

[2] Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 5 million; M, medium, 5 million to 100 million; L, large, greater than 100 million.

[3] Class of reserve-resource is reported as described in the reference. The following abbreviations are used: Infr, inferred; Pot, potential ore; Rsrv, reserve; Rsrc, resource.

[4] Deposit abstract in directory.

[5] Bedded deposit.

[6] Based only on current resources.

[7] Massive deposit.

[8] No published data have been located.

[9] Alluvial deposit.

[10] Grade given is average wt % magnetite ($Fe_3O_4$) rather than wt % Fe. Grade varies from 1.7 to 10.9.

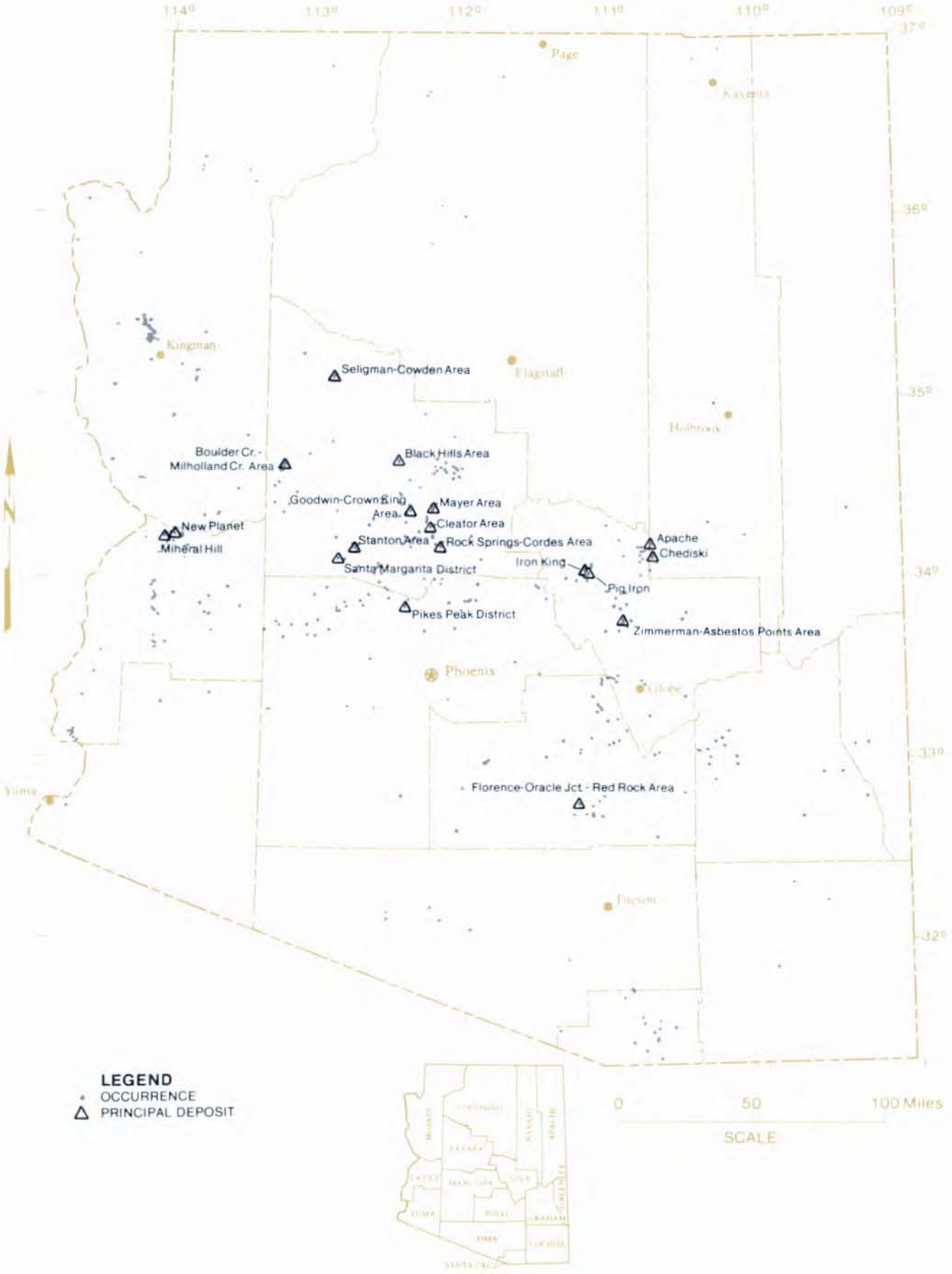



Figure 25. Iron in Arizona.

# LEAD

Lead ranks 34th in average crustal abundance, below iron, copper, and zinc. Lead is a brightly lustrous, bluish-white, heavy metal, which is very soft, highly malleable, and a poor conductor of electricity. It is extrudable, highly resistant to corrosion, only slightly ductile, and has a low melting point. Lead forms eutectics with many metals, and several of these alloys have very low melting points (90, 231, 662, 705).

Lead has been used for jewelry and coins for at least 7,000 years. A spinning bobbin, found in Merv, Union of Soviet Socialist Republics, dated from 5000 B.C. (705). The Egyptians and Sumerians used lead compounds in makeup in about 4000 B.C., and it was also used in Egypt in pottery glazes. The Rio Tinto Mine in Spain dates from approximately 2300 B.C. and is still operating (90). The Chinese were using lead as money as early as 2000 B.C. (90). Other early uses included writing tablets, charms, sling projectiles, and use in bridge construction to protect and anchor iron and bronze fasteners. The hanging gardens of Babylon were floored with soldered lead sheets (223, 705). Much early lead production was a byproduct of the production of silver. The Romans invaded Britain primarily to assure a supply of lead and tin ore. In medieval times, lead was used in construction and stained glass windows. Guttenberg cast the first lead type for printing books. Firearms using lead ammunition were manufactured in the 1400's. The English, in 1675, developed leaded glass, and by the beginning of the 19th century, were using it in optics. Lead was mined in the United States as early as 1621 (90, 223, 231, 394, 705).

Today, lead is principally consumed as pure or alloyed metals or as compounds, mostly oxides. Lead-acid storage batteries require both the metal and oxides for their manufacture and, along with gasoline additives and other transportation-related applications, account for about 70% of the lead used in the United States. These batteries are used for starting vehicles, ships, and aircraft or for uninterruptible power-supply systems for telecommunication networks, hospitals, and large computers (90, 705). They are also used for power storage in powerplants to balance loading and in electric vehicles. Transportation applications include lead alloys for bearings, for wheel-balancing weights, for plating fuel tanks, and for autobody solder and filler. In the United States, lead is used by the petroleum industry as an active component of gasoline antiknock additive and as an octane enhancer. Use in the petroleum industry is decreasing because vehicles requiring lead are no longer produced and because the lead content of gasoline is being lowered by law. Lead is used in construction decreasingly for roofing, flashing, piping, and caulking, but increasingly for sound proofing. The metal is used for protection against X-rays and gamma radiation. Lead and lead oxides are both used for corrosion protection and in glass, porcelain, enamel, and ceramic glazes. Approximately 75% of the lead used in glass and ceramics is for the production of color television picture tubes. Cable sheathing made of lead prevents corrosion and moisture penetration and is important to communications. Lead has other uses too numerous to mention here (90, 231, 241, 308, 662, 705).

Lead is considered both strategic and critical because of the dependency of military and civilian activities on the energy provided by lead-acid

storage batteries. The import reliance in 1986 was 20%, but the potential for supply disruption is low because 54% of imports is from Canada. In addition, the United States has the resources to produce all the lead it needs (241, 662, 705). Much of the lead used in batteries is recycled. There are several materials that are being used instead of lead in packaging, construction, solder, and cable coverings; these include plastics, aluminum, tin, and iron (308, 662).

Historically, Arizona has produced lead primarily as a byproduct of silver, copper, and zinc production. More than 500 st of lead has been produced in each of 35 districts, with 85% coming from only 10 districts (391). Most of these deposits are located in the southwestern half of the State. In the broadest terms, the majority of the deposits in the State may be classified as either vein or replacement (391, 394).

The vein deposits are siliceous fissure veins containing lead minerals, primarily galena, in addition to sphalerite, chalcopyrite, tennantite, and proustite, with gangue composed primarily of quartz accompanied by possible calcite, fluorite, barite, and rhodochrosite. In Mohave and Yavapai Counties, the upper oxidized portion of many of the veins contains rich concentrations of gold and silver, and many deposits were originally mined for these metals; later some were mined for the lead and zinc content. Another type of fissure vein typically contains argentiferous galena, cerussite, and anglesite with gangue of fluorite, barite, calcite, gypsum, iron oxides, and manganese oxides. Although less abundant, these deposits have been important producers in the State.

The replacement deposits in the State are composed of massive sulfides

and, although fewer in number, are of much greater resource significance than the vein deposits. Eight of the top 10 lead-producing districts are composed primarily of massive sulfide replacement deposits. These deposits are relatively simple mineralogically. The principal ore minerals are galena and sphalerite with possible lesser amounts of chalcopyrite and pyrite. The ore bodies are often adjacent to barren, siliceous, pyritic bodies or massive, pyritic, copper ore bodies. They generally are controlled by structures such as bedding or occur as wall rock replacement bodies. The shape of these deposits is tabular, lenticular, or pipelike and they may be conformable with bedding or nonconformable as steeply dipping, veinlike masses in shatter zones.

The estimated lead resource of the State totals approximately 500 million lb. Under current economic conditions, lead is not particularly in demand. The common association of silver with the lead in Arizona, however, could result in exploration for deposits from which both could be produced. Production doubled from 1984 to 1985 principally because Morenci resumed lead production (241, 308, 391, 394).

Mineral Occurrences and Principal Deposits in the State of Arizona--Lead

| | |
|---|---|
| Total properties | 1,630 |
| Known principal deposits | 4 |
| Deposit abstracts in directory | 4 |

Reported Lead Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | [2]st | mt | Value, $10^3$ | st | mt | Value, $10^3$ |
| 1981 | 491,007 | 445,435 | $358,821 | 1,095 | 993 | $800 |
| 1982 | 564,952 | 512,516 | 288,579 | 396 | 359 | 202 |
| 1983 | 495,262 | 449,295 | 214,745 | 258 | 234 | 112 |
| 1984 | 355,690 | 322,677 | 181,745 | W | W | W |
| 1985 | 456,307 | 413,955 | 174,008 | 640 | 581 | 244 |
| 1986 | 374,557 | 339,793 | 165,150 | W | W | W |

W Withheld to avoid disclosing company proprietary data.

[1]As measured by mine shipments or sales of recoverable content of ore.

[2]Converted from metric tons.

Source: Reference 659.

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^3$ st | wt % Pb | Year | Class[3] | Reference |
| Glove Group[4] | Santa Cruz | I-PP | Pb, Zn, Ag, Cu, Au, Mo, Mn | S | ([5]) | ([5]) | NAp | NAp | NAp |
| Iron King[4] | Yavapai | I-PP | Pb, Zn, Ag, Au, Cu, Cd | M | 750 | [6]3-4 | 1988 | Prov | 416 |
| Old Yuma[4] | Pima | A-PP | Pb, Cu, Zn, Mo, Au, Ag | S | ([5]) | ([5]) | NAp | NAp | NAp |
| Seventy-Nine[4] | Gila | I-PP | Pb, Zn, Cu, Ag, Fe, Mo, Sb, Au, V | S | ([5]) | ([5]) | NAp | NAp | NAp |

A Active. I Inactive. NAp Not applicable. PP Past producer.

[1]Commodities are listed in order of decreasing importance.

[2]Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted.The following abbreviations and size ranges are used: S, small, less than 50,000; M, medium, 50,000 to 1,000,000; L, large, greater than 1,000,000.

[3]Class of reserve-resource is reported as described in the reference. The following abbreviation is used: Prov, proven.

[4]Deposit abstract in directory.

[5]No published data have been located.

[6]Combined grade for Pb-Zn.

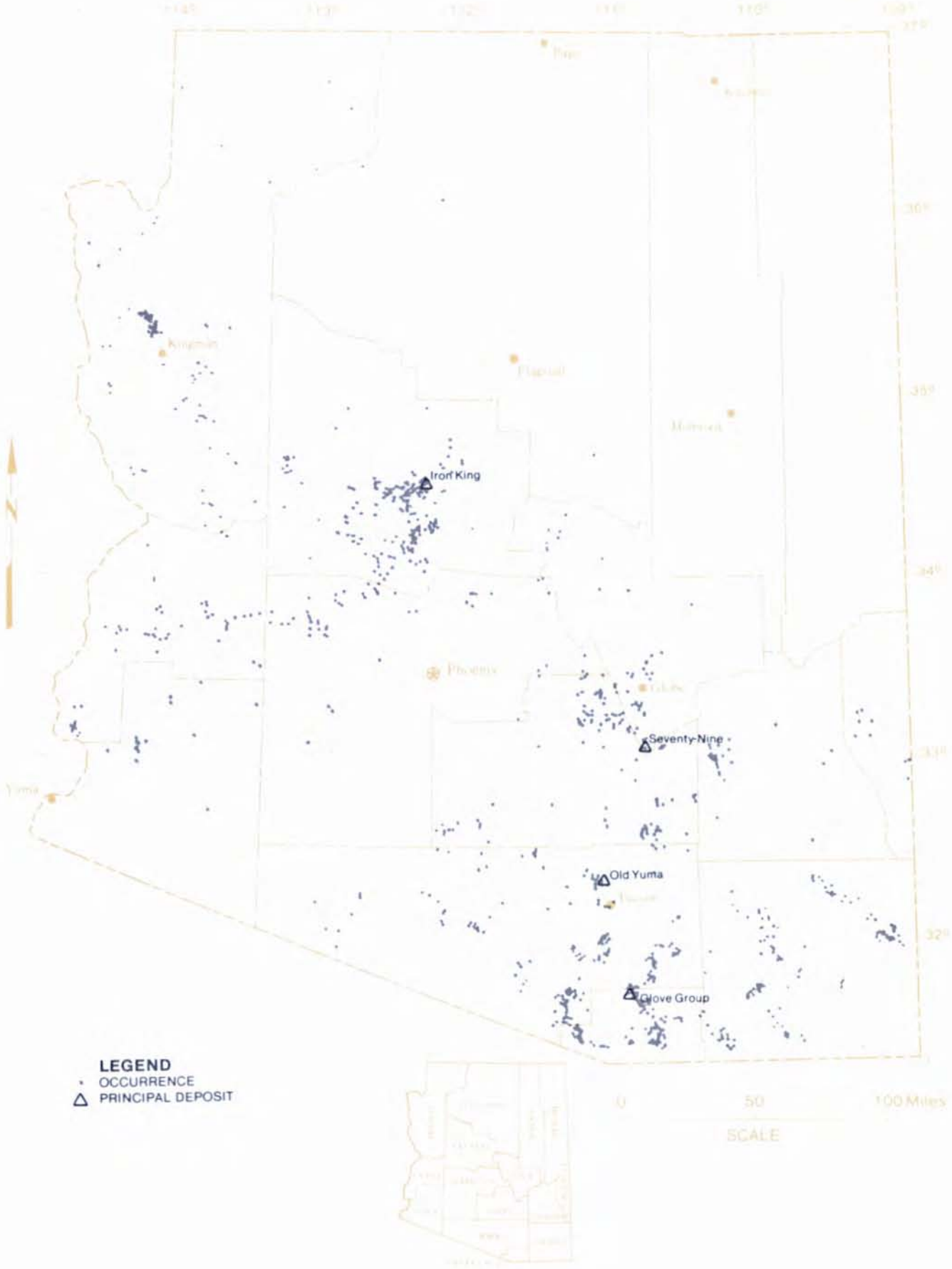



Figure 26. Lead in Arizona.

# MANGANESE

Manganese is a gray-white metal that resembles iron but is harder and very brittle. The element is reactive, and decomposes slowly in cold water. Metallic manganese is unworkable. It is one of the more common elements in the Earth's crust and is easily concentrated by natural processes such as solution and redeposition (231, 292, 662).

The Egyptians and Romans, who considered manganese a variety of iron, used it to decolorize glass. The metal was recognized by Scheede, Bergman, and others and was isolated by Gahn in 1774. It was first mined in the United States in 1830 to color and decolorize glass and pottery, which remained its primary use until 1856 when Mushet recognized that manganese was necessary in the making of nonbrittle steel (223, 231, 292). This discovery made the Bessemer convertor practical and created a demand for manganese (292).

In more recent times, manganese has become important because it functions as a desulfurizing, deoxidizing, and/or inexpensive alloying element and has valuable chemical properties. It is vital in the production of nearly all steels and is very useful in the production of cast iron (241, 292, 662). In addition, it controls impurities and increases the hardness, strength, toughness, and hardenability of steel. Approximately 95% of the manganese consumed in this country is used by the steel industry. Hadfield steels contain about 10% to 14% manganese and are used in wear-resistant applications such as railroad track and crushing and mining equipment. These steels are of particular value because they work harden with impact while retaining toughness and ductility. Manganese is used in aluminum alloys to

improve corrosion resistance. Manganese bronzes are copper-based alloys used for gears, bearings, and marine propellers and fittings. Its compounds are used in battery applications, water treatment, soil conditioners, welding rod coatings, fluxes, coloring agents, micronutrients, and manganese-zinc ferrites for electronics.

Manganese is a strategic metal because it is vital to our steel and iron industries. Because there is no present domestic production of manganese ore containing 35% or more manganese, the United States is dependent on imports. A small amount of ore containing less than 35% manganese is produced domestically, but accounts for less than 2% of domestic consumption. Land-based reserves are large, but the majority of these resources (80%) are in the Union of Soviet Socialist Republics and in the Republic of South Africa. Marine resources are extensive, but as yet cannot be viably collected. Manganese has been certified by the Department of State "as a strategic mineral essential for the economy or defense of the United States that is unavailable in adequate quantities from reliable and secure suppliers." This declaration allows the United States to continue to import manganese from the Republic of South Africa. There are no satisfactory substitutes for manganese in its major applications (241, 292, 309, 662).

Manganese was produced in Arizona prior to 1915 during silver mining, was used as a flux in local smelters, and was lost in the slag. During the period from 1916 to 1918, high prices caused by the war stimulated production of hand cobbed ore. Following this period, production dropped greatly, but picked up again during the late 1920's and increased again during the Second World War. The largest production of manganese in Arizona was during a period when the

Government subsidized production of low-grade ore from 1951 to 1955 and higher grade ore from 1955 to 1959. During this period, a total of about 700,000 lt of ore were produced. No production has occurred since that time (149, 290).

Manganese occurs in two types of deposits in the State. In syngenetic deposits, it occurs as wad interstitial to the coarser clastic material. Some believe that it was derived from volcanic hot springs draining into playa basins. Another possible source of the manganese is from the erosion of large hydrothermal ferruginous manganese deposits. Some of these syngenetic deposits have been reworked by supergene fluids that increased the metal content. This enriched material has a much better manganese-to-iron ratio. Some tufas in the State contain irregular pods and lenses of manganese oxides and have yielded ore averaging nearly 52% manganese (149-150, 209-210, 278, 290, 701).

Epigenetic deposits are widely distributed throughout the State. They consist principally of fissure fillings and irregular replacement bodies. In some districts, this type of deposit is associated with base metal and silver ores. The characteristic minerals in these deposits are the manganese oxides pyrolusite, psilomelane, hausmannite, hetaerolite, and braunite; the carbonates rhodochrosite and black calcite (with contained manganese oxide); and, in some cases, the sulfide alabandite. The oxidized caps of most copper ore bodies in the Bisbee area contained high-grade manganese oxides. The most widespread deposits in the State are the small interstitial fillings in breccia zones; these tend to grade into the traditional vein deposits. Manganese nodules appear in the soil in several parts of the State (149-150, 209-210, 278, 290, 701).

For Arizona to resume production, subsidized prices substantially above current levels would be required. The Artillery Mountains have a major source (175 million st) of easily treated manganiferous material, but the grade of the material is low (3.5% to 4%) and past recoveries were poor (50%) (149, 209). There are other widely scattered small deposits throughout the State that could operate if manganese market prices were substantially higher than at present, but production is unlikely in the foreseeable future (149-150, 701).

Mineral Occurrences and Principal Deposits in the State of Arizona--Manganese

| | |
|---|---|
| Total properties | 554 |
| Known principal deposits | 10 |
| Deposit abstracts in directory | 2 |

Reported Manganese Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | st | [2]mt | Value, $10^3$ | st | mt | Value |
| 1981 | 24,325 | 22,067 | $2,890 | NRP | NRP | NRP |
| 1982 | 3,984 | 3,614 | 293 | NRP | NRP | NRP |
| 1983 | 3,642 | 3,304 | 216 | NRP | NRP | NRP |
| 1984 | 10,553 | 9,574 | 860 | NRP | NRP | NRP |
| 1985 | 1,882 | 1,707 | W | NRP | NRP | NRP |
| 1986 | 14,320 | 12,991 | W | NRP | NRP | NRP |

NRP No reported production.
W Withheld to avoid disclosing company proprietary data.

[1]Manganese content of combined ferruginous manganese ore (10% to 35% Mn, natural) plus manganiferous iron ore (5% to 10% Mn, natural) shipped. Shipments are used as a measure of manganiferous ore production. No manganese ore (35% or more Mn, natural) was reported shipped from 1981 through 1986.

[2]Converted from short tons.

Source: Reference 659.

Principal Known Manganese Deposits and Districts in Arizona

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^3$ lt | wt % Mn | Year | Class[3] | Reference |
| Artillery Mountains District.... | Mohave... | I-PP | Mn | L[5] | [4]175,000 | [4]3.9 | 1969 | NRIR | 245 |
| Bisbee District..... | Cochise.. | I-PP | Mn, Cu, Au, Ag, Pb, Zn | S[5] | [4]30 | LT30(?) | 1969 | NRIR | 149 |
| Doyle..... | La Paz... | I-PP | Mn | S[5] | GT100(?) | 5-10(?) | 1969 | NRIR | 149 |
| Globe District..... | Gila..... | I-PP | Mn, Pb, Zn, Cu, Ag | S[5] | [4]20 | [4]6-10 | 1969 | NRIR | 149 |
| Hardshell[6]..... | Santa Cruz | I-PP | Mn, Pb, Zn, Ag | M[5] | [4]5,900 | 15 | 1972 | Prob | 393 |
| Maggie[6]..... | Mohave... | I-PP | Mn, Fe | M[5] | [4]25,000 | 4.73 | 1958 | NRIR | 245 |
| Mowry..... | Santa Cruz | I-PP | Mn, Ag, Pb | S[5] | GT5 | 20(?) | 1969 | NRIR | 149 |
| Spring..... | La Paz... | I-PP | Mn | S[5] | GT100 | 3-4 | 1969 | NRIR | 149 |
| Superior District..... | Pinal.... | I-PP | Mn, Pb, Zn, Cu, Ag | S[5] | GT50(?) | 10-20 | 1969 | NRIR | 149 |
| Tombstone District..... | Cochise.. | I-PP | Mn, Ag, Pb, Cu, Zn | S[5] | LT10 | LT15-30 | 1969 | NRIR | 149 |

GT Greater than. I Inactive. LT Less than. PP Past producer.

[1]Commodities are listed in order of decreasing importance.

[2]Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 40,000; M, medium, 40,000 to 4 million; L, large, greater than 4 million.

[3]Class of reserve-resource is reported as described in the reference. The following abbreviations are used: Prob, probable; NRIR, not reported in reference.

[4]Value is approximate.

[5]Based only on current resources.

[6]Deposit abstract in directory.




Figure 27. Manganese in Arizona.

# MERCURY

Mercury is a silvery-white, high-density liquid metal with a faint bluish tinge. It has several useful properties including uniform volume expansion with increasing temperature while a liquid, good electrical conductivity, easy alloying capability, and high chemical stability, surface tension, and toxicity of its compounds (94, 231).

Cinnabar, the principal mercury ore mineral, has been used since neolithic times as a pigment. The ancient Egyptians, Greeks, and Romans used cinnabar and possibly realgar for cosmetics, pigments, and medical preparations. Aristotle mentioned fluid silver, in "Meteorologica IV, 8, II," published in fourth century B.C. Greece, and Theophrastus was the first to describe the purification of mercury from cinnabar (264). Mercury and its compounds have been used in antifouling paint for ships, for recovery of gold from embroidered garments, and in alchemy (220). Prior to World War I, mercury's principal use in the United States was in the amalgamation of gold from its ores (231).

Modern uses for mercury have expanded to include explosives, drugs, electrical equipment, and instruments. It is primarily used today in batteries, mercury lamps, and wiring and switching devices. Mercury cells used in the production of chlorine and caustic soda are being used less because of environmental concerns. Mercury compounds are used as fungicides, mildewcides, and bactericides. Alloys with silver and tin have been used for dental amalgams. The metal and its compounds are used in small quantities in catalysts, heat-transfer devices, pigments, refinery lubricating oils, and

research. The aforementioned are only a few of the thousands of industrial uses (94, 220, 231, 241, 662).

Mercury is a critical commodity, and at present, the United States is heavily dependent on imports. Spain supplies 37% of the mercury imported, Algeria supplies 17%, and Turkey supplies 14%. There are few or no satisfactory substitutes for the uses in electrical, industrial, and control instruments that are dependent on mercury's high density, fluidity, or electrical conductivity. Substitutes in other applications include lithium, zinc air, or nickel-cadmium cells in batteries and diaphragm and membrane cells used in the production of chlorine and caustic soda. Substitutes also include composite materials in dental fillings and other compounds in exterior latex paint (94, 220, 241, 662).

Mercury was first mined in Arizona from the Dome Rock Mountains in 1875; since then, about 95% of the mercury produced in Arizona has come from the Mazatzal Mountains. The total production from the State is probably less than 8,000 flasks (53). Mercury deposits typically are found in Arizona along fault zones in Precambrian schists, generally associated with volcanism (52). The mercury was deposited at shallow depths as cinnabar. The remaining deposits are probably those of late Tertiary or Quaternary age that have not been eroded away. Arizona has mercury potential, but most of the deposits so far discovered are of low grade, which has discouraged production and exploration (52-54, 333, 660).

## Mineral Occurrences and Principal Deposits in the State of Arizona--Mercury

| | |
|---|---|
| Total properties | 50 |
| Known principal deposits | 2 |
| Deposit abstracts in directory | 2 |

## Reported Mercury Production[1]--United States and Arizona, 1981-86

| Year | United States | | Arizona | |
|---|---|---|---|---|
| | Flasks | Value, $10^3$ | Flasks | Value |
| 1981 | 27,904 | $11,549 | NRP | NRP |
| 1982 | 25,760 | 9,555[e] | NRP | NRP |
| 1983 | 25,070 | 8,084[e] | NRP | NRP |
| 1984 | 19,048 | 5,988[e] | NRP | NRP |
| 1985 | 16,530 | 5,140[e] | NRP | NRP |
| 1986 | W | W | NRP | NRP |

[e]Estimated as flasks multiplied by average price per year of NYME Market.

NRP No reported production.

W Withheld to avoid disclosing company proprietary data.

[1]Mine production in flasks.

Source: Reference 659.

Principal Known Mercury Deposits in Arizona

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Flasks | wt % Hg | Year | Class[3] | Reference |
| Mazatzal Mountains Area[4] | Gila and Maricopa | I-PP | Hg | M | [5] | [5] | NAp | NAp | NAp |
| Rico Group[4] | Maricopa. | I-PP | Hg, Cu, Ag | M[6] | 20,140 | U | 1930 | NRIR | 665 |

I Inactive. NAp Not applicable. PP Past producer. U Undetermined.

[1] Commodities are listed in order of decreasing importance.

[2] Based on flasks of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 10,000; M, medium, 10,000 to 500,000; L, large, greater than 500,000.

[3] Class of reserve-resource is reported as described in the reference. The following abbreviation is used: NRIR, not reported in reference.

[4] Deposit abstract in directory.

[5] No published data have been located.

[6] Based only on current resources.

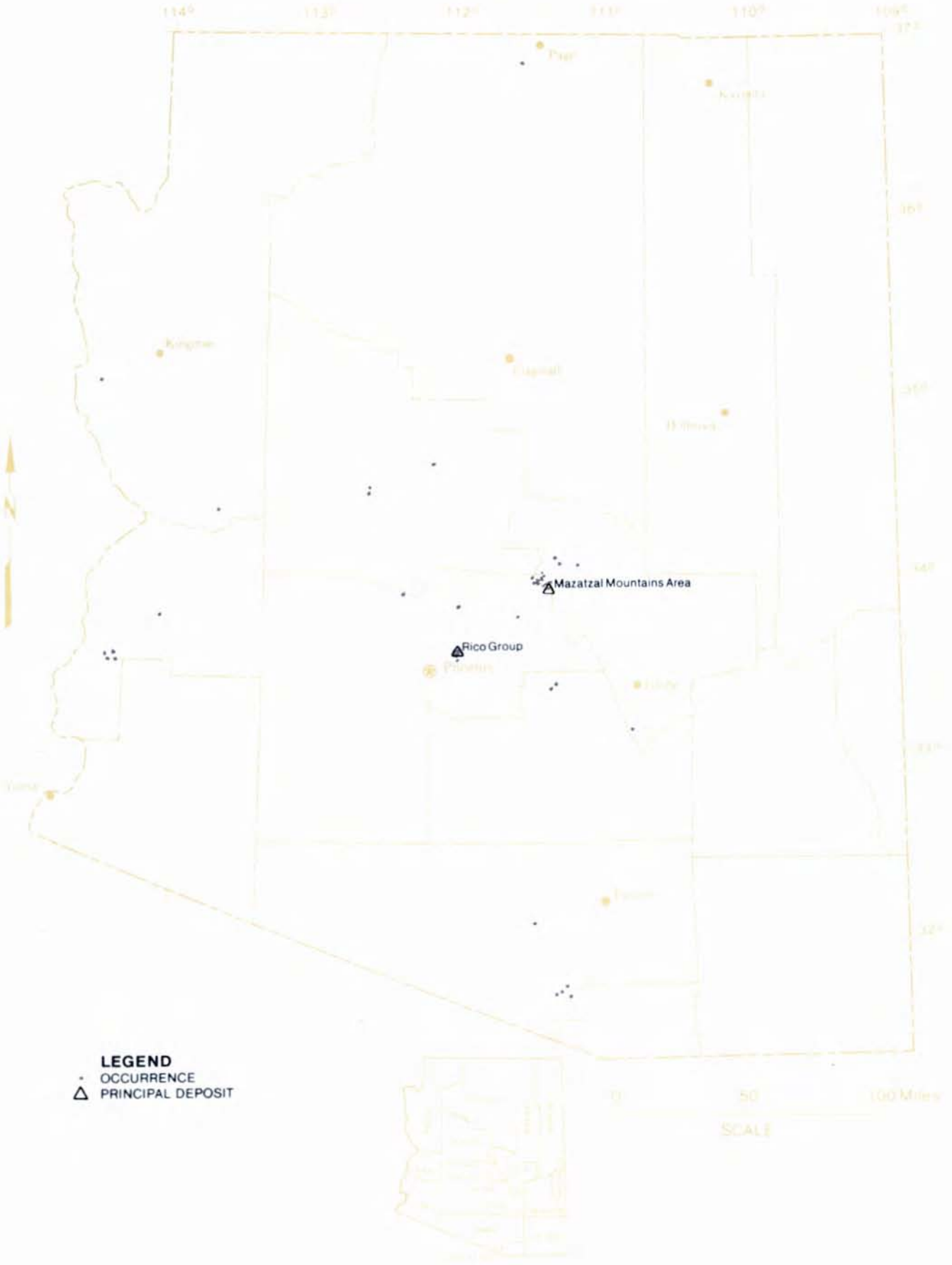



Figure 28. Mercury in Arizona.

# MOLYBDENUM

Molybdenum is a silver-white, very hard metal that is softer and more ductile than tungsten. It has a high melting point that, among the common metals, is exceeded only by tungsten and tantalum. The metal also has a high modulus of elasticity and is tough and durable. It has good thermal conductivity, a low coefficient of thermal expansion, corrosion resistance, and high strength at elevated temperatures (68, 231, 241).

The Greek and Roman civilizations called several minerals "molybdos" or "molybdaena"; these minerals probably included galena, graphite, and molybdenite. They were grouped together because they were soft and "leadlike" (262-263). Pure elemental molybdenum was first prepared by P. J. Hjelm of Sweden only 4 years after Karl Scheele demonstrated that molybdenite was a mineral distinct from galena and graphite (68, 231). Molybdenum was initially used industrially in 1894 as a substitute for tungsten in tool steels. By the end of the 19th century, it was being used in chemicals and dyes. Self-hardening molybdenum tool steel was first marketed in 1898. During World War I, molybdenum was substituted for tungsten in high-speed steels and alloyed in certain steels for military armament (68, 231).

Molybdenum regained popularity in the mid-1920's and is now used in cast iron, steels, superalloys and other alloys, and as a refractory metal. These uses account for approximately 90% of domestic molybdenum consumption (68, 662). In alloys, molybdenum improves hardenability and toughness and increases resistance to temperature-associated embrittlement, abrasion, and corrosion. It also increases hardness and strength at elevated temperatures.

For these reasons, molybdenum is commonly used in steel alloys that are used in all major industries. It is used in high-strength low-alloy steels, which are strong, tough, and weldable. These steels are particularly useful in arctic and marine environments. Molybdenum is also used as a refractory metal for electrical and electronic components, for resistance elements in electric furnaces, and for many other applications where materials are used under extremely high temperatures. It can be applied as a powder to produce a wear-resistant surface. Molybdenum is also used for welding rods, hard-facing alloy rods and materials, metal-to-glass sealing materials, and permanent magnet alloys. Other uses include lubricants, pigments, and catalysts. Its compounds are used for dyes, colored inks, ink- and corrosion- resistant primers, flame retardants, smoke suppressants, and a micronutrient (67-68, 231, 662).

Molybdenum is classified as a strategic element, as is rhenium, which is commonly associated with the molybdenum. Rhenium is used in platinum-rhenium petroleum reformer catalysts and metallurgical alloys. (662). The United States produces more molybdenum than it uses and is a major exporter, but there are only a few mines and conversion plants. Although potential substitutes are available, they are seldom used. In fact, the trend is going in the other direction; because molybdenum is available and versatile, more uses for it are being developed (68, 231, 241, 312, 662).

Molybdenum was originally mined in Arizona in 1915; production peaked during World War I and was discontinued shortly thereafter. Arizona has since resumed production of molybdenum as a coproduct or byproduct from copper mines and has consistently ranked third in U.S. production (659). At present, the

production of molybdenum is tied to that of copper. Arizona is also the largest producer of rhenium from porphyry copper-molybdenum deposits. The rhenium is geologically associated with the molybdenum and is recovered from the molybdenum concentrate during roasting (69, 659). Currently about one-half of the contained rhenium is recovered at the Sierrita roaster. Recovery is likely to increase in the future because of recent demand (69). The molybdenum reserves were estimated in 1968 at about 450,000 st of metal (0.005% to 0.05% molybdenum in copper ore) and may be as great as 900,000 st of metal (67, 116, 311-312).

Mineral Occurrences and Principal Deposits in the State of Arizona--Molybdenum

| | |
|---|---|
| Total properties | 243 |
| Known principal deposits | 22 |
| Deposit abstracts in directory | 19 |

Reported Molybdenum Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | $10^3$ lb | [2]mt | Value, $10^3$ | $10^3$ lb | [2]mt | Value, $10^3$ |
| 1981 | 118,916 | 53,939 | $945,540 | 35,808 | 16,242 | $254,345 |
| 1982 | 76,135 | 34,534 | 504,089 | 20,445 | 9,274 | 89,928 |
| 1983 | 48,805 | 22,138 | 166,612 | 23,934 | 10,856 | 80,210 |
| 1984 | 102,405 | 46,450 | 326,780 | 24,013 | 10,892 | 76,112 |
| 1985 | 111,936 | 50,773 | 347,812 | 24,125 | 10,943 | 63,389 |
| 1986 | 95,006 | 43,094 | 240,484 | 29,382 | 13,327 | 75,607 |

[1]Mine production of contained molybdenum measured as shipments.
[2]Converted from pounds.

Source: Reference 659.

Principal Known Molybdenum Deposits In Arizona

| Deposit | County | Status | Commodity[1] | Size[2] | X-Ref[3] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $10^6$ st | wt % Mo | Year | Class[4] | Reference(s) |
| Bagdad[5] | Yavapai | A-P | Cu, Mo, Ag, Au | M[6] | Cu, Ag, Au | [7]397.3 | [7]0.014 | 1986 | Prov | 126, 406 |
| Chilito | Gila | I-PP | Cu, Mo, Ag, Au | M[6] | Cu | 74 | .01 | 1970 | NRIR | 32 |
| Copper Basin[5] | Yavapai | I-PP | Cu, Mo, Au | M[6] | Cu | 175 | .01 | 1981 | NRIR | 484 |
| Eisenhower[5] | Pima | A-P | Cu, Ag, Mo, Au | U | Cu, Ag, Au | 99,276 | ([8]) | 1986 | Demo | 49 |
| Esperanza[5] | ...do... | A-P | Cu, Mo, Ag | M[6] | Cu, Ag | 48.783 | .034 | 1981 | NRIR | 513 |
| Helvetia East[5] | ...do... | I-PP | Cu, Ag, Mo, Au | M[6] | Cu, Ag | 280 | .016 | 1988 | NRIR | 12 |
| I-10 | Cochise | I-EP | Cu, Mo | M[6] | Cu | 100 | .02 | 1987 | Demo | 64 |
| Lone Star[5] | Graham | I-DD | Cu, Mo | M[6] | Cu | 1,065 | ([8]) | 1981 | NRIR | 25 |
| Mineral Park[5] | Mohave | A-P | Cu, Mo, Ag | M[6] | Cu | 35 | .054 | 1986 | NRIR | 63 |
| Mission-San Xavier[5] | Pima | A-P | Cu, Mo, Ag, Au | L[6,9] | Cu, Ag, Au | 367.5 | ([8]) | 1987 | NRIR | 143 |
| Morenci-Metcalf[5] | Greenlee | A-P | Cu, Mo, Au, Ag, Zn | M[6] | Cu, Au, Ag | 794.235 | ([8]) | 1986 | Meas | 535 |
| | | | | | | 183.529 | ([8]) | 1986 | Meas | 535 |
| New Cornelia[5] | Pima | A-TS | Cu, Mo, Au, Ag, Re | M[6] | Cu, Au, Ag | 209.2 | ([8]) | 1986 | Meas | 535 |
| Pima[5] | ...do... | A-P | Cu, Ag, Mo, Au | U | Cu, Ag, Au | 120.767 | ([8]) | 1984 | NRIR | 254 |
| Pinto Valley[5] | Gila | A-P | Cu, Mo, Au, Ag, Pb, Zn, $U_3O_8$ | M[6] | Cu, Au, Ag | 480.5 | .015 | 1987 | NRIR | 353 |
| Ray[5] | Pinal | A-P | Cu, Mo, Au, Ag, Pb, Zn | M[6] | Cu, Au, Ag | [10]677 | [10,11].010 | 1988 | NRIR | 25, 143 |
| San Manuel-Kalamazoo[5] | ...do... | A-P | Cu, Mo, Au, Ag | M[6] | Cu, Au, Ag | [6]155.846 | [11].028 | 1987 | Demo | 353 |
| Santa Cruz[5] | ...do... | A-EP | Cu, Mo, Au, Ag | M[6] | Cu | 350 | .01 | 1984 | NRIR | 32, 485, 496 |
| Sierrita[5] | Pima | A-P | Cu, Mo, Ag, Re, Au | M[6] | Cu, Ag, Au | 343.3 | .036 | 1986 | Prov | 126 |
| Squaw Peak[5] | Yavapai | I-PP | Mo, Cu, Pb, Zn, Ag | M[6] | NAp | [12]20 | [12].24 | 1976 | NRIR | 558, 665 |
| Twin Buttes[5] | Pima | A-TS | Cu, Mo, Ag, Au, Zn, Pb, $U_3O_8$ | M[6] | Cu | [13]37 | [13].030 | 1988 | NRIR | 219, 507 |
| Vekol Hills[5] | Pinal | I-EP | Cu, Mo, Au, Ag | M[6] | Cu | 104.651 | .014 | 1981 | Prov | 201 |
| Ventura | Santa Cruz | I-EP | Mo, Cu | M[6] | NAp | 6 | [11].28 | 1965 | Demo | 64 |

A Active. DD Developed deposit. EP Explored prospect. I Inactive. NAp Not applicable. P Producer. PP Past producer. TS Temporary shutdown. U Undetermined. X-Ref Cross reference.

[1] Commodities are listed in order of decreasing importance.

[2] Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 5,000; M, medium, 5,000 to 500,000; L, large, greater than 500,000; U, undetermined.

[3] Indicates other commodities for which this deposit has been judged to be a principal deposit. Additional data may be found in the tables of principal deposits for these other commodities.

[4] Class of reserve-resource is reported as described in the reference. The following abbreviations are used: Meas, measured; Prov, proven; Demo, demonstrated; NRIR, not reported in reference.

[5] Deposit abstract in directory.

[6] Based only on current resources.

[7] Reserve tonnage taken from reference 126 and grade from reference 406.

[8] No published data have been located.

[9] Based on resources of entire Mission Complex (Eisenhower, Mission-San Xavier, and Pima).

[10] Reserve tonnage taken from reference 143 and grade from reference 25.

[11] Wt % $MoS_2$.

[12] Reserve tonnage taken from reference 558 and grade from reference 665.

[13] Reserve tonnage taken from reference 507 and grade from reference 219.

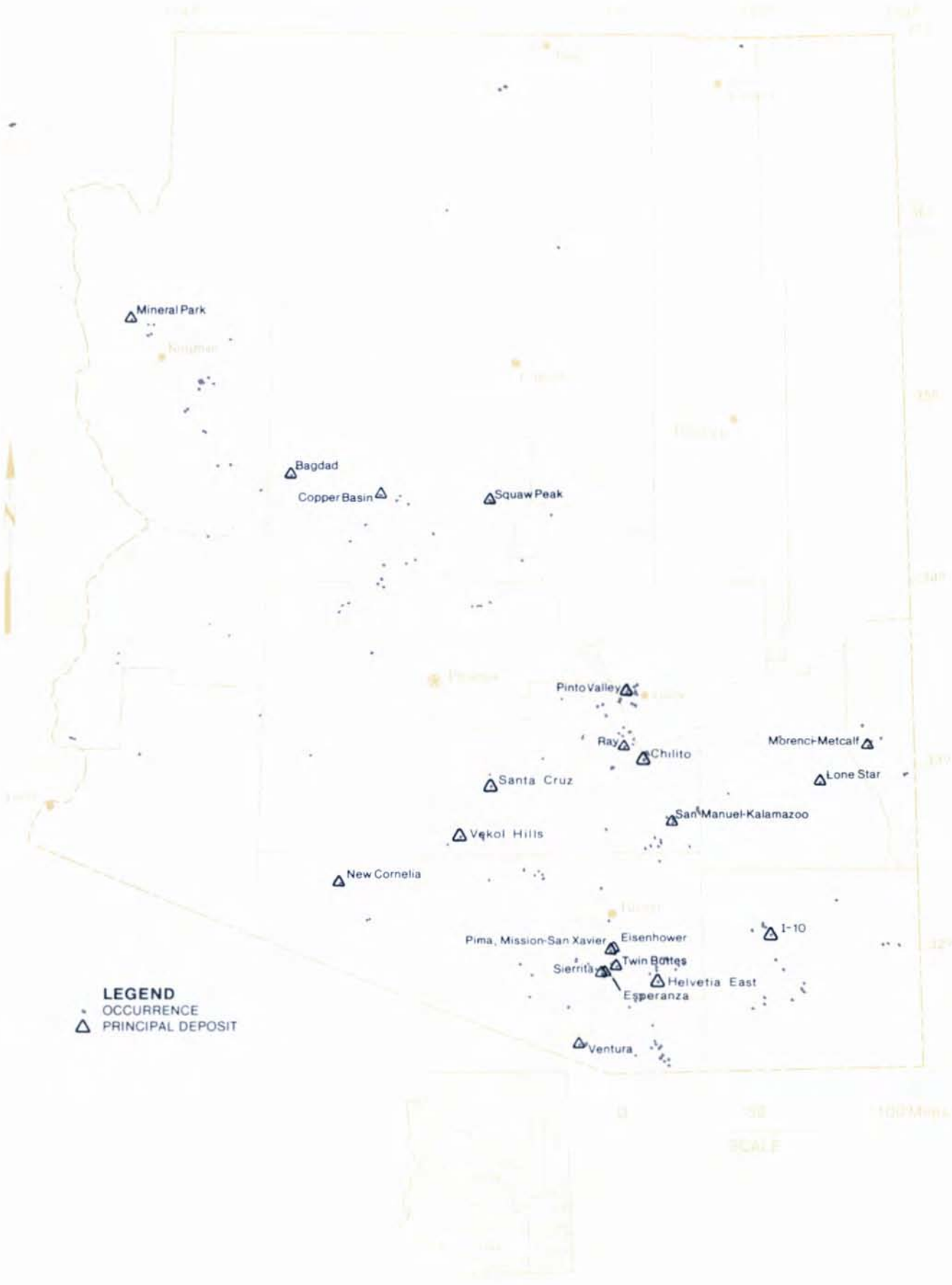



Figure 29. Molybdenum in Arizona.

# SILVER

Silver is a dense metal with a brilliant white metallic luster. It is harder than gold. Its ductility and malleability are exceeded only by gold and possibly palladium. It has the highest electrical and thermal conductivity of any pure metal, with the lowest contact resistance. The metal is stable in pure air and water, but it tarnishes when exposed to air containing sulfur, ozone, or hydrogen sulfide. It is the most reflective of all metals for visible light, although it tarnishes rapidly (231, 241, 553).

Man has used silver since ancient times, originally for utensils and ornaments. Silver was separated from lead as early as 3000 B.C. by the process of cupellation. Slag dumps from this process are found in Asia Minor and on islands in the Aegean Sea. As a precious metal, silver was used in barter and, from the time of the ancient Greeks, was used as a standard in monetary systems. This practice continued until the discovery of major silver deposits in Mexico and Peru, at which time the standard shifted to gold. Expanding industrial use has precluded its use for coinage in this country in recent decades (223, 231, 553).

Silver is used in nonindustrialized countries mainly for jewelry and sterlingware. In industrialized countries, it is used primarily for utilitarian purposes. The United States uses approximately 45% of its silver consumption in photographic materials such as film, photocopying paper, photographic paper, and photo offset printing plates. The tarnish which forms on silver has little electrical resistance and thus does not interfere with its use in electrical and electronic products such as switching devices. Its

alloys with copper or palladium are used where higher strength, wear resistance, resistance to arcing, or lower costs are required. Silver batteries produce high energy output for their size and weight, but have a short life and high cost. This shortcoming has limited their use to military and space applications. Small silver-zinc button cells are being used increasingly in calculators and hearing aids. Thus, 25% of the metal is used for electrical applications (231, 241, 553, 662).

The next major use (11%) is for sterlingware, electroplating, and jewelry. Sterling silver is an alloy containing 92.5% silver and 7.5 percent copper and is the major alloy used for manufacturing bowls, candlesticks, and flatware, and for electroplating of base metal objects. Five percent of the silver consumed domestically is in brazing alloys and solder that are used primarily by the refrigeration and air conditioning industries. Silver is also used in mirrors, medicines, dental amalgams, catalysts, coins, and in medallions and commemorative objects (231, 241, 553, 662).

Import reliance is 69% of current consumption. At present, the United States imports silver primarily from Canada, Mexico, and Peru. Any two of these countries are capable of supplying all import needs, and the simultaneous disruption of imports from all three is unlikely. There are numerous substitutes for silver in many of its applications. For mirrors and other reflecting surfaces, aluminum and rhodium can be used. Tantalum can replace silver in surgical applications, and stainless steel is often used for flatware. Films are being developed that do not use silver, and xerography also reduces the amount of photographic silver used (241, 553, 662).

Silver ore was originally discovered in Arizona in 1583 at the headwaters of the Verde River, probably at the present site of the United Verde base metal mine. Production recorded in 1705 was probably from the Santa Rita Mountains. In 1856, the Santa Rita silver mine opened. Mining spread rapidly, but ceased almost entirely during the Civil War because of lack of protection from the Indians (159, 553).

In 1871, Federal troops returned to the area, mining and prospecting resumed, and silver mining flourished. By 1879, silver had become the major metal produced in the State. The demonetization of silver in 1893 caused a shift of the prospector's attention to gold. After 1903, silver was produced mainly as a byproduct of porphyry copper deposits. Silver has been produced in Arizona from deposits in approximately 60 mining districts, mostly in the southwestern half of the State (159, 553).

There are three common types of silver deposits in Arizona: (1) siliceous vein deposits, (2) high-grade sulfides, and (3) low-grade disseminated copper deposits. The siliceous vein deposits may occur either with or without base metal sulfides and may be epithermal or mesothermal. The epithermal veins contain free gold with some silver and lesser amounts of pyrite and chalcopyrite. The veins are primarily composed of quartz with some calcite and occasional minor amounts of adularia and fluorite. These deposits range from fissure vein fillings to fillings in shatter zones up to 70 ft wide and are principally found in Tertiary volcanic flows. The mesothermal deposits have free gold and silver with limited amounts of argentiferous galena, sphalerite, chalcopyrite, and pyrite. Quartz forms the only gangue mineral in these simple fissure fillings in Precambrian granite, gneiss, and

schist. Occasionally, other rocks may serve as hosts (250, 392).

The high-grade sulfide deposits consist of veins that contain a major commodity such as lead, zinc, or copper with significant amounts of silver as an accessory metal.

The low-grade disseminated copper deposits, also known as porphyry copper deposits, are the State's principal silver source today, even though silver is produced from them only as a byproduct (250, 392).

Silver production during the past few decades has been closely related to base metal mining. At present, Arizona contributes only 8% of the silver produced in the United States (159, 250, 392).

Mineral Occurrences and Principal Deposits in the State of Arizona--Silver

| | |
|---|---|
| Total properties | 3,030 |
| Known principal deposits | 24 |
| Deposit abstracts in directory | 24 |

Reported Silver Production--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | $10^3$ tr oz | [1] $10^3$kg | Value, $10^3$ | $10^3$ tr oz | [1] $10^3$kg | Value, $10^3$ |
| 1981 | 40,683 | 1,265 | $427,922 | 8,055 | 251 | $84,728 |
| 1982 | 40,248 | 1,252 | 319,975 | 6,309 | 196 | 50,159 |
| 1983 | 43,431 | 1,351 | 496,850 | 4,492 | 140 | 51,383 |
| 1984 | 44,592 | 1,387 | 362,976 | 4,247 | 132 | 34,570 |
| 1985 | 39,433 | 1,227 | 242,205 | 4,885 | 152 | 30,007 |
| 1986 | 34,220 | 1,064 | 187,183 | 4,202 | 131 | 22,987 |

[1] Converted from troy ounces.

Source: Reference 659.

Principal Known Silver Deposits in Arizona

| Deposit | County | Status | Commodity[1] | Size[2] | X-Ref[3] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $10^6$ st | Grade[4] | Year | Class[5] | Reference |
| Bagdad[6] | Yavapai.. | A-P | Cu, Mo, Ag, Au | U | Cu, Mo, Au | 397.3 | (7) | 1986 | Prov | 126 |
| C. O. D.[6] | Mohave... | A-PP | Ag, Au, Pb, Cu, Zn | S | U | [8].003 | 7.90 | 1980 | Meas | 539 |
| | | | | | | [9].004 | 3.74 | 1980 | Meas | 539 |
| Commonwealth[6] | Cochise.. | I-PP | Ag, Au, Mo, Cu, Pb | S[10] | NAp | (7) | (7) | NAp | NAp | NAp |
| Contention-Grand Central[6] | ...do.... | A-PP | Ag, Au, Pb, Cu, Zn | M | NAp | .1 | 2.0 | 1987 | NRIR | 409 |
| Eisenhower[6] | Pima..... | A-P | Cu, Ag, Mo, Au | M | Cu, Mo, Au | 99.276 | .14 | 1986 | Demo | 49 |
| Esperanza[6] | ...do.... | A-P | Cu, Mo, Ag | U | Cu, Mo | 48.783 | (7) | 1981 | NRIR | 513 |
| Fountain Head[6] | Mohave... | A-PP | Ag, Au, Pb, Zn, Cu | U | NAp | (7) | (7) | NAp | NAp | NAp |
| Helvetia East[6] | Pima..... | I-PP | Cu, Ag, Mo, Au | U | Cu, Mo | 280 | (7) | 1988 | NRIR | 12 |
| McCabe[6] | Yavapai.. | A-P | Au, Ag, Pb, Cu, Zn | S | Au | .7537 | 1.730 | 1988 | Demo | 681 |
| Mission-San Xavier[6] | Pima..... | A-P | Cu, Mo, Ag, Au | M[11] | Cu, Mo, Au | 367.5 | .12 | 1987 | NRIR | 143 |
| Montana[6] | Santa Cruz | A-DD | Ag, Au, Pb, Zn, Cu | S | Au | .7 | 1.0 | 1987 | NRIR | 409 |
| Morenci-Metcalf[6] | Greenlee. | A-P | Cu, Mo, Au, Ag, Zn | U | Cu, Mo, Au | 977.764 | (7) | 1986 | Meas | 535 |
| New Cornelia[6] | Pima..... | A-TS | Cu, Mo, Au, Ag, Re | U | Cu, Mo, Au | 209.2 | (7) | 1986 | Meas | 535 |
| Pima[6] | ...do.... | A-P | Cu, Ag, Mo, Au | U | Cu, Mo, Au | 120.767 | (7) | 1984 | NRIR | 254 |
| Pinto Valley[6] | Gila..... | A-P | Cu, Mo, Au, Ag, Pb, Zn, $U_3O_8$ | U | Cu, Mo, Au | 480.5 | (7) | 1987 | NRIR | 353 |
| Ray[6] | Pinal.... | A-P | Cu, Mo, Au, Ag, Pb, Zn | U | Cu, Mo, Au | 677 | (7) | 1988 | NRIR | 143 |
| Reymert[6] | ...do.... | A-P | Ag, Cu, Au, Pb, Mn, $CaF_2$ | S | NAp | .94 | 4.5 | 1987 | NRIR | 409 |
| Sanchez[6] | Graham... | A-DD | Cu, Au, Ag, Mo | S[11] | Cu, Au | 100 | .10 | 1988 | NRIR | 51 |
| San Manuel-Kalamazoo[6] | Pinal.... | A-P | Cu, Mo, Au, Ag | S[11] | Cu, Mo, Au | 155.846 | .029 | 1987 | Demo | 353 |
| Sierrita[6] | Pima..... | A-P | Cu, Mo, Ag, Re, Au | U | Cu, Mo, Au | 343.3 | (7) | 1986 | Prov | 126 |
| Silverbell-Martinez[6] | Pinal.... | A-PP | Ag, Pb, Cu, Au, Zn | S[11] | NAp | .4 | 6.3 | 1987 | NRIR | 409 |
| Silver-Eureka District[6] | Yuma..... | I-PP | Ag, Pb, $BaSO_4$ | M[11] | NAp | 6 | 4.5 | 1981 | NRIR | 482 |
| Silver King[6] | Pinal.... | A-PP | Ag, Pb, Cu, Au, Zn, As | S | NAp | (7) | (7) | NAp | NAp | NAp |
| Wildflower[6] | Yavapai.. | I-PP | Ag, Au, Cu, Zn, Pb | S | NAp | (7) | (7) | NAp | NAp | NAp |

A Active. DD Developed deposit. I Inactive. NAp Not applicable. P Producer. PP Past producer. TS Temporary shutdown. U Undetermined. X-Ref Cross reference.

[1] Commodities are listed in order of decreasing importance.

[2] Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 500; M, medium, 500 to 10,000; L, large, greater than 10,000.

[3] Indicates other commodities for which this deposit has been judged to be a principal deposit. Additional data may be found in the tables of principal deposits for these other commodities.

[4] Tr oz/st Ag.

[5] Class of reserve-resource is reported as described in the reference. The following abbreviations are used: Meas, measured; Prov, proven; Demo, demonstrated; NRIR, not reported in reference.

[6] Deposit abstract in directory.

[7] No published data have been located.

[8] Dump material.

[9] Tailings.

[10] Based only on past production.

[11] Based only on current resources.

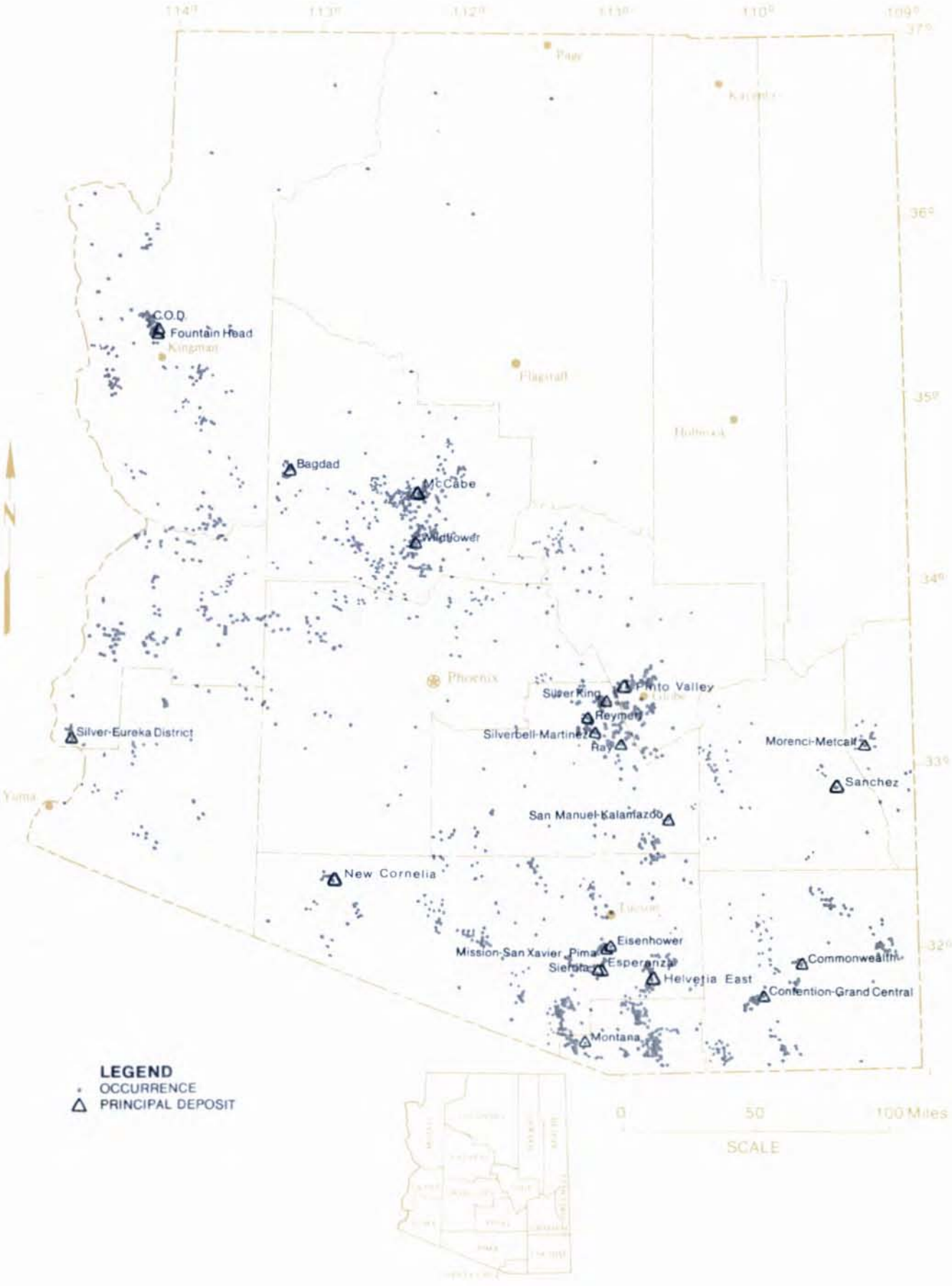



Figure 30. Silver in Arizona.

# TUNGSTEN

Tungsten is a steel-gray to tin-white, very heavy metal that, when pure, can be forged, spun, drawn, and extruded. The metal has the highest melting point and lowest vapor pressure of all metals. It also has the highest tensile strength of any metal at temperatures greater than 1650° C but tends to oxidize in air at elevated temperatures. Tungsten has excellent corrosion resistance and good thermal and electrical conductivity. It has approximately the same low coefficient of thermal expansion as borosilicate glass (231, 241, 630).

Tungsten was initially noticed because wolframite interfered with the smelting of tin and was thought to devour the tin. Peter Woulfe examined wolframite and determined that it was a new substance. In 1781, Scheele discovered an acid made from scheelite (then called tun sten). In 1783, the de Elhuyan brothers reduced this acid to the form of elemental tungsten. The first use of this element was in a high-speed tungsten-manganese steel alloy, which was its primary use until 1900. During World War I, tungsten was first used in armaments. The resulting demand led to the discovery and development of the major wolframite deposits in China into the world's largest tungsten producer (231, 630, 662).

Tungsten materials are divided into four major classes dependent on use. The carbide is used for cutting and wear-resistant materials and for welding and hard-facing rods. In 1983, these uses accounted for 65% of domestic consumption. Mill products such as tungsten wire, used for loop filaments and electronic tube cathodes, and disks, used for automotive distributor points

and contact points in manufactured products, are made of relatively pure metal. It is also used for heat and radiation shielding, parts of X-ray and cathode ray tubes, electrodes for inert gas welding, and in heating elements in high-temperature resistance furnaces. Tungsten is used extensively by the aerospace industry for its strength at elevated temperatures in reducing and inert atmospheres. These uses for the pure metal account for 25% of 1983 domestic consumption. Tungsten is alloyed to make nonferroalloys, superalloys, and high-speed die and tool steels, which collectively account for 9% of 1983 consumption. Tungsten chemicals and compounds are used in textile dyes, tones, enamels, paints, and for coloring glass. Some of these are luminescent and are used as phosphors in fluorescent lights, X-ray screens, and television picture tubes. These uses account for the final 1% of 1983 consumption (231, 241, 630, 662).

Tungsten is a strategic material necessary for defense purposes. The United States relied on imports for 80% of the tungsten used in 1987. At present, there are no operating tungsten mines in the United States, and 90 percent of the world's resources of tungsten are located outside of the United States. The metal is imported from a variety of sources. The increased use of coatings on cemented tungsten tool inserts has increased the life of these parts and decreased demand. These inserts are also being replaced by titanium carbide, ceramic, and polycrystalline diamond inserts (231, 241, 630, 662).

Tungsten was first reported from Arizona in 1896 by the Territorial Geologist. The first production from the State occurred in 1900 from veins at Bluebird Hill in the Little Dragoon Mountains. Shortly thereafter, deposits were discovered at Las Giujas, Boriana, Camp Bonita, and the Huachuca

Mountains. Nearly 200 occurrences have been discovered in Arizona, primarily in the southwestern half of the State. Arizona has produced over 280,000 st units of tungsten, and the State ranked sixth in the country for total production from 1900 to 1957. The Boriana Mine has produced more than half of the total production for the State.

Deposits are of three basic types: quartz veins with scheelite and/or wolframite; contact-metamorphic bodies containing scheelite, garnet, and other silicates that were formed when granitic intrusives contacted limestones (257); and disseminated hydrothermal deposits containing scheelite and wolframite with other base metals in various host rock types (258). Tungsten also occurs occasionally in pegmatites and placer deposits. Most tungsten ores appear to be genetically related to granitic intrusives and contain only small amounts of the metal (133). The amount of tungsten oxide in ores that have been mined in the past has ranged from 0.25% to more than 10% with an average between 0.5% and 1.0% (134). Because of the erratic and spotty distribution of tungsten minerals, the future of Arizona resources is difficult to evaluate (133-134, 241, 256-258, 698).

Mineral Occurrences and Principal Deposits in the State of Arizona--Tungsten

| | |
|---|---|
| Total properties | 320 |
| Known principal deposits | 14 |
| Deposit abstracts in directory | 14 |

Reported Tungsten Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | [2]st | mt | Value, $10^3$ | st | mt | Value |
| 1981 | 3,908 | 3,545 | $62,231 | NRP | NRP | NRP |
| 1982 | 1,736 | 1,575 | 22,062 | NRP | NRP | NRP |
| 1983 | 1,120 | 1,016 | 10,528 | NRP | NRP | NRP |
| 1984 | 1,293 | 1,173 | 13,409 | NRP | NRP | NRP |
| 1985 | 1,084 | 983 | 9,143 | NRP | NRP | NRP |
| 1986 | 901 | 817 | 5,774 | NRP | NRP | NRP |

NRP No reported production.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by consumers).

[2]Converted from metric tons.

Source: Reference 659.

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^3$ st | wt %[3] | Year | Class[4] | Reference |
| Black Pearl[5] | Yavapai | I-PP | W, quartz crystal, Be, Bi, F, Fe, Au, Ag, Mo, Cu | S[6] | (7) | (7) | NAp | NAp | NAp |
| Borlana[5] | Mohave | I-PP | W, Ag, Au | M[8] | 2.4 | 1-1.5 | 1943 | Meas | 256 |
| | | | | | 9.7 | 1-1.5 | 1943 | Ind | 256 |
| Edna Group[5] | Santa Cruz | I-PP | W, Mo, Cu | S | (7) | (7) | NAp | NAp | NAp |
| Lucky Strike[5] | Cochise | I-PP | W, Pb, Ag, Au | S[6] | (7) | (7) | NAp | NAp | NAp |
| Morning Star[5] | Pinal | I-PP | W, Cu, Pb | S | 11.2 | .7 | 1981 | NRIR | 665 |
| North Star[5] | Yavapai | I-PP | W | S | (7) | (7) | NAp | NAp | NAp |
| Primos Group[5] | Cochise | I-PP | W, Cu, Bi, Be | S[6] | (7) | (7) | NAp | NAp | NAp |
| Pure Gold[5] | Pinal | I-PP | W | S[6] | (7) | (7) | NAp | NAp | NAp |
| Reef[5] | Cochise | I-PP | W, Au, Ag, Pb, Cu, Zn, Te | S | (7) | (7) | NAp | NAp | NAp |
| Rose[5] | Gila | I-PP | W | S | (7) | (7) | NAp | NAp | NAp |
| Samsel[5] | ...do | I-PP | W, Au, Ag, Pb, Cu, Mo | S[6] | (7) | (7) | NAp | NAp | NAp |
| Three Musketeers[5] | La Paz | I-PP | W, Au | S[8] | (7) | (7) | NAp | NAp | NAp |
| Wakefield Group[5] | Cochise | I-PP | W, Au, Ag, Cu, Pb | S | (7) | (7) | NAp | NAp | NAp |
| Williams[5] | Mohave | I-PP | W, Cu, $CaF_2$ | S[6] | (7) | (7) | NAp | NAp | NAp |

I Inactive. NAp Not applicable. PP Past producer.

[1]Commodities are listed in order of decreasing importance.

[2]Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 500; M, medium, 500 to 10,000; L, large, greater than 10,000.

[3]Wt % $WO_3$.

[4]Class of reserve-resource is reported as described in the reference. The following abbreviations are used: Meas, measured; Ind, indicated; NRIR, not reported in reference.

[5]Deposit abstract in directory.

[6]Based only on past production.

[7]No published data have been located.

[8]Based only on current resources.

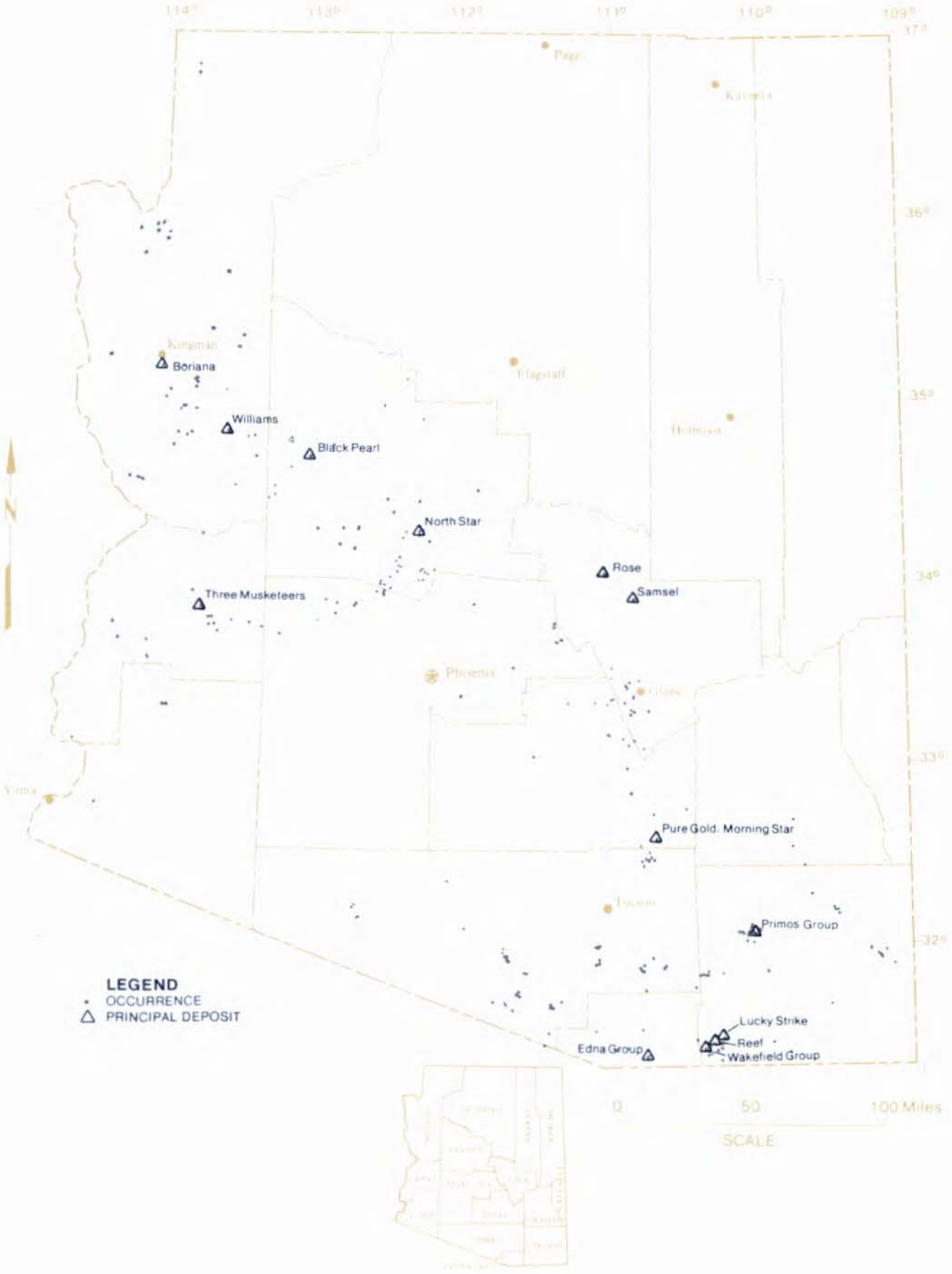



Figure 31. Tungsten in Arizona.

# ZINC

Zinc is a relatively soft, bluish-white, brittle, lustrous metal. The metal is a fair conductor of electricity and becomes malleable at 100° to 150° C. When heated to a high red heat, it burns, generating white clouds of zinc oxide. Zinc also has a low melting point and high electrochemical activity (231, 287).

Although zinc has been found in bronze artifacts made 7,000 years ago, the metal itself was unknown in Europe until the 16th century. The oldest known, largely zinc-alloy artifact, containing 87 percent zinc, was found in prehistoric ruins in Transylvania. Zinc was smelted in China in the seventh century A.D. and in India as early as A.D. 1000. The Chinese used it for mirrors and coins. During the 17th and 18th centuries, the Asian smelting of zinc provided slab zinc for use in Europe. Zinc ores were used for centuries for making brass before zinc was recognized as a distinct element. In 1746, Marggraf first reduced calamine with charcoal to produce zinc (223).

Zinc is the fourth most widely used industrial metal. Its use is surpassed by that of iron, aluminum, and copper. The end uses are not as obvious as those of other common metals. It is used for galvanizing, the process of coating steel and iron products, thereby providing a barrier between the environment and the base metal; when this no longer works, it protects the base metal by galvanic action. Galvanized steel is used in structural components of industrial plants, buildings, bridges, roads, and automobiles. Zinc is also alloyed with copper to make brass, where it imparts workability at low-temperatures, corrosion protection, and attractive

finishes. Zinc die-cast components are used in builders' hardware and automobile and electrical components. Brass and bronzes are used for plumbing and heating and for radiators, tubing, and trim in automobiles. Zinc oxide is used in paints because of its high opacity to ultraviolet light and high refractive index, which enhance durability and covering ability. Zinc oxide is also used as an essential activator and accelerator in vulcanizing rubber, as an electrostatic and photoconductive agent in photocopying, and as a raw material for making various zinc chemicals. Rolled zinc is used for the production of pennies as well as for dry well battery cases, roofing, plate-engraving plates, and sacrificial anodes used to protect ship hulls from galvanic action. Zinc dust is used for primers, paints, sherardizing, precipitation of noble metals from solution, desilvering leads, and removal of impurities from solution in zinc electrowinning. Zinc compounds are used as catalysts, fluxes, fungicides, phosphors, and additives to lubricating oils and greases (287, 662).

The only use for which there is no satisfactory substitute for zinc is galvanizing large-sized iron and steel products; otherwise, aluminum, manganese, and plastics can be used. Import reliance for the United States was 69% in 1987, with most imports coming from Canada (241, 287, 662).

Zinc was first produced in Arizona in 1905 when it was selectively floated. Since then, production has been sporadic, peaking in the late 1940's. Production has come from more than 135 mines and prospects in 50 districts. Of these 50 districts, 23 produced more than 500 st of zinc, but only 10 districts accounted for more than 90% of the State's past production. Zinc deposits are found primarily in the Jerome-Wickenburg area and in the

southwestern half of the State (391, 572).

Zinc deposits are generally of either vein or replacement type. The vein deposits typically consist of siliceous fissure veins with lead minerals and lesser amounts of zinc, copper, and silver minerals. The primary base metal ore minerals are galena, sphalerite, chalcopyrite, tennantite, and proustite. Quartz is the primary gangue mineral, but it may be accompanied by calcite, fluorite, barite, and rhodochrosite (391, 572).

The replacement deposits occur as massive sulfides and as tactites. Eight of the top 10 zinc-producing districts in the State consist of massive sulfides. These are characterized by relatively simple mineralogy with abundant galena and sphalerite and lesser amounts of chalcopyrite and pyrite. The replacement ore bodies occur in favorable structures and tend to be tabular, lenticular, or pipelike. They may either conform to existing bedding or follow existing shatter zones. The tactite deposits generally contain more zinc than lead. The principal ore minerals are chalcopyrite, sphalerite, bornite, and pyrite; they are distributed throughout the silicate replacement body. The most important of these tactite deposits, in terms of the zinc resources of the State, are in the Pima and Cochise districts (391, 572).

The State was estimated in 1969 to have zinc resources of about 1 billion lb. New deposits of zinc may also be found that will increase this figure (391).

Mineral Occurrences and Principal Deposits in the State of Arizona--Zinc

| | |
|---|---|
| Total properties | 768 |
| Known principal deposits | 3 |
| Deposit abstracts in directory | 3 |

Reported Zinc Production[1]--United States and Arizona, 1981-86

| Year | United States | | | Arizona | | |
|---|---|---|---|---|---|---|
| | [2]st | mt | Value, $10^3$ | [2]st | mt | Value, $10^3$ |
| 1981 | 344,381 | 312,418 | $306,879 | 152 | 138 | $135 |
| 1982 | 334,176 | 303,160 | 257,116 | NRP | NRP | NRP |
| 1983 | 303,459 | 275,294 | 251,204 | NRP | NRP | NRP |
| 1984 | 278,629 | 252,768 | 270,833 | NRP | NRP | NRP |
| 1985 | 249,723 | 226,545 | 201,607 | NRP | NRP | NRP |
| 1986 | 223,750 | 202,983 | 170,050 | NRP | NRP | NRP |

NRP No reported production.

[1]Recoverable content of ore.

[2]Converted from metric tons.

Source: Reference 659.

| Deposit | County | Status | Commodity[1] | Size[2] | Published reserves-resources | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $10^6$ st | wt % Zn | Year | Class[3] | Reference |
| Antler[4] | Mohave... | I-PP | Zn, Cu, Pb | M[5] | 5 | 4.13 | 1978 | Demo | 64 |
| Bruce[4] | Yavapai.. | I-PP | Zn, Cu, Ag, Au | S[5] | 0.1276 | 12.5 | 1976 | NRIR | 131 |
| San Juan[4] | Cochise.. | I-PP | Zn, Pb, Ag, Bi, Be, Li, Ga, Cd | M | ([6]) | ([6]) | NAp | NAp | NAp |

I Inactive. NAp Not applicable. PP Past producer.

[1]Commodities are listed in order of decreasing importance.

[2]Based on metric tons of commodity contained in past production plus current resources, unless otherwise noted. The following abbreviations and size ranges are used: S, small, less than 50,000; M, medium, 50,000 to 1,000,000; L, large, greater than 1,000,000.

[3]Class of reserve-resource is reported as described in the reference. The following abbreviations are used: Demo, demonstrated; NRIR, not reported in reference.

[4]Deposit abstract in directory.

[5]Based only on current resources.

[6]No published data have been located.

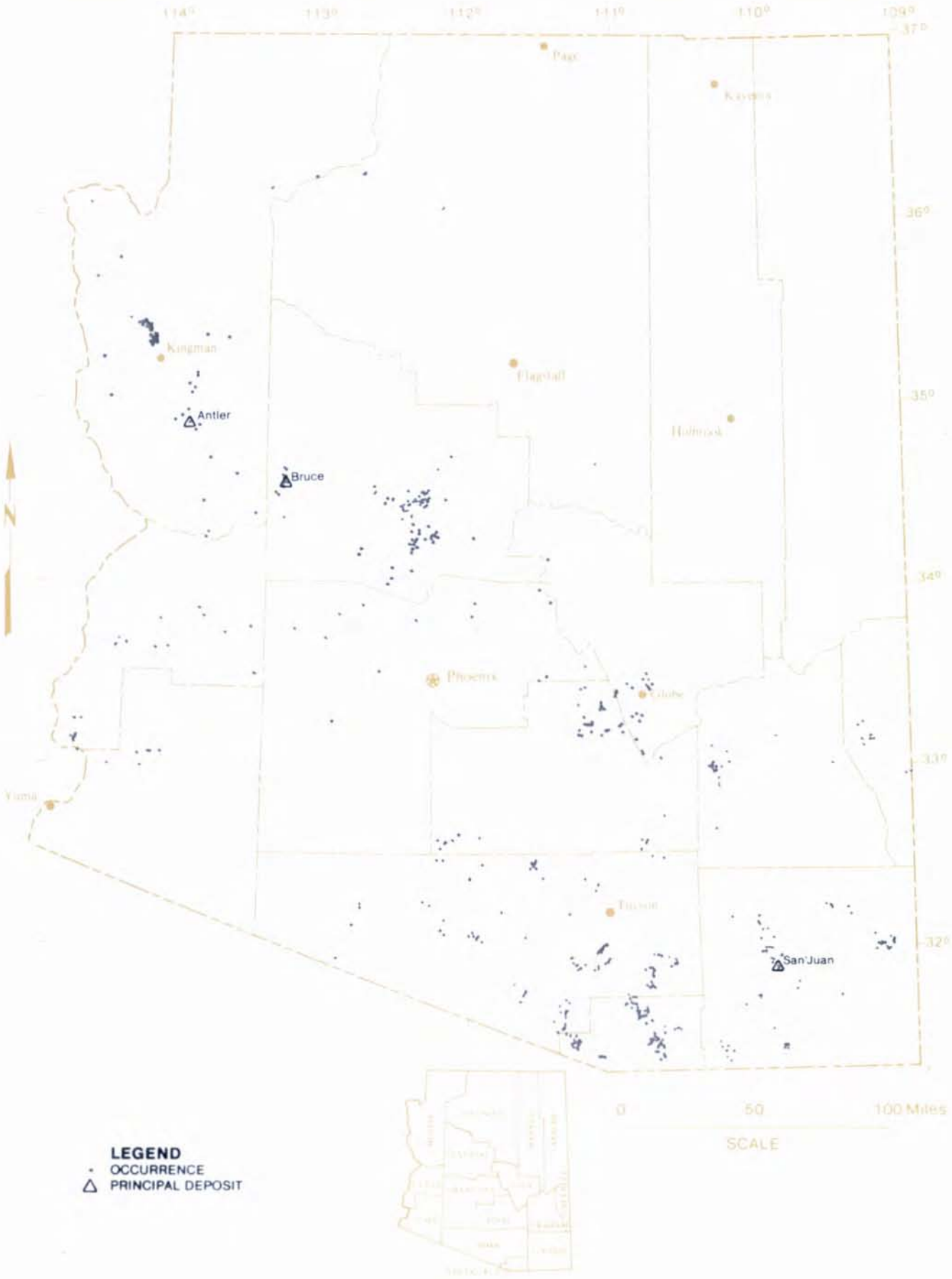
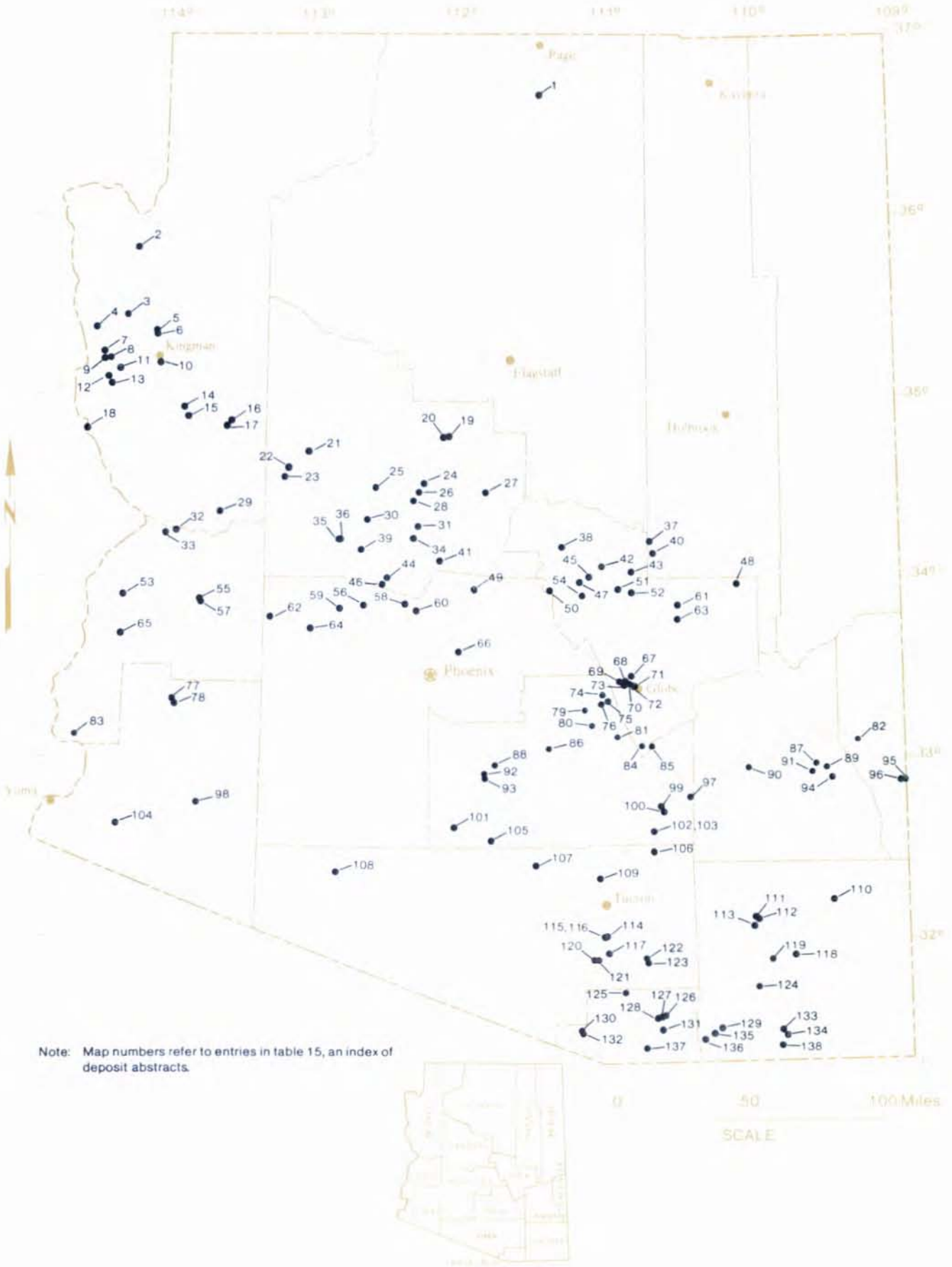



Figure 32. Zinc in Arizona.

## ABSTRACTS OF SELECTED DEPOSITS IN ARIZONA

As previously described, the heart of this publication consists of single-page, site-specific deposit abstracts for 138 selected deposits in Arizona. Figure 33 and table 15 serve as an index for the deposit abstract section.




Note: Map numbers refer to entries in table 15, an index of deposit abstracts.

Figure 33. Location of principal deposits with deposit abstracts.

Table 15.--Deposit abstract index

(Refer to figure 33)

| Map no. | Deposit name | Primary commodity | Map no. | Deposit name | Primary commodity | Map no. | Deposit name | Primary commodity |
|---|---|---|---|---|---|---|---|---|
| 1 | White Mesa District.... | Cu | 47 | Quartz Ledge..... | $CaF_2$ | 93 | Santa Cruz..... | Cu-Mo |
| 2 | Cyclopic..... | Au | 48 | Red Rock..... | $CaF_2$ | 94 | Sanchez..... | Cu |
| 3 | Mineral Park..... | Cu-Mo | 49 | Silver Cross..... | Au | 95 | Fourth of July..... | $CaF_2$ |
| 4 | Portland..... | Au | 50 | Mazatzal Mountains Area | Hg | 96 | Daniels Camp 1 & 2..... | $CaF_2$ |
| 5 | C.O.D..... | Ag | 51 | McFadden Peak..... | $CaF_2$ | 97 | Old Reliable..... | Cu |
| 6 | Fountain Head..... | Ag | 52 | Samsel..... | W | 98 | Renner..... | $BaSO_4$ |
| 7 | Roadside..... | Au | 53 | Copperstone..... | Au | 99 | Mammoth-Tiger..... | Au |
| 8 | Frisco..... | Au | 54 | Packard..... | $CaF_2$ | 100 | San Manuel-Kalamazoo.... | Cu-Mo |
| 9 | Arabian..... | Au | 55 | Yuma..... | Cu | 101 | Vekol Hills..... | Cu-Mo |
| 10 | Bi-Metal..... | Au | 56 | Newsboy..... | Au | 102 | Pure Gold..... | W |
| 11 | Secret Pass..... | Au | 57 | Three Musketeers..... | W | 103 | Morning Star..... | W |
| 12 | Moss..... | Au | 58 | Pikes Peak District.... | Fe | 104 | La Fortuna..... | Au |
| 13 | United Western..... | Au | 59 | Vulture..... | Au | 105 | Lakeshore..... | Cu |
| 14 | Borlana..... | W | 60 | Clementine..... | Au | 106 | Oracle Ridge..... | Cu |
| 15 | Antler..... | Zn | 61 | Canadian..... | Asb | 107 | Silver Bell..... | Cu |
| 16 | Rare Metals..... | Cb-Ta | 62 | Snowball..... | $CaF_2$ | 108 | New Cornelia..... | Cu-Mo |
| 17 | Williams..... | W | 63 | El Dorado..... | Asb | 109 | Old Yuma..... | Pb |
| 18 | Van Deemen..... | Au | 64 | Big Horn..... | Au | 110 | Gold Prince..... | Au |
| 19 | United Verde Extension. | Cu | 65 | Sugarloaf Butte..... | Al | 111 | Cyprus Johnson..... | Cu |
| 20 | United Verde..... | Cu | 66 | Rico Group..... | Hg | 112 | Keystone..... | Cu |
| 21 | Black Pearl..... | W | 67 | Copper Cities..... | Cu | 113 | Primos Group..... | W |
| 22 | Bagdad..... | Cu-Mo | 68 | Bluebird..... | Cu | 114 | Eisenhower..... | Cu-Mo |
| 23 | Bruce..... | Zn | 69 | Pinto Valley..... | Cu-Mo | 115 | Mission-San Xavier..... | Cu-Mo |
| 24 | Iron King..... | Pb | 70 | Inspiration..... | Cu | 116 | Pima..... | Cu-Mo |
| 25 | Copper Basin..... | Cu-Mo | 71 | Miami Unit..... | Cu | 117 | Twin Buttes..... | Cu-Mo |
| 26 | McCabe..... | Au-Ag | 72 | Van Dyke..... | Cu | 118 | Commonwealth..... | Ag |
| 27 | Squaw Peak..... | Mo | 73 | Ox Hide..... | Cu | 119 | San Juan..... | Zn |
| 28 | Transcendent..... | Au | 74 | Silver King..... | Ag | 120 | Sierrita..... | Cu-Mo |
| 29 | Maggie..... | Mn | 75 | Magma-Superior..... | Cu | 121 | Esperanza..... | Cu-Mo |
| 30 | Zonia..... | Cu | 76 | L. S. and A..... | Au | 122 | Helvetia West..... | Cu |
| 31 | North Star..... | W | 77 | North Star..... | Au | 123 | Helvetia East..... | Cu-Mo |
| 32 | New Planet..... | Fe | 78 | King of Arizona..... | Au | 124 | Contention-Grand Central | Ag |
| 33 | Mineral Hill..... | Fe | 79 | Reymert..... | Ag | 125 | Glove Group..... | Pb |
| 34 | Wildflower..... | Ag | 80 | Silverbell-Martinez.... | Ag | 126 | Treasure King..... | Au |
| 35 | New Congress..... | Au | 81 | Ray..... | Cu-Mo | 127 | Pat Alunite..... | Al |
| 36 | Congress..... | Au | 82 | Morenci-Metcalf..... | Cu-Mo | 128 | Red Mountain..... | Cu |
| 37 | Apache..... | Fe | 83 | Silver-Eureka District. | Ag | 129 | Lucky Strike..... | W |
| 38 | Oxbow..... | Au | 84 | Seventy-Nine..... | Pb | 130 | Montana..... | Ag-Au |
| 39 | Octave..... | Au | 85 | Christmas..... | Cu | 131 | Hardshell..... | Mn |
| 40 | Chediski..... | Fe | 86 | Florence..... | Cu | 132 | Margarita Group..... | Au |
| 41 | Kay..... | Cu | 87 | Dos Pobres..... | Cu | 133 | Dubacher Canyon..... | Cu |
| 42 | Rose..... | W | 88 | Sacaton..... | Cu | 134 | Denn..... | Cu |
| 43 | American..... | Asb | 89 | Peacock..... | Cu | 135 | Reef..... | W |
| 44 | Midnight Owl..... | Cb-Ta | 90 | Mt. Jackson..... | $CaF_2$ | 136 | Wakefield Group..... | W |
| 45 | Top Hat Group..... | $BaSO_4$ | 91 | Lone Star..... | Cu-Mo | 137 | Edna Group..... | W |
| 46 | Picacho View..... | Cb-Ta | 92 | Casa Grande..... | Cu | 138 | Copper Queen..... | Cu |

Table 15.--Deposit abstract index--Continued

| Deposit name (alphabetical) | Primary commodity | Map no. | Deposit name (alphabetical) | Primary commodity | Map no. | Deposit name (alphabetical) | Primary commodity | Map No. |
|---|---|---|---|---|---|---|---|---|
| American | Asb | 43 | Keystone | Cu | 112 | Quartz Ledge | $CaF_2$ | 47 |
| Antler | Zn | 15 | King of Arizona | Au | 78 | Rare Metals | Cb-Ta | 16 |
| Apache | Fe | 37 | La Fortuna | Au | 104 | Ray | Cu-Mo | 81 |
| Arabian | Au | 9 | Lakeshore | Cu | 105 | Red Mountain | Cu | 128 |
| Bagdad | Cu-Mo | 22 | Lone Star | Cu-Mo | 91 | Red Rock | $CaF_2$ | 48 |
| Big Horn | Au | 64 | L. S. and A. | Au | 76 | Reef | W | 135 |
| Bi-Metal | Au | 10 | Lucky Strike | W | 129 | Renner | $BaSO_4$ | 98 |
| Black Pearl | W | 21 | Maggie | Mn | 29 | Reymert | Ag | 79 |
| Bluebird | Cu | 68 | Magma-Superior | Cu | 75 | Rico Group | Hg | 66 |
| Borlana | W | 14 | Mammoth-Tiger | Au | 99 | Roadside | Au | 7 |
| Bruce | Zn | 23 | Margarita Group | Au | 132 | Rose | W | 42 |
| Canadian | Asb | 61 | Mazatzal Mountains Area | Hg | 50 | Sacaton | Cu | 88 |
| Casa Grande | Cu | 92 | McCabe | Au-Ag | 26 | Samsel | W | 52 |
| Chediski | Fe | 40 | McFadden Peak | $CaF_2$ | 51 | Sanchez | Cu | 94 |
| Christmas | Cu | 85 | Miami Unit | Cu | 71 | San Juan | Zn | 119 |
| Clementine | Au | 60 | Midnight Owl | Cb-Ta | 44 | San Manuel-Kalamazoo | Cu-Mo | 100 |
| C.O.D. | Ag | 5 | Mineral Hill | Fe | 33 | Santa Cruz | Cu-Mo | 93 |
| Commonwealth | Ag | 118 | Mineral Park | Cu-Mo | 3 | Secret Pass | Au | 11 |
| Congress | Au | 36 | Mission-San Xavier | Cu-Mo | 115 | Seventy-Nine | Pb | 84 |
| Contention-Grand Central | Ag | 124 | Montana | Ag-Au | 130 | Sierrita | Cu-Mo | 120 |
| Copper Basin | Cu-Mo | 25 | Morenci-Metcalf | Cu-Mo | 82 | Silver Bell | Cu | 107 |
| Copper Cities | Cu | 67 | Morning Star | W | 103 | Silverbell-Martinez | Ag | 80 |
| Copper Queen | Cu | 138 | Moss | Au | 12 | Silver Cross | Au | 49 |
| Copperstone | Au | 53 | Mt. Jackson | $CaF_2$ | 90 | Silver-Eureka District | Ag | 83 |
| Cyclopic | Au | 2 | New Congress | Au | 35 | Silver King | Ag | 74 |
| Cyprus Johnson | Cu | 111 | New Cornelia | Cu-Mo | 108 | Snowball | $CaF_2$ | 62 |
| Daniels Camp 1 & 2 | $CaF_2$ | 96 | New Planet | Fe | 32 | Squaw Peak | Mo | 27 |
| Denn | Cu | 134 | Newsboy | Au | 56 | Sugarloaf Butte | Al | 65 |
| Dos Pobres | Cu | 87 | North Star | Au | 77 | Three Musketeers | W | 57 |
| Dubacher Canyon | Cu | 133 | North Star | W | 31 | Top Hat Group | $BaSO_4$ | 45 |
| Edna Group | W | 137 | Octave | Au | 39 | Transcendent | Au | 28 |
| Eisenhower | Cu-Mo | 114 | Old Reliable | Cu | 97 | Treasure King | Au | 126 |
| El Dorado | Asb | 63 | Old Yuma | Pb | 109 | Twin Buttes | Cu-Mo | 117 |
| Esperanza | Cu-Mo | 121 | Oracle Ridge | Cu | 106 | United Verde | Cu | 20 |
| Florence | Cu | 86 | Oxbow | Au | 38 | United Verde Extension | Cu | 19 |
| Fountain Head | Ag | 6 | Ox Hide | Cu | 73 | United Western | Au | 13 |
| Fourth of July | $CaF_2$ | 95 | Packard | $CaF_2$ | 54 | Van Deemen | Au | 18 |
| Frisco | Au | 8 | Pat Alunite | Al | 127 | Van Dyke | Cu | 72 |
| Glove Group | Pb | 125 | Peacock | Cu | 89 | Vekol Hills | Cu-Mo | 101 |
| Gold Prince | Au | 110 | Picacho View | Cb-Ta | 46 | Vulture | Au | 59 |
| Hardshell | Mn | 131 | Pikes Peak District | Fe | 58 | Wakefield Group | W | 136 |
| Helvetia East | Cu-Mo | 123 | Pima | Cu-Mo | 116 | White Mesa District | Cu | 1 |
| Helvetia West | Cu | 122 | Pinto Valley | Cu-Mo | 69 | Wildflower | Ag | 34 |
| Inspiration | Cu | 70 | Portland | Au | 4 | Williams | W | 17 |
| Iron King | Pb | 24 | Primos Group | W | 113 | Yuma | Cu | 55 |
| Kay | Cu | 41 | Pure Gold | W | 102 | Zonia | Cu | 30 |

## AMERICAN--ASBESTOS

Alternate names..... Cherry Creek, Buckhorn, Wolf Spring, Vosberg, Wilson, Benstago, Smith, No. 1, No. 2, Home, Tony, Wolf Springs, No. 7.

Commodities: Asb

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Gila. | General location..... | 8 mi southeast of Young. |
| Mining district..... | Sierra Ancha. | Meridian..... | Gila & Salt River. |
| Elevation..... | 5,200 ft. | Tract..... | T 8 N, R 14 & 15 E. |
| Topography..... | Rugged. | Latitude..... | 34°00'58" N. |
| Domain..... | National forest. | Longitude..... | 110°53'09" W. |

Owner..... American Asbestos Cement Corp. (year of information 1979).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Vein. | Host formation..... | Mescal Limestone. |
| Origin..... | Hydrothermal. | Geologic age..... | Precambrian. |
| Shape of ore body..... | Irregular. | Rock relationship..... | Mescal Limestone intruded by diabase sills. |
| Ore controls..... | Bedding, intrusives. | Alteration..... | Undetermined. |
| Strike and dip of mineralized zone..... | Flat-lying. | Size..... | Medium. |
| Age of mineralization.. | Precambrian. | | |
| Mineral zone average dimensions, m: | | | |
| Length..... | Variable. | | |
| Thickness..... | Variable. | | |
| Width..... | Variable. | | |
| Depth to..... | Crops out in cliff faces. | | |
| Mineral names..... | Chrysotile. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | On-site. |
| Type of operation..... | Surface-underground. | Road requirement..... | Variable. |
| Mining method..... | Opencut and coyoting. | Distance to power..... | 8 mi. |
| | | Mill location..... | On-site. |
| Year of discovery..... | 1916. | Mill status..... | Inactive, 1954. Condition unknown. |
| Discovery method..... | Ore mineral in place. | Milling method..... | Roll crush, hammer mill, cyclone separation (640). |
| | | Process rate..... | 15 to 20 st per 8 hours, in cruding. |
| Initial production..... | 1921. | | 5 to 6 st per 8 hours, in fiberizing. |
| Last production..... | 1954. | Product type..... | Crude grades--No. 1, No. 2, No. 3, No. 4. |
| Past production..... | Undetermined. | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

640, 665.

| | |
|---|---|
| USGS quad maps..... | Holbrook, 1:250,000. |
| | Young, 1:62,500. |
| USBM sequence number.... | None. |
| USGS MRDS number..... | M002976, D003024. |

Comments: Holdings cover a large area including the following sections: T 8 N, R 14 E, Sec. 24, 25, 26, 35, & 36 and T 8 N, R 15 E, Sec. 19, 20, 29, 30, 31, 32, & 33.

## ANTLER--ZINC

Alternate names..... Spuyten Duyvel.

Commodities: Zn, Cu, Pb

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Cedar Valley.
Elevation..... 3,200 ft.
Topography..... Hilly.
Domain..... BLM administration.

General location..... 12 mi east of Yuma.
Meridian..... Gila & Salt River.
Tract..... Secs. 3, 4, 9, T 17 N, R 16 W.
Latitude..... 34°52'00" N.
Longitude..... 113°52'00" W.

Owner..... Standard Metals Corp. (year of information 1987).

### GEOLOGY

Type of ore body..... Vein, replacement.
Origin..... Hydrothermal.
Shape of ore body..... Lenticular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... NE; NW.
Age of mineralization.. Undetermined.
Mineral zone average dimensions, ft:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... 20.
  Depth to..... Undetermined.
Mineral names..... Sphalerite, galena, chalcopyrite, marmatite, covellite, bornite, antlerite, chalcanthite, malachite, mica, quartz, pyrrhotite, magnetite, anthophyllite, tremolite, and pyrite.

Host formation..... Granite, schist, and pegmatite dikes.
Geologic age..... Precambrian.
Rock relationship..... Large roof pendant of schist.
Alteration..... Undetermined.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Gophering, open stoping.

Year of discovery..... 1879.
Discovery method..... Ore mineral in place.

Initial production..... 1916.
Last production..... 1953.
Past production:
  1944-46..... 6,426 st ore.
  1947..... 3,200 st ore.
  1949-53..... 5,500 st ore (158).

Distance to water..... 3 mi.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Demonstrated | 5,000,000 st ore | 1.95% Cu, 4.13% Zn, 0.94% Pb, 1.05 tr oz/st Ag. | 1978 | 064 |

### REFERENCES

64, 158, 559, 665.

USGS quad maps..... Prescott, 1:250,000.
Creamery Canyon, 1:24,000.
USBM sequence number.... None.
USGS MRDS number..... D002987.

## APACHE--IRON

Alternate names..... East Apache, West Apache, Swamp Creek Mountain, Alsace Lorraine Hematite, Bear Spring Mountain.

Commodities: Fe

### LOCATION-OWNERSHIP

County..... Navajo.
Mining district..... Apache Iron.
Elevation..... 1,320 m.
Topography..... Rugged.
Domain..... Indian reservation.

General location..... Upper Canyon Creek about 0.5 mi northwest of The Pyramids.
Meridian..... Gila & Salt River.
Tract..... Sec. 15, T 9 N, R 15 E.
Latitude..... 34°10'45" N.
Longitude..... 110°44'30" W.

Owner..... Fort Apache Indians (year of information 1980).
Operator..... Colorado Fuel and Iron Corp. (year of information 1976).

### GEOLOGY

Type of ore body..... Bedded.
Origin..... Sedimentation.
Shape of ore body..... Tabular.
Ore controls..... Bedding.
Strike and dip of mineralized zone..... Flat-lying.
Age of mineralization.. Cambrian.
Mineral zone average dimensions, mi:
Length..... 90.
Thickness..... Undetermined.
Width..... 36.
Depth to..... Exposed at surface.
Mineral names..... Hematite, quartz, magnetite, sericite, apatite, specularite.

Host formation..... Mescal Limestone.
Geologic age..... Precambrian.
Rock relationship..... The hematite zone is near the boundary between the white Chediski Sandstone of the Troy Formation and the Mescal Limestone, just below a silicified algal zone. The ore ranges from nearly pure red to bluish-black hematite with some specularite to beds that are interlayered and mixed with chert, jasperoid, sandstones, and shales. The ore is in an anticlinal structure.
Alteration..... Silicification, sericitization.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.

Year of discovery..... 1890's.
Discovery method..... Ore mineral in place.

Initial production..... 1966.
Last production..... Undetermined.
Past production..... Undetermined.

Distance to water..... Undetermined.
Road requirement..... Undetermined.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 15,000,000 lt ore..... | 43% to 66% Fe..... | 1967 | 314 |

### REFERENCES

84, 87, 243, 296, 314, 389, 639, 657.

USGS quad maps..... Holbrook, 1:250,000.
Chediski Peak, 1:24,000.
USBM sequence number.... 0040170023.
USGS MRDS number..... None.

Comments: Iron mineralization appears to be related to the silicification in the middle member of the Mescal Limestone.

## ARABIAN--GOLD

Alternate names..... Arabia Group, Perry, Rising Fawn, Rebecca.

Commodities: Au, Ag, Be

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Union Pass.
Elevation..... 2,480 ft.
Topography..... Rugged.
Domain..... BLM administration.

General location..... About 3 mi southwest of Union Pass, approx. 0.7 mi south of Sugarloaf Mountain.
Meridian..... Gila & Salt River.
Tract..... Sec. 20, T 21 N, R 20 W.
Latitude..... 35°11'34" N.
Longitude..... 114°26'10" W.

Owner..... Sutton Resources, Ltd. (year of information 1987).
Meridian Land and Mineral (year of information 1987).

### GEOLOGY

Type of ore body..... Quartz veins.
Origin..... Hydrothermal.
Shape of ore body..... Stringers and lenses.
Strike and dip of mineralized zone..... N 45° E; 82° SE.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 500.
  Thickness..... 1.
  Width..... 30.
  Depth to..... Surface.
Mineral names..... Gold, silver.

Host formation..... Granite, gneiss, schist.
Geologic age..... Precambrian.
Rock relationship..... Mineralized vein occurs within the rhyolite dike and the granite footwall. Individual veinlets range in size from less than 1 to more than 12 in. Rhyolite overlies granite.
Alteration..... Undetermined.
Size..... Small.

### DEVELOPMENT

Current status..... Active-past producer. New exploration.
Type of operation..... Surface-underground.
Mining method..... Shaft and adit, shrinkage stope. Open cut bench.

Year of discovery..... 1917.
Discovery method..... Ore mineral in place.

Initial production..... 1917.
Last production..... 1934.
Past production..... 593 tr oz Au, 1,156 tr oz Ag (702).

Distance to water..... 8 mi.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 500,000 st ore..... | 0.06 tr oz/st Au..... | 1987 | 409 |

### REFERENCES

172, 215, 332, 409, 567, 657, 665, 702.

USGS quad maps..... Kingman, 1:250,000
Union Pass, 1:24,000
USBM sequence number.... 0040150073.
USGS MRDS number..... M00454.

Comments: Niemuth (409) reports that the Arabian property was being evaluated by Meridian Minerals, Crown Minerals, and Sutton Minerals, but does not make clear what the various roles and duties of the companies are.

## BAGDAD--COPPER-MOLYBDENUM

Commodities: Cu, Mo, Ag, Au

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Eureka.
Elevation..... 1,040 m.
Topography..... Rugged.
Domain..... Private.

General location..... About 120 mi northwest of Phoenix.
Meridian..... Gila & Salt River.
Tract..... Sec. 4, T 14 N, R 9 W.
Latitude..... 34°35'05" N.
Longitude..... 113°12'28" W.

Owner-operator..... Cyprus Bagdad Copper Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Stockwork, disseminated.
Origin..... Oxidation.
Shape of ore body..... Massive.
Ore controls..... Intrusives, faulting.
Age of mineralization.. Paleozoic.
Mineral zone average dimensions, ft:
  Length..... 10,400.
  Thickness..... 350.
  Width..... 5,200.
  Depth to..... 200.
Mineral names..... Chalcopyrite, molybdenite, pyrite, chrysocolla, malachite, azurite, silver, chalcocite, cuprite.

Host formation..... Igneous intrusive.
Geologic age..... Late Cretaceous.
Rock relationship..... Ore in fractured quartz monzonite.
Alteration..... Sericitization, argillization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1886.
Discovery method..... Ore mineral in place.

Initial production..... 1906.
Past production:
  1985..... 167,300,000 lb Cu, 5,000,000 lb Mo (123).
  1986..... 173,800,000 lb Cu (126).
Production rate..... 54,000 st/d sulfide ore and 12,500 gpm solution.

Distance to water..... Greater than 10 km.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Milling method..... Flotation, dump leaching, SX-EW.
Process rates..... 54,000 st/d sulfide ore. 12,500 gpm of solution.
Product type..... Cu and Mo concentrates, cathode Cu.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Proven | 300,000,000 st sulfide ore | 0.49% Cu, 0.014% Mo | 1980 | 406 |
| 2. | Proven | 417,000,000 st ore | 0.44% Cu | 1985 | 123 |
| 3. | Proven | 397,300,000 st ore | 0.44% Cu | 1986 | 126 |

### REFERENCES

15, 20, 28, 64, 66, 71, 83, 86, 123, 126-128, 132, 158, 291, 360, 371, 406, 431, 449, 457, 467, 478, 493-495, 498, 503, 571, 611, 618, 631-633, 655, 657, 665, 708, 710, 712, 727.

USGS quad maps..... Prescott, 1:250,000.
Bagdad, 1:62,500.
USBM sequence number.... 0040250001.
USGS MRDS number..... D000347, D003266, W002114, M003467, W002659.
MSHA ID number..... 0200137, 0201738.

## BIG HORN--GOLD

Alternate names..... U. S., Furlough.

Commodities: Au, Ag

### LOCATION-OWNERSHIP

County..... Maricopa.
Mining district..... Vulture.
Elevation..... 2,400 ft.
Topography..... Rolling.
Domain..... BLM administration.

General Location..... 25 mi southwest of Wickenburg.
Meridian..... Gila & Salt River.
Tract..... Sec. 1, T 4 N, R 8 W.
Latitude..... 33°42'42" N.
Longitude..... 113°01'41" W.

Owner-operator..... Roddy Resources Arizona, Inc. (year of information 1988).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Epithermal.
Shape of ore body..... Lenticular.
Ore controls..... Undetermined.
Age of mineralization.. Tertiary.
Strike and dip of mineralized zone..... Undetermined.
Mineral zone maximum dimensions, ft:
  Length..... 4,500.
  Thickness..... 600.
  Width..... Up to 130.
  Depth to..... Surface.
Mineral names..... Gold, silver.

Host formation..... Andesite.
Geologic age..... Undetermined.
Rock relationship..... Ore in cracks and fractures of host rock.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, shaft and drift, dump leach.

Year of discovery..... 1942.

Initial production..... July 1987.
Past production..... 1987: 2,600 tr oz Au (366).
Production rate:
  1944..... 1 carload per day (665).
  1988..... 1,000 st/d ore (366).

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Milling method..... Heap leach with carbon adsorption.
Process rate..... 1,000 st/d ore.
Product type..... Dore gold.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 600,000 st ore..... | 0.09 tr oz/st Au..... | 1987 | 409 |
| 2. Inferred..... | 1,000,000 st ore..... | 0.059 tr oz/st Au..... | 1988 | 366 |

### REFERENCES

366, 409, 665.

USGS quad maps..... Phoenix, 1:250,000
Big Horn Mountains, 1:62,500
USBM sequence number.... None.
USGS MRDS number..... M003334.

Comments: In 1983 through 1986 there was a surface drilling program with underground bulk samples taken from old mine workings. Test dump leaching was done before reinitiation of mining. Effective May 3, 1988, Belmoral Mines, Ltd., of Toronto, Ontario, negotiated a $4.5 million convertible debenture with Roddy Resources. Belmoral has advanced $2.3 million and will spend an additional $2.2 million in 1988 for acquisition of the property, repayment of debts, and installation of equipment. Belmoral intends to convert the debenture into a 51% interest in Roddy Resources. Belmoral's plans for 1988 include sampling, trenching, and drilling of five exploration targets to confirm current reserves and possibly double or even triple them (366).

BI-METAL--GOLD

Alternate names..... McGuire, Oro Fino, Una Weep, Cadillac, Kiondyko, Mineral Point Placer, Lewis Placer.

Commodities: Au

LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... McConnico.
Elevation..... 3,000 ft.
Topography..... Hilly.
Domain..... Mixed.

General location..... Approximately 3.5 mi southwest of Kingman and 3 mi south of Bull Mountain.
Meridian..... Gila & Salt River
Tract..... Sec. 4, T 20 N, R 17 W.
Latitude..... 35°09'22" N.
Longitude..... 114°04'52" W.

Owner..... Sharon Steel (year of information 1987).
Frisco Land & Mining Co. (year of information 1987).

GEOLOGY

Type of ore body..... Residual concentration.
Origin..... Oxidation, surface erosion.
Shape of ore body..... Massive.
Ore controls..... Erosion, oxidation.
Strike and dip of mineralized zone..... Flat-lying.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
Length..... 300.
Thickness..... 80.
Width..... 300.
Depth to..... Surface.
Mineral names..... Gold, auriferous pyrite.

Host formation..... Granite, granitic gneiss.
Geologic age..... Precambrian.
Rock relationship..... An oxidized pyrite-bearing core of microcline granite has had an overlying mineralized structure eroded away, leaving the fine gold in the cavities formed by the loss of the pyrite.
Alteration..... Undetermined.
Size..... Small.

DEVELOPMENT

Current status..... Active-past producer. New exploration.
Type of operation..... Surface-underground.
Mining method..... Open pit.

Year of discovery..... Before 1907.
Discovery method..... Ore mineral in place.

Initial production..... 1907.
Last production..... 1950.
Past production..... Undetermined.

Distance to water..... 3 mi.
Road requirement..... None.
Distance to power..... 3 mi.
Mill location..... None.
Mill status..... Proposed.
Milling method..... Leach.

PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 60,000 st ore..... | 0.1 tr oz/st Au..... | 1987 | 409 |

REFERENCES

409, 567, 657, 665, 702.

USGS quad maps..... Kingman, 1:250,000
Kingman SE, 1:24,000
USBM sequence number.... 0040150376.
USGS MRDS number..... M241462.

## BLACK PEARL--TUNGSTEN

Alternate names..... Camp Wood Tungsten Mine.

Commodities: W, Quartz Crystal, Be, Bi, $CaF_2$, Fe, Au, Ag, Mo, Cu

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Camp Wood.
Elevation..... 1,753 m.
Topography..... Rugged.
Domain..... State.

General location..... 19 mi by road northeast of Bagdad.
Meridian..... Gila & Salt River.
Tract..... Sec. 18, T 15 N, R 7 W.
Latitude..... 34°41'18" N.
Longitude..... 113°02'08" W.

Owner..... John Lawlor (year of information 1973).
Operator..... Hillside Mining & Milling Co. (last operator, 1955-56; year of information 1961).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 70° to 75° W; 75° to 85° S.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... 1,600.
  Thickness..... Unknown.
  Width..... 5.
  Depth to..... Exposed at surface.
Mineral names..... Wolframite, scheelite, quartz, beryl, fluorite, pyrite, bismuthinite, specularite, chalcopyrite, molybdenite, gold, silver, muscovite, orthoclase, biotite, hornblende.

Host formation..... Granite.
Geologic age..... Precambrian.
Rock relationship..... Granite, host rock for vein. Quartz, encloses ore.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Open stoping; adit and shafts.

Year of discovery..... 1914.
Discovery method..... Ore mineral in place.

Initial production..... 1915.
Last production..... 1956.
Past production:
1915-35..... 62,100 lb concentrate at 70% $WO_3$ (134).
1951-56..... 6,312 short ton units[1] of $WO_3$ (134).
Total past production is estimated at about 68 mt of contained W.

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

134, 257, 657, 665, 698.

USGS quad maps..... Prescott, 1:250,000.
Bagdad, 1:62,500.
USBM sequence number.... 0040250233.
USGS MRDS number..... M003351, D000838.

[1]Short ton unit = 20 lb of $WO_3$ containing 15.862 lb of W.

## BLUEBIRD--COPPER

Commodities: Cu

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Globe-Miami.
Elevation..... 1,050 m.
Topography..... Hilly.
Domain..... National forest and BLM administration.

General location..... 1 mi southwest of City of Miami.
Meridian..... Gila & Salt River.
Tract..... Sec. 35, T 1 N, R 14 E.
Latitude..... 33°24'35" N.
Longitude..... 110°54'15" W.

Owner-operator..... Cyprus Miami Mining Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Lithology.
Strike and dip of mineralized zone..... N 20° W; 40° W.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... 1100.
  Thickness..... 150.
  Width..... 160.
  Depth to..... 30.
Mineral names..... Chrysocolla, malachite, azurite.

Host formation..... Schultze Granite, Pinal Schist.
Geologic age..... Tertiary, Precambrian.
Rock relationship..... Intense fracturing of the rocks in and around the granite porphyry allowed subsequent copper-bearing hydrothermal fluids to penetrate the schist and granite to deposit the copper minerals.
Alteration..... Slight.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Leaching.

Year of discovery..... 1900.
Discovery method..... Ore mineral in place.

Initial production..... 1961.
Last production..... 1982.
Past production..... 1971-82: 140,000,000 lb cathode Cu (252, 407-408).

Distance to water..... On-site.
Road requirement..... Less than 1 km.
Distance to power..... On-site.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Measured | 20,000,000 st ore | 0.6% Cu | 1984 | 275 |

### REFERENCES

252, 275, 407-408, 517, 548, 657, 665.

USGS quad maps..... Mesa, 1:250,000
Inspiration, 1:62,500
USBM sequence number.... 0040070007
USGS MRDS number..... M241238

Comments: Cyprus Metals Co. acquired Inspiration Consolidated Copper Co. on July 1, 1988.

## BORIANA--TUNGSTEN

Commodities: W, Ag, Au

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Boriana.
Elevation..... 1,600 m.
Topography..... Rolling.
Domain..... Mixed.

General location..... About 21 km east-northeast of Yucca.
Meridian..... Gila & Salt River.
Tract..... Sec. 13, T 18 N, R 16 W.
Latitude..... 34°56'12" N.
Longitude..... 113°55'02" W.

Owner-operator..... Boriana Mining Corp. (year of information 1982).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular, lenticular.
Ore controls..... Fracturing, lithology.
Strike and dip of mineralized zone..... N 35° E; 75° SE.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... 2,200.
  Thickness..... 165.
  Width..... 400.
  Depth..... 1,650.
Mineral names..... Wolframite, scheelite, chalcopyrite, gold, silver, molybdenite, beryl.

Host formation..... Phyllite.
Geologic age..... Precambrian.
Rock relationship..... Wolframite and scheelite are prominent in quartz cut by veinlets of sericite. Ore in fractures.
Alteration..... Sericitization.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Cut and fill.

Year of discovery..... 1914.
Discovery method..... Geological inference.

Initial production..... 1915.
Last production..... See comments.
Past production..... 1915-43: 1,080 st $WO_3$ (256).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... Less than 10 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Measured | 2,400 st ore | 1% to 1.5% $WO_3$ | 1943 | 256 |
| 2. Indicated | 9,700 st ore | 1% to 1.5% $WO_3$ | 1943 | 256 |

### REFERENCES

134, 196, 256, 328, 382, 470, 567, 657.

USGS quad maps..... Prescott, 1:250,000.
Wabayuma Peak, 1:62,500.
USBM sequence number.... 0040150044.
USGS MRDS number..... None.

Comments: In 1918, the Boriana Mine was the largest producer of tungsten in Arizona. True ownership of the property is unclear. Milling of tungsten-bearing tailings closed down in 1943, and equipment was sold in 1944 and was removed from the property in 1945. In 1951, the mill was reequipped and operations continued until 1957. A mill was constructed and operated for 7 months in 1979 and 1980 in an attempt to recover tungsten from tailings. An undetermined quantity of resources certainly exists in the tailings present at the site, and it is likely that a considerably larger resource exists than is shown in the published reserve figures.

## BRUCE--ZINC

Alternate names..... Old Dick.

Commodities: Zn, Cu, Ag, Au

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Eureka.
Elevation..... 1,139 m.
Topography..... Hilly.
Domain..... Private.

General location..... About 4.4 km north of Bagdad.
Meridian..... Gila & Salt River.
Tract..... Sec. 20, T 14 N, R 9 W.
Latitude..... 34°32'47" N.
Longitude..... 113°13'43" W.

Owner-operator..... Cyprus Bagdad Copper Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Replacement.
Origin..... Hydrothermal, metamorphic.
Shape of ore body..... Tabular.
Ore controls..... Bedding, folding.
Strike and dip of mineralized zone..... N 27° E; 75° W.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... 1,450.
  Thickness..... 35.
  Width..... 395.
  Depth to..... 950.
Mineral names..... Pyrite, sphalerite, chalcopyrite, magnetite, arsenopyrite, galena, tennantite.

Host formation..... Dick Rhyolite, Bridle Formation.
Geologic age..... Precambrian.
Rock relationship..... Massive pyritic, zinc-copper deposits stratabound, replacement-type ore body.
Alteration..... Silicification, sericitization.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Cut and fill.

Year of discovery..... 1882.
Discovery method..... Ore mineral in place.

Initial production..... 1943.
Last production..... 1977.
Past production..... Undetermined.
Production rate..... 360 st/d ore.

Distance to water..... On-site.
Road requirement..... Less than 10 km.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Shut down in 1977. Condition unknown.
Milling method..... Flotation.
Process rate..... 360 st/d ore.
Product type..... Zn and Cu concentrates.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 127,600 st ore..... | 12.5% Zn, 3.73% Cu..... | 1976 | 131 |

### REFERENCES

20, 131, 371, 587, 657, 665.

USGS quad maps..... Prescott, 1:250,000.
Bagdad, 1:62,500.
USBM sequence number.... 0040250016.
USGS MRDS number..... M800223, W002662, W000354, M003474.

## CANADIAN--ASBESTOS

Alternate names..... Asbestos King.

Commodities: Asb

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Salt River.
Elevation..... 1,400 m.
Topography..... Rugged.
Domain..... National forest.

General location..... West-northwest of Mule Hoof Bend, 43 mi by road north of Globe.
Meridian..... Gila & Salt River.
Tract..... Sec. 21, T 5 N, R 17 E.
Latitude..... 33°48'21" N.
Longitude..... 110°32'29" W.

Owner-operator..... Jaquays Mining Corp. (year of information 1982).

### GEOLOGY

Type of ore body..... Replacement.
Origin..... Contact metasomatic.
Shape of ore body..... Tabular.
Ore controls..... Contact zone, fracturing.
Age of mineralization.. Precambrian.
Strike and dip..... Flat-lying.
Mineral zone average dimensions, m:
  Length..... Withheld.
  Thickness..... Withheld.
  Width..... Withheld.
  Depth to..... Withheld.
Mineral names..... Chrysotile.

Host formation..... Mescal Limestone.
Geologic age..... Precambrian.
Rock relationship..... Asbestos in serpentinized zones of lower member.
Alteration..... Carbonatization, silicification, dolomitization.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Room and pillar.

Year of discovery..... 1916.
Discovery method..... Ore mineral in place.

Initial production..... 1920.
Last production..... 1953.
Past production..... Withheld.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... None, but Jaquays owns an asbestos mill in Globe.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

5, 72, 282, 295, 336, 354, 364, 385, 578, 640-642, 653, 657, 665, 695, 699, 704.

USGS quad maps..... Mesa, 1:250,000.
Blue House Mountain, 1:62,500.
USBM sequence number.... 0040070073.
USGS MRDS number..... M001975.

## CASA GRANDE--COPPER

Alternate names..... Casa Grande West.

Commodities: Cu

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Casa Grande.
Elevation..... 403 m.
Topography..... Flat.
Domain..... Private.

General location..... 11 km west of Casa Grande.
Meridian..... Gila & Salt River.
Tract..... Sec. 13, T 6 S, R 4 E.
Latitude..... 32°53'36" N.
Longitude..... 111°52'54" W.

Owner..... ASARCO Incorporated, and Freeport McMoran Gold Co. (year of information 1988).
Operator..... Casa Grande Copper Co. (year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Hydrothermal, oxidation, supergene enrichment.
Shape of ore body..... Massive.
Ore controls..... Lithology, fracturing.
Age of mineralization.. Late Cretaceous.
Mineral zone average dimensions, ft:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... 1,500.
Mineral names..... Chalcocite, copper sulfides and oxides.

Host formation..... Oracle Granite.
Geologic age..... Precambrian.
Rock relationship..... The Oracle Granite country rock has been intruded by a Laramide intrusive of quartz monzonite composition. The orebody is a "porphyry type" that displays primary sulfide mineralization, a secondary chalcocite capping, and a zone of copper oxides.
Alteration..... Undetermined.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-explored prospect.
Type of operation..... Underground.
Mining method..... Block cave (proposed).

Year of discovery..... 1976.
Discovery method..... Geological inference.

Distance to water..... Less than 3 km.
Road requirement..... Less than 10 km.
Distance to power..... Less than 10 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 350,000,000 st sulfide ore..... | 1% Cu..... | 1978 | 233 |
| 2. Not reported in reference..... | 352,000,000 st mixed ore ..... | 1% Cu..... | 1980 | 064 |

### REFERENCES

64, 217, 232-233, 657.

USGS quad maps..... Tucson, 1:250,000.
Stanfield, 1:62,500.
USBM sequence number.... 0040210076.
USGS MRDS number..... None.

## CHEDISKI--IRON

Alternate names..... Marley Ranch Iron, Chediski Hematite, Black Iron, Iron Mountain.

Commodities: Fe

### LOCATION-OWNERSHIP

County..... Navajo.
Mining district..... Apache Iron.
Elevation..... 1,725 m.
Topography..... Rugged.
Domain..... Indian reservation.

General location..... 2 mi northwest of Chediski Farms.
Meridian..... Gila & Salt River.
Tract..... Sec. 35, T 9 N, R 15 E.
Latitude..... 34°07'56" N.
Longitude..... 110°43'01" W.

Owner..... Fort Apache Indian Reservation (year of information 1970).

### GEOLOGY

Type of ore body..... Sedimentary.
Origin..... Sedimentation.
Shape of ore body..... Tabular.
Ore control..... Bedding.
Strike and dip of mineralized zone..... Flat-lying.
Age of mineralization.. Cambrian.
Mineral zone average dimensions, m:
  Length..... 5,500.
  Thickness..... Undetermined.
  Width..... 18.
  Depth to..... 300-700.
Mineral names..... Hematite, quartz, magnetite, sericite, apatite, specularite.

Host formation..... Mescal Limestone.
Geologic age..... Precambrian.
Rock relationship..... The hematite zone is near the boundary between the white Chediski Sandstone of the Troy Formation and the Mescal Limestone, just below a silicified algal zone. The ore ranges from nearly pure red to bluish-black hematite with some specularite to beds that are interlayered and mixed with chert, jasperoid, sandstones, and shales.
Alteration..... Silicification.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-raw prospect.
Type of operation..... Surface.
Year of discovery..... 1890's.
Discovery method..... Ore mineral in place.

Distance to water..... Undetermined.
Road requirement..... Undetermined.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 10,000,000 to 15,000,000 lt ore... | 23% to 62% Fe..... | 1969 | 314 |

### REFERENCES

84, 87, 243, 296, 314, 389, 639, 657, 665.

USGS quad maps..... Holbrook, 1:250,000.
Chediski Peak, 1:24,000.
USBM sequence number.... 0040170087.
USGS MRDS number..... M003066.

Comments: Iron mineralization appears to be related to the silicification in the middle member of the Mescal Limestone.

## CHRISTMAS--COPPER

Alternate names..... Inspiration, Red Bird Shaft, Hackberry Shaft.

Commodities: Cu, Au, Ag, Mo

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Banner.
Elevation..... 930 m.
Topography..... Very rugged.
Domain..... Federal.

General location..... About 7 mi north-northeast of Winkelman.
Meridian..... Gila & Salt River.
Tract..... Sec. 19, T 4 S, R 16 E.
Latitude..... 33°03'32" N.
Longitude..... 110°44'30" W.

Owner-operator..... Cyprus Christmas Mining Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Replacement.
Origin..... Contact metasomatic.
Shape of ore body..... Tabular.
Ore controls..... Limestone diorite contact, favorable limestone bed.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone maximum dimensions, m:
  Length..... 900.
  Thickness..... 90.
  Width..... 225.
  Depth to..... 15.
Mineral names..... Chalcocite, covellite, copper, malachite, pyrite, chalcopyrite, bornite, magnetite, hematite, sphalerite, galena, molybdenite, cuprite, azurite, tenorite, dioptase, brochantite, chalcanthite.

Host formation..... Escabrosa Limestone, Naco Limestone, Martin Limestone, diorite, andesite.
Geologic age..... Paleozoic (sediments), Tertiary (intrusives).
Rock relationship..... Mineralization occurs primarily in limestones adjacent to the diorite stock, but is also found to a lesser degree in the diorite and andesite intrusives.
Alteration..... Carbonatization silicification.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-temporary shutdown.
Type of operation..... Surface-underground.
Mining method..... Open pit, cut and fill.

Year of discovery..... 1880.
Discovery method..... Ore mineral in place.

Initial production..... 1905.
Last production..... 1981.
Past production..... 1916-76: 130,680 st Cu; 1,593,000 tr oz Ag, 41,929 tr oz Au (665).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive.
Milling method..... Flotation.
Process rate..... 5,500 st/d ore.
Product type..... Cu concentrate.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Proven | 7,567,000 st ore (surface) | 0.63% Cu | 1983 | 274 |
| 2. Proven | 12,862,000 st ore (underground) | 1.78% Cu | 1983 | 274 |
| 3. Probable | 7,269,000 st ore (underground) | 1.94% Cu | 1983 | 274 |
| 4. Not reported in reference | 20,131,000 st ore | 1.78% Cu | 1981 | 273 |

### REFERENCES

64, 164, 273-274, 329, 365, 371, 397, 519, 583, 657, 665, 693.

USGS quad maps..... Mesa, 1:250,000.
Christmas, 1:62,500.
USBM sequence number.... 0040070052.
USGS MRDS number..... D000315, M000635.
MSHA ID number..... 0201319.

Comments: Cyprus Metals Co. acquired Inspiration Consolidated Copper Co. on July 1, 1988.

## CLEMENTINE--GOLD

Commodities: Au, Ag

### LOCATION-OWNERSHIP

County..... Maricopa.
Mining district..... Undetermined.
Elevation..... 2,000 ft.
Topography..... Hilly.
Domain..... Undetermined.

General location..... Approximately 10 mi northwest of Sun City.
Meridian..... Gila & Salt River.
Tract..... Sec. 10, T 5 N, R 1 W.
Latitude..... 33°48'45" N.
Longitude..... 112°18'45" W.

Owner..... Bob Hicks (year of information 1983).
Operator..... Copper Lake Exploration, Ltd. (year of information 1983).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Undetermined.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... NE: 30° SE.
Age of mineralization.. Undetermined.
Mineral zone average dimensions, ft:
  Length..... 5,280.
  Thickness..... Undetermined.
  Width..... 700.
  Depth to..... 700.
Mineral names..... Gold, quartz, hematite.

Host formation..... Yavapai Schist.
Geologic age..... Precambrian.
Rock relationship..... Gold occurs at the interface of the quartz-hematite.
Alteration..... Undetermined.
Size..... Small.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1975.
Discovery method..... Drilling and surface assays.

Initial production..... Undetermined.
Last production..... Undetermined.
Past production..... Undetermined.

Distance to water..... 1 mi.
Road requirement..... None.
Distance to power..... 8 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 100,000 st ore..... | 0.05 tr oz/st Au, 0.2 tr oz/st Ag. | 1987 | 409 |

### REFERENCES

32, 409, 657.

USGS quad maps..... Phoenix, 1:250,000.
Baldy Mountain, 1:24,000.
USBM sequence number.... 0040130890.
USGS MRDS number..... None.

## C.O.D.--SILVER

Alternate names..... Rico.

Commodities: Ag, Au, Pb, Cu, Zn

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Wallapai.
Elevation..... 1,585 m.
Topography..... Rugged.
Domain..... BLM administration.

General location..... 7 mi southeast of Chloride, 1 mi northeast of Stockton Hill.
Meridian..... Gila & Salt River.
Tract..... Sec. 28, 33, T 23 N, R 17 W.
Latitude..... 35°20'44" N.
Longitude..... 114°06'13" W.

Owner..... Mrs. Nellie Clack Estate and Partners (year of information 1976).
Operator..... C.O.D. Alanco, Ltd. (year of information 1988).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Lenses and shoots.
Ore controls..... Fissures and dikes.
Strike and dip of mineralized zone..... N 85° W: 80° N.
Age of mineralization.. Late Cretaceous-Tertiary.
Mineral zone average dimensions, ft:
  Length..... 5,280.
  Thickness..... Undetermined.
  Width..... 0.6.
  Depth to..... Surface.
Mineral names..... Silver, argentite, galena, sphalerite, chalcopyrite.

Host formation..... Granite gneiss, schist.
Geologic age..... Precambrian.
Rock relationship..... The vein cuts the porphyritic granite and the basalt dikes, both of which are associated with chlorite schists.
Size..... Small.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Underground.
Mining method..... Shrinkage stope.

Year of discovery..... 1878.
Discovery method..... Ore mineral in place.

Initial production..... 1885.
Last production..... 1974.
Past production:
1901-48..... 1,550 tr oz Au; 151,263 tr oz Ag; 23,924 lb Cu; 348,872 lb Pb; 23,188 lb Zn (665).
1885-92..... 402,000 tr oz Ag; 1,180 tr oz Au; 575,760 lb Pb (567).
1900-02..... 17,550 tr oz Ag; 180 tr oz Au; 114,360 lb Pb (567).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Under construction.
Milling method..... Undetermined.
Process rate..... 60 st/d ore.
Product type..... Undetermined.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Measured | 3,000 st ore (dump) | 0.14 tr oz/st Au, 7.90 tr oz/st Ag, 0.50% Cu, 1.25% Pb, 3.89% Zn. | 1980 | 539 |
| 2. Measured | 4,000 st ore (tailings) | 0.12 tr oz/st Au, 3.74 tr oz/st Ag, 0.29% Pb, 1.25% Zn. | 1980 | 539 |

### REFERENCES

31, 172, 539, 567, 657, 665.

USGS quad maps..... Kingman, 1:250,000
Stockton Hill, 1:24,000
USBM sequence number.... 0040150436.
USGS MRDS number..... M004063.

Comments: According to ADMMR (31), this deposit was under development in 1987 as an underground base and precious metals mine. The underground reserves are undetermined.

## COMMONWEALTH--SILVER

Alternate names..... Commonwealth Extension, Silver Ware, Pearce (includes Elsanhart Vein, North, Rinaud, Smith, Footwall, Main, Extension, Ritter, Brockman, Hartery, Discovery Stope).

Commodities: Ag, Au, Mo, Cu, Pb

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Pearce.
Elevation..... 4,580 ft.
Topography..... Rugged.
Domain..... Private.

General location..... 0.8 km east of Pearce.
Meridian..... Gila & Salt River.
Tract..... Sec. 5, T 18 S, R 25 E.
Latitude..... 31°54'02" N.
Longitude..... 109°48'56" W.

Owner..... C. O. R. Ford Corp. (year of information 1979).
Operator..... Gourmet Chief, Inc. (year of information 1975).

### GEOLOGY

Type of ore body..... Fissure veins.
Origin..... Hydrothermal.
Shape of ore body..... Irregular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 4,000.
  Thickness..... 60.
  Width..... 350.
  Depth to..... 500.
Mineral names..... Cerargyrite, embolite, silver and gold halides, pyrite, wulfenite, sulfosalts, gold, chrysocolla, silver, argentite, iodyrite, chalcocite, galena, chalcopyrite, proustite, tetrahedrite, molybdenite.

Host formation..... Rhyolite and andesite.
Geologic age..... Tertiary.
Rock relationship..... Irregular silver-gold halides and minor sulfo-salts with some manganese in quartz-calcite fissure veins and in fault breccia zones in silicified Tertiary rhyolite and andesite volcanics.
Alteration..... Silicification.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Coyoting.

Year of discovery..... 1895.
Discovery method..... Ore mineral in place.

Initial production..... 1895.
Last production..... 1979.
Past production..... 1895-1942: More than 1,000,000 tr oz of silver produced (392).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... Undetermined.
Mill status..... Unknown.
Milling method..... Flotation.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

300, 392, 657, 665.

USGS quad maps..... Douglas, 1:250,000.
Pearce, 1:24,000.
USBM sequence number.... 0040030120 (mine), 0040030068 (mill).
USGS MRDS number..... M030569 (Commonwealth), M241066 (Commonwealth Extension).

Comments: Additional resource material is probable at greater depth but has not been proven.

## CONGRESS--GOLD

Alternate names..... Niagra, Niagara, Queen of the Hills.

Commodities: Au, Ag, Pb, Cu, $U_3O_8$

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Yavapai. | General location..... | 3 mi north of Congress. |
| Mining district..... | Martinez. | Meridian..... | Gila & Salt River. |
| Elevation..... | 3,360 ft. | Tract..... | Sec. 23, T 10 N, R 6 W. |
| Topography..... | Rugged. | Latitude..... | 34°12'03" N. |
| Domain..... | Mixed. | Longitude..... | 112°50'59" W. |

Owner..... Echo Bay Mines, Ltd. (year of information 1988).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Fissure veins. | Host formation..... | Porphyritic granite. |
| Origin..... | Hydrothermal. | Geologic age..... | Precambrian. |
| Shape of ore body..... | Tabular. | Rock relationship..... | Granite, contains veins. |
| Ore controls..... | Faulting. | | Andesite dikes, parallel veins. |
| Strike and dip of | | | Quartz, vein material. |
| mineralized zone..... | E-W: 20° to 30° N. | | Mafic dikes, parallel veins. |
| Age of mineralization.. | Tertiary. | Alteration..... | None. |
| Mineral zone average | | Size..... | Small. |
| dimensions, ft: | | | |
| Length..... | 1,800. | NOTE: Size based only on past production. | |
| Thickness..... | 4,000. | | |
| Width..... | 3. | | |
| Depth to..... | Exposed at surface. | | |
| Mineral names..... | Gold, pyrite, goethite, quartz, galena, liebigite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | Undetermined. |
| Type of operation..... | Underground. | Road requirement..... | None. |
| Mining method..... | Undetermined. | Distance to power..... | Undetermined. |
| | | Mill location..... | On-site. |
| Year of discovery..... | 1887. | Mill status..... | Abandoned, current condition undetermined. |
| Discovery method..... | Ore mineral in place. | Milling method..... | Cyanidation. |
| Initial production..... | 1887. | | |
| Last production..... | 1950(?). | | |
| Past production..... | 1899-1910: 692,322 st ore (368). | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

31, 158, 368, 370, 409, 520, 657, 665, 702.

| | |
|---|---|
| USGS quad maps..... | Prescott, 1:250,000. |
| | Congress, 1:24,000. |
| USBM sequence number.... | 0040250534, 0040250537. |
| USGS MRDS number..... | M003323. |

Comments: Possible resources at the Congress Mine are unknown, but Echo Bay Mines, Ltd., in mid-1988 was considering starting an exploration program to determine whether minable resources might still exist at the property (520).

## CONTENTION-GRAND CENTRAL--SILVER

Alternate names..... Contention, Grand Central, Head Center, Flora Morrison, Tranquility, Pump Shaft, Yellow Jacket.

Commodities: Ag, Au, Pb, Cu, Zn

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Tombstone.
Elevation..... 4,730 ft.
Topography..... Hilly.
Domain..... Undetermined.

General location..... 1.6 km due south of Tombstone.
Meridian..... Gila & Salt River.
Tract..... Sec. 11, 14, T 20 S, R 22 E.
Latitude..... 31°42'10" N.
Longitude..... 110°03'44" W.

Owner..... Tombstone Development Co. (year of information 1989).
Operator..... PBR Minerals, Inc. (year of information 1989).

### GEOLOGY

Type of ore body..... Fissure veins, replacement beds.
Origin..... Hydrothermal.
Shape of ore body..... Irregular, bedded.
Ore controls..... Faulting, fracturing, lithology.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Late Cretaceous.
Mineral zone average dimensions, m:
  Length..... 3,300.
  Thickness..... 800.
  Width..... 1,000.
  Depth to..... Surface.
Mineral names..... Argentiferous and/or auriferous galena.

Host formation..... Limestone, intrusive dike.
Geologic age..... Cretaceous, Late Cretaceous.
Rock relationship..... Oxidized argentiferous and auriferous galena and minor copper and zinc mineralization in large rich ore bodies in faulted and fractured segments of a large dike and in brecciated footwall zones of the dike.
Alteration..... Kaolinization.
Size..... Medium.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit (proposed), shaft workings, and dump leach.

Year of discovery..... 1880's.
Discovery method..... Ore mineral in place.

Initial production..... 1880's.
Last production..... 1929.
Past production..... More than $10 million produced prior to 1886. Several hundred thousand st ore produced from 1880's until early 1900's. Small production until 1929 (300).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... Undetermined.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 100,000 st ore..... | 2.0 tr oz/st Ag..... | 1987 | 409 |

### REFERENCES

88, 300, 409, 657, 665.

USGS quad maps..... Nogales, 1:250,000.
Tombstone, 1:62,500.
Tombstone, 1:24,000.
USBM sequence number.... 0040030590.
USGS MRDS number..... M800323 (Contention), M050475 (Grand Central).

Comments: Contention and Grand Central are linked by common ownership and not because the two mines are actually joined through workings. They are two separate mines with the same geology as a result of being located on the same intrusive dike and fault system responsible for orogenesis. The lower portions of the mines were not developed because of water problems. Niemuth (409) states that the deposit presumably has a larger tonnage than reported.

## COPPER BASIN--COPPER-MOLYBDENUM

Commodities: Cu, Mo, Au

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Copper Basin.
Elevation..... 1,647 m.
Topography..... Rolling.
Domain..... Private.

General location..... About 19 km southwest of Prescott.
Meridian..... Gila & Salt River.
Tract..... Sec. 20, T 13 N, R 3 W.
Latitude..... 34°29'30" N.
Longitude..... 112°35'00" W.

Owner-operator..... Phelps Dodge Corp. (year of information 1988).

### GEOLOGY

Type of ore body..... Breccia fill, disseminated.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive, pipelike.
Ore controls..... Fracturing, breccia pipes.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Late Cretaceous.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... 20.
Mineral names..... Pyrite, chalcopyrite, molybdenite, chrysocolla, tenorite, chalcocite, malachite, azurite, copper.

Host formation..... Metamorphosed sediments, intrusives, breccia pipes.
Geologic age..... Precambrian.
Rock relationship..... Mineralization is primarily confined to breccia pipes formed within a quartz monzonite and quartz monzonite porphyry stock that intruded older metamorphosed sediments and intrusives. The breccia pipes probably acted as conduits for mineralizing late magmatic fluids.
Alteration..... Potassic alteration, silicification, oxidation.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1890.
Discovery method..... Ore mineral in place.

Initial production..... 1911.
Last production..... 1961.
Past production..... Small, sporadic shipments, mainly copper flux (286).

Distance to water..... Less than 10 km.
Road requirement..... Less than 50 km.
Distance to power..... Less than 50 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 175,000,000 st ore..... | 0.55% Cu, 0.021% Mo..... | 1981 | 484 |

### REFERENCES

64, 66, 286, 484, 537, 657, 665.

USGS quad maps..... Prescott, 1:250,000.
Wilhoit, 1:24,000.
USBM sequence number.... 0040250015.
USGS MRDS number..... D000348, W016056.

Comments: Development of Copper Basin will depend upon economic conditions and secure additional land for dumps, tailings dams, shops, and concentrator. An environmental impact statement is currently being prepared.

## COPPER CITIES--COPPER

Alternate names..... Diamond-H, Sleeping Beauty, Porphyry Reserves, Lost Gulch, Yellow Metal.

Commodities: Cu, Mo, Ag, Au, Pb, Zn

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Globe-Miami.
Elevation..... 1,190 m.
Topography..... Rugged.
Domain..... National forest.

General location..... 3 km north of Miami.
Meridian..... Gila & Salt River.
Tract..... Sec. 12, T 1 N, R 14 E.
Latitude..... 33°26'45" N.
Longitude..... 110°52'54" W.

Owner-operator..... Magma Copper Co. (year of information 1987).

### GEOLOGY

Type of ore body..... Stockwork, disseminated, secondary enrichment.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Fracturing, faulting, lithology.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... 3,000.
  Thickness..... 300.
  Width..... 900.
  Depth to..... 30.
Mineral names..... Chalcopyrite, molybdenite, malachite, azurite, pyrite, chalcocite, sphalerite, galena, covellite, metatorbernite, turquoise.

Host formation..... Lost Gulch Quartz Monzonite.
Geologic age..... Late Cretaceous-Early Tertiary.
Rock relationship..... Ore in fractures and gangue.
Alteration..... Sericitization, argillization.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1896.
Discovery method..... Geological inference.

Initial production..... 1896.
Last production..... 1982.
Past production..... 1979-82: 45,000,000 lb Cu (252, 407-408).

Distance to water..... On-site.
Road requirement..... Less than 10 km.
Distance to power..... On-site.
Mill location..... None.
Mill status..... Conventional mill dismantled and removed.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

239, 252, 329, 342-343, 397, 407-408, 516-517, 581, 583, 606, 657, 665, 682, 693.

USGS quad maps..... Mesa, 1:250,000.
Globe, 1:24,000.
Inspiration, 1:24,000.
USBM sequence number.... 0040070009.
USGS MRDS number..... W002707, M003145.

## COPPER QUEEN--COPPER

Alternate names..... Halero.

Commodities: Cu, Ag, Au, Pb, Zn

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Warren.
Elevation..... 1,621 m.
Topography..... Hilly.
Domain..... Private.

General location..... 0.8 km east-southeast of Bisbee.
Meridian..... Gila & Salt River.
Tract..... Sec. 9, T 23 S, R 24 E.
Latitude..... 31°21'02" N.
Longitude..... 109°54'15" W.

Owner-operator..... Phelps Dodge Corp. (year of information 1988).

### GEOLOGY

Type of ore body..... Limestone replacement.
Origin..... Hydrothermal.
Shape of ore body..... Irregular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Early to mid-Mesozoic
Mineral zone average dimensions, ft:
  Length..... 2,500.
  Thickness..... 950.
  Width..... 2,500.
  Depth to..... Surface.
Mineral names..... Malachite, azurite, delafossite, cuprite, chalcocite, copper, gold, silver, chalcopyrite, bornite, cerussite, anglesite.

Host formation..... Martin Limestone.
Geologic age..... Devonian.
Rock relationship..... High-grade copper carbonates with minor lead and zinc carbonates in irregular replacement ore bodies, mainly in Devonian limestone along a structural trough.
Alteration..... Replacement.
Size..... Large.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface-underground.
Mining method..... Dump leach, surface shut down 1974, underground shut down 1975.
Year of discovery..... 1877.
Discovery method..... Ore mineral in place.

Initial production..... 1881.
Last production..... 1988.
Past production..... Undetermined.
Annual production..... 3,000,000 lb copper (162).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Flotation-inactive; leach-producing.
Milling method..... Dump leach-precipitation.
Process rate..... 1,500 st/yr output.
Product type..... Cement copper.
Distance shipped..... 200 mi (truck).
Destination..... Inspiration smelter (Claypool, AZ).

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

16, 80, 162, 300, 371, 644, 657, 665.

USGS quad maps..... Douglas, 1:250,000.
Bisbee, 1:24,000.
USBM sequence number.... 0040030043 (mine), 0040030045 (smelter), 0040030052 (leach).
USGS MRDS number..... M241115.
MSHA ID number..... 0201656.

Comments: Original copper mine of the district. No identified reserves. Although a resource is known to exist, its size and grade are undetermined. Leach operation is marginal and declining. Underground has only minor quantities of ore left in widely scattered locations throughout the underground workings. The identified material was quantified at less than one year's production and deemed unrecoverable. The mine pumps were subsequently pulled and the mine allowed to flood. Phelps Dodge engineer's opinion is that it would be almost impossible to reopen. Open pit operations were closed because of exhaustion of ore reserves. Current operation of the leach hinges on the decision of management to begin leaching a neighboring property's mine dumps. If it is found amenable to leaching, then the current Copper Queen facilities will be moved. If the decision is made not to move, then the facility will be shut down in mid-1989.

## COPPERSTONE--GOLD

Commodities: Au

### LOCATION-OWNERSHIP

County..... La Paz.
Mining district..... La Paz.
Elevation..... 890 ft.
Topography..... Flat.
Domain..... BLM administration.

General location..... 13 mi north of Quartzsite.
Meridian..... Gila & Salt River.
Tract..... Sec 12, T 6 N, R 20 W.
Latitude..... 33°52'30" N.
Longitude..... 114°17'30" W.

Owner..... Dan Patch (retains royalty right from production; year of information 1988).
Cyprus Minerals Co. (100% working interest from owner; year of information 1988).
Operator..... Morrison-Knudsen Co., Inc., Mining Division, (under 31-month contract; year of information 1988).

### GEOLOGY

Type of ore body..... Epithermal vein, breccia zone.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Detachment faulting.
Strike and dip of mineralized zone..... N 30° W; 32° NE.
Age of mineralization.. Miocene or younger.
Mineral zone average dimensions, ft:
Length..... 2,500.
Thickness..... 50.
Width..... 1,000.
Depth to..... 0 to 100 (varies).
Mineral names..... Gold, chrysocolla, amethyst, specular hematite, quartz, magnetite, barite, calcite.

Host formation..... Quartz latite metavolcanics.
Geologic age..... Jurassic.
Rock relationship..... Fracture and fault filling with hydrothermal brecciation of quartz latites.
Alteration..... Sericitization, some chloritization.
Size..... Small.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Bench open pit.

Year of discovery..... 1979.
Discovery method..... Ore mineral in place.

Initial production..... 1987.
Past production..... 6,000 tr oz Au estimated for 1987 (240).
Annual production..... 60,000 tr oz Au estimated at full production rate in 1988 (240).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... 5 mi.
Mill location..... On-site.
Mill status..... Operating.
Milling method..... Vat leach, CIP-EW, furnace.
Process rate..... 2,500 st/d ore.
Product type..... Gold dore.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Proven | 6,000,000 st ore (surface) | 0.085 tr oz/st Au | 1987 | 564 |

### REFERENCES

727, 240, 305, 371, 564, 657.

USGS quad maps..... Salton Sea, 1:250,000.
Moon Mountain NE, 1:24,000.
Moon Mountain SE, 1:24,000.
USBM sequence number.... 0040120006.
USGS MRDS number..... None.
MSHA ID number..... 0202364.

## CYCLOPIC--GOLD

Alternate names..... Indian Secret.

Commodities: Au, Ag, Pb, Mo

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Gold Basin.
Elevation..... 4,360 ft.
Topography..... Rugged.
Domain..... Undetermined.

General location..... About 6 mi west-southwest of Burnt Mill Ranch.
Meridian..... Gila & Salt River.
Tract..... Sec. 30, T 28 N, R 18 E.
Latitude..... 35°46'58" N.
Longitude..... 114°14'39" W.

Owner-operator..... Saratoga Mines (96%) (year of information 1979).
Drs. Richard V. Wyman and Thomas C. King (4%) (year of information 1979).

### GEOLOGY

Type of ore body..... Detachment fault.
Origin..... Epithermal, hydrothermal.
Shape of ore body..... Irregular, tabular.
Ore control..... Fault breccia.
Strike and dip of mineralized zone..... N 50° W: dipping variably NE.
Age of mineralization.. Late Cretaceous-Early Tertiary.
Mineral zone average dimensions, m:
Length..... 1,500.
Thickness..... 60.
Width..... 400.
Depth to..... 50.
Mineral names..... Galena, pyrite, ferrocalcite, malachite, wulfenite, gold, cerussite, cuprite(?), quartz, Fe and Mn(?) oxides.

Host formation..... Porphyritic monzogranite of Garnet Mountain.
Geologic age..... Proterozoic.
Rock relationship..... Abundant angular fragments contain milky-white quartz with dark-reddish-gray matrix. Considerable cellular gossan, with wulfenite common. Ore consists of brecciated fragments of coarse-textured grayish vein quartz and country rock more or less firmly cemented by iron oxide and silica.
Alteration..... Silicification, chloritization.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... See comments.

Year of discovery..... 1880.
Discovery method..... Ore mineral in place.

Initial production..... 1921.
Last production..... Undetermined.
Past production..... 13,000 tr oz Au (32).

Distance to water..... Less than 1 mi.
Road requirement..... Less than 1 mi.
Distance to power..... Undetermined.
Mill status..... None.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Proven | 60,000 st tailings | 0.10 tr oz/st Au, 0.4 tr oz/st Ag. | 1980 | 032 |
| 2. | Probable | 67,000 st ore | 0.28 tr oz/st Au | 1980 | 032 |
| 3. | Possible | 300,000 st ore | 0.15 tr oz/st Au | 1980 | 032 |
| 4. | Not reported in reference | 70,000 st ore | 0.28 tr oz/st Au | 1987 | 409 |
| 5. | Not reported in reference | 50,000 st tailings | 0.06 tr oz/st Au | 1987 | 409 |

### REFERENCES

32, 409, 567, 648, 657, 666, 702.

USGS quad maps..... Kingman, 1:250,000.
Garnet Mountain, 1:62,500.
USBM sequence number.... 0040151277.
USGS MRDS number..... None.

Comments: The mine was mainly developed by shallow, mostly inclined shafts, drifts, and crosscuts to a maximum depth of about 70 ft, but most workings do not extend beyond 30 ft in depth.

## CYPRUS JOHNSON--COPPER

Alternate names..... Johnson Pit, Climax Shaft, Johnson Mine, Coronado Copper & Zinc Co., Republic, Mammoth, Peabody, and Copper Chief.

Commodities: Cu, Ag, Au, Zn, Pb

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Johnson Camp.
Elevation..... 1,524 m.
Topography..... Hilly.
Domain..... BLM administration.

General location..... About 0.5 mi north-northwest of Johnson.
Meridian..... Gila & Salt River.
Tract..... Sec. 26, T 15 S, R 22 W.
Latitude..... 32°06'10" N.
Longitude..... 110°04'05" W.

Owner-operator..... Cyprus Johnson Copper Co. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Breccia fill, replacement, secondary enrichment.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Tabular.
Ore controls..... Bedding, fracturing.
Strike and dip of mineralized zone..... N 45° W; 37° E.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... 610.
  Thickness..... 700.
  Width..... 200.
  Depth to..... Undetermined.
Mineral names..... Chrysocolla, malachite, azurite, pyrite, chalcopyrite, tenorite, molybdenite, sphalerite, aurichalcite, bornite, schoelite, and powellite.

Host formation..... Escabrosa Limestone, Horquilla Limestone, Abrigo Formation.
Geologic age..... Mississippian, Pennsylvanian, Cambrian.
Rock relationship..... Significant ore bodies may occur at depth where favorable beds of the Abrigo Formation make up the hanging wall of the Republic Fault. Most of ore came from replaced beds in Abrigo and Escabrosa Formations.
Alteration..... Sericitization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, undetermined underground.

Year of discovery..... 1880.
Discovery method..... Ore mineral in place.

Initial production..... 1881.
Last production..... 1985.
Past production:
 Up to 1948..... $8,837,000 (158).
 1947-57..... 640,000 st ore at 4 tr oz/st Au, 1.67% Cu, 6.1% Zn (158).
 1979-84..... 8,547,600 st ore (252, 253, 254, 407-408).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... None. SX-EW plant moved to Sierrita.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Proven | 3,926,800 st ore | 0.40% Cu | 1985 | 203 |
| 2. Not reported in reference | 2,500,000 st ore | 0.45% Cu | 1983 | 634 |

### REFERENCES

26, 109, 122-123, 129-130, 158, 203, 252-254, 371, 407-408, 634, 657, 663-665.

USGS quad maps..... Tucson, 1:250,000.
Dragoon, 1:62,500.
USBM sequence number.... 0040030042.
USGS MRDS number..... M050007.

Comments: Ore was first concentrated in 1942 by selective flotation. Zinc has at times been the main commodity. Mine has had several periods of production and closure since discovery (158).

## DANIELS CAMP 1 & 2--FLUORSPAR

Commodities: $CaF_2$, Mn, Be

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Greenlee. | General location | 12 mi north of Duncan, 2.5 mi east of AZ-NM state line. |
| Mining district | Duncan (Steeple Rock). | | |
| Elevation | 1,341 m. | Meridian | Gila & Salt River. |
| Topography | Hilly. | Tract | Sec. 5, T 7 S, R 32 E. |
| Domain | BLM administration. | Latitude | 32°51'25" N. |
| | | Longitude | 109°05'15" W. |
| Owner-operator | Undetermined. | | |

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Fissure vein, shear zone, breccia fill. | Host formation | Andesite porphyry and breccia. |
| Origin | Hydrothermal. | Geologic age | Tertiary. |
| Shape of ore body | Tabular. | Rock relationship | Medium- to coarse-grained, colorless or green fluorite as lenses in veins of dense, massive, banded quartz cutting tertiary rhyolite, andesite, and basalt. |
| Ore controls | Fracturing, faulting. | | |
| Strike and dip of mineralized zone | Undetermined. | | |
| Age of mineralization | Tertiary. | Alteration | Silicification. |
| Mineral zone average dimensions, m: | | Size | Undetermined. |
| Length | Undetermined. | | |
| Thickness | 3. | | |
| Width | Undetermined. | | |
| Depth to | Undetermined. | | |
| Mineral names | Fluorite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Inactive-explored prospect. | Distance to water | 10 km. |
| Type of operation | Underground. | Road requirement | None. |
| Mining method | Undetermined. | Distance to power | 50 km. |
| | | Mill location | None. |
| Year of discovery | 1918. | | |
| Discovery method | Ore mineral in place. | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

362, 657, 665, 670.

| | |
|---|---|
| USGS quad maps | Silver City, 1:250,000. |
| | York Valley, 1:62,500. |
| USBM sequence number | 0040110011. |
| USGS MRDS number | D011430. |

## DENN--COPPER

Commodities: Cu, Pb, Zn, Au, Ag, Bi

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Warren.
Elevation..... 5,060 ft.
Topography..... Rugged.
Domain..... Undetermined.

General location..... 3.5 km east-southeast of Bisbee.
Meridian..... Gila & Salt River.
Tract..... Sec. 15, T 23 S, R 24 E.
Latitude..... 31°25'49" N.
Longitude..... 109°53'15" W.

Owner-operator..... Phelps Dodge Corp. (year of information 1973).

### GEOLOGY

Type of ore body..... Replacement.
Origin..... Hydrothermal.
Shape of ore body..... Irregular, pipelike.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Jurassic.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Chalcopyrite, chalcocite, bornite, cerussite, anglesite, gold, silver.

Host formation..... Martin Limestone, Escabrosa Limestone.
Geologic age..... Devonian, Mississippian.
Rock relationship..... Copper carbonates, oxides, and sulfides with some areas of lead-zinc mineralization in irregular, often pipelike, replacement ore bodies in a wide range of Paleozoic limestones along the Dividend Fault and close to the granitic porphyry stock.
Alteration..... Undetermined.
Size..... Large.

NOTE: Size based only on past ore production with the assumption that ore grade was greater than 6.25% copper.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Shaft workings.

Year of discovery..... 1905.
Discovery method..... Ore mineral in place.

Initial production..... 1909.
Last production..... 1973.
Past production..... Over 16,000,000 st ore produced (300).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive. Condition undetermined.
Milling method..... Flotation.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

259, 300, 654, 657, 665.

USGS quad maps..... Douglas, 1:250,000.
Bisbee, 1:24,000.
USBM sequence number.... 0040030599.
USGS MRDS number..... M241118.

## DOS POBRES--COPPER

Alternate names..... Safford, Safford Phelps Dodge.

Commodities: Cu

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Graham. | General location..... | 16 km north of Safford. |
| Mining district..... | Lone Star. | Meridian..... | Gila & Salt River. |
| Elevation..... | 1,200 m. | Tract..... | Sec. 27, T 5 N, R 26 E. |
| Topography..... | Rugged. | Latitude..... | 32°57'41" N. |
| Domain..... | Private. | Longitude..... | 109°40'24" W. |

Owner-operator..... Phelps Dodge Corp. (year of information 1988).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Stockwork, disseminated. | Host formation..... | Igneous intrusive. |
| Origin..... | Hydrothermal, oxidation. | Geologic age..... | Late Cretaceous. |
| Shape of ore body..... | Massive. | Rock relationship..... | Quartz monzonite. Ore in fractures. |
| Ore controls..... | Fracturing. | Alteration..... | Oxidation. |
| Strike and dip of mineralized zone..... | Undetermined. | Size..... | Large. |
| Age of mineralization.. | Tertiary. | | |
| Mineral zone average dimensions, m: | | | |
| Length..... | 1,200. | | |
| Thickness..... | 114. | | |
| Width..... | Undetermined. | | |
| Depth to..... | 740. | | |
| Mineral names..... | Chalcopyrite, chalcocite, chrysocolla, bornite. | | |

NOTE: Size based only on current resources.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-explored prospect. | Distance to water..... | Greater than 10 km. |
| Type of operation..... | Underground. | Road requirement..... | Less than 50 km. |
| Mining method..... | Block caving (proposed). | Distance to power..... | Less than 50 km. |
| | | Mill location..... | None. |
| Year of discovery..... | 1969. | | |
| Discovery method..... | Undetermined. | | |

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 400,000,000 st ore..... | 0.72% Cu..... | 1977 | 720 |
| 2. Measured..... | 231,600,000 st mixed ore..... | 0.89% Cu..... | 1986 | 535 |

### REFERENCES

64, 327, 433-434, 439, 441, 524, 532, 535, 557, 617, 657, 713, 720.

| | |
|---|---|
| USGS quad maps..... | Silver City, 1:250,000. Safford, 1:62,500. |
| USBM sequence number.... | 0040090004. |
| USGS MRDS number..... | None. |

## DUBACHER CANYON--COPPER

Alternate names..... Muheim-Anderson.

Commodities: Cu

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Warren.
Elevation..... 1,645 m.
Topography..... Rugged.
Domain..... Private.

General Location..... 0.5 mi east of Bisbee.
Meridian..... Gila & Salt River.
Tract..... Sec. 9, T 23 S, R 24 E.
Latitude..... 31°26'25" N.
Longitude..... 109°54'25" W.

Owner..... State of AZ and seven private owners (year of information 1977).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Undetermined.
Ore controls..... Intrusives, lithology.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Undetermined.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Cuprite, copper, tenorite, malanochalcite, delafossite.

Host formation..... Pinal Schist, Sacramento Hill Porphyry.
Geologic age..... Precambrian, Triassic.
Rock relationship..... The Sacramento Hill Porphyry, the primary source of mineralization, was intruded into the Pinal Schist.
Alteration..... Silicification, pyritization.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-explored prospect.
Type of operation..... Surface.
Mining method..... Open pit (proposed).

Year of discovery..... Prior to 1977.
Discovery method..... Undetermined.

Distance to water..... Less than 2 km.
Road requirement..... Less than 2 km.
Distance to power..... Less than 2 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 20,000,000 st oxide ore..... | 0.8% Cu..... | 1977 | 463 |

### REFERENCES

80, 92, 463, 657.

USGS quad maps..... Douglas, 1:250,000.
Bisbee, 1:62,500.
USBM sequence number.... 0040030086.
USGS MRDS number..... None.

## EDNA GROUP--TUNGSTEN

Alternate names..... Martha Washington.

Commodities: W, Mo, Cu

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Santa Cruz. | General location..... | 8 mi east of Nogales, 2 mi north of Mexican border. |
| Mining district..... | Patagonia. | | |
| Elevation..... | 4,800 ft. | Meridian..... | Gila & Salt River. |
| Topography..... | Rugged. | Tract..... | Sec. 12, T 24 S, R 15 E. |
| Domain..... | National forest. | Latitude..... | 31°21'25" N. |
| | | Longitude..... | 110°46'07" W. |

Owner-operator..... Undetermined.

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Shear zone. | Host formation..... | Biotite quartz monzonite. |
| Origin..... | Hydrothermal. | Geologic age..... | Jurassic. |
| Shape of ore body..... | Pockets. | Rock relationship..... | Sporadic scheelite with minor molybdenite and copper carbonates in quartz and gouge pockets along a shear zone cutting Jurassic granite. |
| Ore controls..... | Shear zone. | | |
| Strike and dip of mineralized zone..... | N 30° W; 34° NE. | Size..... | Small. |
| Age of mineralization.. | Tertiary. | | |
| Mineral zone average dimensions, m: | | | |
| Length..... | Undetermined. | | |
| Thickness..... | Undetermined. | | |
| Width..... | Undetermined. | | |
| Depth to..... | Undetermined. | | |
| Mineral names..... | Scheelite, molybdenite, copper carbonates. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | On-site. |
| Type of operation..... | Surface-underground. | Road requirement..... | None. |
| Mining method..... | Open pit, adit. | Distance to power..... | On-site. |
| | | Mill location..... | None. |
| Year of discovery..... | 1914. | | |
| Discovery method..... | Ore mineral in place. | | |
| Initial production..... | 1914. | | |
| Last production..... | 1971. | | |
| Past production..... | 240 st ore at 1.3% $WO_3$ (302). | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

136, 302, 657, 665.

| | |
|---|---|
| USGS quad maps..... | Nogales, 1:250,000 |
| | Nogales, 1:62,500 |
| USBM sequence number.... | 0040230175. |
| USGS MRDS number..... | M000232. |

## EISENHOWER--COPPER-MOLYBDENUM

Alternate names..... Palo Verde, Mission Extension, Mission Complex.

Commodities: Cu, Mo, Ag, Au

### LOCATION-OWNERSHIP

County..... Pima.
Mining district..... Pima.
Elevation..... 994 m.
Topography..... Rolling.
Domain..... BLM administration.

General location..... About 24 km southwest of Tucson.
Meridian..... Gila & Salt River.
Tract..... Sec. 36, T 16 S, R 12 E.
Latitude..... 31°59'55" N.
Longitude..... 111°04'00" W.

Owner-operator..... ASARCO incorporated (year of information 1988).

### GEOLOGY

Type of ore body..... Replacement, disseminated.
Origin..... Contact metasomatic.
Shape of ore body..... Massive.
Ore controls..... Faulting, folding.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... 137.
  Width..... 229.
  Depth to..... Undetermined.
Mineral names..... Chalcopyrite, molybdenite, bornite, chalcocite.

Host formation..... Igneous intrusive.
Geologic age..... Tertiary.
Rock relationship..... Ore is in quartzite and marble ore zones in tabular bodies.
Alteration..... Undetermined.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit.

Last production..... 1983.
Past production..... 1981-83: 8,153,000 st ore with 47,500 st Cu, 163 st Mo, 930,000 tr oz Ag (45, 47).

Distance to water..... Less than 10 km.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... See Mission-San Xavier deposit abstract.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 128,667,000 st ore..... | 0.65% Cu, 0.14 tr oz/st Ag..... | 1982 | 045 |
| 2. Proven and probable..... | 99,276,000 st ore..... | 0.68% Cu, 0.14 tr oz/st Ag..... | 1986 | 049 |

### REFERENCES

6, 8, 43, 45, 47, 49, 74, 219, 352, 386, 448, 621, 657, 665, 671, 716.

USGS quad maps..... Nogales, 1:250,000.
Twin Buttes, 1:62,500.
USBM sequence number.... 0040190026.
USGS MRDS number..... D000330, M050387, D000815, M050384, M050632.

Comments: The Eisenhower Mine is now part of the Mission Complex operation. See the deposit abstract for Mission-San Xavier for further information. The current status is shown as active-producer because the Mission Complex as a whole is in production, but the last production from the Eisenhower pit was in 1983 as shown above.

## EL DORADO--ASBESTOS

Alternate names..... Chrysotile, Eldorado, Ash Creek.

Commodities: Asb

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Gila. | General location..... | About 58 km north-northwest of Globe. |
| Mining district..... | Salt River. | Meridian..... | Gila & Salt River. |
| Elevation..... | 1,481 m. | Tract..... | Sec. 34, T 4 N, R 17 E. |
| Topography..... | Rugged. | Latitude..... | 33°44'30" N. |
| Domain..... | National forest. | Longitude..... | 110°33'23" W. |

Owner-operator..... Jaquays Mining Corp. (year of information 1982).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Replacement. | Host formation..... | Mescal Limestone. |
| Origin..... | Metasomatic. | Geologic age..... | Precambrian. |
| Shape of ore body..... | Tabular. | Rock relationship..... | The asbestos is found in serpentinized zones in the limestone that are associated with diabase sills. |
| Ore controls..... | Contact zone, fracturing. | | |
| Strike and dip of mineralized zone..... | NW: 5° NE. | Alteration..... | Carbonatization, dolomitization, serpentinization. |
| Age of mineralization.. | Precambrian. | Size..... | Small. |
| Mineral zone average dimensions, m: | | NOTE: Size based only on current resources. | |
| Length..... | Withheld. | | |
| Thickness..... | Withheld. | | |
| Width..... | Withheld. | | |
| Depth to..... | Withheld. | | |
| Mineral names..... | Chrysotile, calcite, serpentine, chert, wollastonite, magnetite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | On-site. |
| Type of operation..... | Underground. | Road requirement..... | None. |
| Mining method..... | Room and pillar. | Distance to power..... | On-site. |
| | | Mill location..... | Globe. |
| Year of discovery..... | 1912. | Mill status..... | Inactive. |
| Discovery method..... | Ore mineral in place. | Milling method..... | Hand cob, crush, screen, fiberize, air classify. |
| | | Product type..... | Four grades of asbestos fiber: 3Z, 4T, AAA, 7MF. |
| Initial production..... | 1918. | | |
| Last production..... | 1982. | | |
| Past production..... | Undetermined. | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

5, 72, 282, 295, 336, 354, 364, 385, 578, 640-642, 653, 657, 695, 699, 704.

USGS quad maps..... Mesa, 1:250,000.
Chrysotile, 1:24,000.

USBM sequence number.... 0040070111.

USGS MRDS number..... None.

Comments: The El Dorado Mine and Jaquays Mill in Globe were for sale in 1982.

## ESPERANZA--COPPER-MOLYBDENUM

Commodities: Cu, Mo, Ag

### LOCATION-OWNERSHIP

County..... Pima.
Mining district..... Pima.
Elevation..... 1,296 m.
Topography..... Hilly.
Domain..... Private.

General location..... About 48 km south of Tucson.
Meridian..... Gila & Salt River.
Tract..... Sec. 16, T 18 S, R 12 E.
Latitude..... 31°52'17" N.
Longitude..... 111°07'37" W.

Owner-operator..... Cyprus Sierrita Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated stockwork.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Intrusives, faulting.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Late Cretaceous.
Mineral zone average dimensions, m:
  Length..... 2,000.
  Thickness..... 52.
  Width..... 700.
  Depth to..... 30.
Mineral names..... Copper oxides, chalcopyrite, molybdenite, silver, chalcocite, malachite, azurite, cuprite, ferromolybdenite.

Host formation..... Igneous intrusive.
Geologic age..... Late Cretaceous.
Rock relationship..... Ore in fractures in quartz.
Alteration..... Pyritization, oxidation.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit, dump leaching.

Year of discovery..... 1895.
Discovery method..... Ore mineral in place.

Initial production..... 1959.
Last production..... 1981 (conventional mining).
Past production..... 1982-86: 19,624,000 kg Cu in cement Cu (576)
Production rate..... 17,500 st/d sulfide ore and 3,500 gpm of solution from dump leach.

Distance to water..... Greater than 10 km.
Road requirement..... None.
Distance to power..... Less than 50 km.
Mill location..... On-site.
Mill status..... Inactive (conventional); dump-leach solution goes to Sierrita SX-EW plant. See Sierrita deposit abstract.
Milling method..... Flotation.
Process rate..... 17,500 st/d sulfide ore; 3,500 gpm of solution.
Product type..... Cu and Mo concentrates, cathode Cu at Sierrita.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 48,783,000 st ore..... | 0.27% Cu, 0.034% Mo..... | 1981 | 513 |

### REFERENCES

63-64, 66, 121, 351, 513, 576, 657, 665, 689.

USGS quad maps..... Nogales, 1:250,000.
Twin Buttes, 1:62,500.
USBM sequence number.... 0040190003.
USGS MRDS number..... M050391.

Comments: Resources combined into Sierrita Mine. Considered as one unit from beginning of 1987.

## FLORENCE--COPPER

Alternate names..... Florence Copper, Conoco, Poston Butte.

Commodities: Cu

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Blackwater.
Elevation..... 475 m.
Domain..... Undetermined.

General location..... About 6.4 km northwest of Florence.
Meridian..... Gila & Salt River.
Tract..... Sec. 33, T 4 S, R 9 E.
Latitude..... 33°02'36" N.
Longitude..... 111°26'21" W.

Owner-operator..... E. I. Dupont De Nemours & Co. (year of information 1982).

### GEOLOGY

Type of ore body..... Disseminated, replacement.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Fracturing, brecciation.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Late Cretaceous.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... 503.
  Width..... Undetermined.
  Depth to..... 107.
Mineral names..... Chalcocite, chrysocolla, cuprite, copper, azurite, brochantite, shattuckite.

Host formation..... Oracle Granite, andesite.
Geologic age..... Precambrian, Cretaceous.
Rock relationship..... Andesite intrudes the granite, but it is undetermined whether the ore is in the andesite or the granite.
Alteration..... Potassic alteration, sericitization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-explored prospect.
Type of operation..... Surface.

Year of discovery..... 1969.
Discovery method..... Ore mineral in place.

Distance to water..... On-site.
Road requirement..... Less than 10 km.
Distance to power..... On-site.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 500,000,000 st sulfide ore..... | 0.39% Cu..... | 1977 | 620 |
| 2. Not reported in reference..... | 250,000,000 st oxide ore..... | 0.32% Cu..... | 1977 | 620 |
| 3. Not reported in reference..... | 800,000,000 st mixed ore..... | 0.40% Cu..... | 1976 | 064, 601 |

### REFERENCES

10, 64, 66, 92, 105, 398, 437, 450-451, 458, 486, 585, 592, 601, 620, 657, 665, 717, 723.

USGS quad maps..... Mesa, 1:250,000.
Florence, 1:24,000.
USBM sequence number.... 0040210007.
USGS MRDS number..... W002694.

## FOUNTAIN HEAD--SILVER

Alternate names..... Banner.

Commodities: Ag, Au, Pb, Zn, Cu

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Wallapai.
Elevation..... 4,880 ft.
Topography..... Hilly.
Domain..... BLM administration.

General location..... 1.5 mi north of Silver Mountain.
Meridian..... Gila & Salt River.
Tract..... Sec. 4, T 22 N, R 17 W.
Latitude..... 35°19'21" N.
Longitude..... 114°06'30" W.

Owner-operator..... Harrison Mining (year of information 1987).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Shoots.
Ore control..... Schistosity, fissures.
Strike and dip of mineralized zone..... N 35° W: 90°.
Age of mineralization.. Late Cretaceous-Tertiary.
Mineral zone average dimensions, ft:
  Length..... 600.
  Thickness..... Undetermined.
  Width..... 30.
  Depth to..... 200.
Mineral names..... Galena, sphalerite, hematite, limonite.

Host formation..... Granite, gneiss, and schist.
Geologic age..... Precambrian.
Rock relationship..... Ore in shoots following schistosity and fissures.
Alteration..... Undetermined.
Size..... Undetermined.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Surface-underground.
Mining method..... Stoping.

Year of discovery..... Undetermined.
Discovery method..... Ore mineral in place.

Initial production..... Undetermined.
Last production..... 1953.
Past production..... Undetermined.

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... Cerbat (GEM) Mill.
Mill status..... Being refurbished.
Milling method..... Flotation.
Process rate..... Undetermined.
Product type..... Undetermined.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

147, 399, 409, 567, 657, 665.

USGS quad maps..... Kingman, 1:250,000.
Stockton Hill, 1:24,000.
USBM sequence number.... 0040150495.
USGS MRDS number..... M003978, D003270.

Comments: In 1984-86, the mill was being refurbished for testing of bulk sample from mine. Underground workings were being rehabilitated (409).

## FOURTH OF JULY--FLUORSPAR

Alternate names..... Ellis Shaft, Sydney, Billingsley Fluorspar.

Commodities: $CaF_2$, Mn, W, Be, Cu, Au, Ag

### LOCATION-OWNERSHIP

County..... Greenlee.
Mining district..... Twin Peaks.
Elevation..... 4,640 ft.
Topography..... Hilly.
Domain..... BLM administration.

General location..... 7.5 mi east-southeast of York, between Willows Creek and Daniels Camp Canyons.
Meridian..... Gila & Salt River.
Tract..... Sec. 4, T 7 S, R 32 E.
Latitude..... 32°51'37" N.
Longitude..... 109°04'32" W.

Owner..... Bon Billingsley (year of information 1975).
Operator..... Producers Minerals Co. (year of information 1975).

### GEOLOGY

Type of ore body..... Vein, shear zone.
Origin..... Hydrothermal.
Shape of ore body..... Lenses, pockets.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 25° W; 80° E.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 2,500.
  Thickness..... 150.
  Width..... 5.
  Depth to..... Surface.
Mineral names..... Fluorite, psilomelane, bertrandite.

Host formation..... Vesicular and porphyritic olivine basalt.
Geologic age..... Tertiary.
Rock relationship..... Fluorspar minerals form lenticular veins and pockets along fault breccia zones and fissures in the basalt. Well-jointed basalt (in northerly and easterly directions) has an undulating contact between upper dark-red basaltic flow and underlying greenish basaltic flow.
Alteration..... Silicification.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Coyoting, with square set timber support.

Year of discovery..... 1900's.
Discovery method..... Ore mineral in place.

Initial production..... 1917.
Last production..... 1955.
Past production:
  1937-41..... 2,600 st ore at 65% $CaF_2$ (665).
  1942..... 573 st ore at 64% $CaF_2$ (665).

Distance to water..... 6 mi.
Road requirement..... None.
Distance to power..... 6 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

657, 665, 670.

USGS quad maps..... Silver City, 1:250,000.
York Valley, 1:62,500.
USBM sequence number.... 0040110014.
USGS MRDS number..... M800430.

Comments: Holdings also in T 6 S, R 32 E, Sec. 33.

## FRISCO--GOLD

Alternate names..... Tragedy, Equator.

Commodities: Au, Ag

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Union Pass.
Elevation..... 921 m.
Topography..... Rolling.
Domain..... BLM administration.

General location..... About 1-3/4 mi southwest of Union Pass.
Meridian..... Gila & Salt River.
Tract..... Sec. 16, T 21 N, R 20 W.
Latitude..... 35°12'42" N.
Longitude..... 114°24'57" W.

Owner-operator..... Frisco Land and Mining Co. (year of information 1987).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Contact between granite and rhyolite.
Strike and dip of mineralized zone..... N 55° E; 12° S.
Age of mineralization.. Tertiary.
Mineral zone maximum dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... 18.
  Depth to..... 300.
Mineral names..... Gold, silver, quartz, calcite.

Host formation..... Golden Gate Volcanics, Katherine Granite.
Geologic age..... Tertiary, Precambrian.
Rock relationship..... Small granite hill capped by a rhyolite flow and tuffs. Strings of banded vuggy quartz occur at the contact; ore is displaced by a fault. Precambrian mineralization occurs at contact and is enriched toward surface.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Underground.
Mining method..... Cut and fill.

Year of discovery..... 1894.
Discovery method..... Ore mineral in place.

Initial production..... 1894.
Last production..... Intermittent.
Past production..... 1894-1916: 44,000 st ore with $14/st Au (215).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Milling method..... Cyanide heap leach.
Product type..... Dore.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 150,000 st ore..... | 0.03 tr oz/st Au..... | 1987 | 409 |

### REFERENCES

215, 332, 341, 371, 409, 567, 657, 665, 684, 702.

USGS quad maps..... Kingman, 1:250,000.
Union Pass, 1:24,000.
USBM sequence number.... 0040150143.
USGS MRDS number..... M004538.
MSHA ID number..... 0202172.

Comments: In 1984-86, surface drilling was being carried out to discover and develop additional reserves for intermittent heap-leach operation (409).

## GLOVE GROUP--LEAD

Alternate names..... Sheehy-O'Donnel, Rover, Zombie & Zero, Blacksmith Adit, O. K., Festingo-Franklin.

Commodities: Pb, Zn, Ag, Cu, Au, Mo, Mn

### LOCATION-OWNERSHIP

County..... Santa Cruz.
Mining district..... Tyndall.
Elevation..... 4,300 ft.
Topography..... Hilly.
Domain..... National forest.

General location..... 0.5 mi north of Cottonwood Canyon, 6.5 mi southeast of Mt. Wrightson.
Meridian..... Gila & Salt River.
Tract..... Sec. 30, T 20 S, R 14 E.
Latitude..... 31°39'35" N.
Longitude..... 110°56'47" W.

Owner..... Arivaca Mining Corp. (year of information 1967).
Operator..... Colorado Fuel and Iron Corp. (year of information 1972).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal, replacement.
Shape of ore body..... Tabular.
Ore controls..... Fault zones, brecciation.
Strike and dip of mineralized zone..... N 60° E; 60° S.
Age of mineralization.. Late Cretaceous.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Argentiferous galena, sphalerite, wulfenite, pyrite, chalcopyrite, cerussite, anglesite, smithsonite, covellite, vanadinite, mimetite.

Host formation..... Naco Limestone, quartz monzonite.
Geologic age..... Pennsylvanian-Permian, Jurassic.
Rock relationship..... Argentiferous galena, sphalerite, and small amounts of pyrite, chalcopyrite, and quartz deposited in permeable zones at the intersection of a bedding plane fault and favorable beds in Pennsylvanian-Permian Naco Limestone. Extensive solution of the limestone and deep oxidation concentrated cerussite, anglesite, wulfenite, and smithsonite in the leached caverns as sand carbonate ores.
Alteration..... Oxidation.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Shaft and adit.

Year of discovery..... 1907.
Discovery method..... Ore mineral in place.

Initial production..... 1911.
Last production..... 1976.
Past production..... 1911-72: 29,260 st ore (302).

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

302, 657, 665.

USGS quad maps..... Nogales, 1:250,000.
Mt. Wrightson, 1:62,500.
USBM sequence number.... 0040230199.
USGS MRDS number..... D000342.

## GOLD PRINCE--GOLD

Alternate names..... Henry Clay, Pat Price, Basin, Bain, Murphy.

Commodities: Au, Pb, Ag, Cu, Zn

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Mascot, Dos Cabezas.
Elevation..... 5,900 ft.
Topography..... Hilly to rugged.
Domain..... Undetermined.

General location..... Approx 2.75 mi northeast of Dos Cabezas.
Meridian..... Gila & Salt River
Tract..... Secs. 22, 27, T 14 S, R 27 E.
Latitude..... 32°11'47" N.
Longitude..... 109°34'20" W.

Owner-operator..... Phelps Dodge Corp. (year of information 1987).

### GEOLOGY

Type of ore body..... Shear zone, metamorphic.
Origin..... Pyrometamorphism.
Shape of ore body..... Irregular, lenticular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 70° W; 65° S.
Age of mineralization.. Cretaceous.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Galena, pyrite.

Host formation..... Sandstone, shale.
Geologic age..... Cretaceous.
Rock relationship..... Lenticular bodies of pyritic quartz containing irregular bunches of auriferous base metal sulfides in a strong zone of sheared and pyrometamorphosed Cretaceous sandstone and graphitic shale along a major fault. Associated rhyolite, andesite, and diabase dikes.
Alteration..... Undetermined.
Size..... Small.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Underground.
Mining method..... Undetermined.

Year of discovery..... 1878.
Discovery method..... Ore mineral in place.

Initial production..... 1880.
Last production..... 1950.
Past production..... 1880-1950: 10,000 st ore (300). Current flux production has not been reported.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 200,000 st ore..... | 0.5 tr oz/st Au..... | 1987 | 409 |

### REFERENCES

172, 300, 409, 657, 665, 702.

USGS quad maps..... Silver City, 1:250,000.
Dos Cabezas, 1:62,500.
Dos Cabezas, 1:24,000.
USBM sequence number.... 0040030144.
USGS MRDS number..... M001704.

Comments: Owner-operator data is based on Niemuth (409) and has not been confirmed.

## HARDSHELL--MANGANESE

Alternate names..... Manto.

Commodities: Mn, Pb, Zn, Ag

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Santa Cruz. | General location..... | About 1.6 km southwest of Harshaw. |
| Mining district..... | Harshaw. | Meridian..... | Gila & Salt River. |
| Elevation..... | 1,554 m. | Tract..... | T 23 S, R 16 E. |
| Topography..... | Hilly. | Latitude..... | 31°27'15" N. |
| Domain..... | Private. | Longitude..... | 110°42'44" W. |

Owner..... ASARCO Incorporated (year of information 1987).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Disseminated, replacement. | Host formation..... | Porphyritic rhyolite. |
| Origin..... | Hydrothermal. | Geologic age..... | Tertiary. |
| Shape of ore body..... | Tabular. | Rock relationship..... | Ore occurs as replacement in fault gouge, silicified breccia, and rhyolite. Ore in gangue of quartz, limonite, clay, silicified breccia fragments, and other volcanic material. |
| Ore controls..... | Contact zone, faulting. | | |
| Strike and dip of mineralized zone..... | Undetermined. | | |
| Age of mineralization.. | Tertiary. | Alteration..... | Silicification. |
| Mineral zone average dimensions, m: | | Size..... | Medium. |
| Length..... | 460. | | |
| Thickness..... | 18. | | |
| Width..... | 275. | | |
| Depth to..... | 60. | | |
| Mineral names..... | Anglesite, galena, cerussite, silver halides, pyrolusite, manganite, wad, pyromorphite, wulfenite, mimetite, hemimorphite, smithsonite, hydrozincite, braunite, psilomelane. | | |

NOTE: Size based only on current resources.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | Undetermined. |
| Type of operation..... | Underground. | Road requirement..... | Undetermined. |
| Mining method..... | Undetermined. | Distance to power..... | Undetermined. |
| | | Mill location..... | None. |
| Year of discovery..... | 1879. | | |
| Discovery method..... | Undetermined. | | |
| Initial production..... | 1901. | | |
| Last production..... | 1964. | | |
| Past production..... | 1896-1964: 35,000 st ore (665). | | |

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Probable..... | 6,500,000 st ore..... | 15% Mn, 0.75% Pb, 0.75% Zn, 5 tr oz/st Ag. | 1972 | 393 |
| 2. Not reported in reference..... | 6,000,000 st ore..... | 5.0 tr oz/st Ag..... | 1986 | 409 |

### REFERENCES

145, 393, 409, 541, 568, 657, 665.

| | |
|---|---|
| USGS quad maps..... | Nogales, 1:250,000. |
| | Harshaw, 7.5 min. |
| USBM sequence number.... | 0040230002. |
| USGS MRDS number..... | M030387. |

Comments: According to U.S. Bureau of Mines standards, these reserves, containing 15% Mn, do not contain the necessary 35% Mn to be classified as manganese ore. If market conditions improve, this property should be reviewed as a potential Ag mine with Mn, Pb, and Zn as byproducts. Niemuth (409), however, reports that Ag recovery is hampered by refractory metallurgical problems caused by the presence of Mn.

## HELVETIA EAST--COPPER-MOLYBDENUM

Alternate names..... Rosemont, Helvetia, Helvetia-Rosemont.

Commodities: Cu, Mo, Ag, Au

### LOCATION-OWNERSHIP

County..... Pima.
Mining district..... Rosemont.
Elevation..... 1,660 m.
Topography..... Rugged.
Domain..... National forest.

General location..... 50 km southeast of Tucson.
Meridian..... Gila & Salt River.
Tract..... Sec. 36, T 18 S, R 15 E.
Latitude..... 31°49'57" N.
Longitude..... 110°45'29" W.

Owner-operator..... ASARCO Incorporated (year of information 1988).

### GEOLOGY

Type of ore body..... Replacement, disseminated, shear zone.
Origin..... Hydrothermal, contact metasomatic.
Shape of ore body..... Massive.
Ore controls..... Intrusives, lithology.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Pyrite, chalcopyrite, bornite, chalcocite, chrysocolla, azurite, malachite, cuprite, biotite.

Host formation..... Greaterville intrusives (quartz latite porphyry).
Geologic age..... Tertiary.
Rock relationship..... Ore in fractures and replaced by ore.
Alteration..... Pyritization, silicification, argillization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Open pit (proposed).

Year of discovery..... 1961.
Discovery method..... Geological inference.

Initial production..... 1870's.
Last production..... 1959.
Past production..... Intermittent and very minor production from deposits overlying the main deposit.

Distance to water..... Less than 10 km.
Road requirement..... Less than 50 km.
Distance to power..... Less than 50 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 337,300,000 st sulfide ore..... | 0.54% Cu..... | 1977 | 724 |
| 2. Not reported in reference..... | 22,000,000 st oxide ore..... | 0.55% Cu ..... | 1977 | 724 |
| 3. Not reported in reference..... | 280,000,000 st sulfide ore..... | 0.62% Cu; 0.016% Mo..... | 1988 | 012 |
| 4. Not reported in reference..... | 23,000,000 st oxide ore..... | 0.78% Cu..... | 1988 | 012 |

### REFERENCES

12, 57, 64, 66, 139, 151-155, 265, 301, 344, 429, 440, 465, 521-523, 540, 569, 593, 657, 665, 709, 720, 724.

USGS quad maps..... Nogales, 1:250,000.
Sahuarita, 1:62,500.
USBM sequence number.... 0040190010.
USGS MRDS number..... D000804, M000917.

Comments: ASARCO Incorporated acquired the property as a "long-term copper reserve" and has no immediate plans to develop it (12).

## HELVETIA WEST--COPPER

Alternate names..... Peach Elgin.

Commodities: Cu, Mo, Ag, Au

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Pima. | General location..... | 40 km south of Tucson. |
| Mining district..... | Helvetia. | Meridian..... | Gila & Salt River. |
| Elevation..... | 1,410 m. | Tract..... | Sec. 15, T 18 S, R 15 E. |
| Topography..... | Rugged. | Latitude..... | 31°51'50" N. |
| Domain..... | Federal. | Longitude..... | 110°46'50" W. |

Owner-operator..... ASARCO Incorporated (year of information 1988).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Replacement. | Host formation..... | Limestone. |
| Origin..... | Mesozoic. | Geologic age..... | Paleozoic. |
| Shape of ore body..... | Massive. | Rock relationship..... | Limestone replaced by ore near late Laramide quartz latite porphyry intrusions. |
| Ore controls..... | Intrusives, lithology, faulting. | | |
| Strike and dip of mineralized zone..... | Undetermined. | Alteration..... | Silicification, oxidation. |
| Age of mineralization.. | Tertiary. | Size..... | Medium. |
| Mineral zone average dimensions, m: | | NOTE: Size based only on current resources. | |
| Length..... | Undetermined. | | |
| Thickness..... | Undetermined. | | |
| Width..... | Undetermined. | | |
| Depth to..... | Undetermined. | | |
| Mineral names..... | Chalcopyrite, chalcocite, chrysocolla, bornite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | Less than 10 km. |
| Type of operation..... | Surface. | Road requirement..... | Less than 50 km. |
| Mining method..... | Open pit (proposed). | Distance to power..... | Less than 50 km. |
| | | Mill location..... | None. |
| Year of discovery..... | 1870. | | |
| Discovery method..... | Ore mineral in place. | | |
| Initial production..... | 1890. | | |
| Last production..... | 1960. | | |
| Past production..... | Intermittent and very minor production from small deposits in the area. | | |

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| I. | Not reported in reference..... | 24,000,000 st ore..... | 0.75% Cu..... | 1977 | 722 |

### REFERENCES

12, 64, 251, 301, 426, 568, 588, 657, 722.

| | |
|---|---|
| USGS quad maps..... | Nogales, 1:250,000. Sahuarita, 1:62,500. |
| USBM sequence number.... | 0040190086. |
| USGS MRDS number..... | None. |

## INSPIRATION--COPPER

Commodities: Cu, Ag, Au, Mo, Se

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Globe-Miami.
Elevation..... 1,130 m.
Topography..... Hilly.
Domain..... Private.

General location..... Directly northeast of Miami.
Meridian..... Gila & Salt River.
Tract..... Sec. 24, T 1 N, R 14 E.
Latitude..... 33°24'30" N.
Longitude..... 110°53'10" W.

Owner-operator..... Cyprus Miami Mining Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated, porphyry copper.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Intrusives, lithology.
Strike and dip of mineralized zone..... N 72° E: SW (dip angle undetermined).
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 12,000.
  Thickness..... 225.
  Width..... Maximum 2,500.
  Depth to..... 150.
Mineral names..... Chalcocite, chalcopyrite, molybdenite, malachite, azurite, chrysocolla, cuprite, covellite, bornite.

Host formation..... Pinal Schist, Schultze Granite.
Geologic age..... Precambrian, Tertiary.
Rock relationship..... Hypogene mineralization is overlain by a chalcocite, supergene-enriched blanket, which in turn is overlain by a leached capping. Copper oxide mineralization occurs between the chalcocite zone and the leached capping.
Alteration..... Sericitization, silicification, argillization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit, heap leach

Year of discovery..... 1872.
Discovery method..... Ore mineral in place.

Initial production..... 1915.
Past production:
  1986..... 104,000,000 lb Cu (276).
  1987..... 106,000,000 lb Cu (277).
Production rate..... 24,000 st/d ore; 8,000-9,000 gpm of solution.

Distance to water..... Greater than 10 km.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive conventional, active heap leach.
Milling method..... Flotation; heap leach; ferric cure leach; precipitation; SX-EW.
Process rate..... 24,000 st/d ore; 8,000-9,000 gpm of solution.
Product type..... Cu and Mo concentrates, cement Cu, and cathode Cu.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Proven | 254,957,000 st ore | 0.58% Cu | 1980 | 197 |
| 2. Not reported in reference | 220,673,000 st ore | 0.51% Cu | 1981 | 273 |
| 3. Demonstrated | 122,700,000 st oxide ore | 0.57% Cu | 1986 | 276 |
| 4. Demonstrated | 129,200,000 st sulfide ore | 0.53% Cu | 1986 | 276 |

### REFERENCES

64, 140, 197, 200, 227, 235, 273, 276-277, 335, 361, 371, 414, 472-474, 517, 548, 571, 657, 665.

USGS quad maps..... Mesa, 1:250,000.
Inspiration, 1:62,500.
USBM sequence number.... 0040070008.
USGS MRDS number..... D000316.
MSHA ID number..... 0200112.

Comments: Cyprus Metal Co. acquired Inspiration Consolidated Copper Co. on July 1, 1988. The SX-EW plant, called Cyprus Miami, serves all Cyprus leach operations in the area and produces 125,000,000 lb/yr of Cu (227).

## IRON KING--LEAD

Commodities: Pb, Zn, Ag, Au, Cu, Cd

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Big Bug.
Elevation..... 4,820 ft.
Topography..... Rugged.
Domain..... National forest.

General location..... 1 mi west of Humboldt.
Meridian..... Gila & Salt River.
Tract..... Sec. 16, T 13 N, R 1 E.
Latitude..... 34°30'07" N.
Longitude..... 112°15'25" W.

Owner-operator..... Stan West Mining Corp. (year of information 1988).

### GEOLOGY

Type of ore body..... Massive sulfide replacement, vein-like.
Origin..... Hydrothermal.
Shape of ore body..... Lenticular.
Ore controls..... Shearing.
Strike and dip of mineralized zone..... N 22° E: 71° NW.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... At least 3,500.
  Thickness..... At least 2,700.
  Width..... Maximum 100.
  Depth to..... Exposed at surface.
Mineral names..... Gold, galena, sphalerite, chalcopyrite, pyrite, arsenopyrite, tennantite, ankerite, quartz, sericite, anglesite, cerargyrite, limonite, chlorite, apatite.

Host formation..... Spud Mountain Volcanics.
Geologic age..... Precambrian.
Rock relationship..... Andesitic tuffaceous breccia, wall rock. Schist, forms partings within ore.
Alteration..... Sericitization, silicification, chloritization.
Size..... Medium.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Shrinkage stoping, cut and fill.

Year of discovery..... 1880.
Discovery method..... Ore mineral in place.

Initial production..... 1906.
Last production..... 1968.
Past production..... 1907-64: 616,493 tr oz Au, 18,494,491 tr oz Ag, 125,375 st Pb, 367,569 st Zn, 9,551 st Cu (416).
Grades: 0.123 tr oz/st Au, 3.69 tr oz/st Ag, 2.50% Pb, 7.34% Zn, 0.19% Cu (416).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... On-site.
Mill status..... Abandoned 1968, condition undetermined.
Milling method..... Cyanidation, flotation.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Proven..... | 750,000 st ore..... | 1 to 2.5 tr oz/st Ag, 3% to 4% combined Pb-Zn, 0.06 to 0.07 tr oz/st Au, less than 1% Cu. | 1988 | 416 |

### REFERENCES

17-18, 113-114, 158, 226, 319-320, 322, 338, 416, 562, 623, 657, 665.

USGS quad maps..... Prescott, 1:250,000.
Prescott Valley South, 1:24,000.
USBM sequence number.... 0040251178, 0040251179, 0040251180.
USGS MRDS number..... M002386.

Comments: The current owners completed acquisition of the property in 1987 and have identified an exploration target in the southern part of the property. In addition, they are using water from the No. 7 shaft for the mill at the McCabe Mine, about 3 mi to the southwest. Further exploration in the near future appears likely. The proven reserves given above are located near the No. 7 shaft toward the northern end of the property and were blocked out by the Shattuck Denn Mining Corp. before it sold the property in the mid-1960's. The grades given are approximate. When operations ceased in 1968 for economic reasons, mining was still in ore at a depth of 2,700 ft. There have been reports in the literature that the Iron King tailings have a problem with pyrite encapsulation of the silver and gold and that zinc and arsenic also present metallurgical problems. Whether these problems apply to the reserves given above is not known, but the fact that Stan West Mining is considering exploration suggests that the problems may not be serious or may apply only to the tailings.

## KAY--COPPER

Alternate names..... Buckeye, Marietta, Diorite, Harriet.

Commodities: Cu, Pb, Zn, Au, Ag

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Kay.
Elevation..... 1,980 ft.
Topography..... Hilly.
Domain..... BLM administration.

General location..... 0.4 mi southwest of Black Canyon City.
Meridian..... Gila & Salt River.
Tract..... Secs. 4, 9, T 8 N, R 2 E.
Latitude..... 34°03'37" N.
Longitude..... 112°09'35" W.

Owner..... Del Harvey (year of information 1966).
Operator..... 4 Bar Mining Co. (year of information 1968).
Exxon Minerals Co. (exploration lease; year of information 1981).

### GEOLOGY

Type of ore body..... Stratiform massive sulfide.
Origin..... Contact metamorphism.
Shape of ore body..... Lenticular.
Strike and dip of mineralized zone..... N 20° E; 70° W.
Age of mineralization.. Proterozoic.
Mineral zone average dimensions, ft:
Length..... 1,500.
Thickness..... 1,500.
Width..... 100.
Depth to..... Surface.
Mineral names..... Chalcopyrite, galena, auriferous pyrite, sphalerite, tetrahedrite.

Host formation..... Metarhyolite, metaandesite, quartz-mica schist.
Geologic age..... Proterozoic.
Rock relationship..... Stratiform massive sulfide in chloritized metarhyolite.
Alteration..... Chloritization, sericitization.
Size..... Small to medium.

NOTE: See comments.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.

Year of discovery..... Prior to 1910.
Discovery method..... Ore mineral in place.

Initial production..... 1910.
Last production..... 1966.
Past production..... Undetermined.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Assumed abandoned, condition unknown.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

538, 657, 665.

USGS quad maps..... Prescott, 1:250,000.
Black Canyon City, 1:24,000.
USBM sequence number.... 0040251231.
USGS MRDS number..... M800040.

Comments: The status of this operation is unclear because of the lack of published production and reserve data. It is possible that this ore body was entirely mined out by 1966. Unconfirmed and/or unpublished reserve figures give tonnages ranging from less than 200,000 st ore to almost 1.5 million st ore in the 1930's.

## KEYSTONE--COPPER

Alternate names..... Hagerman, Bannon Group (claim names are Mary, Calumet, Ultimo, Charles, Nevertholess, O.K., Ella, Gustave, Wolfrime, Louie, Ernest, Erika, Roswell, Hagerman, Dora, Ina, Esmeralda, Halderman, Gladys, Maher).

Commodities: Cu, Zn, Ag, Mo, Au, W

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Cochise. | General location..... | 1.6 km southwest of Johnson. |
| Mining district..... | Cochise. | Meridian..... | Gila & Salt River. |
| Elevation..... | 1,509 m. | Tract..... | Sec. 36, T 15 S, R 22 E. |
| Topography..... | Level, barren. | Latitude..... | 32°05'34" N. |
| Domain..... | Undetermined. | Longitude..... | 110°03'27" W. |

Owner-operator..... Black Prince Copper Co. (year of information 1973).
Keystone Copper Mining Co. (year of information 1973).
Aztec Mining and Development Co. (year of information 1973).
Coronado Copper and Zinc Co. (year of information 1973).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Limestone replacement. | Host formation..... | Martin Limestone, Escabrosa Limestone. |
| Origin..... | Pyrometasomatic. | Geologic age..... | Devonian, Mississippian. |
| Shape of ore body..... | Multiple: tabular, chimney, manto. | Rock relationship..... | Copper, zinc, and spotty molybdenite mineralization in pyrometasomatic orebodies in Devonian Martin and Mississippian Escabrosa limestones. Strong garnetization. Spotty molybdenite in Cambrian Abrigo Limestone. |
| Ore controls..... | Undetermined. | | |
| Strike and dip of mineralized zone..... | Undetermined. | | |
| Age of mineralizationn. | Tertiary. | | |
| Mineral zone average dimensions, m: | | Alteration..... | Garnetization. |
| Length..... | Undetermined. | Size..... | Small. |
| Thickness..... | Undetermined. | | |
| Width..... | Undetermined. | | |
| Depth to..... | Surface. | | |
| Mineral names..... | Chalcopyrite, sphalerite, bornite, pyrite, molybdenite, scheelite, gold, silver. | | |

NOTE: Size based only on past production.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | On-site. |
| Type of operation..... | Underground. | Road requirement..... | None. |
| Mining method..... | Shaft workings. | Distance to power..... | On-site. |
| | | Mill location..... | On-site. |
| Year of discovery..... | 1908. | Mill status..... | Inactive, condition unknown, may not exist. |
| Discovery method..... | Ore mineral in place. | Milling method..... | Flotation. |
| Initial production..... | 1917. | | |
| Last production..... | 1958. | | |
| Past production..... | 2,250 st ore (300). | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

109, 300, 560, 657, 665.

| | |
|---|---|
| USGS quad maps..... | Tucson, 1:250,000. |
| | Dragoon, 1:62,500. |
| USBM sequence number.... | 0040030164. |
| USGS MRDS number..... | M050006. |

Comments: The U.S. Bureau of Mines drilled the property in the late 1940's but did not determine any reserve figure (560). Preliminary private drilling reports show intercepts grading 0.6% to 1.2% Cu, with 1 ft of 4.1% Mo and 7 ft of 1.02% Mo (665).

## KING OF ARIZONA--GOLD

Alternate names..... Gleason.

Commodities: Au, Ag, Mn

### LOCATION-OWNERSHIP

County..... Yuma.
Mining district..... Kofa.
Elevation..... 561 m.
Topography..... Rugged.
Domain..... National wildlife refuge.

General location..... Southern edge of Kofa Mountains.
Meridian..... Gila & Salt River.
Tract..... Sec. 12, T 2 S, R 17 W.
Latitude..... 33°16'13" N.
Longitude..... 113°57'52" W.

Owner..... Kofa Mining Syndicate (last confirmed owner, 1934; year of information 1967).
Operator..... Barons Gold, Inc. (year of information 1987).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 60° to 90° W; 60° S.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... At least 2,200.
  Thickness..... 750.
  Width..... 12.
  Depth to..... Exposed at surface.
Mineral names..... Gold, silver, manganiferous calcite, plagioclase, quartz, iron oxides, manganese oxides.

Host formation..... Volcanics.
Geologic age..... Cretaceous or Tertiary.
Rock relationship..... Andesite breccia, contains ore. Rhyolite, cut by vein. Andesite, cut by vein.
Alteration..... Silicification, carbonatization.
Size..... Small.

NOTE: Size based on combined past production and author's estimate of present resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Underground.
Mining method..... Stoping (extensive workings).

Year of discovery..... 1896.
Discovery method..... Ore mineral in place.

Initial production..... 1897.
Past production..... 1896-1937: 739,300 st ore at 0.25 tr oz/st Au, 0.1 tr oz/st Ag (303).

Distance to water..... 5 mi.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... On-site.
Mill status..... Primary production stopped in July 1910. Intermittent production through 1937 by various operators. Condition--assumed "razed" after 1937.
Milling method..... Cyanidation.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 1,000,000 st ore..... | 0.1 tr oz/st Au..... | 1987 | 409 |

### REFERENCES

158, 289, 303, 390, 409, 651, 657, 665, 696, 702.

USGS quad maps..... Phoenix, 1:250,000.
Kofa Butte, 1:62,500.
USBM sequence number.... 0040270250.
USGS MRDS number..... M002551.

Comments: Vein width increases and grade decreases with depth. At a depth of 750 ft, the vein is 80 ft wide but was reported to contain only $3.00 in combined gold and silver values with a 58:1 ratio of gold value to silver value. Because, in about 1910, the prices of gold and silver were $20.67/tr oz and $0.54/tr oz, respectively, the ore grades can be calculated as about 0.14 tr oz/st Au and about 0.09 tr oz/st Ag. At these grades, the "Large tonnages" referred to by Wilson, Cunningham, and Butler (702) certainly constitute a significant resource. According to Niemuth (409), construction of an agitation leach facility and production from tailings began in late 1986.

## LA FORTUNA--GOLD

Alternate names..... Fortuna.

Commodities: Au, Ag, Cu, Fe

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Yuma. | General location..... | About 28 mi southeast of Yuma. |
| Mining district..... | Fortuna. | Meridian..... | Gila & Salt River. |
| Elevation..... | 780 ft. | Tract..... | Sec. 16, T 10 S, R 20 W. |
| Topography..... | Rugged. | Latitude..... | 32°33'06" N. |
| Domain..... | Military reservation. | Longitude..... | 114°19'47" W. |

Owner..... U.S. Government (Luke Air Force Base Bombing Range; year of information 1959).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Vein intersection. | Host formation..... | Schist. |
| Origin..... | Hydrothermal. | Geologic age..... | Mesozoic. |
| Shape of ore body..... | Branching, chimney-like. | Rock relationship..... | Schist, contains vein. Quartz, vein material. |
| Ore controls..... | Faulting. | Alteration..... | Carbonatization, silicification. |
| Strike and dip of mineralized zone..... | S 40° W; 70° SE. | Size..... | Small. |
| Age of mineralization.. | Undetermined. | | |
| Mineral zone average dimensions, ft: | | | |
| Length..... | 100. | | |
| Thickness..... | About 800. | | |
| Width..... | 1.5-12. | | |
| Depth to..... | Exposed at surface. | | |
| Mineral names..... | Gold, silver, quartz, hematite, limonite, malachite, garnet. | | |

NOTE: Size based only on past production.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | Undetermined. |
| Type of operation..... | Underground. | Road requirement..... | None. |
| Mining method..... | Undetermined. | Distance to power..... | Undetermined. |
| | | Mill location..... | On-site. |
| Year of discovery..... | About 1895. | Mill status..... | Abandoned and dismantled. |
| Discovery method..... | Ore mineral in place. | Milling method..... | Cyanidation. |
| Initial production..... | 1896. | | |
| Last production..... | 1941(?). | | |
| Past production..... | 1896-1941: 213,000 st ore at 0.63 tr oz/st Au, 0.05 tr oz/st Ag, minor Cu (303). | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

158, 172, 303, 657, 665, 702.

| | |
|---|---|
| USGS quad maps..... | Silver City, 1:250,000. |
| | Fortuna Mine, 1:24,000. |
| USBM sequence number.... | 0040270197. |
| USGS MRDS number..... | M002626. |

Comments: The ore body was cut off by a fault at a depth of 800 ft, and only a small segment of it was found between the 900- and 1100-ft levels.

## LAKESHORE--COPPER

Alternate names..... Cyprus Casa Grande.

Commodities: Cu, Au, Ag

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Casa Grande.
Elevation..... 549 m.
Topography..... Rolling.
Domain..... Indian reservation.

General location..... About 45 km southwest of Casa Grande.
Meridian..... Gila & Salt River.
Tract..... Sec. 36, T 10 S, R 4 E.
Latitude..... 32°31'00" N.
Longitude..... 111°54'00" W.

Owner-operator..... Cyprus Casa Grande (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Stockwork, disseminated.
Origin..... Metasomatic.
Shape of ore body..... Massive.
Ore controls..... Intrusives, lithology.
Strike and dip of mineralized zone..... S 11° W; 20° W.
Age of mineralization.. Paleocene.
Mineral zone average dimensions, ft:
  Length..... 6,000.
  Thickness..... 1,080.
  Width..... 2,500.
  Depth to..... 500.
Mineral names..... Chalcopyrite, pyrite, covellite, brochantite, magnetite, hematite, chrysocolla, tenorite, cuprite, chalcocite.

Host formation..... Quartz monzonite, sediments.
Geologic age..... Late Cretaceous (monzonite), Precambrian and Paleozoic (sediments).
Rock relationship..... The copper deposit is a typically massive porphyry type. The three principal parts to the ore body are a core of disseminated sulfide ore in quartz monzonite, a tactite ore in Paleozoic and Precambrian sedimentary rocks at the base and marginal to the thick sulfide deposit, and an enriched blanket of oxide ore formed by the oxidation of a secondary enriched chalcocite blanket overlying the core. A high-angle reverse fault offsets the "overlying" oxide zone (to the west) from the central sulfide zone on the east.
Alteration..... Sericitization, oxidation.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Underground.
Mining methods..... In situ leach.

Year of discovery..... 1966.
Discovery method..... Geological inference.

Initial production..... 1982.
Past production..... 1982-86: 119,145,000 lb Cu (63-64, 252-254).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive (conventional). Active (leach).
Milling method..... Flotation; in situ leach solution fed to SX-EW plant; Cu concentrate from Sierrita is roasted and vat leached. Resulting solution is fed to SX-EW plant.
Process rates..... 10,000 st/d ore (conventional mill). 75,000 st/yr cathode Cu output from SX-EW plant.
Product types..... Cathode Cu, Cu concentrate.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 13,100,000 st oxide ore..... | 1.16% Cu..... | 1983 | 413 |
| 2. Not reported in reference..... | 8,900,000 st sulfide tactite ore. | 1.35% Cu..... | 1983 | 413 |
| 3. Not reported in reference..... | 41,000,000 st porphyry ore..... | 0.65% Cu..... | 1983 | 413 |
| 4. Not reported in reference..... | 50,000,000 st oxide ore..... | Not reported..... | 1986 | 383 |

### REFERENCES

61, 63-64, 66, 242, 244, 252-254, 335, 371, 383, 407-408, 411-413, 505, 602, 619, 657, 665.

USGS quad maps..... Tucson, 1:250,000.
Silver Reef Mountains, 1:62,500.
USBM sequence number.... 0040210004.
USGS MRDS..... 0000752.
MSHA ID number..... 0200498.

Comments: Cyprus Metals Co. acquired the Lakeshore copper property from Noranda Lakeshore Mines, Inc., a subsidiary of Noranda Mines, Ltd., in June 1987. A lease agreement with the Tohono O'odham Nation is being completed (505).

## LONE STAR--COPPER-MOLYBDENUM

Alternate names..... Safford Kennecott.

Commodities: Cu, Mo

### LOCATION-OWNERSHIP

County..... Graham.
Mining district..... Lone Star.
Elevation..... 1,524 m.
Topography..... Rugged.
Domain..... Private.

General location..... 14 km northeast of Safford.
Meridian..... Gila & Salt River.
Tract..... Sec. 5, T 6 S, R 27 E.
Latitude..... 32°54'00" N.
Longitude..... 109°42'00" W.

Owner..... Phelps Dodge Corp. (year of information 1988).

### GEOLOGY

Type of ore body..... Porphyry copper.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Intrusives, fracturing, lithology.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average. dimensions, m:.
Length..... 1,200.
Thickness..... 600.
Width..... 900.
Depth to..... 300.
Mineral names..... Chrysocolla, malachite, brochantite, pyrite, chalcopyrite, bornite, molybdenite.

Host formation..... Andesite flows.
Geologic age..... Cretaceous.
Rock relationship..... Ore in fractures and gangue, pyrometasomatic, replacement of limestone with some oxidation on fractures. Deposit is zoned with a pyrite-chalcopyrite core, a chalcopyrite-bornite intermediate zone, and a pyrrhotite-sphalerite-chalcopyrite margin.
Alteration..... Hydrothermal epidotization, silicification, propylitization, sericitization, chloritization, oxidation.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-developed deposit.
Type of operation..... Surface-underground.
Mining method..... Block caving, in situ leaching.

Year of discovery..... 1950.
Discovery method..... Geological inference.

Distance to water..... Less than 50 km.
Road requirement..... Greater than 10 km.
Distance to power..... Less than 50 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 500,000,000 st ore..... | 0.5% Cu..... | 1977 | 720 |
| 2. Not reported in reference..... | 1,065,000,000 st ore..... | 0.58% Cu..... | 1981 | 025 |

### REFERENCES

25, 64, 92, 185, 234, 346, 442, 557, 605, 657, 665, 718, 720.

USGS quad maps..... Silver City, 1:250,000.
Safford, 1:62,500.
USBM sequence number.... 0040090003.
USGS MRDS number..... M001755.

Comments: Kennecott shut down pilot-plant studies in June 1978 because of poor leach penetration that resulted in poor copper recoveries.

## L. S. AND A.--GOLD

Alternate names..... Lake Superior and Arizona, Gold Eagle, Monarch Vein, Queen Creek-Magma Mine, Superior Manganese.

Commodities: Au, Cu, Pb, Ag, Mn

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Superior.
Elevation..... 892 m.
Topography..... Rugged.
Domain..... National forest.

General location..... On eastern edge of town of Superior.
Meridian..... Gila & Salt River.
Tract..... Sec. 36, T 1 S, R 12 E.
Latitude..... 33°17'55" N.
Longitude..... 111°05'22" W.

Owner/operator..... Tobacco Root Mining Co., Inc. (year of information 1987).
Operator..... John Geyer, Mining Engineer, (year of information 1987).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Epithermal.
Shape of ore body..... Tabular.
Ore controls..... Fault breccia, quartz-limestone contact.
Strike and dip of mineralized zone..... N-S: 30° E.
Age of mineralization.. Devonian.
Mineral zone maximum dimensions, ft:
  Length..... Undetermined.
  Thickness..... 20.
  Width..... 6.
  Depth to..... 1,400.
Mineral names..... Native gold, malachite, chrysocolla, chalcocite, native silver, manganese oxides, limonite, quartz, pyrite.

Host formation..... Troy Quartzite, Martin Limestone.
Geologic age..... Cambrian, Devonian.
Rock relationship..... The vein occurs within a strike-fault zone of brecciated quartzite and lower beds of the limestone. All mined ore has been oxidized.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Underground.
Mining method..... Gophering.

Year of discovery..... Late 1800's.
Discovery method..... Ore mineral in place.

Initial production..... 1904.
Last production..... 1935.
Past production:
1905..... 13 cars of ore containing 31.6% Cu, 2.2 tr oz/st Au (577).
1907-41..... 39,416 tr oz Au; 1,641,000 lb Cu, 73,842 tr oz Ag (577).

Distance to water..... Less than 1 mi.
Road requirement..... Less than 1 mi.
Distance to power..... Less than 1 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

577, 657, 665.

USGS quad maps..... Mesa, 1:250,000.
Superior, 1:24,000.
USBM sequence number.... 0040210596.
USGS MRDS number..... M000244.

## LUCKY STRIKE--TUNGSTEN

Commodities: W, Pb, Ag, Au

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Cochise. | General location | 9.7 km south and 0.8 km west of Sierra Vista. |
| Mining district | Hartford. | Meridian | Gila & Salt River. |
| Elevation | 1,644 m. | Tract | Sec. 4, T 23 S, R 20 E. |
| Topography | Rugged. | Latitude | 31°27'49" N. |
| Domain | National forest. | Longitude | 110°19'01" W. |

Operator: Gold, Silver and Tungsten, Inc. (year of information 1941).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Quartz vein. | Host formation | Quartz vein in granite. |
| Origin | Hydrothermal. | Geologic age | Precambrian. |
| Shape of ore body | Irregular. | Rock relationship | Streaks of scheelite, spotty galena, and disseminated pyrite along the hanging wall and footwall of the quartz vein cutting coarse-grained Precambrian granites. |
| Ore controls | Fracturing. | | |
| Strike and dip of mineralized zone | N 0° E: 25° W. | | |
| Age of mineralization | Undetermined. | Size | Small. |
| Mineral zone average dimensions, m: | | | |
| Length | Undetermined. | | |
| Thickness | Undetermined. | | |
| Width | Undetermined. | | |
| Depth to | Surface. | | |
| Mineral names | Scheelite, galena, pyrite, gold, silver. | | |

NOTE: Size based only on past production.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Inactive-past producer. | Distance to water | On-site. |
| Type of operation | Surface-underground. | Road requirement | None. |
| Mining method | Open pit, gophering. | Distance to power | On-site. |
| | | Mill location | None. |
| Year of discovery | Undetermined. | | |
| Discovery method | Ore mineral in place. | | |
| Initial production | 1900's. | | |
| Last production | 1950's. | | |
| Past production | Undetermined. | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

300, 657, 665, 698.

| | |
|---|---|
| USGS quad maps | Nogales, 1:250,000.<br>Sunnyside, 1:62,500.<br>Miller Peak, 1:24,000. |
| USBM sequence number | 0040030175. |
| USGS MRDS number | M001728. |

Comments: Because of the erratic nature of the tungsten mineralization, exploration programs have never been conducted on this property. Reserve-resource data have not been determined. A fluorine mine (USBM sequence number 0040030292) of the same name is located at 31°28'14" N and 109°59'03" W.

## MAGGIE--MANGANESE

Alternate names..... Artillery Mountains, Maggie Canyon, Artillery Peak.

Commodities: Mn, Fe

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Artillery Mountains.
Elevation..... 658 m.
Topography..... Hilly.
Domain..... Private.

General location..... South of Signal and north of Alamo.
Meridian..... Gila & Salt River.
Tract..... Sec. 31, T 12 N, R 13 W.
Latitude..... 34°20'50" N.
Longitude..... 113°39'00" W.

Owner-operator..... Arizona Manganese Corp. (year of information 1975).

### GEOLOGY

Type of ore body..... Sedimentary, fissure vein, breccia fill.
Origin..... Sedimentation.
Shape of ore body..... Tabular.
Ore controls..... Faulting, bedding.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Pliocene.
Mineral zone average dimensions, m:
  Length..... 1,140.
  Thickness..... 57.
  Width..... 720.
  Depth..... 177.
Mineral names..... Wad, limonite, iron oxides.

Host formation..... Chapin Wash.
Geologic age..... Pliocene.
Rock relationship..... Paleozoic sediments; ore contained in friable-to-compact siltstone, sandstone, and conglomerate; clay and mudstone; and hard ore that is a supergene enrichment of the sandstone ore. Alluvial fan and playa deposits of early Pliocene.
Alteration..... Supergene enrichment.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Room and pillar.

Year of discovery..... 1856.
Discovery method..... Diamond drilling.

Initial production..... 1951.
Last production..... 1957.
Past production..... Undetermined.

Distance to water..... Less than 10 km.
Road requirement..... Less than 100 km.
Distance to power..... Less than 100 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 27,600,000 st ore..... | 5.35% Mn..... | 1958 | 245 |

### REFERENCES

165, 169, 245, 323, 330-331, 541, 657.

USGS quad maps..... Prescott, 1:250,000.
Artillery Peak, 1:62,500.
USBM sequence number.... 0040150036.
USGS MRDS number..... None.

Comments: Since the domestic steel industry is almost totally dependent on foreign imports of manganese, the property could be developed at a subsidized price in the event of a critical supply shortage. Manganese-bearing material underlies a 25-square-mi area in the valley between the Artillery and Rawhide Mountains. The reserve figure given above was calculated using the triangle method of ore reserve estimation.

## MAGMA-SUPERIOR--COPPER

Alternate names..... Magma Copper, Superior Copper, Silver Queen.

Commodities: Cu, Ag, Au, Zn, Pb

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Pioneer.
Elevation..... 1,270 m.
Topography..... Hilly.
Domain..... Private.

General location..... About 4 km east-northeast of Superior.
Meridian..... Gila & Salt River.
Tract..... Sec. 32, T 01 S, R 13 E.
Latitude..... 33°18'19" N.
Longitude..... 111°03'52" W.

Owner-operator..... Magma Copper Co. (year of information 1988).

### GEOLOGY

Type of ore body..... Replacement.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Fracturing.
Strike and dip of mineralized zone..... N-S: 30° E.
Age of mineralization.. Late Cretaceous.
Mineral zone average dimensions, m:
  Length..... 1,200.
  Thickness..... 6.
  Width..... 590.
  Depth to..... 1,180.
Mineral names..... Chalcopyrite, chalcocite, bornite, stromeyerite, gold, quartz, dolomite, magnetite, barite, hematite, enargite, tennantite, sphalerite, galena, pyrite.

Host formation..... Martin Limestone, Escabrosa Limestone, Naco Limestone.
Geologic age..... Devonian, Mississippian, Pennsylvanian-Permian.
Rock relationship..... Mesothermal deposit within Devonian, Mississippian, and Pennsylvanian-Permian limestones. Replacement ore bodies are discontinuous, tabular pods.
Alteration..... Undetermined.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Modified undercut and fill.

Year of discovery..... 1874.
Discovery method..... Ore mineral in place.

Initial production..... 1875.
ast production..... 1982.
Past production:
1911-73..... 17,600,000 st ore at 5.69% Cu, with more than 1,000,000 st Cu produced (665).
1979-82..... 2,895,000 mt ore and 118,000 mt Cu (404).

Distance to water..... On-site.
Road requirement..... Less than 10 km.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active. See comments.
Milling method..... Flotation.
Process rate..... 3,500 st/d ore.
Product type..... Cu concentrate with Ag, Au, Zn, and Pb.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Proven | 10,000,000 st ore | 4.5% Cu | 1976 | 187 |
| 2. Indicated resources | 4,439,000 st ore | 5.69% Cu, 0.71 tr oz/st Ag, 0.026 tr oz/st Au. | 1984 | 404 |

### REFERENCES

62, 64, 158, 187, 193, 230, 371, 395-396, 404, 425, 577, 596, 614, 657, 665.

USGS quad maps..... Mesa, 1:250,000. Superior, 1:24,000.
USBM sequence number.... 0040210038.
USGS MRDS number..... MB99885, W002674.
MSHA ID number..... 0200152.

Comments: Permanently closed as of 1985. Mill facilities for sale. The mill is currently reprocessing tailings and recovering pyrite for local sale.

## MAMMOTH-TIGER--GOLD

Alternate names..... Tiger, Mammoth-St. Anthony, McFarland & Hullinger, Collins, Mohawk, New Years.

Commodities: Au, Pb, Zn, V, Ag, Cu, Mo, $CaF_2$, $BaSO_4$, W

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Tiger.
Elevation..... 3,200 ft.
Topography..... Rugged.
Domain..... Private.

General Location..... 50 mi north-northeast of Tucson.
Meridian..... Gila & Salt River.
Tract..... Sec. 26, T 8 S, R 16 E.
Latitude..... 32°42'22" N.
Longitude..... 110°41'02" W.

Owner..... Magma Copper Co. (year of information 1988).
Operator..... Cyprus Minerals Co. (year of information 1988).

### GEOLOGY

Type of ore body..... Fissure vein, replacement.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... WNW shear zones.
Strike and dip of mineralized zone..... NW: NE & SW.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... 20.
  Width..... Undetermined.
  Depth to..... 1,000.
Mineral names..... Wulfenite, silver, galena, sphalerite, chalcopyrite, vanadinite, descloizite, pyrite, covellite, malachite, azurite, chrysocolla, cerussite, anglesite, hemimorphite, willemite, dioptase, linarite, brochantite, diabolaite, gold, mottramite, quartz, chlorite, specularite, amethyst, fluorite, barite, pyrite, clays, epidote, tourmaline.

Host formation..... Quartz monzonite.
Geologic age..... Precambrian.
Rock relationship..... Ore occurs where Tertiary rhyolite intrudes Precambrian quartz monzonite. Molybdenum-vanadium mineralization postdates lead-copper-zinc mineralization.
Alteration..... Silicification, chloritization, sericitization.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1879.
Discovery method..... Ore mineral in place.

Initial production..... 1881.
Past production:
1886-1918..... $3,000,000 Au from old Mammoth Mine (172).
1930-78..... 4,091,000 st ore, 11,647,000 lb Cu, 214,007,000 lb Pb, 143,153,000 lb Zn, 3,016,000 tr oz Ag, 563,667 tr oz Au, 4,210,000 lb Mo, and 2,541,000 lb $V_2O_5$ from old Mammoth Mine (665).

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| i. Not reported in reference | 10,000,000 st ore..... | 0.04 tr oz/st Au..... | 1987 | 409 |

### REFERENCES

31, 112, 115, 172, 371, 409, 515, 665, 675, 702.

USGS quad maps..... Phoenix, 1:250,000.
Mammoth, 1:24,000.
USBM sequence number.... 0040211074.
USGS MRDS number..... M050189.
MSHA ID number..... 0201881.

Comments: Silica tails have been shipped as flux to Asarco's smelter at Hayden, and rock from the open pit has been shipped as flux to Magma's San Manuel smelter. Cyprus is currently exploring the property as a potential large gold producer and will be the operator in exchange for a 50% interest in the property (675).

## MARGARITA GROUP--GOLD

Alternate names..... McDonald, Golden Eagle, Rob Roy.

Commodities: Au, Ag, Pb, Cu, Zn

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Santa Cruz. | General location..... | 75 mi southwest of Tucson. |
| Mining district..... | Oro Blanco. | Meridian..... | Gila & Salt River. |
| Elevation..... | 1,234 m. | Tract..... | Sec. 7, T 23 S, R 11 E. |
| Topography..... | Hilly. | Latitude..... | 31°26'41" N. |
| Domain..... | National forest. | Longitude..... | 111° 15' 19" W. |

Owner-operator..... Newfields Mineral, Inc. (year of information 1988).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Fissure veins. | Host formation..... | Cobre Ridge Tuff. |
| Origin..... | Hydrothermal. | Geologic age..... | Jurassic. |
| Shape of ore body..... | Tabular. | Rock relationship..... | Irregular, silicified zone composed of numerous quartz veinlets and stringers containing abundant pyrite with very fine-grained gold and silver. |
| Ore controls..... | Fractures. | | |
| Strike and dip of mineralized zone..... | Undetermined. | | |
| Age of mineralization.. | Middle Tertiary. | Alteration..... | Silicification, sericitization, propylitization. |
| Mineral zone average dimensions, m: | | Size..... | Small. |
| Length..... | Undetermined. | | |
| Thickness..... | Undetermined. | | |
| Width..... | Undetermined. | | |
| Depth to..... | Surface. | | |
| Mineral names..... | Fine-grained gold and silver, galena, sphalerite, pyrite, chalcopyrite, quartz, limonite pseudomorphs. | | |

NOTE: Size based only on current resources.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Active-past producer. | Distance to water..... | Undetermined. |
| Type of operation..... | Surface-underground. | Road requirement..... | Undetermined. |
| Mining method..... | Open pit, shaft, adit. | Distance to power..... | Undetermined. |
| | | Mill location..... | On-site. |
| Year of discovery..... | 1890's. | Mill status..... | Proposed. |
| Discovery method..... | Ore mineral in place. | Milling method..... | Heap leaching. |
| | | Process rate..... | 500 stpd. |
| Initial production..... | 1890's. | Product type..... | Dore. |
| Last production..... | 1941. | | |
| Past production..... | 1903-41: 4,400 st ore with 0.3 tr oz/st Au, 0.6 tr oz/st Ag, minor Pb and Cu (665). | | |

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 440,000 st ore..... | 0.072 tr oz/st Au..... | 1988 | 674 |
| 2. Not reported in reference..... | 522,000 st ore..... | 0.046 tr oz/st Au..... | 1988 | 674 |
| 3. Indicated..... | 600,000 st ore..... | 0.07 tr oz/st Au..... | 1988 | 032 |

### REFERENCES

32, 657, 665, 674.

| | |
|---|---|
| USGS quad maps..... | Nogales, 1:250,000.<br>Bartlett Mountain, 1:24,000. |
| USBM sequence number.... | 0040230067. |
| USGS MRDS number..... | M050245. |

Comments: La Teka Resources, Ltd., is currently negotiating with Newfields Minerals, Inc., to purchase the Margarita, Oro Blanco, El Gato, and Iron Cap properties. Exploration has found five areas of mineralization and may delineate additional resources of at least 2 million st. The anticipated stripping ratio is 1.5:1. Permitting is currently being done for the proposed heap-leach operation. Additional geological analysis is being done (674).

## MAZATZAL MOUNTAINS AREA--MERCURY

Alternate names..... Sunflower Group, Robbins Group, L and N Group, Bowman Group, Martin Group, Maricopa Group, Pine Mountain Group, Northern Light Group, Mercuria Group, Red Bird Group, Ord Group, Rattlesnake Group.

Commodities: Hg

### LOCATION-OWNERSHIP

County..... Gila & Maricopa.
Mining district..... Mazatzal Mountains.
Elevation..... From less than 3,000 to more than 4,000 feet.
Topography..... Rugged.
Domain..... National forest.

General location..... Northeast of Phoenix.
Meridian..... Gila & Salt River.
Latitude..... 33°55'00" N.
Longitude..... 111°25'00" W.

Owner..... Undetermined.
Operator..... Undetermined.

### GEOLOGY

Type of ore body..... Lode, veinlets.
Origin..... Undetermined.
Shape of ore body..... Irregular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... Variable.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... Variable.
  Thickness..... Less than 2,000.
  Width..... Variable.
  Depth to..... Surface.
Mineral names..... Cinnabar, native mercury, mercurial tennantite.

Host formation..... Quartz-sericite schist.
Geologic age..... Precambrian.
Rock relationship..... Mercury occurs in the schist that overlies the brown slate and is in turn overlain by jasper.
Size..... Medium.

NOTE: The size determination was made including the past production of 7,000 flasks.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Opencut, room & pillar.

Year of discovery..... 1911.
Discovery method..... Ore mineral in place.

Initial production..... 1911.
Last production..... 1961.
Past production..... Approximately 7,000 flasks (333).

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

65, 333, 547, 665.

USGS quad maps..... Mesa, 1:250,000.
USBM sequence number.... None.
USGS MRDS number..... Individual designations for each group, including two listings for Maricopa. M055104, M055108, M055112, M055102, M055133, (M055103, M001905), M055122, M055113, M055117, M055115, M055116, M055118.

Comments: Because of the sporadic nature of these deposits and their low grade, no systematic drilling program has ever been undertaken to prove the reserves.

## MCCABE--GOLD-SILVER

Alternate names..... Gladstone-McCabe, McCabe-Gladstone, Gladstone.

Commodities: Au, Ag, Pb, Cu, Zn

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Big Bug.
Elevation..... 5,200 ft.
Topography..... Rugged.
Domain..... National forest.

General location..... 2 mi northwest of Poland Junction.
Meridian..... Gila & Salt River.
Tract..... Sec. 30, T 13 N, R 1 E.
Latitude..... 34°28'44" N.
Longitude..... 112°17'24" W.

Owner-operator..... Stan West Mining Corp. (year of information 1988).

### GEOLOGY

Type of ore body..... Vein system.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 54° E; 79° SE.
Age of mineralization.. Cretaceous-Tertiary.
Mineral zone average dimensions, ft:
  Length..... At least 3,000.
  Thickness..... At least 800.
  Width..... 4.
  Depth to..... 833.
Mineral names..... Gold, silver, pyrite, arsenopyrite, sphalerite, galena, chalcopyrite, chalcocite.

Host formation..... Spud Mountain volcanics.
Geologic age..... Precambrian.
Rock relationship..... Meta-andesite breccia, host rock for vein. Tuff, host rock for vein. Banded quartz vein, contains ore.
Alteration..... Undetermined.
Size..... Medium.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Underground.
Mining method..... Shrinkage stoping.

Year of discovery..... 1870's.
Discovery method..... Ore mineral in place.

Initial production..... 1870's.
Last production..... 1937 (Mine flooded accidentally).
Past production..... Total of 80,000 tr oz Au, 800,000 tr oz Ag (624).
Annual production..... Anticipated by early 1989 to be 700 st/d ore, 5 d/wk, or 50,000 tr oz/yr Au and 140,000 tr oz/yr Ag (681).

Distance to water..... 3 mi pipeline, installed.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Operating.
Milling method..... Cyanidation (CIP) with optional Cu flotation.
Process rate..... 500 st/d mill feed, 7 d/wk.
Product type..... Doré bars, optional Cu concentrate.
Distance shipped..... Undetermined.
Destination..... Undetermined.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Not reported in reference..... | 1,000,000 tr oz contained Au, 5,000,000 tr oz contained Ag. | 0.35 tr oz/st Au..... | 1988 | 624 |
| 2. | Measured..... | 362,000 st ore..... | 0.33 tr oz/st Au, 1.8 tr oz/st Ag. | 1988 | 416 |
| 3. | Demonstrated..... | 753,700 st ore..... | 0.332 tr oz/st Au, 1.730 tr oz/st Ag. | 1989 | 681 |

### REFERENCES

18, 31, 97, 158, 226, 319, 338, 371, 416, 624, 657, 665, 681.

USGS quad maps..... Prescott, 1:250,000.
Poland Junction, 1:24,000.
USBM sequence number.... 0040250772.
USGS MRDS number..... M002412.
MSHA ID number..... 0202063.

Comments: Initial production began in September with the first gold poured on October 1, 1988. The initial production rate was 250 st/d ore. Four levels, at depths below the collar of 833 ft, 1,050 ft, 1,250 ft, and 1,450 ft, are initially being developed. Drilling to a depth of 200 ft below the 1,450-ft level has not reached the bottom of the ore (416).

## MCFADDEN PEAK--FLUORSPAR

Alternate names..... Jerky Group, Mack Group.

Commodities: $CaF_2$

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Unnamed.
Elevation..... 6,000 ft.
Topography..... Rugged.
Domain..... Tonto National Forest.

General location..... 70 km north-northwest of Globe.
Meridian..... Gila & Salt River.
Tract..... Sec. 36, T 7 N, R 13 E; Sec. 31, T 7 N, R 14 E.
Latitude..... 33°54'10" N.
Longitude..... 110°58'15" W.

Owner..... Estate of Woodie Nichols (year of information 1982).
Operator..... Western Fluorspar, Ltd (year of information 1982).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 90° E; 73° S.
Age of mineralization.. Undetermined.
Mineral zone average dimensions, mi.:
  Length..... 2,000.
  Thickness..... 45.
  Width..... 0.3 to 4.
  Depth to..... 5.
Mineral names..... Fluorite, quartz, calcite.

Host formation..... Dripping Springs quartzite.
Geologic age..... Precambrian.
Rock relationship..... Quartzite, hornfels, ore in fractures.
Alteration..... Contact metamorphism.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-explored prospect.
Type of operation..... Surface-underground.
Mining method..... Undetermined..

Year of discovery..... 1972.
Discovery method..... Ore mineral in place.

Initial production..... 1975.
Last production..... 1979.
Past production..... 1976-79: 25,000 st ore for testing only (544).

Distance to water..... Less than 10 km.
Road requirement..... 2 mi.
Distance to power..... Less than 10 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

544, 657.

USGS quad maps..... Mesa, 1:250,000.
McFadden Peak, 1:62,500.
USBM sequence number.... 0040070070.
USGS MRDS number..... None.

## MIAMI UNIT--COPPER

Commodities: Cu, Au, Ag, Mo

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Globe-Miami.
Elevation..... 1,100 m.
Topography..... Hilly.
Domain..... Private.

General location..... North edge of Miami, AZ.
Meridian..... Gila & Salt River.
Tract..... Sec. 30, T 1 N, R 15 E.
Latitude..... 33°24'25" N.
Longitude..... 110°52'30" W.

Owner-operator..... Magma Copper Co. (year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated, porphyry copper.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Intrusives, lithology.
Strike and dip of mineralized zone..... N 72° E; 34° N.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:.
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Chalcocite, chalcopyrite, bornite, covellite, malachite, azurite, chrysocolla, cuprite, copper, molybdenite.

Host formation..... Pinal Schist, Schultz Granite.
Geologic age..... Precambrian, Tertiary.
Rock relationship..... Hypogene mineralization is overlain by a chalcocite, supergene-enriched blanket, which, in turn, is overlain by a leached capping. Cu oxide mineralization occurs between the chalcocite zone and the leached capping.
Alteration..... Sericitization, silicification, argillization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface-underground.
Mining method..... In situ leach; hydraulic recovery and leach of mill tailings (proposed).

Year of discovery..... 1907.
Discovery method..... Shaft intercepted ore body.

Initial production..... 1909.
Past production..... Undetermined.
Production rate..... 3,000 gpm of solution; the tailings operation will increase the flow to 6,000 gpm in November 1988.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Milling method..... SX-EW.
Process rate..... 3,000 gpm of solution. Scheduled to be increased to 6,000 gpm in November 1988.
Product type..... Cathode Cu.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Not reported in reference..... | 55,000,000 st ore..... | 1.95% Cu..... | 1973 | 590 |
| 2. | Not reported in reference..... | 5,976,000 st ore..... | 3.14% Cu..... | 1985 | 064, 405 |
| 3. | Measured..... | 35,000,000 st tailings..... | 0.331% Cu..... | 1988 | 680 |

### REFERENCES

64, 66, 211-212, 237-238, 269, 343, 374, 401, 405, 428, 488, 517, 548, 590, 594, 597-598, 657, 665, 680, 729.

USGS quad maps..... Mesa, 1:250,000.
Inspiration, 1:62,500.
USBM sequence number.... 0040070051, 0040070053.
USGS MRDS number..... M003084.

Comments: The name Miami Unit is used to refer to the Miami East Mine, the in situ leach operation, and the proposed tailings leach project. According to Fiori (211), the Miami East Mine has been shut down because of unfavorable economic conditions. Pinto Valley Division of Magma Copper Co. will reclaim copper from the tailings pile by hydraulic mining, leaching, and processing through the modified Miami Unit SX-EW plant.

## MIDNIGHT OWL--COLUMBIUM-TANTALUM

Alternate names..... Lithia King.

Commodities: Cb-Ta, Li, feldspar, Be, Bi

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... White Picacho.
Elevation..... 3,700 ft.
Topography..... Rugged.
Domain..... Mixed.

General location..... 13 mi east of Wickenburg.
Meridian..... Gila & Salt River.
Tract..... Sec. 31, T 8 N, R 2 W.
Latitude..... 33°59'54" N.
Longitude..... 112°30'48" W.

Owner..... Sidney B. Anderson (year of information 1982).
Operator..... Fansteel Corp. (year of information 1987).

### GEOLOGY

Type of ore body..... Pegmatite dikes.
Origin..... Magmatic differentiation.
Shape of ore body..... Irregular, tabular.
Ore controls..... Fracturing.
Strike and dip of mineralized zone..... Mostly E-W strike: variable, steep dip.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... Maximum 450.
  Thickness..... Undetermined.
  Width..... Maximum 100.
  Depth to..... Exposed at surface.
Mineral names..... Beryl, spodumene, ieplolite, amblygonite, triphylite-lithiophilite, columbite-tantalite, tourmaline, quartz, perthite, albite, muscovite, cleavelandite, apatite, spessartite, bismutite, purpurite, strengite, stewartite, other phosphate minerals.

Host formation..... Unnamed gneiss and schist.
Geologic age..... Precambrian.
Rock relationship..... Gneiss and schist form walls of pegmatite intrusive bodies.
Pegmatite, contains ore.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Surface.
Mining method..... Opencut.

Year of discovery..... Undetermined.
Discovery method..... Undetermined.

Initial production..... Undetermined.
Last production..... Undetermined.
Past production..... 1 st Cb-Ta ore (grade unknown); 13 st ore at 11.5% BeO; 62 st ore at 7.4% $Li_2O$ (279).

Distance to water..... Undetermined.
Road requirement..... Undetermined.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

279, 409, 562, 657, 665.

USGS quad maps..... Phoenix, 1:250,000.
Red Picacho, 1:24,000.
USBM sequence number.... 0040251405.
USGS MRDS number..... M003258.

Comments: Niemuth (409) describes current activity by Fansteel Corp. as "sampling of pegmatites, surface drilling program, pilot gravity test of bulk sample for tantalum recovery."

## MINERAL HILL--IRON

Alternate names..... Continental.

Commodities: Fe, Cu

### LOCATION-OWNERSHIP

County..... La Paz.
Mining district..... Planet.
Elevation..... 1,000 ft.
Topography..... Rugged.
Domain..... Private.

General location..... 2.5 mi from Planet and 20 mi north of Bouse.
Meridian..... Gila & Salt River.
Tract..... Sec 3, T 10 N, R 17 W.
Latitude..... 34°13'56" N.
Longitude..... 114°00'45" W.

Owner..... Undetermined.

### GEOLOGY

Type of ore body..... Massive, bedded.
Origin..... Supergene enrichment.
Shape of ore body..... Irregular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... Variable.
Age of mineralization.. Middle Tertiary.
Mineral zone average dimensions, ft:
  Length..... 2,200.
  Thickness..... 75.
  Width..... 300.
  Depth to..... Surface.
Mineral names..... Specularite (hematite), chrysocolla, malachite, chalcopyrite, pyrite, bornite.

Host formation..... Quartz-mica schist, limestone & shale.
Geologic age..... Mesozoic, Paleozoic.
Rock relationship..... Limestones interbedded in a conglomerate. Limestone replacement by hematite, with supergene enrichment followed by hydrothermal copper fracture fillings.
Alteration..... Hydrothermal replacement.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Open-stope, timber set.

Year of discovery..... 1900.
Discovery method..... Ore mineral in place.

Initial production..... 1900.
Last production..... 1970.
Past production..... 1,000,000 mt ore at 1.7% Cu (665).

Distance to water..... 1 mi.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 3,356,000 lt ore..... | 48.3% Fe..... | 1961 | 243 |
| 2. Not reported in reference..... | 1,000,000 lt ore..... | 38.1% Fe..... | 1961 | 243 |

### REFERENCES

55, 243, 272, 314, 657, 665.

USGS quad maps..... Needles, 1:250,000.
Black Peak, 1:62,500.
USBM sequence number.... 0040120007.
USGS MRDS number..... M003958.

Comments: Mineral zone width is conservative estimate based on exploration map (243).

## MINERAL PARK--COPPER-MOLYBDENUM

Alternate names..... Ithaca Peak, Turquoise Mountain, Gross Peak.

Commodities: Cu, Mo, Ag

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Wallapai.
Elevation..... 1,350 m.
Topography..... Hilly.
Domain..... Private.

General location..... 26 km north of Kingman.
Meridian..... Gila & Salt River.
Tract..... Sec. 19, T 23 N, R 17 W.
Latitude..... 35°26'20" N.
Longitude..... 114°17'39" W.

Owner-operator..... Cyprus Mineral Park Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Stockwork, disseminated.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Lenticular.
Ore controls..... Faulting, fracturing.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Late Cretaceous.
Mineral zone average dimensions, mi.
  Length..... 1,020.
  Thickness..... Undetermined.
  Width..... 660.
  Depth to..... 60.
Mineral names..... Chalcopyrite, molybdenite, copper, chalcocite, sphalerite, argentiferous galena, covellite, turquoise, ferrimolybdite.

Host formation..... Cerbat Complex.
Geologic age..... Precambrian.
Rock relationship..... Ithaca Peaks stock and surrounding rock were fractured and ore deposited by hydrothermal solutions.
Alteration..... Intense potassic.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit, in situ leach.

Year of discovery..... 1902.
Discovery method..... Ore mineral in place.

Initial production..... 1965.
Past production:
1971-86..... 40,789 st Cu from leaching (64, 407).
1979-81..... 38,687 st Cu and 5,667 st Mo from ore (64, 408).

Distance to water..... 26 km.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive (conventional); active (leach).
Milling method..... Flotation; in situ leach and precipitation.
Process rate..... 15,000 st/d ore (conventional); 4,500,000 lb/yr Cu as cement Cu.
Product type..... Cu and Mo concentrates, cement Cu.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 49,982,000 st ore..... | 0.20% Cu, 0.051% Mo..... | 1980 | 679 |
| 2. Not reported in reference..... | 35,000,000 st ore..... | 0.17% Cu, 0.054% Mo..... | 1986 | 063 |

### REFERENCES

63-64, 166-167, 252-254, 280, 371, 407-408, 512, 595, 609, 623, 657, 665, 678, 694, 728.

USGS quad maps..... Kingman, 1:250,000.
Element Canyon, 1:24,000.
USBM sequence number.... 004015001.
USGS MRDS number..... w002675.
MSHA ID number..... 0200843.

Comments: Cyprus Metals Co. purchased the property in March 1986.

## MISSION-SAN XAVIER--COPPER-MOLYBDENUM

Alternate names..... Mission Complex.

Commodities: Cu, Mo, Ag, Au

### LOCATION-OWNERSHIP

County..... Pima.
Mining district..... Pima.
Elevation..... 1,022 m.
Topography..... Rolling.
Domain..... Indian reservation, BLM administration, State.

General location..... About 24 km southwest of Tucson.
Meridian..... Gila & Salt River.
Tract..... Sec. 36, T 16 S, R 012 E.
Latitude..... 31°59'23" N.
Longitude..... 111°04'15" W.

Owner-operator..... ASARCO Incorporated (year of information 1988).

### GEOLOGY

Type of ore body..... Replacement, disseminated.
Origin..... Metasomatic.
Shape of ore body..... Massive.
Ore controls..... Intrusives, lithology.
Age of mineralization.. Tertiary.
Mineral zone average. dimensions, m:.
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Chalcopyrite, bornite, molybdenite, pyrite.

Host formation..... Sediments.
Geologic age..... Tertiary.
Rock relationship..... Host formation altered and replaced by ore.
Alteration..... Sericitization, carbonatization, silicification, argillization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1955.
Discovery method..... Ore mineral in place.

Initial production..... 1959.
Past production..... 1982-84: 18,249,000 st ore with 101,700 st Cu, 1,685,000 tr oz Ag (49).
Production rate..... 29,000 st/d ore (entire Mission Complex).

Distance to water..... Less than 10 km.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Milling method..... Flotation.
Process rate..... 29,000 st/d ore (entire Mission Complex).
Product type..... Cu concentrate.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Proven and probable | 84,781,600 st ore | 0.75% Cu, 0.17 tr oz/st Ag | 1982 | 045 |
| 2. | Proven and probable | 161,733,600 st ore | 0.51% Cu, 0.08 tr oz/st Ag | 1982 | 045 |
| 3. | Proven and probable | 128,667,000 st ore | 0.65% Cu, 0.14 tr oz/st Ag | 1982 | 045 |
| 4. | Proven and probable | 31,485,200 st ore | 0.79% Cu, 0.21 tr oz/st Ag | 1982 | 045 |
| 5. | Proven and probable | 275,752,000 st ore | 0.62% Cu, 0.13 tr oz/st Ag | 1986 | 049 |
| 6. | Not reported in reference | 367,500,000 st ore | 0.64% Cu, 0.12 tr oz/st Ag | 1987 | 143 |

### REFERENCES

6, 23-24, 41-43, 45, 48-49, 64, 66, 74, 82, 106, 108, 143, 171, 175, 177-178, 204, 207, 219, 254, 281, 310, 313, 325, 371, 448, 454, 556, 584, 647, 657, 665, 671, 685-687, 716, 721, 724.

USGS quad maps..... Nogales, 1:250,000.
Twin Buttes, 1:62,500.
USBM sequence number.... 0040190007.
USGS MRDS number..... D000330, M050387, D000815.
MSHA ID number..... 0200135.

Comments: Since July 1988 the Mission, San Xavier, Pima, and Eisenhower (formerly Palo Verde) operations have been combined under the name of Mission Complex. Explanation of reserve information follows: Line 1 represents the Mission pit only. Line 2 represents the San Xavier pit only. Line 3 represents the total reserve of the Eisenhower pit in 1982, and line 4 represents Asarco's share of the partnership. Line 5 represents the total reserve of Mission Complex in 1986, and line 6 represents the total reserve in 1987. Although Mo is present in recoverable quantities, it has not been recovered since 1982 because of poor market conditions. Asarco plans to complete a plant expansion in 1989 that would increase the total Mission Complex milling capacity to 41,000 st/d ore.

MONTANA--SILVER-GOLD

Alternate names..... Rough & Ready.

Commodities: Ag, Au, Pb, Zn, Cu

LOCATION-OWNERSHIP

County..... Santa Cruz.
Mining district..... Oro Blanco.
Elevation..... 1,295 m.
Topography..... Rugged.
Domain..... National forest.

General location..... Tailings at southeast edge of Ruby with abandoned workings to southwest.
Meridian..... Gila & Salt River.
Tract..... Sec. 5, T 23 S, R 11 E.
Latitude..... 31°27'29" N.
Longitude..... 111°14'05" W.

Owner..... Undetermined (last known owner was Eagle-Picher Mining and Smelting Co., 1926-40; year of information 1940).

GEOLOGY

Type of ore body..... Veins, fracture fillings, replacement in fault zone; tailings.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 90° E; 40° to 90° N.
Age of mineralization.. Early Tertiary (Laramide).
Mineral zone average dimensions, ft:
  Length..... 1,000.
  Thickness..... 725.
  Width..... 50.
  Depth to..... 25.
Mineral names..... Galena, sphalerite, chalcopyrite, tetrahedrite, pyrite, quartz, gold, undetermined silver mineral.

Host formation..... Oro Blanco.
Geologic age..... Cretaceous.
Rock relationship..... Conglomerate, contains ore.
Diorite, contains ore.
Diorite porphyry dikes, intrude into ore.
Alteration..... Iron and manganese staining.
Size..... Small.

NOTE: Size based only on combined past production and estimated resources contained in tailings.

DEVELOPMENT

Current status..... Active-developed deposit.
Type of operation..... Surface.
Mining method..... Tailings pond leach (proposed).

Year of discovery..... 1870's.
Discovery method..... Ore mineral in place.

Initial production..... 1870's.
Last production..... 1958.
Past production:
1870's-1958.... Estimated 870,000 st ore at 3.5% Pb, 3.5% Zn, 5 tr oz/st Ag, 0.5 tr oz/st Au, 0.3% Cu (302).
1928-40..... 773,197 st ore (705).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... Less than 1 mi.
Mill location..... On-site.
Mill status..... Flotation, abandoned in 1940, condition unknown.
Milling method..... Leach (proposed); possible cyanidation, CIP, EW.
Process rate..... Undetermined.
Product type..... Dore.

PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Probable | 650,000 st tailings | 0.011 tr oz/st Au, 1.22 tr oz/st Ag. | 1988 | Author's estimate; see comments |
| 2. Not reported in reference | 700,000 st tailings | 1.0 tr oz/st Ag | 1987 | 409 |

REFERENCES

22, 213, 302, 390-391, 409, 657, 665, 683, 702-703.

USGS quad maps..... Nogales, 1:250,000.
Ruby, 1:62,500.
USBM sequence number.... 0040230070.
USGS MRDS number..... M050255.

Comments: The deposit is believed to be fully mined out. The tailings pond, however, represents a possible resource for gold and silver leaching. The pond was created during the period of principal production, 1928-40. Using 6-mo mill feed and concentrate production figures presented in Andrus (22) and a total production figure for 1928-40 from Wilson (705), it is possible to estimate a tonnage of tails produced at the tailings grades also given by Andrus (22). The authors believe that this estimated resource figure is reasonable, especially when compared with the published resource figure of 700,000 st given above. According to Niemuth (409), the tailings were under development in 1986 by K & K Co.

From 1935 through 1939, the Montana Mine was the largest lead-zinc producer in the State, and, in 1938, it ranked third in silver output. Early production from the property consisted primarily of gold and silver produced from the upper part of the deposit. During the period 1916-18, the mine was operated for lead, zinc, gold, and silver by the Goldfield Consolidated Mines Exploration Co. In 1926, Eagle-Picher Lead Co. acquired the property, built a mill, and operated it primarily for lead and zinc, but with significant production of gold and silver. This operation continued through 1940. Production of lead-silver and lead-zinc ores occurred sporadically from 1941 until 1958.

## MORENCI-METCALF--COPPER-MOLYBDENUM

Alternate names..... Morenci, Metcalf, Western Copper, King Peace.

Commodities: Cu, Mo, Au, Ag, Zn

### LOCATION-OWNERSHIP

County..... Greenlee.
Mining district..... Morenci.
Elevation..... 1,370 m.
Topography..... Rugged.
Domain..... Private.

General location..... About 80 km northeast of Safford.
Meridian..... Gila & Salt River.
Tract..... Sec. 16, T 4 S, R 29 E.
Latitude..... 33°05'21" N.
Longitude..... 109°21'11" W.

Owner..... Phelps Dodge Corp. (85%) (year of information 1987).
Sumitomo Metal Mining Co. (15%) (year of information 1987).
Operator..... Phelps Dodge Corp. (year of information 1987).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive, lenticular.
Ore controls..... Fracturing, intrusives.
Strike and dip of mineralized zone..... N 50° E; 45° W.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:.
Length..... 2,000.
Thickness..... 150.
Width..... 1,700.
Depth to..... 90.
Mineral names..... Chalcocite, molybdenite, argentite, gold, sphalerite, chalcopyrite, covellite, copper, cuprite, tenorite, chrysocolla, malachite, azurite, brochantite, chalcanthite, turquoise, and stromeyerite.

Host formation..... Quartz monzonite, granite porphyry.
Geologic age..... Tertiary.
Rock relationship..... Ore occurs largely in a supergene enrichment blanket in Tertiary quartz monzonite and granite porphyry.
Alteration..... Argillization, sericitization, silicification.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit, dump leach.

Year of discovery..... 1872.
Discovery method..... Ore mineral in place.

Initial production..... 1942.
Past production..... 1986: 39,676,000 st ore at 0.84% Cu (535).
Production rate..... 100,000 st/d ore.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Milling method..... Two flotation mills, dump leach with three SX-EW units, and one EW unit. The Metcalf mill has a Mo circuit.
Process rate..... Morenci mill: 60,000 st/d ore
Metcalf mill: 40,000 st/d ore
SX-EW: 30,000 gpm of solution.
Product type..... Cu and Mo concentrates, cathode Cu.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Measured | 794,235,000 st ore | 0.77% Cu | 1986 | 535 |
| 2. Measured | 183,529,000 st ore | 0.64% Cu | 1986 | 535 |

### REFERENCES

64, 170, 186, 206, 335, 371, 388, 446, 484, 525, 527-528, 532-536, 616, 646, 657, 665, 672, 714.

USGS quad maps..... Clifton, 1:250,000.
Clifton, 1:62,500.
USBM sequence number.... 004011001B.
USGS MRDS number..... M800422, D000320, W002681, M002216.
MSHA ID number..... 0200024, 0200305.

Comments: Au and Ag grades and production are company confidential and are not reported. The reserve figures given above represent the Morenci-Metcalf property (line 1) and the adjoining Western Copper property (line 2). These figures were calculated from the tonnage given in the Phelps Dodge annual report for 1986, which reported only the 85% portion belonging to Phelps Dodge.

## MORNING STAR--TUNGSTEN

Alternate names..... Fortuna, Happy Thot, Gold Bug, General Hancock, Careless, Ewing Property.

Commodities: W, Cu, Pb

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Campo Bonito.
Elevation..... 1,550 m.
Topography..... Rugged.
Domain..... National forest.

General location..... 0.5 mi south of Campo Bonito.
Meridian..... Gila & Salt River.
Tract..... Secs. 17, 18, 19, 20, T 10 S, R 16 E.
Latitude..... 32°33'26" N.
Longitude..... 110°44'10" W.

Owner..... YMCA, Tucson, AZ (year of information 1958).
Operator..... Nikas Mining Co. (last operator, 1952-53; year of information 1959).

### GEOLOGY

Type of ore body..... Disseminated, stringers and veinlets in fault zone.
Origin..... Pyrometasomatic.
Shape of ore body..... Irregular massive.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N of W: 30° to 60° S.
Age of mineralization.. Early Tertiary (Laramide).
Mineral zone average dimensions, ft:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... 112.
Mineral names..... Scheelite, quartz, calcite, dolomite, cerussite, galena.

Host formation..... Escabrosa Limestone.
Geologic age..... Mississippian.
Rock relationship..... Silicified limestone, locally brecciated or dolomitized, contains ore. Pink quartzite, borders ore on all sides except northeast, where it is cut off by the Mogul fault. Precambrian granite underlies ore to northeast of Mogul fault. Marble, near ore.
Alteration..... Silicification, dolomitization.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit (glory hole), stoping.

Year of discovery..... Before 1913.
Discovery method..... Ore mineral in place.

Initial production..... 1913.
Last production..... 1953.
Past production..... At least 6,000 short ton units[1] of $WO_3$ (133).

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 11,200 st..... | 0.7% $WO_3$..... | 1981 | 665 |

### REFERENCES

133, 257, 657, 665, 698.

USGS quad maps..... Tucson, 1:250,000.
Campo Bonito, 1:24,000.
USBM sequence number.... 0040210724.
USGS MRDS number..... M050218.

Comments: Present resources are estimated by the author at about 100 mt of contained W.

[1]Short ton unit = 20 lb of $WO_3$ containing 15.862 lb of W.

## MOSS--GOLD

Commodities: Au, Ag

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Mohave. | General location | 6 mi northwest of Oatman. |
| Mining district | San Francisco (Oatman). | Meridian | Gila & Salt River. |
| Elevation | 2,160 ft. | Tract | Sec. 19, T 20 N, R 20 W. |
| Topography | Rugged. | Latitude | 35°05'59" N. |
| Domain | BLM administration. | Longitude | 114°26'48" W. |

Owner-operator..... Undetermined.

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Porphyry, vein, shear zone. | Host formation | Quartz monzonite porphyry. |
| Origin | Hydrothermal. | Geologic age | Tertiary. |
| Shape of ore body | Undetermined. | Rock relationship | Quartz filled vein structures in Moss porphyry overlay the Alcyne Trachyte. |
| Ore controls | Undetermined. | | |
| Strike and dip of mineralized zone | N 80° W: 70° S. | Alteration | Oxidation. |
| Age of mineralization | Tertiary. | Size | Small. |
| Mineral zone maximum dimensions, ft: | | | |
| Length | 5,280. | | |
| Thickness | 220. | | |
| Width | 100. | | |
| Depth to | Surface. | | |
| Mineral names | Gold, pyrite, marcasite, chalcopyrite, chalcocite, chrysocolla, wulfenite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Active-past producer. | Distance to water | 7 mi. |
| Type of operation | Underground. | Road requirement | None. |
| Mining method | Undetermined. | Distance to power | 7 mi. |
| | | Mill location | On-site (1931). |
| Year of discovery | 1864. | Mill status | Undetermined, assumed to be razed. |
| Discovery method | Ore mineral in place. | | |
| Initial production | 1864. | | |
| Last production | 1909. | | |
| Past production | $500,000 prior to 1909 (665). | | |

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference | 250,000 st ore | 0.25 tr oz/st Au | 1987 | 409 |

### REFERENCES

332, 409, 567, 657, 665, 702.

| | |
|---|---|
| USGS quad maps | Kingman, 1:250,000. Oatman, 1:24,000. |
| USBM sequence number | 0040150220. |
| USGS MRDS number | M004525. |

## MT. JACKSON--FLUORSPAR

Alternate names..... Rhodes Spar.

Commodities: $CaF_2$, Cu, Pb, Ag

### LOCATION-OWNERSHIP

County..... Graham.
Mining district..... Aravaipa.
Elevation..... 2,030 m.
Topography..... Rugged.
Domain..... BLM administration.

General location..... 1 mi north of Jackson Mountain.
Meridian..... Gila & Salt River.
Tract..... Secs. 6, T 6 S, R 22 E.
Latitude..... 32°56'13" N.
Longitude..... 110°07'38" W.

Owner..... Rhodes Brothers (year of information 1975).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Irregular, tabular.
Ore controls..... Open space filling.
Strike and dip of mineralized zone..... S 50° E; 60° W.
Age of mineralization.. Precambrian, Miocene.
Mineral zone average dimensions, ft:
  Length..... 800.
  Thickness..... Undetermined.
  Width..... 7.
  Depth to..... Surface.
Mineral names..... Fluorite, malachite, azurite, chrysocolla, chalcedony, barite, pyrite.

Host formation..... Granite, Galluro Volcanics.
Geologic age..... Precambrian, Miocene.
Rock relationship..... Undetermined.
Alteration..... Epidotization, silicification.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, undetermined.

Year of discovery..... Undetermined.
Discovery method..... Ore mineral in place.

Initial production..... Undetermined.
Last production..... 1955.
Past production..... 1955: 300 st $CaF_2$ (665).

Distance to water..... Undetermined.
Road requirement..... Undetermined.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

657, 665, 670.

USGS quad maps..... Tucson, 1:250,000
Jackson Mountain, 1:24,000
USBM sequence number.... 0040090015.
USGS MRDS number..... M050716.

## NEW CONGRESS--GOLD

Alternate names..... Niagara, Queen of the Hills, Congress, Congress Extension.

Commodities: Au

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Martinez.
Elevation..... 3,480 ft.
Topography..... Rugged.
Domain..... Mixed.

General location..... 2 mi north of Congress.
Meridian..... Gila & Salt River.
Tract..... Sec. 23, T 10 N, R 6 W.
Latitude..... 34°12'03" N.
Longitude..... 112°51'08" W.

Owner..... Echo Bay Mines, Ltd. (year of information 1988).

### GEOLOGY

Type of ore body..... Fissure veins.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... E-W: 45° N.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... Approx. 2,000.
  Thickness..... Approx. 700-800.
  Width..... 1-32, Average 4-5.
  Depth to..... 200-300.
Mineral names..... Gold, quartz, pyrite, goethite.

Host formation..... Unnamed granodiorite.
Geologic age..... Precambrian.
Rock relationship..... Granodiorite, contains veins. Quartz, vein material.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on current reserves.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Underground.
Mining method..... Combined cut-and-fill and sublevel stoping. Access by spiral decline.

Year of discovery..... 1887.
Discovery method..... Ore mineral in place.

Initial production..... 1887.
Past production..... None from this part of vein.
Annual production..... About 93,600 st/yr ore (300 st/d, 6 d/wk).

Distance to water..... On-site (wells).
Road requirement..... None.
Distance to power..... On-site.
Mill location..... None.
Product type..... Direct-ship, gold-bearing silica flux, average grade 78% to 79% silica.
Distance shipped..... Undetermined.
Destination..... Hidalgo smelter, Playas, NM.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 350,000 st ore..... | 0.28 tr oz/st Au..... | 1987 | 409 |
| 2. Proven..... | 400,000 st ore..... | 0.4 tr oz/st Au..... | 1988 | 370 |

### REFERENCES

31, 158, 368, 370-371, 409, 520, 657, 665, 702.

USGS quad maps..... Prescott, 1:250,000.
Congress, 1:24,000.
USBM sequence number.... 0040250537, 0040250534.
USGS MRDS number..... M001105, M003323.
MSHA ID number..... 0202340.

Comments: Echo Bay is mining a westward extension of the Niagara vein. Exploration work was done in 1984-85 and production began in March 1988.

## NEW CORNELIA--COPPER-MOLYBDENUM

Alternate names..... Ajo.

Commodities: Cu, Mo, Au, Ag, Re

### LOCATION-OWNERSHIP

County..... Pima.
Mining district..... Ajo.
Elevation..... 550 m.
Topography..... Hilly.
Domain..... Private.

General location..... About 8 km south of Ajo.
Meridian..... Gila & Salt River.
Tract..... Sec. 27, T 12 S, R 6 W.
Latitude..... 32°21'14" N.
Longitude..... 112°52'04" W.

Owner-operator..... Phelps Dodge Corp. (year of information 1988).

### GEOLOGY

Type of ore body..... Stockwork, disseminated.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Intrusives.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... 2,100.
  Thickness..... 275.
  Width..... 1,250.
  Depth to..... 20.
Mineral names..... Chalcopyrite, bornite, chalcocite, cuprite, chrysocolla, malachite, silver, gold, molybdenite, shattuckite.

Host formation..... Cornelia Quartz Monzonite, Cornelia Quartz Diorite.
Geologic age..... Tertiary.
Rock relationship..... Ore body has intruded volcanics of area; ore in fractures in the intrusives.
Alteration..... Sericitization, silicification, argillization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-temporary shutdown.
Type of operation..... Surface.
Mining method..... Open pit, dump leach.

Year of discovery..... 1750.
Discovery method..... Ore mineral in place.

Initial production..... 1854.
Last production..... Temporary shutdown early 1984.
Past production..... 1982-84: 72,539 st Cu and 239 st Mo (252-254).
Production rate..... 30,000 st/d ore.

Distance to water..... Less than 10 km.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive.
Milling method..... Flotation, dump leach, precipitation.
Process rate..... 30,000 st/d ore; leach capacity undetermined.
Product type..... Cu and Mo concentrates, cement Cu.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Measured | 209,200,000 st ore | 0.50% Cu | 1986 | 535 |

### REFERENCES

64, 148, 252-254, 371, 469, 476, 484, 492, 526, 529-531, 535, 657, 665.

USGS quad maps..... Ajo, 1:250,000.
Ajo, 1:62,500.
USBM sequence number.... 0040190008.
USGS MRDS number..... W002658, W002113, M002276, M002272, D002165, M002358, D000331, M002273.
MSHA ID number..... 020156.

Comments: Au, Ag, and Mo grades of the reserve are undetermined.

## NEW PLANET--IRON

Alternate names..... Planet, Planet Copper, Planet Mine Group.

Commodities: Fe, Cu, Au, Ag

### LOCATION-OWNERSHIP

County..... La Paz.
Mining district..... Planet.
Elevation..... 800 ft.
Topography..... Rugged.
Domain..... Private.

General location..... 28 mi north-northeast of Bouse.
Meridian..... Gila & Salt River.
Tract..... Secs. 31, 32, T 11 N, R 16 W.
Latitude..... 34°14'44" N.
Longitude..... 113°57'27" W.

Owner..... Arizona Ranch and Metals Co. (year of information 1967).

### GEOLOGY

Type of ore body..... Massive, bedded.
Origin..... Supergene enrichment.
Shape of ore body..... Irregular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... Variable.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 1,800.
  Thickness..... 160.
  Width..... 200.
  Depth to..... 170.
Mineral names..... Hematite, malachite, specularite, pyrite, bornite, chalcopyrite, chrysocolla, gold, silver, azurite, limonite.

Host formation..... Granitic gneiss, limestone and shale.
Geologic age..... Precambrian, Paleozoic.
Rock relationship..... Interbedded hematite replacement bodies above the granitic gneiss and below the quartz-mica schist within the limestone and shale formation.
Alteration..... Hydrothermal replacement.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Room & pillar.

Year of discovery..... 1863.
Discovery method..... Ore mineral in place.

Initial production..... 1863.
Last production..... 1937.
Past production:
  1863-1917..... 3,000,000 lb Cu (665).
  1863-1937..... 60,000 st Cu ore (665).

Distance to water..... 0.5 mi.
Road requirement..... 3 mi.
Distance to power..... 3 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Measured | 1,250,000 st ore | 60% Fe | 1945 | 314 |
| 2. Inferred | 21,000,000 st ore | 35% Fe, 40% $SiO_2$ | 1961 | 314 |

### REFERENCES

55, 243, 314, 657, 665.

USGS quad maps..... Needles, 1:250,000.
Swansea, 1:62,500.
USBM sequence number.... 0040120004.
USGS MRDS number..... M003887.

## NEWSBOY--GOLD

Alternate names..... Newsboy Group, Grande Group, Charles Blacks Claims, Gnome Development, Pitt.

Commodities: Au, Ag, Mn, Cu, Fe

### LOCATION-OWNERSHIP

County..... Maricopa.
Mining district..... Vulture.
Elevation..... 573 m.
Topography..... Hilly.
Domain..... Private.

General location..... About 4 mi southwest of Morristown.
Meridian..... Gila & Salt River.
Tract..... Sec. 22, T 6 N, R 4 W.
Latitude..... 33°50'51" N.
Longitude..... 112°40'00" W.

Owner..... Mills Mining and Development, and MM&M Alunite (year of information 1986).
Operator..... Westmount Mining, Inc. (year of information 1987).

### GEOLOGY

Type of ore body..... Fissure veins.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Fault zone.
Strike and dip of mineralized zone..... N 55° W; 65° NW.
Mineral zone average dimensions, ft:
  Length..... 1,000.
  Thickness..... 50.
  Width..... 400.
  Depth to..... Surface.
Mineral names..... Gold, silver, iron oxides, copper oxides, quartz, manganiferous calcite.

Host formation..... Biotite schist, rhyolite.
Geologic age..... Precambrian, Tertiary.
Rock relationship..... Silver-gold siliceous fissure veins emplaced between Tertiary rhyolite hanging wall and Precambrian schist footwall.
Alteration..... Unknown.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Surface.
Mining method..... Selective mining.

Year of discovery..... Undetermined.
Discovery method..... Ore mineral in place.

Initial production..... Undetermined.
Last production..... 1942.
Past production..... 1942: 11,000 st ore (32).

Distance to water..... Undetermined.
Road requirment..... Undetermined.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 30,000 st ore..... | 0.05-0.06 tr oz/st Au..... | 1984 | 032 |
| 2. Not reported in reference..... | 60,000 st ore..... | Unknown..... | 1984 | 032 |
| 3. Not reported in reference..... | 30,000 st ore..... | 0.03 tr oz/st Au, 4.5 tr oz/st Ag. | 1987 | 409 |
| 4. Probable..... | 1,000,000 st ore..... | 0.045 tr oz/st Au, indeterminate Ag. | 1989 | 157 |

### REFERENCES

32, 157, 392, 409, 657, 688.

USGS quad maps..... Phoenix, 1:250,000
Wickenburg SW, 1:24,000
USBM sequence number.... 0040130462.
USGS MRDS number..... None.

Comments: Recent drilling project involved 25 surface holes with report containing logs, assays, and maps compiled for owners (32). Manganese affects silver recovery.

## NORTH STAR--GOLD

Commodities: Au, Ag

### LOCATION-OWNERSHIP

County..... Yuma.
Mining district..... Kofa.
Elevation..... 610 m.
Topography..... Rugged.
Domain..... National wildlife refuge.

General location..... Southern edge of Kofa Mountains.
Meridian..... Gila & Salt River.
Tract..... Sec. 36, T 1 S, R 17 W.
Latitude..... 33°17'49" N.
Longitude..... 113°58'20" W.

Owner..... Gold Star Mining Co. (last confirmed owner, 1934; year of information 1967).
Operator..... Unidentified lessee (last operator, 1925; year of information 1967).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... E-W: 60° N.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
Length..... At least 3,500.
Thickness..... 500.
Width..... 10.
Depth to..... Exposed at surface.
Mineral names..... Gold, silver, pyrite, biotite, quartz, chlorite, epidote, adularia.

Host formation..... Volcanics.
Geologic age..... Cretaceous or Tertiary.
Rock relationship..... Biotite andesite (pink, flow-banded), hanging wall. Calcareous slate or shale, footwall. Andesite breccia (silicified) and quartz, contains ore.
Alteration..... Silicification, chloritization.
Size..... Small.

NOTE: Size based only on combined past production and author's estimate of present resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Stoping; extensive workings.

Year of discovery..... 1906.
Discovery method..... Ore mineral in place.

Initial production..... 1907.
Last production..... 1925.
Past production..... 1907-11: 38,735 st ore at 1.4 tr oz/st Au and 0.6 tr oz/st Ag. Much additional ore was stolen during operations (303).

Distance to water..... 3 mi.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... On-site.
Mill status..... Abandoned in 1911.
Milling method..... Cyanidation.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

158, 289, 303, 390, 651, 657, 697, 702.

USGS quad maps..... Phoenix, 1:250,000.
Kofa Butte, 1:62,500.
USBM sequence number.... 0040270307.
USGS MRDS number..... None.

Comments: Grade decreases with depth. At limit of workings (500-ft depth), ore produced $14.00/st from combined gold and silver values in 1911. The ratio of gold value to silver value was 58:1, the price of gold was $20.67/tr oz, and the price of silver was $0.54/tr oz. With the preceding information, the ore grade at depth can be estimated at about 0.67 tr oz/st Au and about 0.44 tr oz/st Ag. At these grades, the "Large tonnages" referred to by Wilson, Cunningham, and Butler (702) certainly constitute a significant resource.

## NORTH STAR--TUNGSTEN

Alternate names..... Money Maker, What-A-Pal.

Commodities: W

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Money Maker.
Elevation..... 4,700 ft.
Topography..... Rugged.
Domain..... National forest.

General location..... 3.5 mi northeast of Crown King.
Meridian..... Gila & Salt River.
Tract..... Secs. 5, 6, T 10 N, R 1 E.
Latitude..... 34°16'10" N.
Longitude..... 112°17'20" W.

Owner..... Ben Scott and R. P. McLeod (year of information 1961).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Irregular, lenticular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 40° E: Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 21,120.
  Thickness..... 20 (estimated).
  Width..... 5,280.
  Depth to..... Surface.
Mineral names..... Scheelite.

Host formation..... Yavapai Schist.
Geologic age..... Precambrian.
Rock relationship..... Undetermined.
Alteration..... Undetermined.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Open pit and opencut.

Year of discovery..... 1953.
Discovery method..... Ore mineral in place.

Initial production..... 1953.
Last production..... 1958.
Past production..... 1953-58: 260 lb $WO_3$ (665).

Distance to water..... Undetermined.
Road requirement..... Undetermined.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

134, 657, 665.

USGS quad maps..... Prescott, 1:250,000.
Battle Flat, 1:24,000.
USBM sequence number.... 0040250927.
USGS MRDS number..... M003414.

## OCTAVE--GOLD

Alternate names..... Joker.

Commodities: Au, Ag, Pb, Cu

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Weaver.
Elevation..... 1,049 m.
Topography..... Rugged.
Domain..... Private.

General location..... 10 mi east of Congress Junction.
Meridian..... Gila & Salt River.
Tract..... Secs. 5, 6, T 9 N, R 4 W.
Latitude..... 34°08'39" N.
Longitude..... 112°42'24" W.

Owner..... Consolidated Chemical and Mining Corp., and Winner Industries (year of information 1975).
Operator..... Cal Schroeder and Gary Dechristina (last operators, about 1980; year of information 1981).

### GEOLOGY

Type of ore body..... Siliceous base metal vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 70° E; 20° to 30° N.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 3,000.
  Thickness..... 2,000.
  Width..... 2.25.
  Depth to..... Surface.
Mineral names..... Gold, silver, galena, chalcopyrite, pyrite, sphalerite, quartz.

Host formation..... Unnamed quartz diorite.
Geologic age..... Precambrian.
Rock relationship..... Quartz diorite, encloses ore. Diabase, dikes that cut vein. Schist, lenses in quartz diorite. Pegmatite, dikes near ore. Aplite, dikes near ore.
Alteration..... Silicification.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Stoping; access by 3 shafts; more than 10,000 ft of workings.
Year of discovery..... 1860's.
Discovery method..... Ore mineral in place.

Initial production..... 1897.
Last production..... About 1980.
Past production..... 1895-1929: $1,825,000 Au, $75,000 Ag (172). At the price of $20.67/tr oz, early gold production can be estimated at about 88,000 tr oz. Ore mined in 1936 had a grade of 0.364 tr oz/st Au, 0.464 tr oz/st Ag, 0.240% Pb, and 0.030% Cu.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Abandoned, condition undetermined.
Milling method..... Flotation.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

172, 390, 400, 657, 665, 697, 702.

USGS quad maps..... Prescott, 1:250,000.
Yarnell, 1:24,000.
USBM sequence number.... 0040250935.
USGS MRDS number..... M003608.

Comments: There is some evidence that leaching may have been performed around 1980, but further information is not available.

## OLD RELIABLE--COPPER

Commodities: Cu, Ag, Au, Mo

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Bunker Hill.
Elevation..... 4,200 ft.
Topography..... Hilly.
Domain..... Private.

General location..... 5 mi west of Copper Creek in Galview Mountain.
Meridian..... Gila & Salt River.
Tract..... Secs. 10, T 8 S, R 18 E.
Latitude..... 32°45'05" N.
Longitude..... 110°29'23" W.

Owner..... Magma Copper Co. (year of information 1988).

### GEOLOGY

Type of ore body..... Breccia pipe.
Origin..... Hydrothermal, supergene enrichment.
Shape of ore body..... Pipelike.
Ore controls..... Fracturing, intrusive, brecciation.
Strike and dip of mineralization, m.... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 500.
  Thickness..... 475.
  Width..... 500.
  Depth to..... Surface.
Mineral names..... Chalcocite, chalcopyrite, malachite, chalcanthite, chrysocolla, covellite, bornite, tetrahedrite, atacamite, olivenite, barite, molybdenite.

Host formation..... Glory Hole Volcanic.
Geologic age..... Cretaceous.
Rock relationship..... Andesite flows fractured by granite intrusives that were then the source of copper-bearing solutions resulting in fracture fillings. Later supergene enrichment left a relatively barren capping.
Alteration..... Silicification.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Leach, surface.
Mining method..... In situ leach.

Year of discovery..... 1861-65.
Discovery method..... Ore mineral in place.

Initial production..... 1890.
Last production..... 1981.
Past production..... 1973-81: 11,000,000 lb cement Cu (665).

Distance to water..... 6 mi.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive.
Milling method..... Precipitation.
Process rate..... 19,000 lb/d Cu.
Product type..... Cement Cu.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Measured | 4,000,000 st ore | 0.74% Cu | 1971 | 543 |

### REFERENCES

542-543, 657, 665.

USGS quad maps..... Tucson, 1:250,000.
Oak Grove Canyon, 1:24,000.
USBM sequence number.... 0040210037.
USGS MRDS number..... M050126.

## OLD YUMA--LEAD

Commodities: Pb, Cu, Zn, Mo, Au, Ag

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Pima. | General location | 1 mi east-northeast of Tucson Mountain Park. |
| Mining district | Amole. | Meridian | Gila & Salt River. |
| Elevation | 792 m. | Tract | Sec. 9, T 13 S, R 12 E. |
| Topography | Rugged. | Latitude | 32°18'53" N. |
| Domain | Undetermined. | Longitude | 111°07'16" W. |

Owner-operator..... Consolidated Mining & Milling (year of information 1987).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Fissure vein, contact metasomatic. | Host formation | Andesite. |
| Origin | Supergene enrichment. | Geologic age | Cretaceous. |
| Shape of ore body | Lenticular. | Rock relationship | Partly oxidised base metal sulfides with spotty wulfenite and vanadinite and quartz-calcite gangue in a steeply dipping, lensing, and faulted ore body along a fracture zone cutting Cretaceous andesite and associated with a Laramide porphyritic intrusive. |
| Ore controls | Fractures, faults. | | |
| Strike and dip of mineralized zone | N 60° E: 40° S. | | |
| Age of mineralization | Tertiary. | | |
| Mineral zone average dimensions, m: | | Alteration | Argillization. |
| Length | Undetermined. | Size | Small. |
| Thickness | Undetermined. | | |
| Width | Undetermined. | | |
| Depth to | Undetermined. | | |
| Mineral names | Base metal sulfides, vanadinite, wulfenite, cerussite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Active-past producer. | Distance to water | On-site. |
| Type of operation | Surface-underground. | Road requirement | None. |
| Mining method | Opencut, undetermined. | Distance to power | On-site. |
| | | Mill location | On-site. |
| Year of discovery | Undetermined. | Mill status | In development. |
| Discovery method | Ore mineral in place. | Milling method | Heap leach. |
| Initial production | Undetermined. | | |
| Last production | Undetermined. | | |
| Past production | Undetermined. | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

284, 301, 409, 657, 665.

| | |
|---|---|
| USGS quad maps | Tucson, 1:250,000.<br>Jaynes, 1:24,000. |
| USBM sequence number | 0040190345. |
| USGS MRDS number | M050625, D000106. |

Comments: Niemuth (409) lists redevelopment of the old workings for producing mineral specimens while developing a heap-leaching facility on the surface. It is unclear whether the mine will be used to supply ore to be leached or if the leach facility will be used strictly as a custom processor.

## ORACLE RIDGE--COPPER

Alternate names..... Control, Control Copper Property, Marble Peak.

Commodities: Cu, Ag

### LOCATION-OWNERSHIP

County..... Pima.
Mining district..... Old Hat.
Elevation..... 1,800 m.
Topography..... Very rugged.
Domain..... Mixed.

General location..... About 25 km north-northeast of Tucson.
Meridian..... Gila & Salt River.
Tract..... Sec. 18, T 11 S, R 16 E.
Latitude..... 32°28'34" N.
Longitude..... 110°43'39" W.

Owner-operator..... South Atlantic Ventures, Ltd. (year of information 1989).

### GEOLOGY

Type of ore body..... Replacement, sedimentary.
Origin..... Continental metasomatic.
Shape of ore body..... Tabular, irregular.
Ore controls..... Intrusives, contact metamorphism.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Mesozoic.
Mineral zone average dimensions, m:
  Length..... 2,286.
  Thickness..... 5.
  Width..... 1,372.
  Depth to..... 61.
Mineral names..... Chalcopyrite, pyrite, bornite, chalcocite, covellite, silver, biotite, calcite, scheelite, quartz, magnetite, garnet, epidote.

Host formation..... Escabrosa Limestone.
Geologic age..... Mississippian.
Rock relationship..... Ore near marble contact and in fractures. Quartz diorite lies under ore, lamprophyre replaced by ore.
Alteration..... Carbonation, silicification, propylitization.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-developed deposit.
Type of operation..... Underground.
Mining method..... Cut-and-fill (possible).

Year of discovery..... 1900.
Discovery method..... Ore mineral in place.

Distance to water..... Greater than 10 km.
Road requirement..... None.
Distance to power..... Less than 50 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Measured | 11,300,000 st ore | 2.28% Cu, 0.64 tr oz/st Ag | 1975 | 373 |

### REFERENCES

64, 75, 102-104, 180, 184, 194, 371, 373, 415, 459, 466, 468, 475, 550, 657, 665.

USGS quad maps..... Tucson, 1:250,000.
Mount Bigelow, 1:24,000.
USBM sequence number.... 0040190035.
USGS MRDS number..... M050644.

## OXBOW--GOLD

Alternate names..... Golden Wreath.

Commodities: Au, Cu, Pb, Mo, $CaF_2$, Ag

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Green Valley.
Elevation..... 4,400 ft.
Topography..... Hilly.
Domain..... National forest.

General location..... 0.8 mi west of top of Oxbow Hill.
Meridian..... Gila & Salt River.
Tract..... Sec. 32, T 10 N, R 10 E.
Latitude..... 34°10'08" N.
Longitude..... 111°21'11" W.

Owner..... Pete Saccuci (year of information 1973).
Operator..... Clay Thorne (year of information 1980).

### GEOLOGY

Type of ore body..... Vein, shear zone.
Origin..... Hydrothermal.
Shape of ore body..... Linear.
Ore controls..... Intrusives, fracturing, faulting.
Strike and dip of mineralized zone..... N-S: 45° to 85° W.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... 2,000.
  Thickness..... 528.
  Width..... 6.
  Depth to..... Surface.
Mineral names..... Gold, chalcopyrite, cuprodescloizite, dioptase, wulfenite, malachite, chrysocolla, fluorite.

Host formation..... Diorite.
Geologic age..... Precambrian.
Rock relationship..... Uniform-textured, coarse-grained hornblende diorite, cut by a complex of dikes and fault fissures.
Alteration..... Undetermined.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, opencut, shafts, and adits.

Year of discovery..... 1876.
Discovery method..... Ore mineral in place.

Initial production..... 1916.
Last production..... 1936.
Past production..... Undetermined.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

334, 657, 665.

USGS quad maps..... Holbrook, 1:250,000.
Payson South, 1:24,000.
USBM sequence number.... 0040070535.
USGS MRDS number..... M241207, M030443.

## OX HIDE--COPPER

Alternate names..... Upper Ox Hide, Lower Ox Hide.

Commodities: Cu, Mo, Ag

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Globe-Miami.
Elevation..... 1,340 m.
Topography..... Hilly.
Domain..... Mixed.

General location..... 3 km west-southwest of Miami.
Meridian..... Gila & Salt River.
Tract..... Sec. 34, T 1 N, R 14 E.
Latitude..... 33°23'15" N.
Longitude..... 110°55'20" W.

Owner-operator..... Cyprus Miami Mining Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Oxidation, erosion.
Shape of ore body..... Undetermined.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Cenozoic.
Mineral zone average dimensions, m:
  Length..... 540.
  Thickness..... 60.
  Width..... 540.
  Depth to..... Surface.
Mineral names..... Chrysocolla, malachite, azurite, tenorite, cuprite.

Host formation..... Pinal Schist, Schultze Granite.
Geologic age..... Precambrian, Tertiary.
Rock relationship..... Undetermined.
Alteration..... Oxidation.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1894.
Discovery method..... Ore mineral in place.

Initial production..... 1968.
Last production..... 1984.
Past production..... 1968-80: 35,428 mt cement Cu (273).
Production rate..... 12,500 st/d sulfide ore (273).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive.
Milling method..... Heap leach, flotation, SX-EW.
Process rate..... 12,500 st/d ore, 2,000 gpm.
Product type..... Cement Cu, Cu concentrate, cathode Cu.
Distance shipped..... 16 km.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Proven | 28,573,000 st ore | 0.30% Cu | 1981 | 273, 274 |

### REFERENCES

271, 273-274, 371, 517, 657, 665.

USGS quad maps..... Mesa, 1:250,000.
Inspiration, 1:24,000.
USBM sequence number.... 0040070060.
USGS MRDS number..... M241219.

Comments: Cyprus Metals Co. acquired Inspiration Consolidated Copper Co. on July 1, 1988.

## PACKARD--FLUORSPAR

Alternate names..... Bluebird Fluorspar.

Commodities: $CaF_2$

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Gila. | General location..... | 3.8 mi west-southwest of Bonyback Peak Summit. |
| Mining district..... | Tonto Basin. | Meridian..... | Gila & Salt River. |
| Elevation..... | 3,400 ft. | Tract..... | Sec. 9, T 6 N, R 11 E. |
| Topography..... | Rugged. | Latitude..... | 33°52'24" N. |
| Domain..... | National forest. | Longitude..... | 111°13'40" W. |

Owner..... Magma Copper Co. (year of information 1988).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Vein. | Host formation..... | Granite. |
| Origin..... | Hydrothermal. | Geologic age..... | Precambrian. |
| Shape of ore body..... | Irregular. | Rock relationship..... | Undetermined. |
| Ore controls..... | Undetermined. | Alteration..... | Undetermined. |
| Strike and dip of mineralized zone..... | Undetermined. | Size..... | Small. |
| Age of mineralization.. | Tertiary. | | |
| Mineral zone average dimensions, ft: | | | |
| Length..... | 320. | | |
| Thickness..... | Undetermined. | | |
| Width..... | 3. | | |
| Depth to..... | Surface. | | |
| Mineral names..... | Fluorite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | On-site. |
| Type of operation..... | Underground. | Road requirement..... | Undetermined. |
| Mining method..... | Coyoting. | Distance to power..... | Undetermined. |
| | | Mill location..... | None. |
| Year of discovery..... | 1938. | | |
| Discovery method..... | Ore mineral in place. | | |
| Initial production..... | Undetermined. | | |
| Last production..... | Undetermined. | | |
| Past production..... | Undetermined. | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

657, 665.

| | |
|---|---|
| USGS quad maps..... | Mesa, 1:250,000<br>Greenback Creek, 1:24,000 |
| USBM sequence number.... | 0040070004. |
| USGS MRDS number..... | M241498. |

## PAT ALUNITE--ALUMINUM

Alternate names..... Pat Property, Patagonia Property.

Commodities: Al, $K_2SO_4$, S

### LOCATION-OWNERSHIP

County..... Santa Cruz.
Mining district..... Harshaw.
Elevation..... 1,935 m.
Topography..... Rugged.
Domain..... BLM administration.

General location..... Near Nogales.
Meridian..... Gila & Salt River.
Tract..... Sec. 21, T 22 S, R 16 E.
Latitude..... 31°30'21" N.
Longitude..... 110°43'35" W.

Owner-operator..... Earth Sciences Inc. (year of information 1975).
National Steel Corp. (year of information 1975).
Southwire Co. (year of information 1975).

### GEOLOGY

Type of ore body..... Replacement.
Origin..... Hydrothermal.
Shape of ore body..... Undetermined.
Ore controls..... Intrusive, lithology.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
Length..... Undetermined.
Thickness..... Undetermined.
Width..... Undetermined.
Depth to..... Undetermined.
Mineral names..... Alunite.

Host formation..... Rhyolite and andesite.
Geologic age..... Tertiary volcanics.
Rock relationship..... Rhyolite and andesite replaced by ore.
Alteration..... Phyllic alteration, sericitization.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-explored prospect.
Type of operation..... Surface.
Mining method..... Open pit (proposed).

Year of discovery..... 1972.
Discovery method..... Aerial survey, bedrock sampling, and drilling.

Distance to water..... Undetermined.
Road requirement..... Undetermined.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| I. Indicated | 97,000,000 st ore | 30% alunite | 1974 | 163 |

### REFERENCES

163, 179, 568, 657, 665.

USGS quad maps..... Nogales, 1:250,000.
Mt. Hughes, 1:24,000.
USBM sequence number.... 0040230001.
USGS MRDS..... D002154.

Comments: As of 1974, Earth Sciences, Inc., held Federal Potassium Prospecting Permits on 6,813.11 acres (163).

## PEACOCK--COPPER

Alternate names..... San Juan.

Commodities: Cu, Au, Ag, Mo

### LOCATION-OWNERSHIP

County..... Graham.
Mining district..... Lone Star.
Elevation..... 1,268 m.
Topography..... Gentle.
Domain..... Private.

General location..... 16 km north-northeast of Safford.
Meridian..... Gila & Salt River.
Tract..... Sec. 35, T 5 S, R 26 E.
Latitude..... 32°56'57" N.
Longitude..... 109°35'05" W.

Owner..... Producers Minerals Corp. (year of information 1978).

### GEOLOGY

Type of ore body..... Breccia fill, disseminated, stockwork.
Origin..... Supergene enrichment.
Shape of ore body..... Massive.
Ore controls..... Intrusives, fracturing.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Eocene.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Surface..
Mineral names..... Chalcopyrite, chalcocite, chrysocolla, silver, gold.

Host formation..... San Juan Stock.
Geologic age..... Eocene.
Rock relationship..... Undetermined.
Alteration..... Supergene enrichment, oxidation.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Open pit, leaching.

Year of discovery..... 1905.
Discovery method..... Ore mineral in place.

Initial production..... 1907.
Past production..... 1976.
Past production..... 1973-76: 1,982,000 kg Cu (718).

Distance to water..... Greater than 10 km.
Road requirement..... Less than 50 km.
Distance to power..... Less than 50 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Indicated | 20,000,000 st ore | 0.50% Cu | 1976 | 718 |

### REFERENCES

64, 66, 172, 657, 665, 718.

USGS quad maps..... Silver City, 1:250,000.
Safford, 1:62,500.
USBM sequence number.... 0040090018.
USGS MRDS number..... M050139.

## PICACHO VIEW--COLUMBIUM-TANTALUM

Alternate names..... Homestead, Buena Vista, Monster, Starlight, Anderson Pegmatites.

Commodities: Cb-Ta, feldspar, Be, Li, mica, W

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... White Picacho.
Elevation..... 3,600 ft.
Topography..... Rugged.
Domain..... Undetermined.

General location..... About 11 mi north-northeast of Morristown.
Meridian..... Gila & Salt River.
Tract..... Sec. 10, T 7 N, R 3 W.
Latitude..... 33°57'45" N.
Longitude..... 112°33'27" W.

Owner-operator..... Rupert Spivey (year of information 1988).

### GEOLOGY

Type of ore body..... Pegmatite.
Origin..... Magmatic differentiation.
Shape of ore body..... Tabular.
Ore controls..... Fractures, bedding and foliation planes, contact zones.

Strike and dip of mineralized zone..... N 55° E: 35° to 55° SE.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... 240.
  Thickness..... Undetermined.
  Width..... 140.
  Depth to..... Undetermined.
Mineral names..... Columbite-tantalite, albite, allanite, arsenopyrite, beryl, biotite, cerussite, fluorite, galena, garnet, hemimorphite, iron oxides, lepidolite, microcline, molybdite, muscovite, perthite, pyrite, quartz, sphalerite, tourmaline, vulfenite.

Host formation..... Pegmatite.
Geologic age..... Precambrian.
Rock relationship..... Zoned pegmatites are intruded into a hornblende-biotite-schist.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, gophering.

Year of discovery..... 1939.
Discovery method..... Ore mineral in place.

Initial production..... 1942.
Last production..... 1980's.
Past production..... 3-5 st beryl (665).

Distance to water..... Less than 1 mi.
Road requirement..... Less than 1 mi.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

134, 279, 665.

USGS quad maps..... Phoenix, 1:250,000.
Red Picacho, 1:24,000.
USBM sequence number.... 0040251836.
USGS MRDS number..... 0000080, 0000844, 0001776.

Comments: This deposit is representative of the pegmatites of this mining district. Historically the columbium-tantalum has been a byproduct of the beryl production.

## PIKES PEAK DISTRICT--IRON

Alternate names..... Hieroglyphic Mtns, Pig Iron, Iron Age, Bessemer.

Commodities: Fe

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Maricopa. | General location..... | 7.5 mi northwest of Wittman. |
| Mining district..... | Pikes Peak. | Meridian..... | Gila & Salt River. |
| Elevation..... | 2160 ft. | Tract..... | Secs. 8, 17, 18, 19, T 6 N, R 1 W and Sec. 24, T 6 N, R 2 W. |
| Topography..... | Rugged. | | |
| Domain..... | BLM administration. | Latitude..... | 33°50'14" N. |
| | | Longitude..... | 112°23'10" W. |

Owner..... Elbe Oil Land Development Co., and E. A. Parkford (year of information 1957).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Stratiform. | Host formation..... | Yavapai Schist. |
| Origin..... | Sedimentation. | Geologic age..... | Precambrian. |
| Shape of ore body..... | Lenticular. | Rock relationship..... | Mineralization in a series of elongated lenses in a broad zone in the schist. Deposits have a schistose structure with alternate bands of iron oxides and dark quartz (taconite-semitaconite). The iron bands are up to several feet thick. |
| Ore controls..... | Bedding. | | |
| Strike and dip of mineralized zone..... | N 60° E: 85° S. | | |
| Age of mineralization.. | Precambrian. | | |
| Mineral zone average dimensions, ft: | | Alteration..... | Advanced argillic. |
| | | Size..... | Small. |
| Length..... | 16,000. | | |
| Thickness..... | 1,000. | | |
| Width..... | 400. | | |
| Depth to..... | Undetermined. | | |
| Mineral names..... | Hematite-martite, magnetite, feldspar, goethite, pyrolusite-hausmannite, pyrite, apatite, mica, and ilmenite. | | |

NOTE: Size based only on current resources.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-explored prospect. | Distance to water..... | 8 mi. |
| Type of operation..... | Surface. | Road requirement..... | 12 mi. |
| | | Distance to power..... | 8 mi. |
| Year of discovery..... | 1906. | Mill location..... | None. |
| Discovery method..... | Ore mineral in place. | | |

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| I. Inferred..... | 100,000,000 st ore..... | 30% Fe, 2.8% Mn, 0.136% P..... | 1957 | 208 |

### REFERENCES

208, 657, 665.

| | |
|---|---|
| USGS quad maps..... | Phoenix, 1:250,000. Hieroglyphic Mountains SW, 1:24,000. |
| USBM sequence number.... | 0040130478. |
| USGS MRDS number..... | M003249. |

PIMA--COPPER-MOLYBDENUM

Commodities: Cu, Mo, Ag, Au

LOCATION-OWNERSHIP

County..... Pima.
Mining district..... Pima.
Elevation..... 1,022 m.
Topography..... Hilly.
Domain..... Mixed.

General location..... About 24 km southwest of Tucson.
Meridian..... Gila & Salt River.
Tract..... Sec. 36, T 16 S, R 12 E.
Latitude..... 31°59'19" N.
Longitude..... 111°04'19" W.

Owner-operator..... ASARCO Incorporated (year of information 1988).

GEOLOGY

Type of ore body..... Replacement, disseminated.
Origin..... Metasomatic.
Shape of ore body..... Massive.
Ore controls..... Intrusives, bedding, jointing, faulting.
Strike and dip of mineralized zone..... Flat-lying.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Chalcopyrite, pyrite, molybdenite, sphalerite, galena, silver.

Host formation..... Quartz monzonite porphyry, sediments.
Geologic age..... Tertiary (porphyry), Paleozoic and Mesozoic (sediments).
Rock relationship..... Mineralization related to intrusion of quartz monzonite porphyry into Paleozoic and Mesozoic sediments.
Alteration..... Sericitization, carbonate silicification, argillization, propylitization, potassic alteration.
Size..... Large.

NOTE: Size based only on current resources.

DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1951.
Discovery method..... Geophysical anomaly.

Initial production..... 1957.
Last production..... 1982.
Past production:
  1952-54..... 60,000 st ore at 5.83% Cu (underground) (219).
  1955-77..... 199,800,000 st ore at 0.477% Cu, 0.004% Mo, 0.06 fr oz/st Ag (219).
  1979-82..... 207,000,000 lb Cu, 3,800,000 lb Mo (252, 407-408).
Production rate..... 29,000 st/d ore.

Distance to water..... Less than 10 km.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive.
Milling method..... Flotation.
Process rate..... 15,000 st/d ore (Pima mill only).
Product type..... Cu and Mo concentrates.

PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 120,800,000 st ore..... | 0.48% Cu..... | 1983 | 634 |
| 2. Not reported in reference..... | 120,767,000 st ore..... | 0.482% Cu..... | 1984 | 254 |

REFERENCES

60, 64, 107, 142, 219, 248, 252, 254, 384, 407-408, 435, 479, 490, 591, 612, 634, 657, 665.

USGS quad maps..... Nogales, 1:250,000.
Twin Buttes, 1:62,500.
USBM sequence number.... 0040190006.
USGS MRDS number..... M050388.

Comments: Acquired from Cyprus Metals Co. In 1985, the Pima Mine was consolidated with the Mission Complex operation on July 1, 1988. The old mill has been scavenged, but the new mill is intact. See the Mission-San Xavier deposit abstract for further information.

## PINTO VALLEY--COPPER-MOLYBDENUM

Alternate names..... Castle Dome.

Commodities: Cu, Mo, Au, Ag, Pb, Zn, $U_3O_8$

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Globe-Miami.
Elevation..... 1,220 m.
Topography..... Rugged.
Domain..... Private.

General location..... About 8 km west of Miami.
Meridian..... Gila & Salt River.
Tract..... Sec. 19, 20, T 1 N, R 14 E.
Latitude..... 33°24'30" N.
Longitude..... 110°57'50" W.

Owner-operator..... Magma Copper Co. (year of information 1987).

### GEOLOGY

Type of ore body..... Disseminated veins.
Origin..... Hydrothermal, oxidation, supergene enrichment.
Shape of ore body..... Massive.
Ore controls..... Intrusives, faulting, lithology.
Strike and dip of mineralized zone..... N 75° E: 85° S.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... 1,460.
  Thickness..... 335.
  Width..... 760.
  Depth to..... 30.
Mineral names..... Chalcopyrite, chalcocite, molybdenite, covellite, sphalerite, galena, pyrite, cuprite, malachite, azurite, copper, silver, gold.

Host formation..... Lost Gulch Quartz Monzonite, granite porphyry, diabase sills.
Geologic age..... Tertiary.
Rock relationship..... Hypogene mineralization confined principally to the quartz monzonite. Massive chalcopyrite associated with the diabase sills.
Alteration..... Silicification, sericification.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit, dump leach.

Year of discovery..... 1881.
Discovery method..... Ore mineral in place.

Initial production..... 1907.
Past production..... 1982-86: 51,882,930 st ore with, 188,859 st Cu, 2,207 st Mo plus 43,745 st cathode Cu from SX-EW (63-64, 252-254).
Production rate..... 60,000 st/d ore, 6,000 gpm of solution.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Milling method..... Flotation, dump leach, SX-EW.
Process rate..... 60,000 st/d, 8,000 gpm of solution.
Product type..... Cu and Mo concentrates, cathode Cu.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Proven | 316,000,000 st ore | 0.44% Cu | 1982 | 202 |
| 2. | Demonstrated | 398,600,000 st ore | 0.447% Cu | 1981 | 099 |
| 3. | Not reported in reference | 229,300,000 st ore | 0.400% Cu, 0.015% $MoS_2$ | 1987 | 353 |
| 4. | Not reported in reference | 251,200,000 st ore | 0.411% Cu, 0.015% $MoS_2$ | 1987 | 353 |

### REFERENCES

63-64, 99, 141, 202, 252-254, 329, 337, 343, 353, 371, 378, 397, 402-403, 405, 408, 443, 517-518, 583, 615, 657, 665, 693, 729.

USGS quad maps..... Mesa, 1:250,000.
Inspiration, 1:62,500.
USBM sequence number.... 0040070010.
USGS MRDS number..... M002863, W002706, D000352.
MSHA ID number..... 021049.

Comments: Line 3 of the reserve information represents reserves included in Magma's mine plan for 1987-97. Line 4 represents additional reserves beyond those included in the mine plan.

## PORTLAND--GOLD

Commodities: Au, Ag

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Black Mountains.
Elevation..... 622 m.
Topography..... Hilly.
Domain..... National recreation area.

General location..... 6 mi south of Lost Cabin Spring.
Meridian..... Gila & Salt River.
Tract..... Sec. 15, T 23 N, R 21 W.
Latitude..... 35°22'51" N.
Longitude..... 114°30'45" W.

Owner-operator..... Western States Minerals Corp. (year of information 1988).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Fracture.
Strike and dip of mineralized zone..... Undetermined: 35° E.
Age of mineralization.. Undetermined.
Mineral zone maximum dimensions, ft:
  Length..... 1,200.
  Thickness..... 160.
  Width..... 12.
  Depth to..... Surface.
Mineral names..... Gold.

Host formation..... Undetermined.
Geologic age..... Undetermined.
Rock relationship..... Undetermined.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, undetermined.

Year of discovery..... 1920.
Discovery method..... Ore mineral in place.

Initial production..... 1931-41.
Last production..... Undetermined.
Past production..... Undetermined.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Milling method..... Cyanide heap leach, CIP.
Process rate..... Undetermined.
Product type..... Dore.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 42,000 tr oz contained Au.. | Undetermined..... | 1985 | 409 |

### REFERENCES

31, 371, 409, 657, 665.

USGS quad maps..... Kingman, 1:250,000.
Spirit Mtn. NE, 1:24,000.
USBM sequence number.... 0040150715.
USGS MRDS number..... M241495; M241460.
MSHA ID number..... 0202154.

Comments: Alteration zones were drilled, in 1984-86, to expand reserve base (409).

## PRIMOS GROUP--TUNGSTEN

Alternate names..... Bluebird (Bluebird Hill), Dividend Tunnel.

Commodities: W, Cu, Bi, Be

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Cochise.
Elevation..... 1,600 m.
Topography..... Rugged.
Domain..... Private.

General location..... 2.5 mi south-southwest of Johnson and 4 mi northeast of Dragoon.
Meridian..... Gila & Salt River.
Tract..... Sec. 3, T 16 S, R 22 E, and Secs. 26, 27, 34, T 15 S, R 22 E.
Latitude..... 32°04'00" N.
Longitude..... 110°05'20" W.

Owner-operator..... Primos Chemical Co. (year of information 1973).

### GEOLOGY

Type of ore body..... Quartz veins.
Origin..... Hydrothermal (hypogene), vein filling.
Shape of ore body..... Tabular, irregular.
Ore controls..... Fracturing, faulting.
Strike and dip of
Age of mineralization.. Tertiary.
mineralized zone..... N 50° E; 39° SE.
Mineral zone average dimensions, ft:
Length..... 800.
Thickness..... 15.
Width..... 600.
Depth to..... Surface.
Mineral names..... Huebnerite, scheelite, pyrite, chalcopyrite.

Host formation..... Laramide quartz monzonite.
Geologic age..... Cretaceous-Tertiary (Paleocene).
Rock relationship..... Mineralization in irregular quartz veins in fractured and altered Laramide quartz monzonite.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Coyoting.

Year of discovery..... 1898.
Discovery method..... Ore mineral in place.

Initial production..... 1900.
Last production..... 1954.
Past production..... Several hundred st of tungsten concentrates produced at Bluebird (300). About 100 st of tungsten concentrate produced at Dividend (300).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive, condition unknown (constructed 1915).
Milling method..... Gravity (1915). Also, some crushing and hand jigging in early 1940's.
Process rate..... 5 st/h ore (1915).
Product type..... Huebnerite concentrate at 60% to 70% $WO_3$.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

109, 136, 300, 657, 665, 698.

USGS quad maps..... Tucson, 1:250,000.
Dragoon, 1:62,500.
USBM sequence number.... 0040030102 Bluebird.
0040030128 Dividend Tunnel.
USGS MRDS number..... M050208 Primos Group.
M050028 Bluebird Mine.
M050026 Dividend Tunnel.

Comments: Most of the data are applicable only to Bluebird. The Dividend Tunnel is on the same geologic structure, but it is located 3,000 ft to the northeast of the Bluebird. The Dividend Tunnel location is 32°04'32" N latitude and 110°04'53" W longitude at an elevation of 1,524 m. For additional geologic information and/or clarification see reference 109.

PURE GOLD--TUNGSTEN

Alternate names..... Campo Bonito, Bonito Mine.

Commodities: W

LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Campo Bonito.
Elevation..... 1,530 m.
Topography..... Rugged.
Domain..... National forest.

General location..... 0.5 mi south of Campo Bonito.
Meridian..... Gila & Salt River.
Tract..... Secs. 17, 18, 20, 21, T 10 S, R 16 E.
Latitude..... 32°33'30" N.
Longitude..... 110°44'08" W.

Owner..... Edward H. Molson (year of information 1959).
Operator..... Edward H. Molson, and E.J. Ewing (last operators, 1943-44; year of information 1959).

GEOLOGY

Type of ore body..... Disseminated, stringers, and veinlets in fault zone.
Origin..... Pyrometasomatic.
Shape of ore body..... Irregular massive.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N of W: 30° to 60° S.
Age of mineralization.. Early Tertiary (Laramide).
Mineral zone average dimensions, ft:
  Length..... 200 at surface.
  Thickness..... Undetermined.
  Width..... 5 to 40 at surface.
  Depth to..... Exposed at surface.
Mineral names..... Scheelite, quartz, calcite, dolomite.

Host formation..... Escabrosa Limestone.
Geologic age..... Mississippian.
Rock relationship..... Silicified, brecciated limestone, locally dolomitized, contains ore. Precambrian granite underlies ore to northeast of Mogul fault. Marble, near ore.
Alteration..... Silicification, dolomitization.
Size..... Small.

NOTE: Size based only on past production.

DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open cuts, inclined shafts, vertical shafts, adit.

Year of discovery..... 1943.
Discovery method..... Ore mineral in place.

Initial production..... 1943.
Last production..... 1944.
Past production..... 7,825 st ore at 1.51% $WO_3$ (equivalent to 11,816 short ton units[1] of $WO_3$) (133).
Past production is equivalent to about 85 mt of contained W.

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

REFERENCES

133, 257, 349, 657, 665, 698.

USGS quad maps..... Tucson, 1:250,000.
Campo Bonito, 1:24,000.
USBM sequence number.... 0040210189, 0040210213, 0040210214, 0040210215.
USGS MRDS number..... M050217.

[1]Short ton unit = 20 lb of $WO_3$ containing 15.862 lb of W.

## QUARTZ LEDGE--FLUORSPAR

Alternate names..... White Cow, Porcupine.

Commodities: $CaF_2$, Au, Ag

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Tonto Basin.
Elevation..... 975 m.
Topography..... Rugged.
Domain..... National forest.

General location..... 13.5 km north-northeast of Tonto Basin.
Meridian..... Gila & Salt River.
Tract..... Sec. 20, T 7 N, R 11 E.
Latitude..... 33°56'31" N.
Longitude..... 111°14'35" W.

Owner-operator..... Pro-Met of Arizona, Inc. (year of information 1982).

### GEOLOGY

Type of ore body..... Shear zone, fracture filling.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Sheer zone.
Strike and dip of mineralized zone..... N 45° W; 75° S.
Age of mineralization.. Cretaceous.
Mineral zone average dimensions, m:.
  Length..... Withheld.
  Thickness..... Withheld.
  Width..... Withheld.
  Depth to..... Withheld.
Mineral names..... Fluorite, quartz.

Host formation..... Granite.
Geologic age..... Precambrian and Cretaceous.
Rock relationship..... Fluorspar occurs as fracture fillings along a shear zone in both granites.
Alteration..... None.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Opencut, inclined shaft.

Year of discovery..... Before 1971.
Discovery method..... Ore mineral in place.

Initial production..... 1971.
Last production..... 1973.
Past production..... Fire destroyed records.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... Less than 10 km.
Mill location..... 3.2 km east of Tonto Basin.
Mill status..... Inactive.
Milling method..... Flotation.
Product type..... $CaF_2$ concentrate.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

117, 224, 508, 538, 657, 670.

USGS quad maps..... Mesa, 1:250,000.
Picture Mountain, 1:24,000.
USBM sequence number.... 0040070006.
USGS MRDS number..... None.

## RARE METALS--COLUMBIUM-TANTALUM

Commodities: Cb-Ta, RAE, Bi, Th, $U_3O_8$

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Aquarius Mountains.
Elevation..... 4,000 ft.
Topography..... Rugged.
Domain..... BLM administration.

General location..... By road, 55 mi southeast of Kingman.
Meridian..... Gila & Salt River.
Tract..... Sec. 21, T 17 N, R 12 W.
Latitude..... 34°50'28" N.
Longitude..... 113°33'17" W.

Owner..... L. L. Edgerton (year of information 1960).

### GEOLOGY

Type of ore body..... Pegmatite body.
Origin..... Magmatic differentiation.
Shape of ore body..... Tabular.
Ore controls..... Fracturing.
Strike and dip of mineralized zone..... N 85° E: 30° to 40° NE (sic).
Age of mineralization.. Precambrian (?).
Mineral zone average dimensions, ft:
  Length..... 600.
  Thickness..... Undetermined.
  Width..... Up to 40.
  Depth to..... Exposed at surface.
Mineral names..... Monazite, euxenite, gadolinite, yttrotantalite, fergusonite, beryl, bismutite, quartz, microcline, albite, muscovite, garnet, hematite, chalcedony, unidentified bismuth mineral, fluorite.

Host formation..... Unnamed granite.
Geologic age..... Precambrian.
Rock relationship..... Granite, encloses pegmatite dikes. Pegmatite, contains ore.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Opencut.

Year of discovery..... Undetermined.
Discovery method..... Undetermined.

Initial production..... Undetermined.
Last production..... Undetermined.
Past production..... 7-8 st yttrotantalite ore, 6 st beryl, minor bismuth (247).

Distance to water..... Undetermined.
Road requirement..... Undetermined.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

1, 168, 247, 363, 418-419, 657, 665.

USGS quad maps..... Prescott, 1:250,000.
Tule Wash, 1:24,000.
USBM sequence number.... 0040150727.
USGS MRDS number..... M003704, D001768.

Comments: The Rare Metals deposit is primarily a rare-earth deposit with byproduct columbium-tantalum.

## RAY--COPPER-MOLYBDENUM

Alternate names..... Pearl Handle Pit (Old).

Commodities: Cu, Mo, Au, Ag, Pb, Zn

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Mineral Creek.
Elevation..... 646 m.
Topography..... Hilly.
Domain..... State.

General location..... About 120 km east-southeast of Phoenix and 113 km north of Tucson.
Meridian..... Gila & Salt River.
Tract..... Sec. 14, T 3 S, R 13 E.
Latitude..... 33°10'20" N.
Longitude..... 110°59'40" W.

Owner-operator..... ASARCO Incorporated (Ray Mines Division; year of information 1982).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Hydrothermal, supergene enrichment.
Shape of ore body..... Massive.
Ore controls..... Faulting, intrusives.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... 3,200.
  Thickness..... 400.
  Width..... 2,400.
  Depth to..... Undetermined.
Mineral names..... Pyrite, chalcopyrite, bornite, molybdenite, galena, sphalerite, chrysocolla, chalcocite, silver, covellite, cuprite, malachite, bronchantite, copper.

Host formation..... Diabase, Pinal Schist, Granite Mtn. Porphyry.
Geologic age..... Precambrian (diabase, Pinal Schist), Tertiary.
Rock relationship..... Ore is found mainly in the supergene-enriched Pinal Schist.
Alteration..... Sericitization, propylitization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit, heap leach, dump leach.

Year of discovery..... 1846.
Discovery method..... Ore mineral in place.

Initial production..... 1911.
Past production:
  1911-66..... 187,500,000 st ore at 0.80-0.85% Cu, 0.0002 tr oz/st Au, 0.0213 tr oz/st Ag (219).
  1981-86..... 52,456,000 mt combined ore that contained 61,918 mt Cu and 378 mt Mo in the sulfide ore, and 74,831 mt Cu in the oxide ore (625-628, 635-636).
Production rate..... 27,000 st/d sulfide ore, 14,000 st/d oxide ore.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... Hayden, AZ.
Mill status..... Active.
Milling method..... Flotation, heap leach, dump leach, SX-EW.
Process rates..... 27,000 st/d sulfide ore.
14,000 st/d oxide ore.
40,000 st/yr cathode Cu.
Product types..... Cu and Mo concentrates, cathode Cu.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 606,144,000 st ore..... | 0.70% Cu, 0.010% $MoS_2$..... | 1981 | 025 |
| 2. Not reported in reference..... | 225,760,000 st silicate ore..... | 0.68% Cu..... | 1981 | 025 |
| 3. Proven and probable..... | 694,547,000 st ore..... | 0.71% Cu..... | 1986 | 049 |
| 4. Not reported in reference..... | 677,000,000 st ore..... | 0.7% Cu..... | 1988 | 143 |

### REFERENCES

11, 25, 49, 63-64, 143, 189, 199, 205, 219, 252-254, 306, 335, 367, 371, 408, 427, 487, 489, 607, 625-628, 635-636, 657, 665.

USGS quad maps..... Mesa, 1:250,000.
Sonorra, 1:62,500.
USBM sequence number.... 0040210006.
USGS MRDS number..... W002682, D000088, D000340, M000327.
MSHA ID number..... 0200150, 0200826.

## RED MOUNTAIN--COPPER

Commodities: Cu, Mo

### LOCATION-OWNERSHIP

County..... Santa Cruz.
Mining district..... Harshaw.
Elevation..... 1,677 m.
Topography..... Rugged.
Domain..... Mixed.

General location..... About 3.2 km south of Patagonia.
Meridian..... Gila & Salt River.
Tract..... Sec. 20, T 22 S, R 16 E.
Latitude..... 31°30'12" N.
Longitude..... 110°44'14" W.

Owner-operator..... Kerr-McGee Corp. (year of information 1978).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Hydrothermal, supergene enrichment.
Shape of ore body..... Massive.
Ore controls..... Intrusives, faulting.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... 3,400.
Mineral names..... Chalcopyrite, chalcocite, enargite, molybdenite.

Host formation..... Intrusives.
Geologic age..... Mesozoic.
Rock relationship..... Collapse caldera with intrusive source of mineralization. Supergene enriched chalcocite blanket overlying primary chalcopyrite.
Alteration..... Potassic alteration, argillization, sericitization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-explored prospect.
Type of operation..... Underground.
Mining method..... Block caving (proposed).

Year of discovery..... 1970.
Discovery method..... Geochemical anomaly.

Distance to water..... Less than 3 km.
Road requirement..... Less than 10 km.
Distance to power..... Less than 10 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 100,000,000 st ore..... | 0.71% Cu..... | 1975 | 372, 445 |

### REFERENCES

64, 110, 371-372, 445, 657, 665.

USGS quad maps..... Nogales, 1:250,000.
Mt. Hughes, 7.5' quad.
USBM sequence number.... 0040230027.
USGS MRDS number..... M899921.
MSHA ID number..... 0200353.

Comments: Reserve is reported to exceed the 100,000,000 st ore reported above.

## RED ROCK--FLUORSPAR

Commodities: $CaF_2$, Au, Ag

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Tonto Basin.
Elevation..... 1,646 m.
Topography..... Rugged.
Domain..... National forest.

General location..... 18.5 km north-northeast of Tonto Basin.
Meridian..... Gila & Salt River.
Tract..... Sec. 19, T 7 N, R 12 E.
Latitude..... 33°56'16" N.
Longitude..... 110°10'01" W.

Owner-operator..... Pro-Met of Arizona, Inc. (year of information 1982).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 70° W; 90° S.
Age of mineralization.. Cretaceous.
Mineral zone average dimensions, ft.
  Length..... Withheld.
  Thickness..... Withheld.
  Width..... Withheld.
  Depth to..... Withheld.
Mineral names..... Fluorspar, gold, silver.

Host formation..... Apache Quartzite.
Geologic age..... Precambrian.
Rock relationship..... The fluorspar is found in a vertical vein structure in the Apache Quartzite, which is underlain by Precambrian granite.
Alteration..... None.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Shrinkage stoping.

Year of discovery..... Before 1971.
Discovery method..... Undetermined.

Initial production..... 1971.
Last production..... 1973.
Past production..... Records destroyed in a fire.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... Less than 10 km.
Mill location..... 3.2 km east of Tonto Basin.
Milling method..... Flotation.
Mill status..... Inactive.
Product type..... $CaF_2$ concentrate.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

32, 117, 224, 508, 538, 657, 670.

USGS quad maps..... Mesa, 1:250,000.
Picture Mtn, 1:24,000.
USBM sequence number.... 0040070005.
USGS MRDS number..... None.

Comments: Ore from Quartz Ledge deposit, Red Rock Mine, and Bluebird Mine was milled in 1971-73 at the company flotation mill located 3.2 km east of Tonto Basin.

## REEF--TUNGSTEN

Alternate names..... Tungsten Reef, Exposed Reef, Stric.

Commodities: W, Au, Ag, Pb, Cu, Zn, Te

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Hartford.
Elevation..... 2,210 m.
Topography..... Steep hills.
Domain..... National forest.

General location..... 14.5 km south and 1.6 km east of Sierra Vista.
Meridian..... Gila & Salt River.
Tract..... Secs. 14, 15, T 23 S, R 20 E.
Latitude..... 31°25'37" N
Longitude..... 110°17'18" W

Owner-operator..... Primos Chemical Co. (year of information 1973).
Tungsten Reef Mines Co. (year of information 1973).
Exposed Reef Tungsten Co. (year of information 1973).

### GEOLOGY

Type of ore body..... Quartz veins.
Origin..... Hydrothermal.
Shape of ore body..... Irregular and disseminated.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 8° W: 12° SW.
Age of mineralization.. Early Tertiary.
Mineral zone average dimensions, ft:
Length..... 3,200.
Thickness..... 20.
Width..... 1,400.
Depth to..... Crops out at surface.
Mineral names..... Scheelite, galena, chalcopyrite, sphalerite, gold, quartz.

Host formation..... Abrigo Limestone.
Geologic age..... Cambrian.
Rock relationship..... Irregular sporadic bunches and disseminations of scheelite with some gold and silver values and weak, oxidized base metal sulfides along fractures and at joint intersections in a quartz blanket at the base of the Cambrian Abrigo Limestone.
Alteration..... None.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Opencut, adit.

Year of discovery..... 1870's.
Discovery method..... Ore mineral in place.

Initial production..... Au/Ag 1870's, W 1916.
Last production..... 1956.
Past production:
1870's-1906.... minor Au/Ag production.
1916-18..... 63.9 st at 71.6% $WO_3$.
1934-42..... 183,468 lb at 71% $WO_3$.
1953-54..... 991.4 st crushed/sized quartz.
1955-56..... 6,838 lb at 74.96% $WO_3$.
The quartz was sold to the petroleum industry, with no interest shown in the tungsten content (136).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Assumed abandoned--last used 1956.
Milling method..... Jig and table.
Process rate..... Undetermined.
Product type..... Minus 5/16-in. quartz/scheelite, average 71% $WO_3$.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

136, 300, 657, 665.

USGS quad maps..... Nogales, 1:250,000.
Miller Peak, 1:24,000.
USBM sequence number.... 0040030202.
USGS MRDS number..... M241502.

Comments: Because of the erratic nature of the tungsten mineralization, exploration programs have never been conducted on this property. It is reported, however, that there is still tungsten contained in the lower vein that is of a higher grade than was mined in the upper vein (136). Property consists of seven patented claims.

## RENNER--BARITE

Commodities: $BaSO_4$, Ag

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Yuma. | General location | 2 mi northwest of Mohawk. |
| Mining district | Mohawk. | Meridian | Gila & Salt River. |
| Elevation | 600 ft. | Tract | Sec. 11, T 8 S, R 15 W. |
| Topography | Flat. | Latitude | 32°44'20" N. |
| Domain | Undetermined. | Longitude | 113°45'49" W. |
| Owner-operator | Undetermined. | | |

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Vein. | Host formation | Granite gneiss. |
| Origin | Hydrothermal. | Geologic age | Precambrian. |
| Shape of ore body | Linear. | Rock relationship | Undetermined. |
| Ore controls | Fault zones. | Alteration | Undetermined. |
| Strike and dip of mineralized zone | S 70° E; 80° SW. | Size | Small. |
| Age of mineralization | Tertiary. | | |
| Mineral zone average dimensions, ft: | | | |
| Length | 4,000. | | |
| Thickness | 20. | | |
| Width | 2. | | |
| Depth to | Surface. | | |
| Mineral names | Ankerite, barite, chlorite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Inactive-past producer. | Distance to water | Undetermined. |
| Type of operation | Surface. | Road requirement | None. |
| Mining method | Opencut. | Distance to power | On-site. |
| | | Mill location | None. |
| Year of discovery | Undetermined. | | |
| Discovery method | Ore mineral in place. | | |
| Initial production | 1929. | | |
| Last production | 1930. | | |
| Past production | 1929-30: 18 carloads (665). | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

657, 665.

| | |
|---|---|
| USGS quad maps | Ajo, 1:250,000<br>Mohawk, 1:24,000. |
| USBM sequence number | 0040270342. |
| USGS MRDS number | M002554. |

## REYMERT--SILVER

Alternate names..... America, Alaska, Asia, Australia, Africa, Europe, Great Pacific.

Commodities: Ag, Cu, Au, Pb, Mn, $CaF_2$

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Mineral Hill.
Elevation..... 3,200 ft.
Topography..... Rugged.
Domain..... BLM administration.

General location..... 5.1 mi north-northeast of Mineral Mountain.
Meridian..... Gila & Salt River.
Tract..... Secs. 15, 22, 26, 27, T 2 S, R 11 E.
Latitude..... 33°14'40" N.
Longitude..... 111°12'04" W.

Owner..... Reymert Extension Silver Mines, Inc. (year of information 1982).
Operator..... Inspiration (year of information 1987).

### GEOLOGY

Type of ore body..... Shear zone, vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Transverse faults.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 6,000.
  Thickness..... 410.
  Width..... 100.
  Depth to..... Surface.
Mineral names..... Wad, psilomelane, pyrolusite, barite, calcite, fluorite, siderite.

Host formation..... Pinal Schist.
Geologic age..... Precambrian.
Rock relationship..... Fissure zone cutting Precambrian Pinal schist varies in width up to 100 ft with selective high-grade elongated ore shoots found along the walls of the zone.
Alteration..... Undetermined.
Size..... Small.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Underground.
Mining method..... Undetermined.

Year of discovery..... 1885.
Discovery method..... Ore mineral in place.

Initial production..... 1887.
Last production..... 1960.
Past production:
  1887-1930..... $575,000 in Ag (159).
  1935-60..... $1,000,000 in Ag (159).

Distance to water..... 8.5 mi.
Road requirement..... 3.3 mi.
Distance to power..... 8.5 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 940,000 st ore..... | 4.5 tr oz/st Ag..... | 1987 | 409 |

### REFERENCES

159, 210, 409, 657, 665.

USGS quad maps..... Mesa, 1:250,000.
Mineral Mountain, 1:24,000.
USBM sequence number.... 0040211043.
USGS MRDS number..... M899890, D002471.

Comments: Inspiration expects the Ag material to be available by open pit. Current production is limited to flux feed for the Inspiration smelters.

## RICO GROUP--MERCURY

Alternate names..... Pat.# 4047, Hannah, Eureka, Cinnabar, Cinnabar Queen, Sam Hughes, Sam Pesche Copper Group, Larsen Shaft, Dreamy Draw.

Commodities: Hg, Cu, Ag

### LOCATION-OWNERSHIP

County..... Maricopa.
Mining district..... Phoenix Mountains.
Elevation..... 1,550 ft.
Topography..... Rugged.
Domain..... Private.

General location..... 10 mi north-northeast of Phoenix.
Meridian..... Gila & Salt River.
Tract..... Sec. 34, T 3 N, R 3 E.
Latitude..... 33°33'34" N.
Longitude..... 112°02'22" W.

Owner..... Steve Rayburn (year of information 1940).
Operator..... J. B. Girand (year of information 1940).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Lenticular.
Ore controls..... Schistosity, fault zone.
Strike and dip of mineralized zone..... N 25° E; 65° S.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... 12.
  Depth to..... Surface.
Mineral names..... Cinnabar, metacinnabarite, native mercury, quartz, limonite, hematite, tourmaline.

Host formation..... Quartz-sericite schist.
Geologic age..... Precambrian.
Rock relationship..... Ore occurs in a fault zone of crushed schist from 14 in to 5 ft wide that lies in a plane of schistosity with veinlets of cinnabar up to 4 in wide.
Alteration..... Undetermined.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, undetermined.

Year of discovery..... 1916.
Discovery method..... Ore mineral in place.

Initial production..... 1916.
Last production..... Undetermined.
Past production..... 25 flasks (333).

Distance to water..... Less than 0.6 mi.
Road requirement..... Less than 0.6 mi.
Distance to power..... Less than 0.6 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| I. Not reported in reference..... | 20,140 flasks contained Hg. | Undetermined..... | 1930 | 665 |

### REFERENCES

65, 333, 657, 665.

USGS quad maps..... Phoenix, 1:250,000.
Sunnyslope, 1:24,000.
USBM sequence number.... 0040130512.
USGS MRDS number..... M055101.

Comments: This abstract represents the mercury area of the Phoenix Mountains.

ROADSIDE--GOLD

Alternate names..... Arizona Rand Gold Mine Inc, Mother Lode.

Commodities: Au, Ag

LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Union Pass.
Elevation..... 579 m.
Topography..... Rolling.
Domain..... BLM administration.

General location..... About 6 mi north of Union Pass.
Meridian..... Gila & Salt River.
Tract..... Sec. 12, T 21 N, R 21 W.
Latitude..... 35°13'09" N.
Longitude..... 114°28'59" W.

Owner-operator..... Fischer-Watt Mining Co, Inc., and Pecos Resources (year of information 1980).

GEOLOGY

Type of ore body..... Detachment fault.
Origin..... Epithermal, hydrothermal.
Shape of ore body..... Lode stringers, chimney shaped.
Ore controls..... Black Mountain detachment fault breccia.
Strike and dip of mineralized zone..... N 0° E: 30° W.
Age of mineralization.. Tertiary.
Mineral zone maximum dimensions, ft:
Length..... 750.
Thickness..... 60.
Width..... 90.
Depth to..... Surface.
Mineral names..... Quartz, calcite, specularite, chalcopyrite, chlorite, gold, epidote, fluorite, gypsum, hematite.

Host formation..... Granite, rhyolite.
Geologic age..... Precambrian.
Rock relationship..... Fault acts as a floor to the mineralized breccia. Lower plate rocks are blocky, jointed, unaltered, and unmineralized. The mineralized rock is intensely ground and brecciated Precambrian granite and rhyolite dikes and sills. The gold occurs mainly in greenish-yellow quartz and in streaks of chocolate-brown iron oxide.
Alteration..... Chloritization and silicification.
Size..... Small.

NOTE: Size based only on current resources.

DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Underground.
Mining method..... Gophering.

Year of discovery..... 1910's.
Discovery method..... Ore mineral in place.

Initial production..... 1915.
Past production:
1915-33..... $20,000 Au (215).
1932-34..... 890 tr oz Au, 1,734 tr oz Ag (702).
Production rate..... 150 st/d.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill status..... Active.
Milling method..... Leaching.
Product type..... Dore.

PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 300,000 st ore..... | 0.03 tr oz/st Au..... | 1986 | 161, 409 |

REFERENCES

70, 161, 172, 215, 359, 409, 657, 665, 702.

USGS quad maps..... Kingman, 1:250,000.
Union Pass, 1:24,000.
USBM sequence number.... 0040150269.
USGS MRDS number..... M004600.

Comments: Current mining is gophering on listric fault. Activity in 1984-86 included geologic mapping and a geochemical sampling program with surface drilling (409).

## ROSE--TUNGSTEN

Alternate names..... Shoestring, Smith.

Commodities: W

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Spring Creek.
Elevation..... 1,402 m.
Topography..... Rugged, steep.
Domain..... National forest.

General location..... 11.5 mi west from Globe Highway at a point 9 mi south of Young.
Meridian..... Gila & Salt River.
Tract..... Sec. 13, T 8 N, R 12 E.
Latitude..... 34°02'01" N.
Longitude..... 111°04'32" W.

Owner..... C. A. Haught (year of information 1980).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Irregular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 45° W: 85° SW.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Parallel veins, 17 ft apart, 8 in wide.
  Depth to..... 165.
Mineral names..... Wolframite, scheelite, tourmaline, hematite, calcite.

Host formation..... Apache Series.
Geologic age..... Precambrian.
Rock relationship..... Silicified diorite porphyry intrudes ore-containing vein, which cuts the quartzite, shale, and conglomerate of the Apache series.
Alteration..... Silicification.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Coyoting.

Year of discovery..... 1937.
Discovery method..... Ore mineral in place.

Initial production..... 1937.
Last production..... 1958.
Past production..... 1937: 6,000 st ore (665).

Distance to water..... On-site.
Road requirement..... 0.5 mi.
Distance to power..... 4.4 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

134, 657, 665, 698.

USGS quad maps..... Holbrook, 1:250,000.
Buzzard Roost, 1:24,000.
USBM sequence number.... 0040070592.
USGS MRDS number..... M241214, D000763.

## SACATON--COPPER

Commodities: Cu, Mo, Ag, Au

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Casa Grande.
Elevation..... 442 m.
Topography..... Gentle.
Domain..... State and fee ownership.

General location..... About 5 km northwest of Casa Grande.
Meridian..... Gila & Salt River.
Tract..... Sec. 26, T 5 S, R 5 E.
Latitude..... 32°57'21" N.
Longitude..... 111°48'47" W.

Owner-operator..... ASARCO Incorporated (year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Hydrothermal, supregene enrichment, oxidation.
Shape of ore body..... Massive tabular to irregular.
Ore controls..... Intrusives, fracturing.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Pyrite, chalcopyrite, molybdenite, azurite, malachite, chrysocolla, covellite, chalcocite, antlerite, brochantite.

Host formation..... Pinal Schist, Oracle Granite, Sacaton Granite, Three Peaks Monzonite.
Geologic age..... Precambrian (schist and granites), Tertiary.
Rock relationship..... Ore emplacement related to the Three Peaks Monzonite. Supergene-enriched chalcocite blanket has been partially oxidized.
Alteration..... Sericitization, argillization.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, block caving.

Year of discovery..... 1961.
Discovery method..... Geological inference.

Initial production..... 1974.
Last production..... 1984.
Past production..... 1979-86: 102,660 st Cu (63-64, 252-254, 407-408).

Distance to water..... Less than 10 km.
Road requirement..... None.
Distance to power..... Less than 50 km.
Mill status..... Shut down and razed (sold for scrap).

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Proven and probable..... | 15,960,000 st ore (underground). | 1.20% Cu..... | 1983 | 046 |

### REFERENCES

38-41, 46-47, 63-64, 66, 118, 191, 252-254, 371, 377, 379, 407-408, 432, 436, 613, 657, 665, 715, 726.

USGS quad maps..... Tucson, 1:250,000.
Casa Grande West, 1:62,500.
USBM sequence number.... 0040210005.
USGS MRDS number..... M050669.
MSHA ID number..... 0200484.

Comments: Surface reserves depleted. Underground mine shut down.

## SAMSEL--TUNGSTEN

Alternate names..... Pinal Tungsten, Utah Copper Gold.

Commodities: W, Au, Ag, Pb, Cu, Mo

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Pinal Mountains.
Elevation..... 1,372 m.
Topography..... Hilly.
Domain..... National forest.

General location..... 14 mi from Globe on southwestern slope of the Pinal Mountains.
Meridian..... Gila & Salt River.
Tract..... Sec. 11, T 2 S, R 14 E.
Latitude..... 33°54'05" N.
Longitude..... 110°53'30" W.

Owner..... Henry Huffman (year of information 1953).
Operator..... Pinal Tungsten Mines, Inc. (year of information 1941).

### GEOLOGY

Type of ore body..... Vein-shear zone.
Origin..... Hydrothermal.
Shape of ore body..... Irregular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 28° E: 80° NW.
Age of mineralization.. Late Cretaceous-Tertiary.
Mineral zone average dimensions, ft:
  Length..... 3,500.
  Thickness..... 2.
  Width..... 5.
  Depth to..... Surface.
Mineral names..... Wolframite, pyrite, galena, gold, silver, molybdenite.

Host formation..... Pinal Schist.
Geologic age..... Precambrian.
Rock relationship..... Precambrian Pinal Schist intruded by Madera diorite and granodiorite. Principal vein cuts Pinal and Madera formations.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, adits, coyoting.

Year of discovery..... Undetermined.
Discovery method..... Ore mineral in place.

Initial production..... 1924 for tungsten.
Last production..... 1958.
Past production..... 1924-58: A few st of W concentrates (665).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Undetermined.
Milling method..... In 1941 there was a small gravity mill.
Process rate..... Undetermined.
Product type..... Wolframite concentrate.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

134, 657, 665, 698.

USGS quad maps..... Mesa, 1:250,000.
Pinal Ranch, 1:24,000.
USBM sequence number.... 0040070599.
USGS MRDS number..... M000364.

Comments: No information is available on reserves-resources for this property.

## SANCHEZ--COPPER

Alternate names..... Sanchez Inspiration.

Commodities: Cu, Au, Ag, Mo

### LOCATION-OWNERSHIP

County..... Graham.
Mining district..... Lone Star.
Elevation..... 3,200 m.
Topography..... Rugged.
Domain..... Private.

General location..... 15 km east-northeast of Safford.
Meridian..... Gila & Salt River.
Tract..... Sec. 26, T 6 S, R 27 E.
Latitude..... 32°52'00" N.
Longitude..... 109°33'00" W.

Owner..... AZCO Mining (year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Paleozoic.
Mineral zone average dimensions, ft:
  Length..... 2,100.
  Thickness..... 2,000.
  Width..... 2,100.
  Depth to..... Surface.
Mineral names..... Cuprite, chrysocolla, chalcopyrite, tenorite, malachite, pyrite, chalcocite, molybdenite, copper, calchanthite, bornite.

Host formation..... Andesite, quartz monzonite.
Geologic age..... Cretaceous, Tertiary.
Rock relationship..... The andesites were intruded by the quartz monzonite, which is associated with the mineralization. The ore grade is highest in the main stock.
Alteration..... Unknown.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-in development.
Type of operation..... Surface.
Mining method..... Proposed open pit and heap leach.

Year of discovery..... 1899.
Discovery method..... Ore mineral in place.

Initial production..... About 1899.
Last production..... Late 1930's.
Past production..... Very small.

Distance to water..... Greater than 10 km.
Road requirement..... Less than 50 km.
Distance to power..... Less than 50 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Indicated | 200,000,000 st ore | 0.40% Cu | 1976 | 718 |
| 2. Proven | 79,362,000 st ore | 0.36% Cu | 1978 | 272 |
| 3. Not reported in reference | 116,000,000 st ore | 0.37% Cu | 1985 | 063 |
| 4. Not reported in reference | 250,000,000 st oxide ore | 0.28% Cu | 1988 | 050 |
| 5. Not reported in reference | 100,000,000 st sulfide and mixed ore. | 0.30% Cu, 0.01 tr oz/st Au, 0.10 tr oz/st Ag, 0.006% Mo. | 1988 | 050 |

### REFERENCES

50-51, 63-64, 92, 183, 270, 272, 438, 441, 557, 599, 657, 665, 718.

USGS quad maps..... Silver City, 1:250,000.
Safford, 1:62,500.
USBM sequence number.... 0040090005.
USGS MRDS number..... M000791.

Comments: The Sanchez deposit is currently owned by AZCO Mining of Golden, CO. The company is currently proposing an open pit, heap leach operation with an SX-EW plant. Within the 250,000,000 st of oxide ore reserves is an open pit minable block of 120,000,000 st at a grade of 0.37% Cu. The company is proposing a mining operation at a rate of 5,234,000 st/yr of ore and an SX-EW plant that would produce 30-35 million lb of Cu annually at a rate of about 85,000 lb/d.

## SAN JUAN--ZINC

Alternate names..... Gordon.

Commodities: Zn, Pb, Ag, Bi, Be, Li, Ga, Cd

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Cochise. | General location..... | 12.8 km north and 16 km west of Courtland. |
| Mining district..... | Middle Pass. | Meridian..... | Gila & Salt River. |
| Elevation..... | 1,945 m. | Tract..... | Sec. 10, T 18 S, R 23 E. |
| Topography..... | Rugged, hilly. | Latitude..... | 31°52'58" N. |
| Domain..... | National forest. | Longitude..... | 109°58'58" W. |

Owner-operator..... Jonathan Gordon Operations, Inc. (year of information 1951).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Manto. | Host formation..... | Abrigo Limestone. |
| Origin..... | Contact metamorphic. | Geologic age..... | Cambrian. |
| Shape of ore body..... | Irregular. | Rock relationship..... | Sphalerite with minor galena, iron oxides, and helvite in irregular manto-type bodies of pyrometasomatic limy silicates in impure shaly Abrigo Limestone, where it is cut by faults. |
| Ore controls..... | Undetermined. | | |
| Strike and dip of mineralized zone..... | N 70° W: 25° NW. | | |
| Age of mineralization.. | Tertiary. | Alteration..... | Replacement. |
| Mineral zone average dimensions, ft: | | Size..... | Medium. |
| Length..... | 330. | | |
| Thickness..... | 40. | | |
| Width..... | 200. | | |
| Depth to..... | 50. | | |
| Mineral names..... | Sphalerite, galena, hematite, helvite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | On-site. |
| Type of operation..... | Underground. | Road requirement..... | None. |
| Mining method..... | Adits with coyoting. | Distance to power..... | On-site. |
| | | Mill location..... | See comments. |
| Year of discovery..... | 1913. | Mill status..... | Undetermined. |
| Discovery method..... | Ore mineral in place. | Milling method..... | Flotation. |
| Initial production..... | 1913. | | |
| Last production..... | 1952. | | |
| Past production..... | Greater than 25,000 st ore at 15.25% sphalerite (665). | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

300, 657, 665, 700.

| | |
|---|---|
| USGS quad maps..... | Douglas, 1:250,000. |
| | Pearce, 1:62,500. |
| USBM sequence number.... | 0040030205. |
| USGS MRDS number..... | D003068. |

Comments: Ore body dimensions would indicate that as much as 250,000 st of ore could still be present. At the time of last production (1952), the mill had been sold to a private operator, but it is not known if it was dismantled or removed from the site.

## SAN MANUEL-KALAMAZOO--COPPER-MOLYBDENUM

Commodities: Cu, Mo, Au, Ag

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Old Hat.
Elevation..... 976 m.
Topography..... Gentle.
Domain..... Private and State.

General location..... About 19 km north-northwest of San Manuel.
Meridian..... Gila & Salt River.
Tract..... Sec. 35, T 8 S, R 16 E.
Latitude..... 32°40'32" N.
Longitude..... 110°40'41" W.

Owner-operator..... Magma Copper Co. (year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated, stockwork.
Origin..... Hydrothermal, supergene enrichment, oxidation.
Shape of ore body..... Massive.
Ore controls..... Intrusives, faulting.
Strike and dip of mineralized zone..... N 61° E; 50° S; N 55° E; 15° S (San Manuel; Kalamazoo ore bodies).
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... 2,440.
  Thickness..... 300.
  Width..... 1,160.
  Depth to..... 520; 1,140 (San Manuel; Kalamazoo ore bodies).
Mineral names..... Chalcocite, chrysocolla, cuprite, molybdenite, gold, silver, chalcopyrite.

Host formation..... Monzonite porphyry, Oracle Granite.
Geologic age..... Tertiary, Precambrian.
Rock relationship..... The monzonite porphyry intruded the Oracle Granite. Mineralization was associated with this intrusion and occurs in both units. Later faulting split the ore body into two parts.
Alteration..... Potassic alteration.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface-underground
Mining method..... Open pit, block caving, in situ leaching, heap leaching.

Year of discovery..... 1944.
Discovery method..... Ore mineral in place.

Initial production..... 1956.
Past production:
  1979-86..... 149,598,000 st sulfide ore. Cu produced, 824,784 st. $MoS_2$ produced, 13,815 st (63-064, 252-254, 407-408).
  1986..... 6,722,000 st oxide ore. Heap leach Cu produced, 10,348 st. In situ leach Cu produced, 614 st (54).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Milling method..... Flotation, heap leach, in situ leach, SX-EW.
Process rate..... 62,000 st/d ore; 14,000 gpm of solution; SX-EW produces 50,000 st/yr cathode Cu.
Product type..... Cu and Mo concentrates, cathode Cu.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Proven and probable..... | 155,846,000 st sulfide ore..... | 0.771% Cu, 0.028% $MoS_2$, 0.029 tr oz/st Ag, 0.0015B tr oz/st Au. | 1987 | 353 |
| 2. Proven and probable..... | 255,365,000 st oxide ore..... | 0.388% Cu..... | 1987 | 353 |

### REFERENCES

27, 63-64, 81, 85, 95-96, 98, 135, 138, 192, 252-254, 297, 318, 340, 343, 346-347, 353, 371, 401, 407-408, 645, 650, 657, 665, 679.

USGS quad maps..... Tucson, 1:250,000.
Mammoth, 1:62,500.
USBM sequence number.... 0040210001.
USGS MRDS number..... 0000341, W002683, W002105, M050188.
MSHA ID number..... 0200151, 0200845.

Comments: In situ and heap-leach operations are expected to account for 36% of San Manuel's output during 1988-89 (353). See reference 353 for a breakdown of reserves by ore body and operation type.

## SANTA CRUZ--COPPER-MOLYBDENUM

Alternate names..... Francisco Grande, Franny-Granny, Fanny-Granny.

Commodities: Cu, Mo, Au, Ag

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | Pinal. | General location..... | Halfway between Casa Grande and Stanfield. |
| Mining district..... | Francisco Grande. | Meridian..... | Gila & Salt River. |
| Elevation..... | 1,330 ft. | Tract..... | Sec. 19, T 6 S, R 5 E; Secs. 13, 24, T 6 S, R 4 E. |
| Topography..... | Hilly. | Latitude..... | 32°53'59" N. |
| Domain..... | Private. | Longitude..... | 111°52'54" W. |

Owner-operator..... ASARCO Incorporated, and Freeport McMoRan Copper Co. (year of information 1988).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Disseminated. | Host formation..... | Intrusive. |
| Origin..... | Hydrothermal, supergene enrichment, oxidation. | Geologic age..... | Tertiary. |
| Shape of ore body..... | Massive. | Rock relationship..... | Igneous intrusive into host rock. The high grade of the ore body is largely due to a supergene enrichment zone composed of atacamite and chrysocolla in the oxide zone. |
| Ore controls..... | Intrusives, faulting. | | |
| Strike and dip of mineralized zone..... | Undetermined. | | |
| Age of mineralization.. | Tertiary. | Alteration..... | Unknown. |
| Mineral zone average dimensions, m: | | Size..... | Large. |
| Length..... | 2,000. | | |
| Thickness..... | 1,700. | | |
| Width..... | 800. | | |
| Depth to..... | 1,600. | | |
| Mineral names..... | Chalcocite, atacamite, chrysocolla, pyrite, chalcopyrite, molybdenite. | | |

NOTE: Size based only on current resources.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Active-explored prospect. | Distance to water..... | Undetermined. |
| Type of operation..... | Underground. | Road requirement..... | Undetermined. |
| Mining method..... | In situ leach (proposed). | Distance to power..... | Undetermined. |
| | | Mill location..... | None. |
| Year of discovery..... | 1976. | | |
| Discovery method..... | Geologic inferences, geophysical techniques. | | |

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| I. Not reported in reference..... | 350,000,000 st mixed ore..... | 1.0% Cu, 0.01% Mo..... | 1984 | 032, 485, 496 |

### REFERENCES

32, 218, 222, 410, 485, 496, 657, 665.

| | |
|---|---|
| USGS quad maps..... | Nogales, 1:250,000.<br>Casa Grande West, 1:24,000. |
| USBM sequence number.... | 0040211072. |
| USGS MRDS number..... | M030493. |

Comments: It should be noted that this ore body is probably contiguous with the Casa Grande ore body, with split ownership. Currently, the Bureau of Mines is doing research on Santa Cruz. Reserves also contain some gold and silver.

## SECRET PASS--GOLD

Alternate names..... Wilhelm, Tin Cup.

Commodities: Au, Ag

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... San Francisco (Oatman).
Elevation..... 4,000 ft.
Topography..... Hilly.
Domain..... State, BLM administration.

General location..... 20 mi west of Kingman.
Meridian..... Gila & Salt River.
Tract..... Secs. 2, T 20 N, R 20 W.
Latitude..... 35°08'37" N.
Longitude..... 114°21'21" W.

Owner..... Santa Fe Mining Co. (year of information 1988).
Fischer Watt Gold Co. (lessee; year of information 1988).
Operator..... Fischer Watt Gold Co. (year of information 1988).

### GEOLOGY

Type of ore body..... Veins and stringers.
Origin..... Epithermal.
Shape of ore body..... Lens.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 60° W; 70° NE
Age of mineralization.. Middle Tertiary.
Mineral zone average dimensions, ft:
Length..... 400.
Thickness..... 500.
Width..... 100.
Depth to..... Surface.
Mineral names..... Gold, pyrite, silver.

Host formation..... Oatman Latite, volcanics.
Geologic age..... Middle Tertiary, Precambrian.
Rock relationship..... Undetermined.
Alteration..... Potassic, sericitization, silicification.
Size..... Small.

### DEVELOPMENT

Current status..... Active-explored prospect.
Type of operation..... Surface-underground.
Mining method..... Open pit.

Year of discovery..... 1982.
Discovery method..... Ore mineral in place.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Proposed.
Milling method..... Heap leach, CIP.
Process rate..... 1,000 st/d ore.
Product type..... Dore.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Measured | 500,000 st ore | 0.1 tr oz/st Au | 1988 | 160 |

### REFERENCES

160, 409, 657.

USGS quad maps..... Kingman, 1:250,000
Secret Pass, 1:24,000
USBM sequence number.... 0040150275.
USGS MRDS number..... None.

Comments: Underground mining method has not been finalized (7/6/88).

## SEVENTY-NINE--LEAD

Alternate names..... 79 Mine.

Commodities: Pb, Zn, Cu, Ag, Fe, Mo, Sb, Au, V

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Bannor.
Elevation..... 1,036 m.
Topography..... Hilly.
Domain..... Mixed.

General location..... 4.5 mi north-northwest of Hayden.
Meridian..... Gila & Salt River.
Tract..... Sec. 14, T 4 S, R 15 E.
Latitude..... 33°03'54" N.
Longitude..... 110°48'50" W.

Owner-operator..... ACM Corp. (year of information 1967).

### GEOLOGY

Type of ore body..... Replacement, vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular, irregular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 75° E; 40° S.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 1,100.
  Thickness..... 50.
  Width..... 40.
  Depth to..... 450.
Mineral names..... Galena, sphalerite, pyrite, cerussite, chalcopyrite, covellite, molybdenite, anglesite, azurite, brochantite, chalcanthite, limonite, malachite, manganite, melanterite, psilomelane, and wulfenite.

Host formation..... Naco Limestone.
Geologic age..... Pennsylvanian.
Rock relationship..... Galena, sphalerite, pyrite, and quartz in replacement bodies in shattered, alternating, thin bedded shale and impure limestone members of the Naco Formation and as small, discontinuous vein replacements in fractured and brecciated parts of a prominent rhyolite porphyry dike.
Alteration..... Replacement, supergene enrichment.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Open stope and square sets.

Year of discovery..... 1879.
Discovery method..... Ore mineral in place.

Initial production..... 1920.
Last production..... 1962.
Past production..... 1920-62: 210,977 st ore (665).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive, condition undetermined.
Milling method..... Two-product, sulphide flotation. Float lead, depress zinc, then float zinc, depress lead.
Process rate..... 60 st/d ore.
Product type..... Lead concentrate, zinc concentrate.
Distance shipped..... Undetermined.
Destination..... El Paso lead smelter, Amarillo zinc smelter.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

307, 391, 657, 665.

USGS quad maps..... Mesa, 1:250,000.
Hayden, 1:24,000.
USBM sequence number.... 0040070606.
USGS MRDS number..... D000093, M000500.

Comments: Additional holdings in T 4 S, R 15 E, Sec. 28. In the late 1940's, exploration of the deposit was halted when water was encountered 20 ft below the 7 level.

## SIERRITA--COPPER-MOLYBDENUM

Commodities: Cu, Mo, Ag, Re, Au

### LOCATION-OWNERSHIP

County..... Pima.
Mining district..... Twin Buttes.
Elevation..... 1,250 m.
Topography..... Hilly.
Domain..... Private.

General location..... 52 km south of Tucson.
Meridian..... Gila & Salt River.
Tract..... Sec. 8, T 18 S, R 12 E.
Latitude..... 31°52'17" N.
Longitude..... 111°08'53" W.

Owner-operator..... Cyprus Sierrita Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

Type of ore body..... Disseminated.
Origin..... Hydrothermal, oxidation.
Shape of ore body..... Massive.
Ore controls..... Faulting, intrusives.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... 2,300.
  Thickness..... 450.
  Width..... 1,800.
  Depth to..... 40.
Mineral names..... Chalcopyrite, molybdenite, silver, gold, covellite, azurite, copper, malachite, chalcocite.

Host formation..... Ruby Star Granodiorite, quartz monzonite porphyry, other intrusives.
Geologic age..... Tertiary.
Rock relationship..... Ore as disseminations and fracture and fissure fillings. Mineralizing fluids were associated with the granodiorite.
Alteration..... Potassic alteration, pyritization.
Size..... Large.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Open pit, dump leach.

Year of discovery..... 1960.
Discovery method..... Geological inference.

Initial production..... 1970.
Past production..... 1979-86: 245,000,000 st ore (includes Esperanza production for 1985-86) (63-64, 252-254, 407-408).
Production rate..... 86,000 st/d ore, 4,000 gpm of solution.

Distance to water..... Greater than 10 km.
Road requirement..... None.
Distance to power..... Less than 50 km.
Mill location..... On-site.
Mill status..... Active.
Milling method..... Two-product conventional sulfide flotation mill. Molybdenum roasting plant treats Mo concentrate produced by the flotation mill. About 10% of the molybdenum trioxide is further processed into ferromolybdenum. SX-EW plant.
Process rate..... 86,000 st/d ore, 4,000 gpm of solution.
Product type..... Cu concentrate, molybdenum trioxide, ferromolybdenum, cathode Cu.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 336,138,000 st ore..... | 0.30% Cu, 0.035% Mo..... | 1981 | 513 |
| 2. Proven..... | 343,300,000 st ore..... | 0.31% Cu, 0.036% Mo..... | 1986 | 126 |

### REFERENCES

63-64, 125-128, 182, 190, 252-254, 301, 350, 371, 407-408, 480-481, 497, 499-502, 504, 509-514, 608, 637, 657, 665, 689, 706.

USGS quad maps..... Nogales, 1:250,000.
Twin Buttes, 1:62,500.
USBM sequence number.... 0040190004.
USGS MRDS number..... M050331.
MSHA ID number..... 0200144.

Comments: Cyprus Metals Co. purchased and combined the Sierrita and Esperanza operations in April 1986 (126). In April 1987, Cyprus shut down the Esperanza cement copper plant and completed the installation of the SX-EW plant, which had been moved from the Johnson Camp operation. In addition to the Cu and Mo products described above, Sierrita produces byproduct Ag and about 2,700 lb/yr of Re that is recovered from the molybdenum roaster stacks.

## SILVER BELL--COPPER

Commodities: Cu, Ag, Mo

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Pima. | General location | About 40 km west-northwest of Tucson. |
| Mining district | Silver Bell. | Meridian | Gila & Salt River. |
| Elevation | 884 m. | Tract | Sec. 11, T 12 S, R 8 E. |
| Topography | Rugged. | Latitude | 32°23'37" N. |
| Domain | Private. | Longitude | 111°30'03" W. |

Owner-operator..... ASARCO Incorporated (year of information 1986).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Stockwork, disseminated. | Host formation | Dacite porphyry, monzonite. |
| Origin | Hydrothermal, supergene enrichment, oxidation. | Geologic age | Late Cretaceous, Early Tertiary. |
| Shape of ore body | Massive. | Rock relationship | Ore emplacement was associated with the monzonite stocks and dikes. Supergene enrichment formed a thin chalcocite blanket above the primary chalcopyrite ore. |
| Ore controls | Intrusives, fracturing. | | |
| Strike and dip of mineralized zone | Undetermined. | | |
| Age of mineralization | Tertiary. | Alteration | Sericitization, silicification, argillization. |
| Mineral zone average dimensions, m: | | Size | Medium. |
| Length | Undetermined. | | |
| Thickness | Undetermined. | | |
| Width | Undetermined. | | |
| Depth to | Undetermined. | | |
| Mineral names | Chalcocite, chalcopyrite, molybdenite, cuprite, pyrite, silver. | | |

NOTE: Size based only on current resources.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Active-producer. | Distance to water | On-site. |
| Type of operation | Surface. | Road requirement | None. |
| Mining method | Open pit, dump leach. | Distance to power | On-site. |
| | | Mill location | On-site. |
| Year of discovery | 1909. | Mill status | Inactive (conventional). Dump leach and precipitation plant operating. |
| Discovery method | Ore mineral in place. | | |
| | | Milling method | Flotation, dump leach with precipitation. |
| Initial production | 1954. | Process rate | 11,000 st/d ore, 2,500 gpm of solution. |
| Past production | 1982-86: 3,132,000 st ore with 38,600 st Cu, and 144,000 tr oz Ag (47, 49). | Product type | Cu concentrate, cement Cu. |
| Production rate | 11,000 st/d ore, 2,500 gpm of solution. | | |

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| I. Proven and probable | 20,955,000 st ore | 0.68% Cu, 0.07 tr oz/st Ag | 1986 | 049 |

### REFERENCES

13, 41, 43-49, 64, 66, 174, 176, 221, 236, 267, 329, 371, 387, 555, 571, 610, 657, 665.

| | |
|---|---|
| USGS quad maps | Tucson, 1:250,000. Vaca Hills, 1:62,500. |
| USBM sequence number | 0040190009. |
| USGS MRDS number | D000333. |
| MSHA ID number | 0200134, 0200851. |

Comments: Mine and mill operations were suspended in August 1984 because of low copper prices, but the leaching operation is active (13).

## SILVERBELL-MARTINEZ--SILVER

Alternate names..... Silver-Bell, Columbia, Martinez.

Commodities: Ag, Pb, Cu, Au, Zn

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Martinez.
Elevation..... 2,800 ft.
Topography..... Rugged.
Domain..... BLM administration.

General Location..... 4.2 mi east of Mineral Mountain.
Meridian..... Gila & Salt River.
Tract..... Sec. 18, T 3 S, R 12 E.
Latitude..... 33°10'34" N.
Longitude..... 111°09'27" W.

Owner-operator..... Bell, Owen and Wingfield (B.O.W.) Mining Co. (year of information 1966).

### GEOLOGY

Type of ore body..... Vein, shear zone.
Origin..... Hydrothermal.
Shape of ore body..... Tabular, lensatic.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 8° W; 67° W.
Age of mineralization.. Tertiary (probably Miocene).
Mineral zone average dimensions, ft:
  Length..... 4,000.
  Thickness..... 550.
  Width..... 20.
  Depth to..... Surface.
Mineral names..... Galena, cerussite, anglesite, hematite, azurite, chrysocolla, pyromorphite, cerargyrite, embolite, limonite.

Host formation..... Rhyolite.
Geologic age..... Tertiary.
Rock relationship..... Lenses of ore in faulted and sheared rhyolite overlying Pinal Schist.
Alteration..... Strong oxidation.
Size..... Small.

NOTE: Size based only on current reserve.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, shaft, and adit.

Year of discovery..... Prior to 1880.
Discovery method..... Ore mineral in place.

Initial production..... 1880.
Last production..... 1971.
Past production..... Undetermined.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... Undetermined.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| I. Not reported in reference..... | 400,000 st ore..... | 6.5 tr oz/st Ag..... | 1987 | 409 |

### REFERENCES

409, 657, 665.

USGS quad maps..... Mesa, 1:250,000.
Mineral Mountain, 1:24,000.
USBM sequence number.... 0040210756.
USGS MRDS number..... M899858.

## SILVER CROSS--GOLD

Alternate names..... Cave Creak, Heck.

Commodities: Au, Ag, Cu

### LOCATION-OWNERSHIP

County..... Maricopa.
Mining district..... Cave Creek.
Elevation..... 2,640 ft.
Topography..... Rugged.
Domain..... National forest.

General location..... Approximately 1.3 mi east of Black Mesa.
Meridian..... Gila & Salt River.
Tract..... Sec. 28, T 7 N, R 4 E.
Latitude..... 33°55'17" N.
Longitude..... 111°57'17" W.

Owner..... Francine Kokaska (year of information 1987).
Operator..... AMCA Resources Ltd (year of information 1987).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Irregular, blocky.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 70° E: 65° SE.
Age of mineralization.. Early Tertiary.
Mineral zone average dimensions, ft:
  Length..... 110.
  Thickness..... 53.
  Width..... 35.
  Depth to..... Surface.
Mineral names..... Gold, silver, chrysocolla, pyrolusite, argentite, hematite.

Host formation..... Schist, metavolcanic.
Geologic age..... Precambrian.
Rock relationship..... The gold is disseminated through a heavily altered, finely laminated schist structure, with the schist derived from heavily metamorphosed volcanics.
Alteration..... Sericitization.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, undetermined.

Year of discovery..... 1956.
Discovery method..... Undetermined.

Initial production..... 1957.
Last production..... 1958.
Past production..... 80 st ore at 0.4 tr oz/st Au (665).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... 2 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

657, 665.

USGS quad maps..... Mesa, 1:250,000.
New River Mesa, 1:24,000.
USBM sequence number.... 0040130527.
USGS MRDS number..... M241360.

## SILVER-EUREKA DISTRICT--SILVER

Alternate names..... Papago, Geronimo, Black Rock, West Clip, Revelation, Mandivil, Silver King, Eureka Group, Amelia, State, Maxie.

Commodities: Ag, Pb, $BaSO_4$

### LOCATION-OWNERSHIP

County..... La Paz.
Mining district..... Silver Eureka.
Elevation..... 220 m.
Topography..... Rugged.
Domain..... Mixed.

General location..... About 40 km north of Yuma.
Meridian..... Gila & Salt River.
Tract..... Sec. 12, T 4 S, R 23 W.
Latitude..... 33°05'20" N.
Longitude..... 114°35'32" W.

Owner-operator..... Orbex Minerals, Ltd., and Gulf & Western Co. (year of information 1988).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... NNW: steep.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Surface.
Mineral names..... Limonite, hematite, cerrussite, anglesite, smithsonite, yellow lead oxide, calamine, barite, pyrolusite, wulfenite, cerargyrite, argentiferous galena, vanadinite, argentite, calcite, fluorite, quartz.

Host formation..... Granite and schist; volcanic flows, tuffs, and breccias.
Geologic age..... Precambrian; Tertiary.
Rock relationship..... Volcanics overly older granites and schists. Three prominent fault zones form a horst adjacent to a graben with the ore-bearing veins occuring within the fault zones.
Alteration..... Chloritization, sericitization, carbonization, silicification.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1860.
Discovery method..... Ore mineral in place.

Initial production..... 1879.
Past production..... 1879-99: $1,696,000 in Ag and Pb (696).

Distance to water..... Less than 10 km.
Road requirement..... Less than 10 km.
Distance to power..... Less than 50 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 6,000,000 st ore..... | 4.5 tr oz/st Ag..... | 1981 | 482 |

### REFERENCES

66, 482, 491, 580, 657, 665, 696.

USGS quad maps..... Salton Sea, 1:250,000.
Picacho, 1:62,500.
USBM sequence number.... 0040120011.
USGS MRDS number..... M002447, D000097, M002559, M002445, M800244, M002449.

Comments: The deposit also contains lead and barite in potentially recoverable quantities.

## SILVER KING--SILVER

Alternate names..... Fortuna, White Horse, Last Chance, California, Seventyfour.

Commodities: Ag, Pb, Cu, Au, Zn, As

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Pioneer.
Elevation..... 3,640 ft.
Topography..... Hilly.
Domain..... National forest.

General location..... 1 mi west of Kings Crown Point, 3 mi north of Superior.
Meridian..... Gila & Salt River.
Tract..... Sec. 24, T 1 S, R 12 E.
Latitude..... 33°19'49" N.
Longitude..... 111°05'13" W.

Owner..... Dick Lobb, and Grace Middleton (year of information 1982).
Operator..... John Reynolds (year of information 1987).

### GEOLOGY

Type of ore body..... Disseminated stockwork, porphyry.
Origin..... Hydrothermal (includes supergene enrichment at or near the surface).
Shape of ore body..... Irregular.
Ore controls..... Dikes and stocks.
Strike and dip of mineralized zone..... Undetermined: 70° W.
Age of mineralization.. Cretaceous-Paleozoic.
Mineral zone average dimensions, ft:
  Length..... 130.
  Thickness..... 987.
  Width..... 130.
  Depth to..... Surface.
Mineral names..... Silver, galena, argentite, chalcopyrite, tetrahedrite, sphalerite, bornite, stromeyerite, covellite, cuprite, azurite, malachite, anglesite, cerargyrite, chalcocite, gold, pyrite, barite, siderite, copper.

Host formation..... Pinal Schist & Silver King Quartz Diorite.
Geologic age..... Precambrian, Paleozoic.
Rock relationship..... The quartz diorite porphyry enclosed a compact plexus of veinlets while remaining relatively unfissured.
Alteration..... Supergene enrichment at and near the surface. Hypogene enrichment at depth.
Size..... Small.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, undetermined.

Year of discovery..... 1875.
Discovery method..... Ore mineral in place.

Initial production..... 1877.
Last production..... 1955.
Past production:
1875-89..... 5,943,000 tr oz Ag (665).
1918-28..... 232,764 tr oz Ag (665).
1875-1928..... $6,500,000 Ag (172).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... Undetermined.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

172, 409, 546, 657, 665.

USGS quad maps..... Mesa, 1:250,000.
Superior, 1:24,000.
USBM sequence number.... 0040210760.
USGS MRDS number..... M899881.

## SNOWBALL--FLUORSPAR

Commodities: $CaF_2$

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Maricopa. | General location | About 30 km south-southeast of Aguila. |
| Mining district | Ellsworth. | Meridian | Gila & Salt River. |
| Elevation | 619 m. | Tract | Sec. 29, T 5 N, R 10 W. |
| Topography | Gentle. | Latitude | 33°44'34" N. |
| Domain | BLM administration. | Longitude | 113°19'02" W. |

Owner/operator..... Southern Mines & Milling Co. (year of information 1975).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Vein. | Host formation | Andesite breccia. |
| Origin | Hydrothermal. | Geologic age | Precambrian. |
| Shape of ore body | Tabular. | Rock relationship | The vein is composed of altered andesite breccia cemented by fluorite and calcite. |
| Ore controls | Faulting. | | |
| Strike and dip of mineralized zone | N 60° to 75° W; 38° to 78° NE. | Alteration | Propylitization, silicification. |
| Age of mineralization | Precambrian. | Size | Small. |
| Mineral zone average dimensions, ft: | | | |
| Length | 2,500. | | |
| Thickness | At least 50. | | |
| Width | 3-4. | | |
| Depth to | Surface. | | |
| Mineral names | Fluorite, calcite, quartz, feldspar, amphibole, limonite, siderite, hematite, bornite, manganiferous calcite. | | |

NOTE: Size based only on current resources.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Inactive-past producer. | Distance to water | Less than 3 km. |
| Type of operation | Surface-underground. | Road requirement | None. |
| | | Distance to power | Less than 50 km. |
| Year of discovery | 1943. | Mill location | None. |
| Discovery method | Ore mineral in place. | | |
| Initial production | 1957. | | |
| Last production | 1958. | | |
| Past production | Very small. | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

32, 146, 657, 665.

| | |
|---|---|
| USGS quad maps | Phoenix, 1:250,000. |
| | Lone Mountain, 1:62,500. |
| USBM sequence number | 0040130033. |
| USGS MRDS number | M003724. |

## SQUAW PEAK--MOLYBDENUM

Commodities: Mo, Cu, Pb, Zn, Ag

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Yavapai. | General location | 7 mi south of Camp Verde. |
| Mining district | Squaw Peak. | Meridian | Gila & Salt River. |
| Elevation | 4,100 ft. | Tract | Sec. 31, T 13 N, R 5 E. |
| Topography | Hilly to rugged. | Latitude | 34°27'54" N. |
| Domain | National forest. | Longitude | 111°51'27" W. |

Owner: Squaw Peak Copper Mining Co. (year of information 1972).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Disseminated, stockwork. | Host formation | Granodiorite-quartz diorite, quartz monzonite. |
| Origin | Intrusive, hydrothermal. | Geologic age | Precambrian, Late Cretaceous-Tertiary. |
| Shape of ore body | Elliptical stockwork. | Rock relationship | Undetermined. |
| Ore controls | Faulting, fracturing. | Alteration | Silicification, argillization, potassic alteration. |
| Strike and dip of mineralized zone | NNW: undetermined. | Size | Small. |
| Age of mineralization | Tertiary. | | |
| Mineral zone average dimensions, ft: | | | |
| Length | 4,200. | | |
| Thickness | 1,900. | | |
| Width | 700. | | |
| Depth to | Surface. | | |
| Mineral names | Chalcopyrite, molybdenite, bornite, malachite, chrysocolla, azurite, sphalerite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Inactive-past producer. | Distance to water | On-site. |
| Type of operation | Underground. | Road requirement | None. |
| Mining method | Cut-and-fill. | Distance to power | On-site. |
| | | Mill location | None. |
| Year of discovery | Prior to 1944. | | |
| Discovery method | Ore mineral in place. | | |
| Initial production | 1944. | | |
| Last production | 1946. | | |
| Past production | 1944-46: 623 st ore (665). | | |

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference | 2,500,000 st ore | 1.6% Cu, 0.24% $MoS_2$ | 1949 | 665 |
| 2. Not reported in reference | 20,000,000 st ore | 0.36% Cu | 1976 | 558 |

### REFERENCES

558, 657, 665.

| | |
|---|---|
| USGS quad maps | Holbrook, 1:250,000.<br>Horner Mountain, 1:24,000. |
| USBM sequence number | 004025(790. |
| USGS MRDS number | M001101. |

## SUGARLOAF BUTTE--ALUMINUM

Commodities: Al

### LOCATION-OWNERSHIP

County..... La Paz.
Mining district..... Quartzsite.
Elevation..... 427 m.
Topography..... Rugged and flat.
Domain..... Undetermined.

General Location..... 5 mi west of Quartzsite, 1 mi south of Highway 60.
Meridian..... Gila & Salt River.
Tract..... Sec. 3, T 3 N, R 20 W.
Latitude..... 33°37'59" N.
Longitude..... 114°18'56" W.

Owner..... Ropp Brothers (year of information 1935).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Irregular, possibly massive.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... Flat.
Age of mineralization.. Undetermined.
Mineral zone average dimensions, ft (if outcrops are associated with each other):
  Length..... 4,000.
  Thickness..... 200.
  Width..... 1,000.
  Depth to..... 200.
Mineral names..... Alunite, hematite, pyrite.

Host formation..... Dacite.
Geologic age..... Undetermined.
Rock relationship..... Quartzite overlies sericite schist which overlies dacite. Alunite veins occur in the dacite at the base of the butte.
Alteration..... Sericitization.
Size..... Undetermined.

NOTE: If the ore body can be proved out over the length of 0.75 mi by width of 0.2 mi, then the property would be classified as large.

### DEVELOPMENT

Current status..... Inactive-explored prospect.
Type of operation..... Underground.
Mining method..... Adit and decline shaft.

Year of discovery..... 1929 (first samples submitted to AZ Bur. Mines).
Discovery method..... Ore mineral in place.

Distance to water..... 11 mi.
Road requirement..... None.
Distance to power..... 6 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 256,000 st ore..... | 55% alunite..... | 1941 | 649 |

### REFERENCES

246, 649, 657.

USGS quad maps..... Salton Sea, 1:250,000.
Middle Camp Mountains, 1:24,000.
USBM sequence number.... 0040120008.
USGS MRDS number..... None.

Comments: Additional exploration is necessary to prove this property. Thoenen (649) has estimated that the property may have great potential as a very large, low-grade, open pit strip mine.

## THREE MUSKETEERS--TUNGSTEN

Commodities: W, Au

### LOCATION-OWNERSHIP

County..... La Paz.
Mining district..... Ellsworth.
Elevation..... 495 m.
Topography..... Rugged.
Domain..... BLM administration.

General location..... About 10.5 km east of Utting.
Meridian..... Gila & Salt River.
Tract..... Sec. 24, T 6 N, R 15 W.
Latitude..... 33°50'36" N.
Longitude..... 113°46'24" W.

Owner-operator..... Transverse Mines, Inc (year of information 1982).

### GEOLOGY

Type of ore body..... Fissure veins.
Origin..... Hydrothermal.
Shape of ore body..... Irregular, lenticular.
Ore controls..... Intrusives, faulting.
Strike and dip of mineralized zone..... N 53° E: 60° S.
Age of mineralization.. Mesozoic-Tertiary.
Mineral zone average dimensions, ft:
  Length..... 500.
  Thickness..... 150.
  Width..... 200.
  Depth to..... Surface.
Mineral names..... Quartz, scheelite, calcite, biotite, feldspar, muscovite, sericite, hornblende, gold, chlorite, epidote, dolomite.

Host formation..... Calcareous schist, limestone, granite.
Geologic age..... Precambrian, Paleozoic, Mesozoic.
Rock relationship..... Most of the scheelite is found in granite veins enclosed by the calcareous schist, but lesser amounts are found in the generally underlying granite and overlying limestone. Mineralization is believed to have been associated with intrusion of the granite.
Alteration..... Sericitization.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Open pit, stoping.

Year of discovery..... 1951.
Discovery method..... Ore mineral in place.

Initial production..... 1951.
Last production..... 1978.
Past production..... 1951-78: 1,200 st ore (303).

Distance to water..... Less than 10 km.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

133, 303, 328, 657, 665, 698, 730.

USGS quad maps..... Phoenix, 1:250,000.
Utting, 1:62,500.
USBM sequence number.... 0040120009.
USGS MRDS number..... M003843.

## TOP HAT GROUP--BARITE

Alternate names..... Top Hat.

Commodities: $BaSO_4$

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Undetermined.
Elevation..... 1,707 m.
Topography..... Hilly.
Domain..... National forest.

General location..... 6.6 mi north-northeast of Tonto.
Meridian..... Gila & Salt River.
Tract..... Sec. 31, T 8 N, R 12 E.
Latitude..... 33°59'30" N.
Longitude..... 111°09'38" W.

Owner..... South Texas Aggregates (year of information 1981).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Lenticular, irregular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 75° W: 90°.
Age of mineralization.. Undetermined.
Mineral zone average dimensions, ft, for multiple occurences:
  Length..... 100.
  Thickness..... 3.5.
  Width..... Undetermined.
  Depth to..... Surface.
Mineral names..... Barite, fluorite, calcite.

Host formation..... Quartzite, limestone, rhyolite.
Geologic age..... Undetermined.
Rock relationship..... Deposits are fissure fillings along vertical faults in quartzite and rhyolite.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on deposit descriptions by Stewart and Pfister (643).

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... 1956.
Discovery method..... Ore mineral in place.

Initial production..... Undetermined.
Last production..... Undetermined.
Past production..... Undetermined.

Distance to water..... 2 mi.
Road requirement..... None.
Distance to power..... 7 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

76, 643, 657.

USGS quad maps..... Mesa, 1:250,000.
Picture Mountain, 1:24,000.
USBM sequence number.... 0040070661.
USGS MRDS number..... None.

## TRANSCENDENT--GOLD

Alternate names..... Lucky Rea, Fat Chance.

Commodities: Au, Ag, Cu

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Hassayampa.
Elevation..... 2,146 m.
Topography..... Rugged.
Domain..... National forest.

General location..... About 6 mi south of Prescott.
Meridian..... Gila & Salt River.
Tract..... Sec. 25, T 12.5 N, R 2 W.
Latitude..... 34°26'42" N.
Longitude..... 112°24'47" W.

Owner..... Muframton (year of information 1980).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Lenticular.
Ore controls..... Transcendent fault.
Strike and dip of mineralized zone..... N 20° E: 76° W.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 360.
  Thickness..... 250.
  Width..... 4.
  Depth to..... Undetermined.
Mineral names..... Pyrite, chalcopyrite, sphalerite, galena, native gold.

Host formation..... Big Bug volcanics.
Geologic age..... Precambrian.
Rock relationship..... Host rock was intruded by various types of monzonitic diorites. Most of gold is with pyrite. Most of copper is in chalcopyrite.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Stoping.

Year of discovery..... Undetermined.
Discovery method..... Ore mineral in place.

Initial production..... Undetermined.
Last production..... Undetermined.
Past production..... 3,000-5,000 mt ore (32).

Distance to water..... On-site.
Road requirement..... None.
Distance to water..... Undetermined.
Road requirement..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 25,000 st ore..... | Not reported..... | 1975 | 444 |

### REFERENCES

32, 444, 657.

USGS quad maps..... Prescott, 1:250,000.
Groom Creek, 1:24,000.
USBM sequence number.... 0040251500.
USGS MRDS number..... None.

Comments: The 1975 owners (Last Chance Mining Co.) stated that there are "indications" of an underlying porphyry copper deposit at this locality (444).

## TREASURE KING--GOLD

Commodities: Au, Cu, Ag

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Block Canyon Schist Belt.
Elevation..... 1,315 ft.
Topography..... Flat.
Domain..... National forest.

General location..... 7 mi west of Casa Grande, 4.5 mi east of Stanfield.
Meridian..... Gila & Salt River.
Tract..... Sec. 13, T 06 S, R 04 E.
Latitude..... 31°31'54" N.
Longitude..... 110°42'36" W.

Owner..... Radco Treasure King Mine (division of Resource Exploration and Development Co.; year of information 1988).
Operator..... Royal Gold, Inc. (year of information 1987).

### GEOLOGY

Type of ore body..... Strata bound.
Origin..... Metamorphic.
Shape of ore body..... Undetermined.
Ore controls..... Undetermined.
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Undetermined.
Mineral names..... Gold, silver, unspecified copper minerals.

Host formation..... Undetermined.
Geologic age..... Precambrian.
Rock relationship..... Undetermined.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-explored prospect.
Type of operation..... Underground.
Mining method..... In situ leaching (proposed).

Year of discovery..... 1975.
Discovery method..... Geophysics.

Distance to water..... 6 mi.
Road requirement..... None.
Distance to power..... 6 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 300,000 st ore..... | Undetermined..... | 1986 | 032 |
| 2. Not reported in reference..... | 150,000 st ore..... | 0.5 tr oz/st Au..... | 1987 | 409 |

### REFERENCES

32, 409, 657.

USGS quad maps..... Nogales, 1:250,000.
Stanfield, 1:24,000.
USBM sequence number.... 0040251837.
USGS MRDS number..... None.

Comments: Heap-leach operation was "permitted" in 1984-86.

## TWIN BUTTES--COPPER-MOLYBDENUM

Commodities: Cu, Mo, Ag, Au, Zn, Pb, $U_3O_8$

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Pima. | General location | About 40 km south of Tucson. |
| Mining district | Twin Buttes. | Meridian | Gila & Salt River. |
| Elevation | 1,022 m. | Tract | Sec. 5, T 18 S, R 13 E. |
| Topography | Hilly. | Latitude | 31°54'29" N. |
| Domain | Private. | Longitude | 111°03'00" W. |

Owner: Park Corp. (year of information 1988).
Operator: Cyprus Twin Buttes Corp. (subsidiary of Cyprus Metals Co.; year of information 1988).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Replacement, veinlets, and disseminated grains. | Host formation | Limestone and siltstone, clastics. |
| Origin | Contact metasomatic. | Geologic age | Paleozoic, Mesozoic. |
| Shape of ore body | Massive. | Rock relationship | Mineralization is associated with quartz monzonite porphyry and is found in all of the various Paleozoic and Mesozoic sediments, but the primary mineralization is found in the limestone, siltstone, and clastics mentioned above. There is an oxide zone overlying the sulfide zone. |
| Ore controls | Faulting, fracturing, folding, intrusives. | | |
| Strike and dip of mineralized zone | N 45° W: undetermined. | | |
| Age of mineralization | Tertiary. | | |
| Mineral zone average dimensions, ft: | | | |
| Length | 7,900. | Alteration | Carbonatization, silicification, sericitization, argillization. |
| Thickness | 1,000. | | |
| Width | 5,300. | Size | Large. |
| Depth to | 500. | | |
| Mineral names | Chalcopyrite, molybdenite, chalcocite, covellite, bornite, sphalerite, galena, pyrite, magnetite, chrysocolla, tenorite, cuprite, copper, malachite, gold, silver. | NOTE: Size based only on current resources. | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Active-temporary shutdown. | Distance to water | Less than 10 km. |
| Type of operation | Surface. | Road requirement | None. |
| Mining method | Open pit, leaching. | Distance to power | On-site. |
| | | Mill location | SX-EW plant, on-site; sulfide ore treated at Sierrita mill. |
| Year of discovery | About 1870. | | |
| Discovery method | Ore mineral in place. | Mill status | SX-EW plant inactive. |
| Initial production | About 1870. | Milling method | Agitation leach, SX-EW (flotation for sulfide ore treated at Sierrita). |
| Past production | 1979-83: 52,315,598 st sulfide and oxide ore (252-253, 407-408). | Process rate | Plans specify processing 10,000-20,000 st/d combined sulfide and oxide ore in the future. |
| Production rate | Anticipate 10,000-20,000 st/d ore in future. | Product type | Cu and $MoS_2$ concentrates (from Sierrita mill), cathode Cu. |

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Not reported in reference | 294,000,000 st sulfide ore | 0.65% Cu | 1981 | 008 |
| 2. | Not reported in reference | 37,000,000 st oxide ore | 0.94% Cu | 1981 | 008 |
| 3. | Not reported in reference | 122,000,000 st sulfide ore | 0.72% Cu | 1984 | 009 |
| 4. | Not reported in reference | 33,000,000 mt oxide ore | 0.82% Cu | 1984 | 009 |
| 5. | Not reported in reference | 37,000,000 st sulfide ore | 0.92% Cu | 1988 | 507 |
| 6. | Not reported in reference | 10,600,000 st oxide ore | 0.73% Cu | 1988 | 507 |

### REFERENCES

7-9, 58, 63-64, 66, 79, 89, 188, 198, 219, 252-254, 304, 317, 371, 376, 380, 407-408, 455, 460, 477, 507, 603, 621, 657, 665, 676, 716, 719, 725.

USGS quad maps: Nogales, 1:250,000.
Twin Buttes, 1:62,500.
USBM sequence number: 0040190005.
USGS MRDS number: D000336, W002686, M050530.
MSHA ID number: 0200136.

Comments: Cyprus Metals Co. leased the Twin Buttes Mine in March 1988 from Park Corp., which acquired the property from Anamax Mining Co. on March 2, 1988. In addition to the copper, the sulfide ore contains molybdenum and small amounts of silver and gold, and the oxide ore contains uranium at a grade of 35 ppm $U_3O_8$ (477). The molybdenum grade is 0.030% Mo (219), but published grades for the gold and silver were not located. Cyprus plans to start reprocessing about 1,500,000 st of high-oxide mill tailings starting in late 1988. These tails will be processed through both the agitation leach and the SX-EW portions of the oxide plant and should provide feed for about one year. In late 1989, Cyprus plans to start heap leaching and will process the pregnant solution through the SX-EW portion of the oxide plant. Sulfide ore will be mined and then trucked to the mill at the nearby Sierrita property for processing.

## UNITED VERDE--COPPER

Alternate names..... Hull, Big Hole, Hopewell Tunnel.

Commodities: Cu, Au, Ag, Zn, Pb

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Verde.
Elevation..... 1,525 m.
Topography..... Rugged.
Domain..... Private.

General location..... At Jerome.
Meridian..... Gila & Salt River.
Tract..... Secs. 14, 15, 22, T 16 N, R 2 E.
Latitude..... 34°45'07" N.
Longitude..... 112°07'23" W.

Owner..... Phelps Dodge Corp. (year of information 1972).
Operator..... Big Hole Mining Co. (last operator, 1969 or later; year of information 1969).

### GEOLOGY

Type of ore body..... Massive sulfide replacement.
Origin..... Hydrothermal.
Shape of ore body..... Pipelike.
Ore controls..... North-northwestward-plunging anticline.
Strike and dip of mineralized zone..... N 20° W; 65° N plunge (axis of pipe).
Age of mineralization.. Precambrian.
Mineral zone average dimensions, ft:
Length..... 1,000.
Thickness..... 4,500.
Width..... 800.
Depth to..... Exposed at surface.
Mineral names..... Chalcopyrite, pyrite, sphalerite, galena, tennantite, gold, chlorite, dolomite, quartz, arsenopyrite, bornite, specular hematite, chalcocite, cuprite, jasper, ankerite, limonite, silver, pyrrhotite, ripidolite, sericite.

Host formation..... Grapevine Gulch; unnamed quartz porphyry.
Geologic age..... Precambrian.
Rock relationship..... Tuffaceous sediments, replaced by sulfides. Quartz porphyry, replaced by sulfides (footwall). Rhyolite, near ore. Gabbro, above ore (hanging wall). "Black schist" (chlorite rock), replaced quartz porphyry, contains ore. Andesite dikes, intruded other rock types.
Alteration..... Sericitization, chloritization, silicification, pyritization.
Size..... Large.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Stoping: Horizontal cut-and-fill, inclined cut-and-fill, and square-set.

Year of discovery..... 1875.
Discovery method..... Ore mineral in place.

Initial production..... 1883.
Last production..... After 1969.
Past production:
1908-51..... 22,520,000 st ore from underground (18).
1918-40..... 9,709,000 st ore from open pit at 3.47% Cu, 2.07 tr oz/st Ag, 0.071 tr oz/st Au (4).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Abandoned in 1953. Current condition undetermined.
Milling method..... Flotation.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 12,000,000 st ore..... | 12 lb/st Cu, 7% Zn, 4 lb/st Pb, 2 tr oz/st Ag, 0.02 tr oz/st Au. | 1931 | 268 |

### REFERENCES

4, 16, 18-19, 268, 338, 552, 657, 665.

USGS quad maps..... Prescott, 1:250,000.
Clarkdale, 1:62,500.
Clarkdale, 1:24,000.
USBM sequence number.... 0040251537.
USGS MRDS number..... M002664.

## UNITED VERDE EXTENSION--COPPER

Alternate names..... U.V.X., Daisy.

Commodities: Cu, Ag, Au

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Verde.
Elevation..... 1,500 m.
Topography..... Rugged.
Domain..... Private.

General location..... At Jerome.
Meridian..... Gila & Salt River.
Tract..... Secs. 22, 23, T 16 N, R 2 E.
Latitude..... 34°45'14" N.
Longitude..... 112°06'44" W.

Owner..... Phelps Dodge Corp. (year of information 1981).
Operator..... A.F. Budge (Mining), Ltd. (year of information 1988)

### GEOLOGY

Type of ore body..... Massive sulfide replacement.
Origin..... Hydrothermal and secondary enrichment.
Shape of ore body..... Lenticular.
Ore controls..... Anticline, faulting.
Strike and dip of mineralized zone..... Trends eastward.
Age of mineralization.. Precambrian to early Paleozoic.
Mineral zone average dimensions, ft:
  Length..... 500 at 1,300 level (in sulfide ore body).
  Thickness..... 900 (includes oxide and sulfide ore bodies).
  Width..... 200 at 1,300 level (in sulfide ore body).
  Depth to..... Exposed at surface.
Mineral names..... Chalcocite, gold, silver, cuprite, malachite, copper, chrysocolla, pyrite, chalcopyrite, sphalerite, quartz, feldspar, limonite, azurite, jasper.

Host formation..... Deception Rhyolite; Grapevine Gulch; quartz porphyry.
Geologic age..... Precambrian.
Rock relationship..... Rhyolite flows and tuffs, replaced by sulfides.
Quartz porphyry, replaced by sulfides.
Schist, replaced by sulfides.
Gabbro, near ore.
Alteration..... Sericitization, kaolinization, pyritization, silicification.
Size..... Medium.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Square-set stoping, backfilled; extensive workings.

Year of discovery..... 1900.
Discovery method..... Ore mineral in place.

Initial production..... 1900.
Last production..... 1938.
Past production..... 1915-38: 793,331,000 lb Cu, 6,449,000 tr oz Ag, 152,756 tr oz Au, from 3,879,000 dry st ore (18). This production information gives the following calculated grades: 10% Cu, 1.7 tr oz/st Ag, 0.04 tr oz/st Au.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

16, 18-19, 338, 371, 483, 552, 665, 673.

USGS quad maps..... Prescott, 1:250,000.
Clarkdale, 1:62,500.
Clarkdale, 1:24,000.
USBM sequence number.... 0040250018.
USGS MRDS number..... M002668.
MSHA ID number..... 0202066.

Comments: The U.S. Geological Survey's data base (665) reports the last year of production as 1974, but gives no further data. In 1981, Verde Exploration, Ltd., reached an agreement with the owners, Phelps Dodge Corp., to reopen the Edith Shaft for exploration purposes. The results of this effort are not known. A. F. Budge (Mining), Ltd., acquired a lease on the property in April 1985 for exploration purposes and was expected to make a decision on development sometime in 1988.

## UNITED WESTERN--GOLD

Alternate names..... Hallsworth Lode, Western Apex, Western.

Commodities: Au, Ag

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... San Francisco.
Elevation..... 2,840 ft.
Topography..... Rolling.
Domain..... BLM administration.

General location..... 1 mi northwest of Oatman.
Meridian..... Gila & Salt River.
Tract..... Sec. 15, T 19 N, R 20 W.
Latitude..... 35°02'22" N.
Longitude..... 114°23'35" W.

Owner-operator..... Sun River Mining Corp. (year of information 1987).

### GEOLOGY

Type of ore body..... Vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting, fracturing.
Strike and dip of mineralized zone..... NNW-WNW: undetermined.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 1,500.
  Thickness..... Undetermined.
  Width..... 12.
  Depth to..... Undetermined.
Mineral names..... Gold, chalcopyrite, chalcocite, pyrite, chrysocolla, red lead oxide, wulfenite.

Host formation..... Oatman Andesite, Gold Road Latite, Alcyone Trachyte, Time Porphyry.
Geologic age..... Tertiary.
Rock relationship..... Ore deposited in fractures.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-past producer.
Type of operation..... Underground.
Mining method..... Gophering.

Year of discovery..... 1920's.
Discovery method..... Ore mineral in place.

Initial production..... 1927.
Last production..... 1940.
Past production..... 1927-40: 40,000 st with 0.300 tr oz/st Au (215).
Annual production..... 1935: 2,000 st ore.

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Indicated | 118,054 st ore | 0.259 tr oz/st Au | 1987 | 506 |
| 2. Inferred | 107,608 st ore | 0.268 tr oz/st Au | 1987 | 506 |

### REFERENCES

215, 506, 549, 657, 665.

USGS quad maps..... Kingman, 1:250,000.
Oatman, 1:24,000.
USBM sequence number.... 0040150299.
USGS MRDS number..... M004561.

Comments: Published reserves are developed. There are several possible extensions of ore-grade mineral on both sides of the mine on the United Western vein. It should be noted that the mine closed because of the closure of the contracted mill.

## VAN DEEMEN--GOLD

Commodities: Au, Ag

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County | Mohave. | General location | 9.25 mi north-northwest of Mount Perkins Summit. |
| Mining district | Eldorado Pass. | Meridian | Gila & Salt River. |
| Elevation | 2,750 ft. | Tract | Sec. 29, T 27 N, R 21 W. |
| Topography | Hilly. | Latitude | 34°47'24" N. |
| Domain | Undetermined. | Longitude | 114°34'21" W. |

Owner: Arizona Star Resource Corp., and Amir Mines, Ltd. (year of information 1987).
Operator: Amselco Exploration, Inc., and Fischer Watt Mining Co. (year of information 1987).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body | Detachment fault. | Host formation | Patsy Mine Volcanics. |
| Origin | Epithermal, hydrothermal. | Geologic age | Tertiary. |
| Shape of ore body | Deformed tabular. | Rock relationship | Precambrain gneiss and schist are overlain by middle Tertiary volcanics and sediments. The two formations were brought into contact by a regional, low-angle detachment fault with the attendant breccia zone. The gold mineralization appears to be associated with limonite staining in the breccia zone. |
| Ore controls | Detachment breccia zone. | | |
| Strike and dip of mineralized zone | N-S: 7° W | | |
| Age of mineralization | Tertiary. | | |
| Mineral zone average dimensions, ft: | | | |
| Length | 7,800. | Alteration | Chloritization. |
| Thickness | Undetermined. | Size | Small. |
| Width | 50. | | |
| Depth to | Undetermined. | | |
| Mineral names | Gold, silver, limonite. | | |

NOTE: Size based only on current resources.

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status | Active-explored prospect. | Distance to water | Undetermined. |
| Type of operation | Surface. | Road requirement | None. |
| Mining method | Heap leach. | Distance to power | Undetermined. |
| | | Mill location | None. |
| Year of discovery | 1930's. | | |
| Discovery method | Ore mineral in place. | | |
| Initial production | 1941. | | |
| Last production | 1941. | | |
| Past production | Undetermined. | | |

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Probable | 1,000,000 st ore | 0.035 tr oz/st Au | 1987 | 255 |

### REFERENCES

32, 255, 341, 409, 665.

| | |
|---|---|
| USGS quad maps | Needles, 1:250,000.<br>Mt Perkins, 1:24,000. |
| USBM sequence number | 0040151354. |
| USGS MRDS number | M241472. |

Comments: The Van Deemen Mine exploration drilling, with 13 reverse circulation holes, totaled 5,000 ft. Amselco Exploration used geologic mapping and interpretation to determine that the mineralized zone was a low-angle breccia. Van Deemen has been subleased to Frisco Mining for an airtrack drilling program, and Arizona Star Resource has conducted surface drilling over four detachment breccia targets (fall 1986) with further drilling done in 1987. In 1987, Arizona Star Resource Co. started developing the extensive heap-leach gold reserves. Additional reserves of 10 to 15 million st of similar grade to reserve 1 are possible. The mine was an underground operation in 1941.

## VAN DYKE--COPPER

Commodities: Cu

### LOCATION-OWNERSHIP

County..... Gila.
Mining district..... Globe-Miami.
Elevation..... 3,625 ft.
Topography..... Rolling.
Domain..... Private.

General location..... Under the town of Miami.
Meridian..... Gila & Salt River.
Tract..... Sec. 30, T 1 N, R 15 E.
Latitude..... 33°23'30" N.
Longitude..... 110°52'30" W.

Owner-operator..... Kocide Chemical Co. (year of information 1988).

### GEOLOGY

Type of ore body..... Copper oxide capping.
Origin..... Hydrothermal, supergene enrichment, oxidation.
Shape of ore body..... Lenticular.
Ore controls..... Faulting.
Strike and dip of mineralized zone..... N 70° W: 70° E.
Mineral zone average dimensions, ft:
  Length..... 3,750.
  Thickness..... 250.
  Width..... 1,425.
  Depth to..... 1,000-2,000.
Mineral names..... Azurite, malachite, chrysocolla, fluorite.

Host formation..... Pinal Schist.
Geologic age..... Precambrian.
Rock relationship..... The oxide ore body is typical of a capping formed by supergene oxidation and leaching of a low-grade sulfide deposit. The ore body is completely within the Pinal Schist and is overlain by the Gila Conglomerate.
Alteration..... Silicification, carbonatization.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Active-in development.
Type of operation..... Underground.
Mining method..... In situ leaching.

Year of discovery..... 1916.
Discovery method..... Drilling.

Initial production..... 1928.
Last production..... 1945.
Production rate..... Planned in situ leach at 500 gpm of solution.

Distance to water..... Less than 3 km.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Under construction.
Milling method..... Precipitation.
Process rate..... 500 gpm of solution planned.
Product type..... Cement Cu.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 100,000,000 st ore..... | 0.5% Cu..... | 1980 | 471 |

### REFERENCES

64, 375, 447, 452-453, 456, 461-462, 464, 471, 517, 575, 600, 604, 657, 664-665, 677.

USGS quad maps..... Mesa, 1:250,000.
Globe, 1:24,000.
USBM sequence number.... 0040070128.
USGS MRDS number..... M003083.

Comments: Production was planned to commence in late 1988.

## VEKOL HILLS--COPPER-MOLYBDENUM

Commodities: Cu, Mo, Au, Ag

### LOCATION-OWNERSHIP

County..... Pinal.
Mining district..... Vekol Hills.
Elevation..... 550 m.
Topography..... Rolling.
Domain..... Indian reservation.

General location..... About 30 mi southwest of Casa Grande.
Meridian..... Gila & Salt River.
Tract..... Sec. 4, T 10 S, R 3 E.
Latitude..... 32°35'19" N.
Longitude..... 112°03'18" W.

Owner..... Tohono O'odham Indian Reservation (year of information 1985).

### GEOLOGY

Type of ore body..... Stockwork, disseminated.
Origin..... Hydrothermal.
Shape of ore body..... Massive.
Ore controls..... Intrusives, lithology, fracturing.
Strike and dip of mineralized zone..... N 45° E; 10° W.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 3,000.
  Thickness..... 850.
  Width..... 2,200.
  Depth to..... 350.
Mineral names..... Pyrite, chalcopyrite, molybdenite, chrysocolla, bornite, chalcocite, gold, silver, malachite.

Host formation..... Pinal Schist and Apache Group; Bolsa Quartzite and Abrigo Formation; Martin Limestone; quartz, feldspar, and hornblende porphyries.
Geologic age..... Precambrian; Cambrian; Devonian; Tertiary.
Rock relationship..... Precambrian through Devonian age rocks were mineralized by solutions associated with the Laramide porphyries. The porphyries themselves contain only minor mineralization. Oxidation and supergene enrichment are relatively minor.
Alteration..... Hypogene enrichment.
Size..... Medium.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-explored prospect.
Type of operation..... Surface.
Mining method..... Open pit (proposed).

Year of discovery..... 1965.
Discovery method..... Ore mineral in place.

Distance to water..... Less than 10 km.
Road requirement..... Less than 10 km.
Distance to power..... Less than 50 km.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Proven | 104,651,000 st ore | 0.543% Cu, 0.014% Mo | 1981 | 201 |

### REFERENCES

64, 181, 201, 430, 586, 638, 657, 665, 711, 726.

USGS quad maps..... Ajo, 1:250,000.
Vekol Mtns, 1:62,500.
USBM sequence number.... 0040210003.
USGS MRDS number..... M241177.

## VULTURE--GOLD

Alternate names..... Talmage, Jane Elmore, Sheridan, Elmore, Van Buren, Astor, Conkling, Hamilton, Custer, Sherman, Pit Gold, Vulture Extension, Black Hawk, Texhoma, Cook, Peach, Finlayson, Texona, East Vulture Extension.

Commodities: Au, Ag, Pb, Cu, Fe, W, V, Zn, Mo, Li

### LOCATION-OWNERSHIP

County..... Maricopa.
Mining district..... Vulture.
Elevation..... 2,080 ft.
Topography..... Rolling.
Domain..... BLM administration.

General location..... 4.75 mi south-southwest of Vulture Peak.
Meridian..... Gila & Salt River.
Tract..... Secs. 30, 31, T 6 N, R 5 W and Secs. 25, 26, 35, 36, T 6 N, R 6 W.
Latitude..... 33°49'14" N.
Longitude..... 112°50'20" W.

Owner..... Vulture Mine Properties, Inc. (year of information 1988).
Operator..... A.F. Budge, Ltd. (year of information 1988).

### GEOLOGY

Type of ore body..... Fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Shear zone.
Strike and dip of mineralized zone..... N 90° E: 45° N.
Age of mineralization.. Tertiary.
Mineral zone average dimensions, ft:
  Length..... 1,000.
  Thickness..... 40 (estimated).
  Width..... 80.
  Depth to..... Surface.
Mineral names..... Pyrite, gold, galena, silver, wulfenite, chalcopyrite, sphalerite, vanadinite, oxidized lead, hematite-magnetite.

Host formation..... Quartz-sericite schist, granite porphyry dike.
Geologic age..... Precambrian, Tertiary.
Rock relationship..... En echelon pattern of ore shoots. Easternmost schist is buried by Tertiary lavas.
Alteration..... Silicification.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Active-producer.
Type of operation..... Surface.
Mining method..... Talls leach.

Year of discovery..... 1863.
Discovery method..... Ore mineral in place.

Initial production..... 1863.
Last production..... 1966.
Past production:
  1863-68..... $2,500,000 Au (158).
  1879-88..... $2,000,000 Au (158).
  1888-1907..... $1,000,000 Au (158).
  1863-1966..... 350,000 tr oz Au (158), 435,000 tr oz Ag (158).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Active.
Mill process..... Merrill-Crowe zinc precipitate system.
Process rate..... 95-125 gpm.
Product type..... Dore.

### PUBLISHED RESERVES-RESOURCES

| Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|
| 1. Not reported in reference..... | 250,000 st ore (surface)..... | 0.507 tr oz/st Au..... | 1987 | 409 |
| 2. Not reported in reference..... | 250,000 st ore (tailings).... | 0.402 tr oz/st Au..... | 1987 | 409 |
| 3. Not reported in reference..... | 500,000 st ore (underground). | 0.25 tr oz/st Au..... | 1987 | 409 |

### REFERENCES

158, 409-410, 657, 665, 702.

USGS quad maps..... Phoenix, 1:250,000.
Vulture Mountains, 1:62,500.
Vulture Mine, 1:24,000.
USBM sequence number.... 0040130838, 0040130839.
USGS MRDS number..... D000083, M003317.

Comments: Past production has been from surface and underground methods. Richest ore was at 240 level. Current activity is heap leaching of the agglomerated tailings. Surface rotary and diamond drilling was done. Surface and underground ore reserves are currently not economical for cyanide heap leaching (410). The mineral zone dimensions apply only to the talls reserve and have had the thickness estimated based on a density of 165 lb/ft$^3$.

## WAKEFIELD GROUP--TUNGSTEN

Alternate names..... Blue Jay, Jack Wakefield, Covellite.

Commodities: W, Au, Ag, Cu, Pb

### LOCATION-OWNERSHIP

County..... Cochise.
Mining district..... Hartford.
Elevation..... 1,913 m.
Topography..... Hilly.
Domain..... National forest.

General location..... 16 km south and 4 km west of Sierra Vista.
Meridian..... Gila & Salt River.
Tract..... Sec. 30, T 23 S, R 20 E.
Latitude..... 31°24'15" N.
Longitude..... 110°20'52" W.

Owner-operator..... Arid Mines & Development Co. (year of information 1973).

### GEOLOGY

Type of ore body..... Vein, disseminated.
Origin..... Hydrothermal.
Shape of ore body..... Irregular.
Ore controls..... Undetermined.
Strike and dip of mineralized zone..... N 25° W: 65° SW.
Age of mineralization.. Cretaceous.
Mineral zone average dimensions, m:
  Length..... Undetermined.
  Thickness..... Undetermined.
  Width..... Undetermined.
  Depth to..... Surface.
Mineral names..... Scheelite, gold, silver, chalcopyrite, galena.

Host formation..... Bisbee Group contact between Glance Conglomerate and Morita Formation.
Geologic age..... Cretaceous.
Rock relationship..... Irregular quartz vein containing spotty gold and silver values with minor amounts of chalcopyrite and galena and sporadic, disseminated scheelite with some high-grade pockets in a quartz zone along the contact of Glance Conglomerate and Morita Formation of the Cretaceous Bisbee Group.
Alteration..... Undetermined.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Trenching, coyoting.

Year of discovery..... 1896.
Discovery method..... Ore mineral in place.

Initial production..... 1896.
Last production..... 1944.
Past production:
 1896-1940..... over 100 st Au-Ag ore (300).
 1943-44..... about 10 st W ore (300).

Distance to water..... 2 mi.
Road requirement..... None.
Distance to power..... 30 mi.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

136, 300, 657, 665.

USGS quad maps..... Nogales, 1:250,000.
Miller Peaks, 1:24,000.
USBM sequence number.... 0040030226.
USGS MRDS number..... M050353.

Comments: Tungsten is confirmed on the Blue Jay.

## WHITE MESA DISTRICT--COPPER

Alternate names..... Anaconda, Arizona, Bank, Bono, Buster, California, Chico, Clark, Copper King, Copper World, Duke, Dutchman, Eastern Star, Ell, Gopher, Grand Pacific, Harvey, Hilltop, Ida M, Smyth, King, Little Dick, Lucky, Maine, Moon, Nannie E, National, Princess, Queen, Ray, San Juan, Sunset, Thrift, Tanner, Valley Verde, Victory, Wash, White Mesa Queen.

Commodities: Cu, Ag

### LOCATION-OWNERSHIP

County..... Coconino.
Mining district..... White Mesa.
Elevation..... 6,400 ft.
Topography..... Hilly to rugged.
Domain..... BIA, Navajo and Hopi Tribal Councils.

General location..... 11 mi due east of US 89.
Meridian..... Gila & Salt River.
Tract..... T 37 N, R 9 E and T 37 N, R 10 E.
Latitude..... 36°38'10" N.
Longitude..... 111°27'03" W.

Owner..... Undetermined.

### GEOLOGY

Type of ore body..... Pipes, float, fissure vein, joint filling.
Origin..... Hydrothermal.
Shape of ore body..... Tabular.
Ore controls..... Faulting, fracturing.
Strike and dip of mineralized zone..... Flat.
Age of mineralization.. Jurassic.
Mineral zone average dimensions, ft:
  Length..... 26,400.
  Thickness..... 80.
  Width..... 10,560.
  Depth to..... Surface.
Mineral names..... Malachite, chrysocolla, azurite, chalcocite, bornite, cuprite.

Host formation..... Navajo Sandstone.
Geologic age..... Jurassic.
Rock relationship..... Mineralization occurs as fault and joint fillings in the sandstone, with radial dissemination from those areas. Disseminated material occurs as matrix cement within the sandstone.
Alteration..... Supergene enrichment, replacement.
Size..... Medium.

NOTE: Size based only on current resources, assuming that overall grade of ore exceeds 0.3% Cu.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface.
Mining method..... Open pit.

Year of discovery..... Prior to 1900.
Discovery method..... Ore mineral in place.

Initial production..... Prior to 1900.
Last production..... Intermittent high-grading to early 1940's.
Past production..... Less than 1,500,000 lb Cu (665).

Distance to water..... 20 mi.
Road requirement..... 26 mi.
Distance to power..... 11 mi.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Indicated | 260,000 st ore | 1% to 4% Cu | 1943 | 551 |
| 2. | Indicated | 2,000,000 st ore | 0.1% to 1% Cu | 1943 | 551 |
| 3. | Inferred | 14,000,000 st ore | 0.1% to 4% Cu | 1943 | 551 |

### REFERENCES

551, 665.

USGS quad maps..... Marble Canyon, 1:250,000
USBM sequence number.... 0040050510.
USGS MRDS number..... M002995 (California Claim).

Comments: Little has been done with these deposits because of their isolation and lack of facilities. The ore bodies are scattered over a very large area and are not grouped together. This dispersal makes them difficult to mine with large pit efficiency, and the grades preclude small operation mining.

## WILDFLOWER--SILVER

Alternate names..... Sabronje Shoot, Sabronje Drift, Anaconda Tunnel.

Commodities: Ag, Au, Cu, Zn, Pb

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Tiger.
Elevation..... 6,800 ft.
Topography..... Rugged.
Domain..... National forest.

General location..... 2 mi northwest of Crown King.
Meridian..... Gila & Salt River.
Tract..... Sec. 10, T 10 N, R 1 W.
Latitude..... 34°13'45" N.
Longitude..... 112°21'18" W.

Owner..... Golden Crown Mining Co. (year of information 1957).

### GEOLOGY

Type of ore body..... Vein, shear zone.
Origin..... Hydrothermal.
Shape of ore body..... Irregular.
Ore controls..... Faulting, fracturing.
Strike and dip of mineralized zone..... Undetermined.
Age of mineralization.. Cretaceous-Proterozoic.
Mineral zone average dimensions, ft:
  Length..... 4,400.
  Thickness..... 480.
  Width..... 5.
  Depth to..... Surface.
Mineral names..... Silver, sphalerite, chalcopyrite, pyrite.

Host formation..... Metagabbro.
Geologic age..... Proterozoic.
Rock relationship..... Fissure vein, with quartz-sulfide filling, in a mixed quartz-diorite, diorite, quartz porphyry, and amphibolite country rock.
Alteration..... Sericitization.
Size..... Small.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... Shaft and adit.

Year of discovery..... Prior to 1917.
Discovery method..... Ore mineral in place.

Initial production..... 1917.
Last production..... 1919.
Past production:
1917-19..... 400,000 lb Cu, $15,000 Au, $30,000 Ag (172).
1917-19..... 13,000 st ore (226).

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

172, 226, 338, 657, 665.

USGS quad maps..... Prescott, 1:250,000.
Crown King, 1:24,000.
USBM sequence number.... 0040251603.
USGS MRDS number..... M004297.

## WILLIAMS--TUNGSTEN

Alternate names..... Jewel Tungsten, Wothree.

Commodities: W, Cu, $CaF_2$

### LOCATION-OWNERSHIP

County..... Mohave.
Mining district..... Aquarius Mountains.
Elevation..... 5,050 ft.
Topography..... Rugged.
Domain..... BLM administration.

General location..... 14 mi north of Wikieup.
Meridian..... Gila & Salt River.
Tract..... Secs. 19, 20, 29, 30, T 16 1/2 N, R 11 W.
Latitude..... 34°49'09" N.
Longitude..... 113°36'17" W.

Owner..... Tony Melles, and R. J. Miller (year of information 1961).

### GEOLOGY

Type of ore body..... Pegmatite.
Origin..... Magmatic differentiation.
Shape of ore body..... Tabular.
Ore control..... Fracture zone.
Strike and dip of mineralized zone..... N 70° to 80° W; 10° to 30° N.
Age of mineralization.. Laramide.
Mineral zone average dimensions, ft:
  Length..... 500.
  Thickness..... Undetermined.
  Width..... Several.
  Depth to..... Undetermined.
Mineral names..... Pyrite, fluorite, scheelite, apatite, chalcopyrite, wolframite, huebnerite.

Host formation..... Gneissoid granite.
Geologic age..... Precambrian.
Rock relationship..... Ore is in pegmatitic vein.
Alteration..... Undetermined.
Size..... Small.

NOTE: Size based only on past production.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Surface-underground.
Mining method..... Undetermined, stoping.

Year of discovery..... 1902.
Discovery method..... Ore mineral in place.

Initial production..... 1904.
Last production..... 1955.
Past production..... 1904-55: 3,043 short ton units[1] of $WO_3$ (134).

Distance to water..... Undetermined.
Road requirement..... None.
Distance to power..... Undetermined.
Mill location..... None.

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

134, 256, 665, 698.

USGS quad maps..... Prescott, 1:250,000.
Gunsight Canyon, 1:24,000.
USBM sequence number.... 0040151355.
USGS MRDS number..... M003703.

Comments: This deposit represents one of the larger deposits of the Aquarius Range.

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[1] Short ton unit = 20 lb of $WO_3$ containing 15.852 lb of W.

## YUMA--COPPER

Alternate names..... Yuma (Liberator), T & A.

Commodities: Cu, Au, Ag, Fe

### LOCATION-OWNERSHIP

| | | | |
|---|---|---|---|
| County..... | La Paz. | General location..... | 7 mi due north of Vicksburg. |
| Mining district..... | Ellsworth (Harcuvar). | Meridian..... | Gila & Salt River. |
| Elevation..... | 2,200 ft. | Tract..... | Sec. 30, T 6 N, R 14 W. |
| Topography..... | Rugged. | Latitude..... | 33° 50' 26" N. |
| Domain..... | Undetermined. | Longitude..... | 113° 44' 55" W. |

Owner..... Dan Nelson, Frank Aubel, and Art Morin (year of information 1979).

### GEOLOGY

| | | | |
|---|---|---|---|
| Type of ore body..... | Vein. | Host formation..... | Sediments. |
| Origin..... | Hydrothermal. | Geologic age..... | Mesozoic. |
| Shape of ore body..... | Linear. | Rock relationship..... | Mostly oxidized copper mineralization in contact metamorphosed limestone beds in metamorphosed Mesozoic sediments intruded by Laramide granite and cut by acidic and basic dikes. Strong iron gossans from primary magnetite and pyrite, with quartz stringers, calcite, and contact metamorphic minerals. |
| Ore controls..... | Fracturing, contact metamorphism. | | |
| Strike and dip of mineralized zone..... | Irregular. | | |
| Age of mineralization.. | Mesozoic. | | |
| Mineral zone average dimensions, ft: | | | |
| Length..... | Undetermined. | Alteration..... | Chloritization, oxidation, epidotization. |
| Thickness..... | Undetermined. | Size..... | Small. |
| Width..... | Undetermined. | | |
| Depth to..... | Undetermined. | | |
| Mineral names..... | Chalcopyrite, malachite, gold, silver, bornite, pyrite, azurite, cuprite, chalcocite, chrysocolla, hematite, magnetite, calcite, siderite. | | |

### DEVELOPMENT

| | | | |
|---|---|---|---|
| Current status..... | Inactive-past producer. | Distance to water..... | Undetermined. |
| Type of operation..... | Underground. | Road requirement..... | Undetermined. |
| Mining method..... | Coyoting. | Distance to power..... | Undetermined. |
| | | Mill location..... | None. |
| Year of discovery..... | 1860's. | | |
| Discovery method..... | Ore mineral in place. | | |
| Initial production..... | 1942. | | |
| Last production..... | 1963. | | |
| Past production..... | 1942-63: 8,600 st ore at 2.3% Cu, 0.03 tr oz/st Au, 0.3 tr oz/st Ag (665). | | |

### PUBLISHED RESERVES-RESOURCES

No published reserve-resource information.

### REFERENCES

303, 657, 665.

| | |
|---|---|
| USGS quad maps..... | Phoenix, 1:250,000. Salome, 1:62,500. |
| USBM sequence number.... | 0040120010. |
| USGS MRDS number..... | M003845. |

## ZONIA--COPPER

Commodities: Cu, Ag, Au

### LOCATION-OWNERSHIP

County..... Yavapai.
Mining district..... Walnut Grove.
Elevation..... 1,220 m.
Topography..... Hilly.
Domain..... Private.

Meridian..... Gila & Salt River.
Tract..... Sec. 13, T 11 N, R 4 W.
Latitude..... 34°18'02" N.
Longitude..... 112°37'58" W.

Owner-operator..... Antioch Resources (year of information 1986).

### GEOLOGY

Type of ore body..... Disseminated, fissure vein.
Origin..... Hydrothermal.
Shape of ore body..... Undetermined.
Ore controls..... Intrusives, fracturing.
Age of mineralization.. Undetermined.
Strike and dip of mineralized zone..... N 45° E; 55° W.
Mineral zone average dimensions, m:
  Length..... 600.
  Thickness..... Undetermined.
  Width..... 75.
  Depth to..... Surface.
Mineral names..... Malachite, melaconite, azurite, chrysocolla, cuprite, chalcocite, silver, gold.

Host formation..... Sericitic schist, monzonite.
Geologic age..... Precambrian schist, monzonite undetermined.
Rock relationship..... Ore in fractures and as disseminations in the schist.
Alteration..... Sericitization.
Size..... Small.

NOTE: Size based only on current resources.

### DEVELOPMENT

Current status..... Inactive-past producer.
Type of operation..... Underground.
Mining method..... In situ leaching.

Year of discovery..... 1880.
Discovery method..... Ore mineral in place.

Initial production..... 1880's.
Last production..... 1975.
Past production..... Undetermined.

Distance to water..... On-site.
Road requirement..... None.
Distance to power..... On-site.
Mill location..... On-site.
Mill status..... Inactive. Shut down in 1975. Condition undetermined.
Milling method..... Precipitation.
Process rate..... 5,000 lb/d Cu.
Product type..... Cement Cu.

### PUBLISHED RESERVES-RESOURCES

| | Class | Quantity | Grade | Year | Reference |
|---|---|---|---|---|---|
| 1. | Demonstrated..... | 35,000,000 st oxide ore..... | 0.31% Cu..... | 1987 | 064 |

### REFERENCES

64, 321, 381, 589, 599, 657, 665.

USGS quad maps..... Prescott, 1:250,000.
Peoples Valley, 1:24,000.
USBM sequence number.... 0040250017.
USGS MRDS number..... M800384, M004613.

Comments: To prepare this deposit for in situ leaching, the ore body was shot using 4,140,000 lb of ANFO in April 1973. This was the largest nonnuclear blast up to that time, and it is estimated that the shot broke more than 5,000,000 st of ore.

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## APPENDIX A.--LIST OF ABBREVIATIONS

### CHEMICAL AND MINERAL SYMBOLS

| | |
|---|---|
| Ag | Silver. |
| Al | Aluminum. |
| $Al_2O_3$ | Aluminum oxide, alumina. |
| As | Arsenic. |
| Asb | Asbestos. |
| Au | Gold. |
| Ba | Barium. |
| $BaSO_4$ | Barium sulfate, barite. |
| Be | Beryllium. |
| BeO | Beryllium oxide, beryllia. |
| Bi | Bismuth. |
| Ca | Calcium. |
| $CaF_2$ | Calcium fluoride, fluorite (fluorspar). |
| Cb | Columbium. |
| Cd | Cadmium. |
| Cu | Copper. |
| F | Fluorine. |
| Fe | Iron. |
| $Fe_3O_4$ | Ferroferric oxide, magnetite. |
| Ga | Gallium. |
| H | Hydrogen. |
| Hg | Mercury. |
| K | Potassium. |
| $K_2SO_4$ | Potassium sulfate. |
| Li | Lithium. |
| $Li_2O$ | Lithium oxide, lithia. |
| Mn | Manganese. |
| Mo | Molybdenum. |
| $MoS_2$ | Molybdenum disulfide, molybdenite. |
| O | Oxygen. |
| Pb | Lead. |
| RAE | Rare earths. |
| Re | Rhenium. |
| S | Sulfur. |
| Sb | Antimony. |
| Se | Selenium. |
| Ta | Tantalum. |
| Te | Tellurium. |
| Th | Thorium. |
| U | Uranium. |
| $U_3O_8$ | Triuranium octoxide, (yellowcake). |
| V | Vanadium. |
| $V_2O_5$ | Vanadium pentoxide. |
| W | Tungsten. |
| $WO_3$ | Tungsten trioxide, tungstite. |
| Zn | Zinc. |

### MISCELLANEOUS ABBREVIATIONS AND SYMBOLS

| | |
|---|---|
| ADMMR | Arizona Department of Mines and Mineral Resources. |
| AMA | Active Management Area. |
| APA | Arizona Power Authority. |
| APS | Arizona Public Service Company. |
| ARR | Apache Railway Company. |
| AT & SFRR | Atchison, Topeka, and Santa Fe Railway Company. |
| BIA | (U.S.) Bureau of Indian Affairs. |
| BLM | (U.S.) Bureau of Land Management. |
| BM & LPRR | Black Mesa and Lake Powell Railroad. |
| CDEC | Continental Divide Electric Cooperative, Inc. |
| CEC | Columbus Electric Cooperative, Inc. |
| CIP | Carbon-in-pulp. |
| CIP-EW | Carbon-in-pulp-electrowin. |
| CUC | Citizens Utilities Company. |
| EW | Electrowin. |
| GPA | Garkane Power Association, Inc. |
| GT | Greater than. |
| INA | Irrigation Non-Expansion Area. |
| LT | Less than. |
| MEC | Mohave Electric Cooperative, Inc. |
| MILS | Mineral Industry Location System. |
| MRDS | Mineral Resources Data System. |
| MRR | Magma Arizona Railroad. |
| MSHA | (U.S.) Mine Safety and Health Administration. |
| NEC | Navopache Electric Cooperative, Inc. |

MISCELLANEOUS ABBREVIATIONS AND SYMBOLS--Continued

| | |
|---|---|
| OSHA | (U.S.) Occupational Safety and Health Administration. |
| R | Range. |
| SEC | Securities and Exchange Commission. |
| Sec. | Section. |
| SMRR | San Miguel Arizona Railroad. |
| SPRR | Southern Pacific Railroad. |
| SRP | Salt River Agricultural Improvement and Power District. |
| SX-EW | Solvent extraction-electrowin. |
| T | Township. |
| TC & GBRR | Tucson, Cornelia, and Gila Bend Railroad. |
| TEC | Trico Electric Cooperative, Inc. |
| TEP | Tucson Electric Power Company. |
| USBM | (U.S.) Bureau of Mines. |
| USFS | U.S. Forest Service. |
| USGS | U.S. Geological Survey. |
| WAPA | Western Area Power Administration. |
| ° | Degree. |
| ' | Minute of arc (plane angle). |
| " | Second of arc (plane angle). |
| $ | Dollar. |
| % | Percent. |

## APPENDIX B.--COMMON CONVERSION FACTORS[1]

| To convert to kilograms (kg) from-- | Multiply by-- |
|---|---|
| Grams | **0.001** |
| Troy ounces | .0311035 |
| Pounds (avoirdupois) | .453592 |
| Short tons | 907.185 |
| Metric tons | 1,000.0 |

| To convert to metric tons (mt) from-- | Multiply by-- |
|---|---|
| Grams | **0.000001** |
| Pounds (avoirdupois) | .000453592 |
| Kilograms | **.001** |
| Short tons | .907185 |

| To convert to troy ounces (tr oz) from-- | Multiply by-- |
|---|---|
| Grams | 0.0321507 |
| Pennyweights | **.05** |
| Pounds (avoirdupois) | 14.5833 |
| Kilograms | 32.1507 |
| Short tons | 29,166.7 |
| Metric tons | 32,150.7 |

| To convert to pounds (lb) from-- | Multiply by-- |
|---|---|
| Grams | 0.00220462 |
| Troy ounces | .0685714 |
| Kilograms | 2.20462 |
| Short tons | **2,000.0** |
| Metric tons | 2,204.62 |

| To convert to short tons (st) from-- | Multiply by-- |
|---|---|
| Grams | 0.00000110231 |
| Pounds (avoirdupois) | **.0005** |
| Kilograms | .0011023I |
| Metric tons | 1.10231 |

| To convert to 76-lb flasks from-- | Multiply by-- |
|---|---|
| Grams | 0.0000290082 |
| Pounds (avoirdupois) | .0131579 |
| Kilograms | .0290082 |
| Short tons | 26.3158 |
| Metric tons | 29.0082 |

| To convert to cubic meters ($m^3$) from-- | Multiply by-- |
|---|---|
| Acre-feet | 1,233.6192 |

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[1]Except for cubic meter conversion to acre-feet, conversion factors are from BuMines Statistical Standard I-83, June 6, 1983.

NOTE.--Boldface conversion factors are exact.

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.