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MOLYBDENUM OCCURRENCES IN ARIZONA

by

CLIFFORD J. HICKS
MINERAL RESOURCES SPECIALIST

MINERAL REPORT NO. 3

$PbMoO_4$ $CaMoO_4$

MoS_2

$Fe_2Mo_3O_{12} \cdot 8H_2O$

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October 1979

STATE OF ARIZONA

DEPARTMENT OF MINERAL RESOURCES

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MOLYBDENUM OCCURRENCES IN ARIZONA

Introduction

Within the past few years molybdenum has become a much sought metal and has rewarded its producers with expanding markets and rising prices. There can be little doubt that the decision to reopen the Pima and Esperanza mines south of Tucson was reinforced by the fact that these major copper properties can produce byproduct molybdenum in large quantities. The production of byproduct molybdenum at these and other large mines in the State has placed Arizona second only to Colorado in the domestic output of this fascinating and valuable metal.

Arizona holds an undenied potential for further new production as evidenced by numerous reportings of molybdenum mineralization in mines and prospects in most of the State's fourteen counties. This report published by the Department of Mineral Resources describes many of these occurrences and offers pertinent information about the metal which may encourage and guide the prospector in his search for a commercial deposit.

The Arizona Department of Mineral Resources was created to aid in the promotion, development and conservation of the mineral resources of the State. Particular emphasis is placed on providing prospectors and small miners with technical assistance and economic information. It is a non-regulatory State agency.

Located in the southwest corner of the State Fairgrounds (at the intersection of McDowell Road, Nineteenth Avenue and Grand Avenue) in Phoenix, the Mineral Building houses the headquarters of the Department of Mineral

Resources and its Mineral Museum. The Department's Tucson office is located in Room 208 of the State Office Building at 415 West Congress Street. Both offices have engineering staffs assigned to aid, inform and advise the mineral-interested public, at no charge, from 8:00 am - 5:00 pm on weekdays. The museum has a fine collection of molybdenum minerals (among many others) which may be viewed during the work week from 8:00 am - 5:00 pm and from 1:00 pm - 5:00 pm on weekends. There is no admittance fee. The agency is closed on holidays.

Early History of Molybdenum

In modern times the soft, silvery, metallic element molybdenum, in addition to providing a recurring nightmare for radio announcers and spelling bee participants, has emerged from the anonymity of a scientific curiosity to sharing center stage in the world industrial arena.

The old Greeks had a word for it -- "Molybdos" -- but they meant "Lead". Actually, the ancients did not distinguish between galena (lead sulphide, principal ore mineral of lead), molybdenite (molybdenum sulphide, principal ore mineral of molybdenum) and graphite (carbon, pencil lead). To the untrained eye the three minerals do have visual similarities particularly when disseminated in rock. The distinction did not occur until the second half of the 18th century. First, it was demonstrated that molybdenite and graphite do not contain lead and, therefore, differ from the lead ore mineral galena. Then, in 1778, Karl Scheele, a Swedish chemist, showed that molybdenite can be decomposed by nitric acid while graphite can not, demonstrating that they are separate mineral species. Elemental molybdenum was isolated and named in 1782 by P. J. Hjelm, who succeeded in reducing molybdic oxide with carbon, obtaining a dark metallic dust -- MOLYBDENUM!!!

Molybdenum and Its Uses

Elemental molybdenum is a soft, silvery, refractory, white metal. Its atomic weight is 96, specific gravity 10.2 (compared to 7.3 - 7.8 for iron) and melting point 2620° C. (compared to 1773.5° C. for platinum). It has not been found free in the natural state and even in its compounds is relatively scarce, being only about as plentiful as antimony, tin and mercury. It is a comparatively poor conductor of electricity, but has high tensile strength, toughness and resistance to shock. When annealed it can be drawn, hammered and machined. Because of the desirable properties it gives to steel and the saving in weight from its use, over 95% of it used in this country goes into special steels. It is, therefore, of tremendous value in wartime and was under government control as one of the 23 metals and minerals of prime importance. In spite of its relatively poor electric conductivity, its other properties (notably low coefficient of expansion, and the fact it can be welded to glass) have resulted in its use in practically all electric lamps.

It is used in fluorescent as well as incandescent bulbs, electron tube filaments, turbine blades, miniature dry cells and transistors. It is used as a catalyst by the petroleum industry to raise the octane number of gasoline.

It is when the molybdenum is added to steel that its importance as an industrial metal is expressed most eloquently. This use as a steel additive came into prominence during World War I as a substitute for tungsten which was in short supply. Molybdenum alloy iron and steel proved advantageous when used in military hardware such as guns, armored vehicles and ships of war. Continuing research after the war to the present has added to the evergrowing list of applications. Superior strength and increased hardness, weldability, workability, and resistance to heat and corrosion are the properties gained when this magic metal is blended with steel. Peacetime applications include tools, structural steel, railroads, airplanes, and the special steel used in the trans-Alaskan pipeline. Additionally, the Kennecott Copper Corporation (a producer of molybdenum as a byproduct of its copper mines) has stated "Molybdenum is increasingly important to the transportation industry. It may be the key to opening the Arctic. If a railroad is ever built along the Arctic Circle, it will be because molybdenum has been added to the steel for its construction." Molybdenum steel resists the brittleness imparted to ordinary steel by low temperatures.

Mineralogy and Geology

Molybdenum; unlike the noble metals gold, silver, and platinum; does not occur in a free or elemental state in nature. It is a gregarious metal and readily unites with various elements to form mineral compounds. The major commercial ore mineral and most ubiquitous is molybdenite.

Molybdenite is almost pure molybdenum sulphide (MoS_2) but may contain traces of gold, silver, and rhenium. It is lead gray in color with a metallic luster and a greasy feel. It weathers to a pale yellow in outcrop (ferrimolybdite). On Mohs' hardness scale it rates 1.5 which is intermediate between talc and gypsum and can easily be scratched with a fingernail. Its streak is bluish gray on paper and greenish gray on unglazed porcelain. Often confused with graphite because of similar appearance and hardness, the following characteristics will serve to differentiate the two:

	Molybdenite	Graphite
Specific gravity	4.75 (heavy)	2.25 (ordinary, like quartz)
Streak on porcelain	Greenish gray	Black (will dirty hands)
Reaction to acid	Decomposed by nitric acid	Not attacked by acids
Before blowpipe	Sulphur odor	No odor

The chief deposits in which molybdenite occurs are veins in granitic rocks or in volcanic and metasedimentary rocks closely associated with granitic intrusives. Arizona's production of the mineral is now from low-grade copper-molybdenum ores and largely from Graham, Greenlee, Mohave, Pima, Pinal, Santa Cruz, and Yavapai Counties.

Rhenium, a very heavy, silvery, refractory metallic element is recovered as a byproduct from the roasting of the molybdenite concentrates gained from western copper-molybdenum porphyry ore. It is present in molybdenite in quantities ranging from a few parts per million to tenths of one percent. The major domestic consumption - 91% in 1977 - is by the petroleum industry where it is used in platinum-rhenium catalysts to produce low-lead and leadfree high-octane gasoline. The remainder is used in electric and electronic instruments and appliances. Although prices and production have dropped in the past few years, this trend is expected to reverse itself as the use of tetraethyl lead in gasoline decreases. The price per pound of rhenium powder has steadily decreased from a high of \$1,200/lb. in 1971 to \$525/lb. in 1976 and \$425/lb. in 1977. It reached a low of \$345/lb. in mid-April 1978. The list price was suspended in mid-September 1978.

Wulfenite, a molybdate of lead ($PbMoO_4$), is a heavy (sp. gr. 6.5-7.0), red, orange, yellow, gray or white mineral usually found in veins as well-formed tabular crystals with a resinous or adamantine luster. It has a hardness of 2.75 - 3.00 (can be scratched with a copper coin) and has a white streak on a porcelain plate. It is found most commonly in the oxidized parts of lead deposits. Although wulfenite occurs in at least ten of Arizona's fourteen counties, it is still considered a relatively uncommon mineral. Assuredly an ore mineral of molybdenum, a greater worth for quality wulfenite lies in its specimen value. Crystal aggregates of good color can command premium prices from mineral dealers and collectors. The Red Cloud Mine in Yuma County contains magnificent deep red crystals. The Glove Mine in the Tyndall District of Santa Cruz County has produced remarkable crystal aggregates of various colors and habits, some large crystals measuring four or more inches along the edge. The book "Mineralogy of Arizona" noted in the bibliography of this paper lists many other mines and localities where specimen material has been found.

Powellite, a calcium molybdate ($CaMoO_4$), is usually formed from the alteration of molybdenite. It is nearly always impure; tungsten substitutes for molybdenum up to 10%. Hardness 3.5 (about the same as a copper coin). Specific gravity 4.3 (quite heavy). Its color is variable and includes dirty white, gray, straw yellow, greenish yellow, pale greenish blue and brown.

Powellite is found with scheelite (calcium tungstate, $CaWO_4$), and this association helps to identify the mineral because it fluoresces a golden yellow under ultraviolet light. Arizona occurrences include: Cochise County, near Johnson and in the Warren District; Gila County, in the Inspiration Mine; Maricopa County, in the upper Santo Domingo Wash, the White Picacho District and in the Flying Saucer group, Vulture Mountains; Mohave County, in the Cerbat Range; Pima County, in the Helvetia District and Twin Buttes Mine; Pinal County, near Antelope Peak; and Yavapai County, in the White Picacho District.

Ferrimolybdite, hydrous iron molybdate ($Fe_2Mo_3O_{12} \cdot 8H_2O$), is a very soft mineral of distinctive canary-yellow color. It occurs as fine, needle-like crystals with a hardness of 1.5 and a specific gravity of 2.99 to 4.5. A secondary mineral typically formed by alteration of molybdenite, it is found in Gila County in the Globe-Miami District; in Mohave County in the Mineral Park District; in Pima County in the Santa Rita and South Comobabi Mountains; in Pinal County in the Childs-Aldwinkle and Rare Metals mines; in Santa Cruz County in the Patagonia Mountains; and in Yavapai County in the Copper Basin District.

Should the demand and price of molybdenum continue to rise -- as it has in late 1978 and early 1979 -- wulfenite, powellite and ferrimolybdite may become economically important source minerals.

Other molybdenum minerals include:

Chillagite:	$3PbWO_4 \cdot PbMoO_4$
Ilsemannite:	$MoO_2 \cdot 4MoO_2$

Koechlinite:	$Bi_2O_3 . MoO_3$
Lindgrenite:	$2CuMoO_4 . Cu(OH)_2$
Achrematite:	$35PbO . 3PbCl_2 . 9As_2O_5 . 4MoO_3$
Belonisite:	$MgMoO_4$
Jordisite:	Amorphous MoS_2

Exploration

Most of the world's (and Arizona's) minable molybdenum deposits are hydrothermal in origin, i.e., the metallic minerals are transported by high temperature aqueous solutions and precipitated in fractures, cavities, cracks or interstices of the host rocks by evaporation, and/or changes in temperature or pressure. The genetic types of deposits which are classified as hydrothermal include: 1. quartz veins, 2. contact metamorphic zones adjacent to granitic intrusives, and 3. most importantly, porphyry or disseminated deposits including breccia pipes and stockworks. In type 3. the favorable host rocks are granite, diorite, quartz monzonite and their porphyritic equivalents. The metallization commonly takes place in both the intrusive and adjacent country rock.

Two other genetic type molybdenum deposits are: 1. Bedded deposits in sedimentary rocks and 2. pegmatite and aplite dikes. These types do not represent a large volume of molybdenum but are of economic importance only when the metal is associated with other minerals.

In mineral exploration and its purpose -- the discovery of an ore body -- it is well to remember that the word "ore" is not a mineralogic or geologic term but applies to the economics of a mineral deposit. If a commodity can be mined, processed, shipped and marketed at a profit, the raw material from which it is derived is ore. Since nature is often capricious in its placement of mineral deposits and their proximity to such necessities as transportation, water, power and a labor source, the ability to economically meet these requirements often makes the difference between an ore body and mineralized waste.

Obviously wildcat drilling for oil, even in areas of favorable geology, has a much lower incidence of success than production well drilling in a known field. The prospector seeking molybdenum might do well to start his search in areas where molybdenum minerals have been noted. The mining districts and mines listed in this paper provide a guide to these areas. Additionally, the information relating to the geology and mineralogy of molybdenum should be carefully studied and applied to geologic maps and cross-sections to determine additional scientifically appropriate target areas. Geochemistry, in addition to traditional field techniques, may be useful.

The Arizona State Department of Mineral Resources has a voluminous reference library, extensive individual mine files, and a trained technical staff to help prospectors.

General Metallurgy

The milling and concentration of molybdenum ore is fairly simple inasmuch as molybdenite is one of the minerals most amenable to the flotation process. The chief problem in the flotation of molybdenite was depressing copper sulphide but reagents have been developed to over come this difficulty.

Most of the companies producing byproduct molybdenum, including those in Arizona, sell their output as molybdenite concentrate or molybdic oxide.

Virtually all molybdenite concentrate is first roasted to technical-grade molybdic oxide (MoO_3) at a controlled temperature -- up to 600° C. -- in the presence of excess air. This is the base material for producing chemical compounds, ferromolybdenum and purified molybdenum. However, some lubricant grade molybdenite is prepared by passing commercial grade molybdenite concentrate (90% MoS_2) through several successive grinding and flotation circuits. Technical-grade molybdic oxide contains 5-10% of the impurities present in the concentrate and is added as a charge material or directly to most steels and cast iron, the molybic oxide having been briqueted with a coal tar based binder.

The selective recrystallization or sublimation of technical-grade molybdic oxide at 1000° C. produces pure molybdic oxide which is used as a base material for metallic molybdenum and for sodium and ammonium molybdates. The later two compounds are commercial products which are used as chemical reagents.

The reduction of technical-grade molybdic oxide and iron oxide in an electric furnace or by the silicothermic or aluminothermic process results in the production of ferromolybdenum containing 58-64% molybdenum. Ferromolybdenum is an alternate molybdenum additive to a charge material in producing ferrous alloys, cast iron and steel.

Molybdenum metal powder is produced by reducing ammonium molybdate or pure molybdic oxide in a current of hydrogen at 900° C. to 1000° C. The product, a grayish-black powdered metal, is pressed into 12 inch bars, a quarter to half an inch thick, and heated between contacts in hydrogen to a temperature slightly below the melting point (2620° C.). The resulting porous bar can be hot-worked to fine wire, sheet or rod.

Many uses of molybdenum require it in the form of large sheets or sections from which impurities, especially oxygen, have been virtually eliminated. To meet these needs, new techniques have been developed in which large ingots are produced in vacuum furnaces.

Most domestic consumers of molybdenum are located in the Eastern and Midwestern States.

Occurrences

The following noted occurrences of molybdenum mineralization in Arizona were obtained from various publications and files which are identified by abbreviations:

DMR - Arizona Department of Mineral Resources Mine Files.

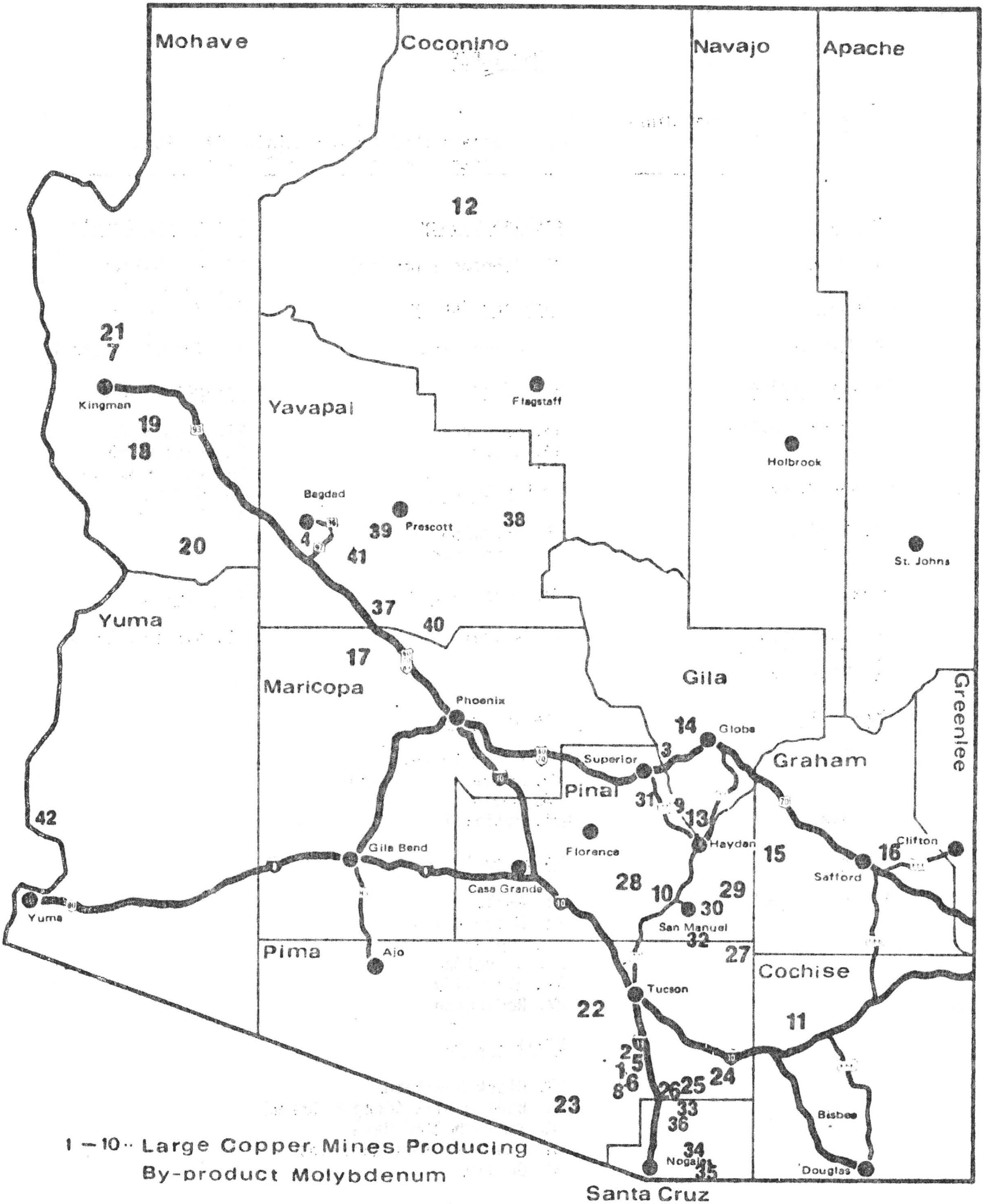
ABM - Arizona Bureau of Geology and Mineral Technology (formerly the Arizona Bureau of Mines)

USBM - United States Department of Interior Bureau of Mines.

USGS - United States Department of Interior, United States Geological Survey

The occurrences are listed alphabetically by county. Locations are noted by either latitude and longitude; section, township and range (G&SRM - Gila and Salt River Meridian) or with reference to geographical features and mining districts. When available, a brief description of mineralogy, geology, development work and production are given.

It will be noted that the most important source of these abstracts was the mine files of the Department of Mineral Resources. The files are open for public examination and the Department welcomes the serious prospector or student and provides a reading room for study. All sources and references listed at the end of this paper are also available as well as U.S.G.S. topographic maps, trade and technical journals and a wide selection of books and other publications relating to the minerals industry.



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11 – 42 – Mining Districts With Molybdenum Occurrences

MAP INDEX

Large Arizona Copper Mines Producing By-Product Molybdenum

ANAMAX

1. Twin Buttes

ASARCO

2. Mission

Cities Service

3. Pinto Valley

Cyprus Mines

4. Bagdad
5. Pima

Duval

6. Esperanza
7. Mineral Park
8. Sierrita

Kennecott

9. Ray

Magma

10. San Manuel

Established Arizona Mining Districts Containing Molybdenum Occurrences

Cochise County

11. Johnson (Cochise)

Coconino County

12. Grand View

Gila County

13. Banner
14. Globe

Graham County

15. Aravaipa
16. Lone Star

Maricopa County

17. Vulture

Mohave County

18. Cedar Valley
19. Maynard (Hualpai)
20. Owens
21. Wallapai

Pima County

22. Amole
23. Baboquivari
24. Empire
25. Helvetia
26. Old Baldy
27. Redington

Pinal County

28. Black Mountain
29. Bunker Hill (Copper Creek)
30. Mammoth (Old Hat)
31. Mineral Creek (Kelvin)
32. Oracle

Santa Cruz County

33. Old Baldy
34. Palmetto
35. Patagonia (Duquesne)
36. Tyndall (Aztec)

Yavapai County

37. Blue Tank
38. Camp Verde
39. Copper Basin
40. Humbug
41. Kirkland

Yuma County

42. Silver (Eureka)

COCHISE COUNTY

Republic Mine: Lat. N 32° 07', Long. W 110° 07'; Johnson Camp, Cochise County. Molybdenite with copper, tungsten and bismuth in pyrometasomatic deposit in limestone.

Source: King, R.U., ABM Bull. 180 p. 236

COCONINO COUNTY

Alyce Tolino Mine: Lat. N 35° 53', Long. W 111° 24'; Cameron, Coconino County. Umohoite (uranium and molybdenum oxide) and ilsemannite (molybdenum oxide) with uranium minerals in sandstone.

Source: King, R.U., ABM Bull. 180 p. 235

Orphan Lode Mine: Sec. 24, T 30 N, R 2 E; Grandview Mining District, Coconino County. Various uranium minerals comprise the dominant ore in a breccia pipe, however, molybdenite and wolfenite have been observed. Extensive underground workings and uranium production.

Source: DMR

Sun Valley Mine: At base of the Vermillion Cliffs Range about thirteen miles west of Navajo Bridge, Coconino County. Ilsemannite (molybdenum oxide) with uranium minerals in sandstone.

Source: DMR
King, R.U., ABM Bull. 180 p. 235

GILA COUNTY

Bronx Mines: T 1 N, R 14 E; Globe Mining District, Gila County. Fissure veins of molybdenite, cerussite, muscovite and white quartz in a pegmatite porphyry. Hundreds of feet of tunnels, winzes, drifts and crosscuts. Was worked in the 1890's as a copper, silver and gold property.

Source: DMR

Castle Dome Mine: T 1 N, R 14 E; Globe Mining District, five miles west of Miami, Gila County. Pyrite and chalcopyrite either disseminated in quartz veinlets or in quartz monzonite with accessory molybdenite, sphalerite and galena with some ferrimolybdite as a supergene mineral. This open pit copper mine shipped 177 million pounds of copper from June 1943 to the end of 1946. The Castle Dome ore contains 0.01-0.02% MoS_2 but no attempt was made to recover it because of the lack of fresh water.

Source: Peterson, N.P., et al., USGS Bull. 971

Christmas Mine: Sec. 19, 20, 29, 30, T 4 S, R 16 E and Sec. 25, T 4 S, R 15 E, Banner District, Gila County. Contact-metamorphic deposits that occur adjacent to the quartz diorite mass in certain favorable limestone beds which have been largely replaced by lime-silicate minerals and copper and iron sulphides. A little sphalerite and galena are commonly present and molybdenite is present in a few places. Extensive underground workings and copper production.

Source: Dept. of Interior, Bureau of Mines
War Minerals Report 339

Kulhman - McCool Mine (formerly Regan Mine): NE 1/4 of SE 1/4, Sec. 28, T 4 S, R 15 E; Banner Mining District, Gila County. Replacement in limestone along faults and fissures near a contact with andesite porphyry. Fractures contain a calcite and hematite gangue with considerable amounts of jasper. Wulfenite and vanadinite crystals throughout all openings and in places are concentrated in rich streaks and pockets. Anglesite and cerussite are also present appearing as a higher grade streak near the center of the vein. Copper carbonates were observed at a few points. Three shafts: one 240' deep, one of unknown depth and one 40' deep. About 500' of drifting and crosscutting. No shipments noted.

Source: DMR

Roscoe Group: Lat. N 33° 23', Long. W 110° 56'; Gila County. Molybdenite with copper in veins in granite.

Source: King, R.U., ABM Bull. 180, p. 235

79 Mine: Sec. 21, T 4 S, R 15 E, Banner Mining District (4 1/2 miles northwest of Hayden), Gila County. Limestone replacement ore body mineralized by galena, cerussite and oxide and sulphide copper minerals. Molybdenite coats the walls of veinlets of chalcopyrite and pyrite. Wulfenite has been observed in oxidized areas. Extensive mine workings to the 700 level and considerable lead, copper, gold and silver production until 1953.

Source: DMR
Ross, Clyde P., USGS Bull. 771, p. 66 - 67

Suckerite Deposit: Sec. 24, T 6 N, R 13 E, Workman Creek area, Gila County. Molybdenite associated with uraninite in hornfels near diabase. Prospect explored by a bulldozed opencut about 100 ft. long and several diamond drill holes.

Source: DMR
Granger, H.C., et al., USGS Bull. 1046-P, p. 469-470

GRAHAM COUNTY

Grand Reef Mine: Sec. 17, T 6 S, R 20 E; Aravaipa Mining District, Graham County. A great mass of iron stained rock composed of brecciated and silicified igneous rock and vein material cemented with quartz and other vein minerals. Galena is the most abundant sulphide. Argentite in tiny blebs is present in much of the galena. Veinlets and small irregular masses of chalcopyrite are prominent in some specimens. Sphalerite and wulfenite are associated with the galena but in subordinate amounts. Thirty thousand tons of production reported from extensive underground workings.

Source: DMR
Ross, C.P., USGS Bull. 763, p. 78-86

Lone Star Mining District Project: Sec. 24, T 6 S, R 26 E, about 2-1/2 miles due north of the Safford Municipal Airport; Lone Star Mining District, Graham County. Molybdenite with copper sulphides in disseminated deposits.

Source: DMR
King, R.U., ABM Bull. 180, p. 235

MARICOPA COUNTY

La Mina Mine (Flying Saucer Claims): Sec. 12, T 6 N, R 6 W; Vulture Mining District, Maricopa County. The country rock is medium to coarse granite which has been intruded by porphyry, pegmatite, rhyolite and andesite dikes. Molybdenum and tungsten mineralization occur in shear zones and occasionally in thin quartz veins. The principal tungsten mineral is powellite with some scheelite. The principal molybdenum minerals are ferrimolybdite and other oxidized molybdenum minerals. Development work only -- no production.

Source: DMR
Dale, V.B., USBM RI 5516, p. 32, 36-37

Rowley Mine: Sec. 25, T 4 S, R 8 W, ; Painted Rock Mountains. Late basalts overlie andesite and rhyolite flows which in turn cover a biotite granite. All were invaded by an andesite porphyry dike, the apparent source of mineralization. Float on the dump indicates that the minerals are cerargyrite, wulfenite, vanadinite, ecdemite and colloidal chrysocolla. Old assays show Cu, Au and some Pb. Three shafts with 1,462 total feet of development. Ore shipped to the value of $10,000.

Source: DMR

MOHAVE COUNTY

Gold Medal Mine: W 1/2 Sec. 24, T 20 N, R 15 W; Mohave County. Quartz fissures 4-6' wide in granite. Mineralization is pyrite, chalcopyrite and molybdenite. Crosscut tunnel and 80' of drifting on vein. No shipments noted.

Source: DMR

Gross Molybdenite Prospects: Wallapai District, Mohave County. Molybdenite specks and small stringers in quartz veinlets that cut the Ithaca Peak granite and a rhyolite dike. Two adits. No ore shipped.

Source: Dings, M.G., USGS Bull. 978E, p. 155

Leviathan Mines: Cedar Valley Mining District, Mohave County. Fifty miles southeast of Kingman. Molybdenite and chalcopyrite in 3' - 20' wide quartz veins. The country rock is diorite. Four hundred foot shaft, 200' adit and two working levels. Some ore reserve blocks and inferred ore. Unknown amount of production.

Source: DMR

Lone Eagle: Owens Mining District, Mohave County. Wulfenite, Au, Ag with barite and fluorspar in 5' vein. Assessment work only. Three claims. No production.

Source: DMR

Midwest Mine: About five miles south of Wickiup on the west side of the Big Sandy River, Mohave County. A large vein-dike (up to 30' wide), in granite gneiss country rock, outcrops for over a mile and a number of similar but smaller parallel veins occur close to the main vein. The ore minerals are principally galena and wulfenite. A dry concentrating plant was built in 1958.

Source: DMR

O.K. Claims: Lat. N 35° 49', Long. W 114° 13'; Mohave County. - Molybdenite, galena and wolframite in quartz veins.

Source: King, R.U., ABM Bull. 180, p. 235

Samoa Mine: 3 1/2 miles east of Chloride near the crest of the Cerbat Mountains, Wallapai Mining District, Mohave County. Prevailing rocks consist of gray granite intruded by a large dike of microcline granite and a 100 foot dike of rhyolite porphyry. Ore shoot was 30 inches in maximum width and more than 800 feet long and contained pyrite, galena and sphalerite in quartz gangue with a little molybdenite in carbonate veinlets. Most active producer of gold and silver in the Chloride area from 1880-1908. Approximately $200,000.

Source: Wilson, E.D., et al., ABM Bull. 137, p. 111-112
Dunning, Rock to Riches, p. 377

Telluride Chief: Sec. 13 & 24, T 20 N, R 15 W and Sec. 18 & 19, T 20 N, R 14 W; Maynard (Hualpai) District, Mohave County. Quartz veins in altered granite. Ore widths range from a few inches to several feet. Scheelite, feberite, pyrite, sphalerite, galena, chalcopyrite and molybdenite. A 450' shaft with levels at 200', 300' and 400'. Moderate lengths of drifts and crosscuts. There was a mill designed to recover molybdenite in operation during WW I and a gravity mill for tungsten in 1950-51. Shipped seven cars of good gold-silver ore.

Source: DMR

PIMA COUNTY

Cuprite Mine: Eight miles south of Vail in the extreme north end of the Santa Rita Mountains, Pima County. Mine is on the west edge of a north-south mineralized zone in altered silicated limestone on or near its contact with underlying quartzsite. Two veins or ledges intersect in or near mineralized garnetiferous limestone and carry mainly chalcopyrite although one additionally contains considerable iron and some molybdenite. Mine was developed by four shafts principally on the 60 and 100 ft. levels aggregating about 700 ft. of work and shipped 2000 tons of good grade copper ore.

Source: Schrader, F.C., USGS Bull. 582, p. 134-135

Gold Bullion Mine (Banes 1 & 2): Sec. 2, T 20 S, R 7 E; Baboquivari Mining District, Pima County. Aplitic granite cut by quartz veins varying in trend and width. Initially operated as a gold property, molybdenite was found on the lower level in the hanging wall of the main quartz vein. Approximately 700' of shafts, drifts and stopes. Unknown amount of gold ore shipped in 1913.

Source: DMR

Graveyard Mine: Sec. 21, T 18 S, R 15 E; Helvetia Mining District, Pima County. Ten tons of sorted silver, copper, lead and zinc ore ran 0.18% molybdenite.

Source: DMR

Jackson Mine (also called Old Hickory): Sec. 24, T 19 S, R 14 E; Old Baldy District, Pima County. Ore mineralization in a lens of dark diorite intruded into gray granite. The deposit is a compound fissure vein or stockwork. Minerals are chalcopyrite, bornite and a small amount of molybdenite. Inclined shaft said to be 210' deep. Four levels with approximately 1,000' of drifting. No shipments noted.

Source: Schrader, F.C., USGS Bull. 582, p. 171-172
DMR

Leader Mine: T 18 S, R 15 E; Helvetia Mining District, Pima County. Low grade copper producer. Molybdenite is plentiful. "The molybdenite occurs at a point about 150' in from the mouth of the main tunnel, in dull-brownish and greenish to yellowish mineralized garnetiferous silicified limestone and quartz." Tunnels and shafts. Three levels. Considerable Cu production.

Source: Schrader, F.C., USGS Bull. 582, p. 98, 106

Lucky Strike No. 1: T 11 S, R 19 E; Redington Mining District, 4 mi. N.W. from Redington, Pima County. The country rock is igneous consisting of a number of porphyritic rocks mainly intermediate in acidity, and limestone. The vein is in silicified, iron stained limestone. Minerals recognized included carbonates of copper, wulfenite and vanadinite (scarce). Mineralization is strongest on the footwall. One inclined shaft 12' deep, one 25' deep and one 10' deep. Few tons of ore left on dump. No shipments noted.

Source: DMR

Old Yuma Mine: Sec. 9, T 13 S, R 12 E; Amole Mining District, Pima County. The ore bodies occur in the contact between a porphyry and limestone, the limestone being so altered as to be barely recognizable. Mineralization occured at several periods as the minerals wulfenite, vanadinite and galena are often found separately, filling fracture planes or replacing limestone. One shaft (inclined) with one and one-half compartments 300' deep. Drifting on 100' level 250' E and 200' W. Drifting on 200' level 250' E and 200' W. Drifting on 300' level 30' E. Many shallow workings 20' - 30' on outcrop. Shipments made to ASARCO (El Paso). Large dumps remain.

Source: DMR

Pauline Mine: Nine miles southeast of Vail in the north end of Santa Rita Mountains, Pima County. Dark carboniferous garnet-bearing limestone freely intruded by aplite dikes and stocks. A seven foot mineralized limestone ledge carries chalcopyrite and pyrite with some chalcocite, galena, specularite, sphalerite and molybdenite. Developed by a 150 ft. shaft and a short crosscut. Produced some lead ore near the surface. Mineralization is mostly copper at depth.

Source: Schrader, F.C., USGS Bull. 582, p. 138

Sun Lode Claims: Lat. N 31° 44', Long. W 110° 52'; Pima County. Molybdenite in quartz along fault and in quartz veins in diorite.

Source: King, R.U., ABM Bull. 180, p. 236

Total Wreck Mine: Sec. 3, T 18 S, R 17 E; Empire Mining District, Pima County. The country rock of the mine is a dark-bluish medium to heavy bedded carboniferous limestone which is interstratified with heavy to thin beds of light-gray quartzsite. Ore minerals occur in steep dipping fissures cutting the limestone and as blanket veins along the limestone bedding planes. Ore minerals are all oxidized -- cerargyrite, cerussite, wulfenite, malachite, azurite and chrysocolla. The mine is well developed to a depth of about 500' by shafts, tunnels, drifts, inclines, winzes and stopes aggregating about 5,000' of work. The mine is dry. Production seems to have been more than 10,000 tons.

Source: Schrader, F.C., USGS Bull. 582, p. 142-147

PINAL COUNTY

Burkhardt Claims: Sec. 14, 15, 22, 23, T 9 S, R 12 E; Black Mountain District, Pinal County. Copper sulphides and oxides with minor molybdenite in quartz monzonite. One large open cut and 12-15 smaller ones.

Source: DMR

Childs-Aldwinkle Mine: Sec. 11, T 8 S, R 18 E, Bunker Hill (Copper Creek) Mining District, Pinal County. A breccia pipe or diatreme in granodiorite. Two pipes outcrop with dimensions of 270 ft. x 150 ft. and 220 ft. x 100 ft. and join at a depth of 450 ft. At 510 ft. the pipe has a dimension of 210 ft. x 170 ft. and diminishes to 160 ft. x 140 ft. on the bottom level of the mine at a depth of 820 ft. The diatreme is composed of angular blocks of altered granodiorite cemented by gangue and ore minerals. Ore minerals are bornite, chalcocite and molybdenite. Extensive mine workings including shrinkage stopes. Seventy million pounds of molybdenite were produced between 1933-38. Extremely high rhenium content.

Source: DMR
Kuhn, T.H., Economic Geology, V. 36, p. 520
Anthony, J.W., et al., Mineralogy of Arizona, p. 141

Copper Creek Project: Sec. 11, T 8 S, R 18 E; Bunker Hill (Copper Creek) Mining District, Pinal County. Molybdenite in mineralized breccia pipe. Drilled only. No development noted.

Source: King, R.U., ABM Bull. 180, p. 236
DMR

Mammoth-St. Anthony Mine: T 8 S, R 16 E, Mammoth Mining District, Pinal County. Gold-bearing base metal sulphide deposits occuring as fissure-filling and wall rock replacements in shear zones. Wulfenite and vanadinite occur in boxworks in quartz. Molybdenum and vanadium minerals were observed only in the upper levels of the mine, i.e. in the oxide zone. Extensive workings on a number of levels. In 1916 and 1917 the district produced most of the molybdenum mined in the United States. Property is now part of Newmont Mining Corporation's San Manuel operations.

Source: DMR
Peterson, N.P., ABM Bull. 144, p. 54-58

Maybee Group: Kelvin Mining District, six miles SE of Ray, Pinal County. Country rock is monzonite. Vein material is limonitic quartz and was mined for silver with some lead. Gold and copper in trace amounts only. Both molybdenite and wulfenite noted in small quantities. More than 1000' of tunneling. No shipments noted.

Source: DMR

Ninetyone Claim, et al: Kelvin Mining District, Pinal County, along the backbone of the Dripping Springs Mountains. The Gila River and Arizona Eastern Railroad lie about five miles to the south and Dripping Springs Wash about three miles north. Five feet of brecciated material which contain wulfenite, cerussite and some galena. Large ore dumps and a tailings dump carry molybdenum. One 350' shaft and 800' drifts and crosscuts on two levels. No shipments noted.

Source: DMR

Rainbow Claims (Clark Claims): Sec. 12, T 1 S, R 13 E, Pinal Ranch Area, Pinal County. Minor molybdenite, chalcopyrite and bornite with more major amounts of wolframite and scheelite in quartz veins. One hundred feet of shaft. Some tungsten ore (float) was shipped during WW I.

Source: DMR

Rare Metals Deposit: Sec. 8, 9, 11, T 4 S, R 13 E; Mineral Creek Mining District, Pinal County. Granite cut by diabase and monzonite dikes and sills. Transverse E-W parallel shears cross the formation. Shears are mineralized by molybdenite with some Cu, Ag and Au. Eight or nine shafts (10' - 84') with some drifting, tunneling and stoping. No shipments noted.

Source: DMR

Van Ricken Mine: Old Hat Mining District, Pinal County. Wulfenite, vanadinite in veins 5' - 9' wide, carrying Au, Pb, Ag. Inclined shaft 34' deep and a crosscut 290' long. Seven claims. No production. 700 tons in dumps.

Source: DMR

SANTA CRUZ COUNTY

Belmont Mine: Patagonia (Duquesne) Mining District, Santa Cruz County. Galena chalcopyrite, pyrite and a little molybdenum associated with drusy quartz in granite 1/4 mile west of Belmont Mine. Several water filled shafts. No production noted.

Source: Schrader, F.C., et al., USGS Bull. 430, p. 161

Benton Mine: T 24 S, R 16 E; 3/4 mile northwest of international boundary post no. 113, Patagonia Mining District, Santa Cruz County. The country rock is granite, intruded by granite porphyry and aplitic granite. The granite porphyry contains the values of the mine which consist of low grade copper and gold ore. The ore occurs chiefly in a dike of this rock 60' wide carrying pyrite, chalcopyrite and a little flaky molybdenite.

Source: Schrader, F.C., USGS Bull. 582, p. 346-47
Schrader, F.C., et al., USGS Bull. 430, p. 161
DMR

Bonanza Mine (Nash Mines): T 24 S, R 16 E (unsurveyed), about 1 1/2 miles south of Washington Camp, Duquesne Mining District, Santa Cruz County. Ore bodies are steeply dipping, lenticular ore shoots along a generally north-south vein zone in limestone near its contact with a granite porphyry. Chalcopyrite, sphalerite, silver bearing galena, minor molybdenite and gold. Fairly extensive workings off a 635 ft. shaft on six levels. Copper ores were shipped to El Paso for smelting and the lead, zinc, silver ores to the Trench mill.

Source: DMR

Edwards Mine (St. Mary's Group): T 20 S, R 14 E; Tyndall Mining District, Santa Cruz County. Molybdenite plus lead and gold in fractured monzonite. Fifty foot shaft. No production.

Source: DMR

Glove Mine: Sec. 24, 25, 29, 30, 31, 32, T 20 S, R 13-14 E; Tyndall Mining District, Cottonwood Canyon, Santa Rita Mountains, Santa Cruz County. Wulfenite in oxidized lead-zinc-silver veins in quartz monzonite. Main shaft 360' deep, two old shafts about 75' deep, an old tunnel 500' long and new tunnel 600' long, one winze below the 240' level, 66' deep plus extensive drifting, crosscutting and stoping. Extensive intermittent production reported from 1911-76.

Source: King, R.U., ABM Bull. 180, p. 236
DMR

Line Boy Mine: T 24 S, R 16 E; 2 1/2 miles south of Duquesne and just north of international boundary post no. 113, Patagonia Mining District, Santa Cruz County. Copper ore with some molybdenite. Molybdenite also occurs dis-associated with the other sulphides in a silicious, sericitic phase of the granite country rock.

Source: Schrader, F.C., USGS Bull. 582, p. 347-348
Schrader, F.C., et al, USGS Bull. 430, p. 161-163
DMR

Madera Canyon Molybdenite Prospects: Old Baldy Mining District, Santa Cruz County. Pyrite and molybdenite in granite between stockworks of quartz veinlets 3' - 7' wide. The quartz is smoky, limonite stained and carries some molybdenite. Some prospect shafts and tunnels. No production.

Source: Schrader, F.C., USGS Bull. 582, p. 173

Red Hill (Four Metals) Mine: Lat. N 31° 24', Long. W 110° 44', Santa Cruz County. Molybdenite with copper sulphides disseminated in breccia pipe.

Source: King, R.U., ABM Bull. 180, p. 236

Red Racer Mine: Patagonia Mining District, 15 miles east of Nogales, Santa Cruz County. Talc vein and ferrimolybdite (?). One hundred fifty feet of drifts and tunnels. Several cars of production.

Source: DMR

Santo Nino Mine: Sec. 9, T 24 S, R 16 E; Duquesne Mining District, Santa Cruz County. The ore occurs as vein-like replacements of quartz monzonite on a contact with altered granite. Chalcopyrite and bornite in a gangue of unaltered monzonite. High grade pockets of molybdenite occur with the copper and is, additionally, disseminated a considerable distance into the monzonite. Extensive mine workings, prospect drilling and production. Shipments were to Douglas as silicious ore.

Source: DMR

Ventura Mine: Sec. 1, T 23 S, R 15 E; Palmetto Mining District, Santa Cruz County. Brecciated shear zone in monzonite. Copper, lead, zinc, gold, silver and molybdenum (molybdenite). One shaft plus or minus 125', six tunnels ranging from 150'-600' in length, one raise and one stope. Extensive diamond drilling. Production not noted.

Source: DMR

YAVAPAI COUNTY

Blue Bird and Copper Chief Groups: Sec. 2, 3, 9, 10, 11, T 8 N, R 1 W; Humbug Mining District, Yavapai County. Pegmatitic quartz monzonite intruding andesite along a major NW-SE regional fault where it intersects a NE-SW shear zone. A brecciated zone in the andesite carries silver, lead, zinc, copper and minor molybdenum. One 40' shaft and a 140' x 8" water well. An unspecified quantity of copper ore was shipped to the Inspiration Consolidated Copper Company.

Source: DMR

Commercial Mine: Sec. 20-21, T 13 N, R 3 W; Copper Basin Mining District, Yavapai County. High silica copper oxide ore plus molybdenite (not recovered) in a breccia pipe. Shafts, adits, drifts and crosscuts. One hundred fifty thousand tons high-silica copper ore produced.

Source: Kirkemo, H., et al, USGS Bull. 1182-E, p. E17

Copper Hill Mine: Sec. 20, T 13 N, R 3 W; Copper Basin Mining District, Yavapai County. The workings of the Copper Hill Mine are in the southern part of a 400' diameter pipe of brecciated and altered hornblende-quartz diorite. Chalcopyrite is found disseminated in quartz and molybdenite occurs in finely divided veinlets cutting quartz or at the margin of the veins. The main shaft was over 300' deep with extensive workings on six levels. The higher grade molybdenite occurs in the upper workings. Some ferrimolybdite in evidence. From 1916-18, 1800 tons of molybdenite ore was mined,300 tons of which reportedly averaged 5% MoS_2.

Source: Kirkemo, H., et al, USGS Bull. 1182-E, p. E17-25

Fiesta Group: Kirkland Mining District, 3-1/2 miles SW from Kirkland Jct., Yavapai County. Quartz porphyry cut by quartz veins. Veins strike NE-SW and dip SE at 60°. Widths vary from 1'-30' at outcrop. Cerussite molybdenite, silver and gold. One 75' and one 60' tunnel plus two open cuts. No production noted.

Source: DMR

Genung Spring Molybdenum Mine: 14 miles northeast of Wickenburg, Blue Tank Mining District, Yavapai County. Wulfenite with small quantities of galena in altered diabase dike. The dike ranges from 3' - 30' in width on the outcrop. The country rock is gneiss. Development work consists of a 45' + shaft with modest drifting on two levels. Approximately 250 tons of ore on the stockpile. Some shipments indicated during WW I.

Source: DMR

Loma Prieta Mine: SW 1/4, Sec. 21, T 13 N, R 3 W; Copper Basin District, Yavapai County. Quartz cemented altered quartz diorite. Possibly a breccia pipe. Pyrite, chalcopyrite and molybdenite in the cementing quartz. Four hundred fourteen foot shaft and 1170' + drifts on four levels. Most extensive, by far, on the 400' level. The only noted production was two to three cars of copper sulphide shipping ore between 1916 and 1918.

Source: Kirkemo, H., et al, USGS Bull. 1182-E, p. E26-30

Ruby Mine: Sec. 3, T 7N, R 3 W; Picacho Mining District, Yavapai County. Wulfenite (?) in decomposed sandy lime. Ten foot prospect shaft, partly in ore. One claim. No production.

Source: DMR

Squaw Peak Copper Mine: Sec. 29, 30, 31, T 13 N, R 5 E; Camp Verde Mining District, Yavapai County. A quartz vein stockwork in Precambrian quartz diorite carries molybdenite, chalcopyrite, and pyrite. In 1943 there was more than 4,000' of underground workings on three levels. Molybdenite concentrates were produced and shipped in 1945 and 1946.

Source: Kirkemo, H., et al, USGS Bull. 1182-E, p. E30
DMR

The Pegmatites of the White Picacho District: T 6, 7, 8 N, R 2, 3, W, Yavapai and Maricopa Counties. The center of the 150 square mile district is seven miles east of Wickenburg and eight miles north of Morristown. The pegmatites of the White Picacho District occur in igneous and metamorphic rocks of Precambrian age and are covered in the southern part of the district by Tertiary and Quaternary sediments and volcanics. In the north they are relatively more abundant over broad areas of exposure. Scheelite and powellite are scattered sparely through some quartz-rich inner zones of the pegmatites as thin veinlets and stringers. Pyrite, molybdenite and other base metal sulphides are scattered through the coarse-grained inner units of most pegmatites and, locally, are present in surprising abundance.

Source: Jahns, R.H., ABM Bull. 162

Twin Ledge Prospect: Lat. N 34° 28', Long, W 112° 28'; Yavapai County. Molybdenite with pyrite in quartz vein cutting granite.

Source: King, R.U., ABM Bull. 180, p. 235

YUMA COUNTY

Hardscrabble Group: Silver Mining District, Yuma County. Approximately fifty-eight miles by road north of Yuma. Vein is ten ft. wide and is developed by an inclined shaft to a depth of 85'. At the bottom of the shaft a drift has been run on the vein 15' north. Gangue of the vein is calcite encrusted along cleavage planes by crystals of vanadinite and wulfenite. No shipments noted.

Source: DMR

Red Cloud Mine: Sec. 2, 11, T 4 S, R 23 W; Silver Mining District, Yuma County. The Red Cloud vein is from 35 to 40 ft. wide and occurs between granite on the foot wall and andesite on the hanging wall. Strike of vein is NW-SE and dips 45^{O}NE. All ore produced has come from the oxide zone and reportedly runs 5% Pb, 9 oz. Ag and a fair showing of wulfenite and vanadinite plus a little Zn. Extensive workings including shafts to the 519 ft level, which is the water table, plus drifting, crosscutting and stoping. There was a mill on the property. Large shipments of concentrates reported.

Source: DMR

Other Occurrences

In addition to the preceding occurrences, many of the major copper mines produce significant tonnages of molybdenum as a copper ore byproduct, establishing Arizona second only to Colorado in United States production. In the vast majority of such deposits the mineralization is molybdenite associated with disseminated copper sulphides in porphyry. The molybdenum content of Arizona ores is usually less than 0.04% -- less than one pound per ton of ore.

The Duval Corporation (Pennzoil Co.) recovers molybdenum concentrates by flotation from its Mineral Park mine north of Kingman and the Sierrita and Esperanza mines south of Tucson. In 1978 these properties were the source of 66% of Arizona's production and 16% of the United States'. The company's molybdenum concentrates are, for the most part, marketed as molybdenum sulphide ore, the roasted product, molybdenum trioxide. The remainder is converted into ferromolybdenum in a plant adjacent to the Esperanza property for use in the steel and foundry industries. This plant is designed to produce 3.5 million pounds of ferromolybdenum annually.

Other Arizona producers include: ANAMAX -- Twin Buttes mine; ASARCO -- Silver Bell and Mission mines; Cities Service -- Pinto Valley mine; Cyprus mines -- Bagdad mine; Inspiration Consolidated -- Inspiration mine; Magma -- San Manuel mine and Kennecott -- Ray mines. Except for San Manuel, which is an underground property, all producing mines are open pits.

Production

The quantity and value of molybdenum produced in Arizona has been increasing more or less steadily for the past several years and in 1978 reached 31.7 million pounds (molybdenum content of concentrate) with a value of $150 million. U.S. production in 1978 was about 132 million pounds as compared with approximately 215 million pounds total world production.

The world's largest single producer, AMAX, produced 32 million pounds of molybdenum from its Henderson Mine and 52 million pounds from its Climax Molybdenum Division in 1978. Both properties are in the Rocky Mountains west of Denver, Colorado.

Molybdenum Production of Large Arizona Copper Mines

Company Mine	1977 Pounds Recoverable Molybdenum	1978 Pounds Recoverable Molybdenum	
ANAMAX			
Twin Buttes	3,724,000	3,130,000	
ASARCO			
Silver Bell	----	133,776	1.
Mission	277,106	375,239	
		509,015	
CITIES SERVICE MIAMI OPERATIONS			
Pinto Valley	337,406	450,000	
CYPRUS MINES CORP.			
Bagdad	592,227	2,577,425	
DUVAL			
Esperanza	2,311,141	0	2.
Mineral Park	3,867,064	4,512,456	
Sierrita	16,243,214	16,338,357	
	22,421,419	20,850,813	
INSPIRATION			
Inspiration	----	61,507	
KENNECOTT			
Ray	587,559	632,758	
MAGMA			
San Manuel	3,254,477	3,452,101	
TOTAL	31,194,194	31,663,619	

1. Molybdenum production resumed in September 1978.

2. Closed in September 1977. Reopened in April 1979.

Production of Molybdenum in non-Communist countries

(million lb contained Mo)

	1975	1976	1977	1978 (est.)
US	106	113	122	127
Canada	32	31	33	32
Chile	23	24	24	25
Others	2	3	3	3
Totals	163	171	182	187

Consumption of molybdenum produced in non-Communist countries

(million lb contained Mo)

	1975	1976	1977	1978 (est.)
US	55	57	60	65
Western Europe	66	70	70	72
Eastern Bloc	15	15	17	20
Japan	21	25	24	25
Others	11	10	11	12
Totals	168	177	182	194

Sources (both tables): Goth, John W., March, 1979, Molybdenum: Engineering and Mining Journal, McGraw-Hill, p. 129.

UNITED STATES CONSUMPTION OF TECHNICAL GRADE MOLYBDIC ACID - MoO_3

(thousand pounds)

1973	82,477
1974	91,706
1975	90,046
1976	84,966
1977	91,041
1978	96,375

Source: Mineral Industry Surveys, United States Bureau of Mines

CONSUMPTION OF MOLYBDENUM BY MAJOR INDUSTRIAL CATEGORIES IN 1978 (Est.)

Alloy Steels	47%
Stainless Steels	20%
Tool Steels	9%
Cast Iron & Steel Mill Rolls	7%
Super & Spec. Alloys	3%
Molybdenum Metal	4%
Chemicals	9%
Other	1%
	100%

Source: Goth, John W., March, 1979, Molybdenum: Engineering and Mining Journal, McGraw-Hill, p. 122.

Marketing

The following buyers of molybdenum concentrates were compiled from data furnished by U.S. Bureau of Mines, Washington, D.C.:

Climax Molybdenum Co., Div. AMAX, Inc., 1 Greenwich Plaza, Greenwich, Conn. 06830

Cometals, Inc., One Penn Plaza, New York, N.Y. 10001

International Minerals & Metals Corp., 919 Third Avenue., New York, N.Y. 10022

M. & R. Refractory Metals, Inc., Fleming Pike, Winslow, N.J. 08095

Mercer Alloys Corp., P.O. Box 511, Greenville, Pa. 16125

Molycorp, Inc., 6 Corporation Park Dr., White Plains, N.Y. 10604

The Pesses Co., 29605 Hall St., Solon, Ohio 44139

Phillipp Brothers, Div. Englehard Minerals & Chemicals Corp., 1221 Ave. of the Americas, New York, N.Y. 10020

S.W. Shattuck Chemical Co., Inc., 1805 Bannock St., Denver, Colorado 80223

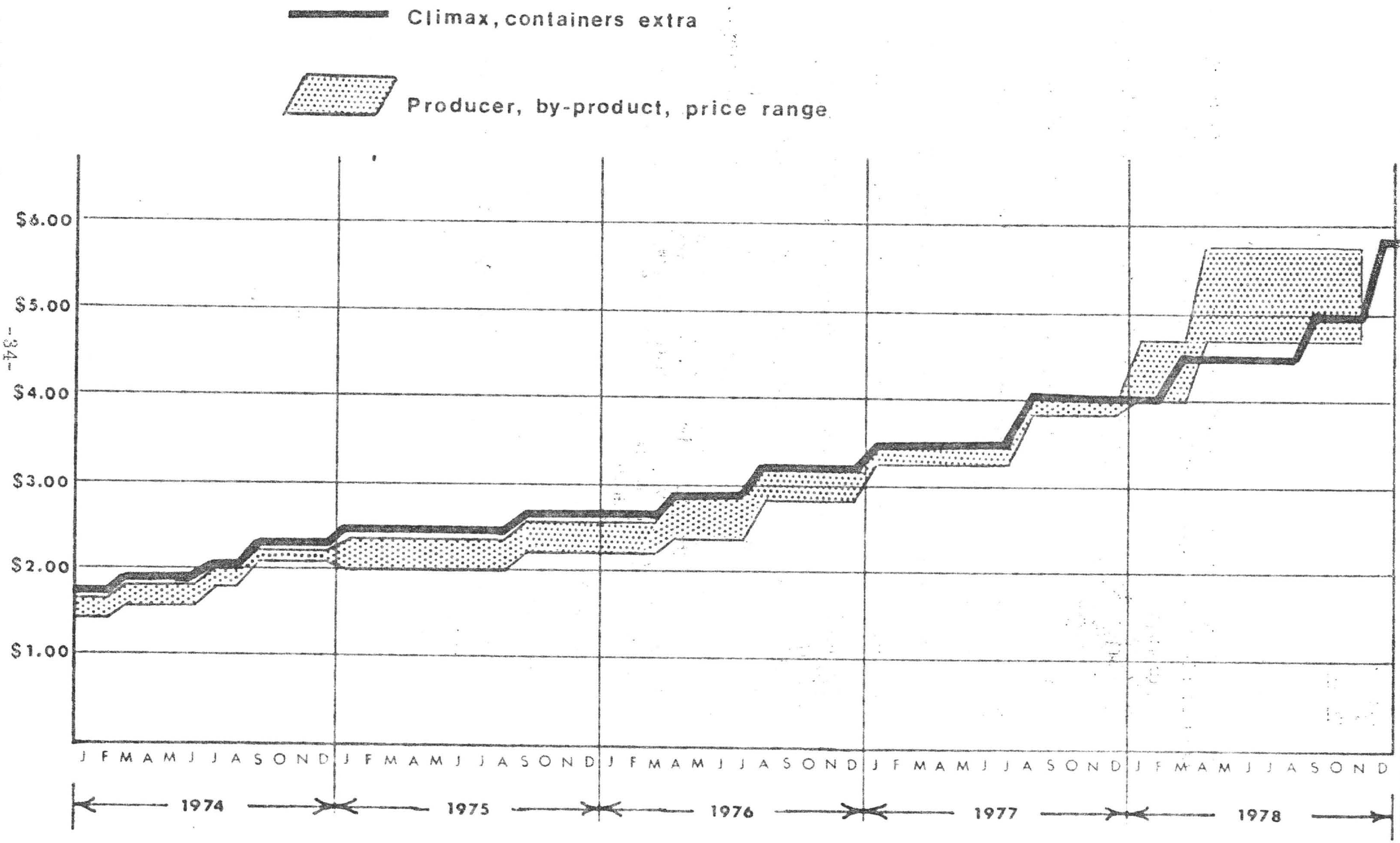
Shieldalloy Corp., Newfield, N.J. 08344

Texas Foundry, Box 1608, Lufkin, Texas 75901

Union Carbide Corp., Mining & Metals Div., 270 Park Avenue, New York, N.Y. 10017

Price: Molybdenum Concentrates

(pound contained Mo, 95% MoS_2)



SOURCE E/MJ

Outlook

"Demand for molybdenum has increased steadily during the past decade, and the outlook is for continued growth. This strong market for molybdenum during 1978 came at a time of unstable copper markets and served to lessen the adverse impact for those Arizona producers fortunate to have significant molybdenum in their copper ores."

"In 1978, molybdenum prices were soaring as growing world demand competed for limited supply. Arizona was responding with an all-out effort to recover as much byproduct molybdenum as possible from the several copper operations where it was feasible."

---Joseph C. Arundale, Liaison Officer,
U.S. Bureau of Mines

The United States should, into the middle of the 1980's or longer, continue to be the world's leading producer of molybdenum. Reserves are believed adequate to satisfy domestic requirements and allow for substantial exports. Other major world producers include Canada, Chile and the U.S.S.R. Beyond the middle 80's a world shortage could develop unless new properties are brought on stream. Existing reserves in a relatively few large deposits are being mined at a rate which will probably not be substantially increased in the future. Highly industrialized nations, are, of course, the largest consumers of molybdenum, however, developing countries are expected to account for an ever increasing share of demand.

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ARIZONA DEPARTMENT OF MINERAL RESOURCES

The Department was created to aid in the promotion, development, and conservation of the mineral resources of the State. Particular emphasis is placed on providing prospectors and small miners with semi-technical assistance and economic information.

The general goal of the Department is developed by working with the following objectives:

- Provide technical assistance to prospectors and operators of small mines.

- Disseminate comprehensive mining and mineral information to the citizens and government officials of Arizona counties.

- Study conditions regarding small mine activity and seek solutions to problems.

- Serve as the State's public bureau of mining and mineral information.

- Maintain and expand the Department's mine file library.

- Provide educational services in the field of mineral resources and mining.

- Analyze proposed Federal and State administrative actions.

- Develop interagency cooperation between the Department and other local State and Federal offices.

- Gather all information available on mineral occurrences, prospects, partially developed properties and known mines in the State in order to promote further exploration.

- Provide publications in the form of mineral reports, annual directories, technical reports, annual mineral industry surveys, information circulars, and media articles.