

MOLYBDENUM
STATISTICS FOR 1969 - 1970
ARIZONA, UNITED STATES, AND THE WORLD

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MOLYBDENUM, 1969-1970

ARIZONA

Arizona's molybdenum production, second only to copper in importance to Arizona's mineral economy, since 1939 has been recovered mainly, and in recent years solely, as a by-product of her copper mines. The production in 1969 amounted to 12,699,000 pounds, valued at \$20,947,000, figures which will be exceeded by those for 1970 production. Two new copper-molybdenum producers, the Sierrita mine of Duval Sierrita Corporation and the Twin Buttes mine of the Anaconda Company are important additions, and in the first eight months of 1970 Arizona copper production ran at an annual rate 11 percent higher than the 1969 figure of 801,363 tons. The Nation's molybdenum production in the same eight months ran at a rate 15 percent higher than in 1969, and Arizona's copper mines no doubt contributed to the increase.

The Sierrita mine started production after mid-1970 and will produce approximately 13 million pounds of molybdenum annually, thus about doubling the State's output. It becomes the second largest producer in the Nation and the largest of the thirteen Arizona producers. The thirteen are all of the larger copper mines excepting those at Ajo, Bisbee, Superior, and Christmas, and those which do not concentrate their ores.

Miami Copper Company first started recovering molybdenum by selective flotation from copper concentrates in August 1938, and in 1939 produced 432,000 pounds of molybdenum sulphide. In 1938, 95.5 percent of the State's total of 1,139,593 pounds came from complex ores from two mines near Mammoth. The State's 1938 total was 3.4 percent of the domestic production. Table I, Appendix page II shows Arizona's 1969 production to be 8 times that of 1955, while the United States production increase for the period is 61.5 percent - an average of 4.4 percent per year.

UNITED STATES

Production

The United States in 1969 produced 99,807,000 pounds of molybdenum, 6.7 percent above 1968, 52.1 percent above 1964, and a new record which 1970 apparently will exceed, with the aid of Molybdenum Corporation of America's expansion completed in 1969 at Questa, New Mexico, the two new large copper-molybdenum producers in Arizona, and continued high level production at the Colorado mines of American Metal Climax, Inc.(AMAX) north of Leadville.

AMAX is by far the largest producer of molybdenum in the world, with a capacity of 60 million pounds per year, a figure reported for its 1968 production, and a rate perhaps exceeded in 1969 and 1970.

Colorado with production of nearly five times that of second place Arizona, is slated to hold the lead in the Nation in the foreseeable future - a lead it took from Arizona in 1918 when the Nation's total was 861,637 pounds, a record at that date.

Consumption

Page 1 of the Appendix describes molybdenum and sets forth its principal uses, chief of which is in alloy steels, a use which has been largely responsible for molybdenum's growth from the first million pounds per year produced in the United States in 1925 to 1969's 100 million. The domestic use in stainless steels increased 60 percent in the decade ending in 1968. Consumption figures are given in Table II, page 111 of the Appendix. The United States consumption of molybdenum in concentrate for the first 8 months of 1970 was 50.9 million pounds, an annual rate of 76.4 million compared with 73.3 in 1968 and 75.6 million in 1968. Tables III and IV of the Appendix give United States consumption of molybdenum in primary molybdenum products and show the totals for 1967-1969 to be practically the same. Table IV-B shows consumption of molybdenum products by end uses. It also shows such consumption for the first eight months of 1970 to be 8 percent below for the first six months of 1969.

Exports - Imports

Table V, Page VI of the Appendix, shows 1969 exports totalling 57,584,000 pounds of molybdenum in ores and concentrates. The figure is nearly double that of 1968, with the major increases going to West Germany, Japan and The Netherlands. Exports in the first 8 months of 1970 indicate an annual rate totalling about the same as in 1969, but with fluctuations among individual countries.

Imports for consumption, shown in Table II, were negligible in 1968 and 1969.

Free World Production and Consumption

Tables II and VI show Free World Production and Consumption of molybdenum in concentrates. Estimates for the year 1969 give increases over 1968 of 15 percent in production and 7 percent in consumption. The 7 percent is about in line with the average consumption for the past 20 years.

Canada has increased its molybdenum output notably in recent years and has replaced Chile as second largest producer, Peru is the other Free World producer of some consequence. About 11 percent of the World production is from Communist countries. Its new Brenda copper mine put into operation by Noranda Mines Ltd. in 1969 yields important by-product molybdenum.

A 5 percent price increase (from \$1.62 to \$1.72 per lb. content of Mo in concentrate 95% MoS₂) occurred in May 1969 and has held since then. Towards the end of 1969 the General Services Administration contracted sales to domestic producers of 13.5 million pounds.

David Mayers, in Mining Annual Review, June 1970, wrote, "AMAX estimates for the 1970s indicate a 1979 demand of about 264 million pounds of molybdenum and it is based on use of the more conservative 7 percent annual growth factor. The picture for the early to middle 1970s is one of more than adequate supplies of molybdenum. A potential shortage which might be expected to develop around 1975 can be overcome with initial production from the AMAX Henderson project in Colorado which is planned for a 50 million lb/year rate. Barring unusual events, the 1970s should close with supply and demand in balance." The Bureau of Mines has estimated that Free World production in 1975 may be "245 million pounds with the United States producing 68.2 percent and Canada, Chile, and Peru 30.3 percent."

M O L Y B D E N U M

PHYSICAL PROPERTIES 1/

Molybdenum is a silvery-white, very hard, metallic element in the Chromium group or group VI of the periodic system. Its physical properties are similar to those of iron and its chemical properties are similar to those of a nonmetal. It is used for electrodes of mercury-vapor lamps, as wire for winding electric-resistance furnaces, and in steel alloys. Symbol, Mo; isometric; valences, 2, 3, 4,?, 5,?, and 6: atomic number, 42; atomic weight 95.94; specific gravity, 10.22 (at 20°C); melting point, $2,620^{\circ} \pm 10^{\circ}\text{C}$; boiling point, $5,560^{\circ}\text{C}$ or sublimes at $4,507^{\circ}\text{C}$ (at 760mm); insoluble in water, in hydrofluoric acid, and in ammonia: soluble in hot concentrated nitric acid, in hot concentrated sulfuric acid, and in aqua regia; and slightly soluble in hydrochloric acid. As an alloying agent, it increases the hardenability and toughness of quenched and tempered steels and it raises the strength of steel at high temperatures. Used in nickel-based alloys that are heat-resistant and corrosion-resistant; in electrodes in electrically heated glass furnaces and forehearths; in nuclear-energy applications; for missile and aircraft parts; and as a wire for filaments for metal-evaporation processes and for filaments, grids, and screens in electronic tubes.

(C.T.D.; Handbook of Chemistry and Physics, 45th ed., 1964, pp.B2, B-121, B-195).

1/ U. S. Bureau of Mines; A Dictionary of Mining, Mineral, and Related Terms, p 723, (1968).

TABLE I - MOLYBDENUM PRODUCTION
Molybdenum (content of concentrate)

Year	U. S. Lbs.	Arizona Lbs.	Arizona's % of U. S.	Value of Arizona's Production
	(000 Omitted)			(000 Omitted)
1955	61,781	1,497	2.4	\$ 1,511
56	57,462	2,392	4.2	2,670
57	60,753	2,385	3.9	3,071
58	41,069	2,320	5.6	2,827
59	50,956	3,181	6.2	4,019
1960	68,237	4,359	6.4	5,211
61	66,563	4,878	7.3	6,232
62	51,244	4,412	8.6	5,864
63	65,011	5,553	8.5	7,584
64	65,605	6,296	9.6	9,532
1965	77,372	9,399	12.1	15,880
66	90,532	10,161	11.2	17,812
67	90,097	9,261	10.3	15,385
68	93,477	12,127	13.0	19,207
69	99,807	12,699	12.7	20,947
1970 (1st 8 Mos.)	71,719			

Source: U. S. Bureau of Mines.

TABLE II - SALIENT MOLYBDENUM STATISTICS

Molybdenum content, thousands of pounds, and thousands of dollars							
	1964	1965	1966	1967	1968	1969	1st 8 Mos. 1970
UNITED STATES:							
Moly. Concentrate:							
Production	65,605	77,372	90,532	90,097	93,477	99,807	71,719
Shipments <u>2/</u>	65,097	77,310	91,670	81,596	93,245	103,009	71,175
Value	\$97,121	\$120,801	\$144,327	\$133,604	\$151,000		
Consumption <u>3/</u>	56,409	68,112	75,476	58,967	75,647	73,275	50,903
Imports for Consumption	- - -	142	5	1,179	1		
Stocks, Dec.31:							
Mine and Plant <u>4/</u>	4,303	4,208	3,433	9,919	12,208	8,398	9,832
Primary Moly. Products:							
Production <u>5/</u>	55,946	66,616	74,392	54,922	69,675	68,526	43,318
Shipments <u>2/</u>	60,403	71,718	78,811	57,231	63,761	77,726	52,593
Consumption	43,119	48,621	52,324	49,506	49,271	49,598r	30,541p
Stocks, Dec.31:Producers	4,398	3,839	5,945	7,156	18,170	17,844	15,102
FREE WORLD: Production <u>6/</u>	77,908	98,531	124,988	126,416	125,673	144,000 ^{1/}	
Consumption <u>6,1/</u>	90,000	100,000	111,000	112,000	123,000	132,000	

p Preliminary r Revised

^{1/} Mining, annual Review - June, 1970, estimates for 1969.^{2/} Including exports. ^{3/} Including quantities exported after conversion to molybdic oxide.^{4/} Producing molybdenum products. ^{5/} Comprise total production of all products less quantities of oxide, etc. used to produce other products.^{6/} Molybdenum in concentrate, mine production. See Table VI.

Source: U. S. Bureau of Mines.

TABLE III - MAJOR U. S. PRODUCERS OF MOLYBDENUM CONCENTRATES ^{1/}

	Molybdenum content, thousands of pounds			
	1966	1967	1968	1969
American Metal Climax, Inc.	55,779	55,622	57,834	59,840
ASARCO	950	830	848	1,172
Duval Corp.	3,902	4,286	5,728	5,215
Kennecott Copper Corp.	15,557	9,853	11,933	15,904
Magma Copper Company	2,554	2,402	2,758	3,301
Molybdenum Corp. of America	7,743	9,362	9,101	10,908
Pima Mining Co.	- - -	841	1,446	1,722
Cities Service Co.				
Miami Copper Operations	70	106	101	195
Total of above Co.'s	86,555	83,302	89,749	98,257
TOTAL U.S. PRODUCTION ^{2/}	90,532	90,097	93,477	99,807

^{1/} Yearbook of the American Bureau of Metal Statistics, 1969, p123.

^{2/} Source: U.S. Bureau of Mines.

TABLE IV UNITED STATES CONSUMPTION OF MOLYBDENUM IN MOLYBDENUM PRODUCTS
BY END USES, IN 1969 A/ AND FIRST 8 MONTHS OF 1970 B/

End Uses	Contained Molybdenum, thousands of pounds				Totals ^{3/}
	Molybdic oxides	Ferro molyb- denum ^{1/}	Ammonium and Sodium molybdate	Other moly- bdenum materials ^{2/}	
Steel:					
Carbon - - - - -	3,068	468	-	W	3,536
Stainless and heat resisting - - - - -	4,259	1,883	-	117	6,259
Alloy (excludes stainless and heating resisting) -	18,768	2,309	-	28	21,105
Tool - - - - -	2,045	1,204	-	237	3,486
Cast Irons - - - - -	1,050	3,140	-	84	4,274
Superalloys - - - - -	338	597	-	1,581	2,516
Alloys (exclude alloy steels and superalloys):					
Cutting and wear resistant materials - - - - -	W	W	-	3	3
Welding and alloy hard- facing rods and materials	-	383	-	29	412
Magnetic alloys - - - - -	(4)	W	-	W	W
Other alloys ^{5/} - - - - -	W	87	-	109	196
Mill products made from metal powder - - - - -	W	W	-	1,899	1,899
Chemical and ceramic uses:					
Pigments - - - - -	731	-	371	W	1,102
Catalysts - - - - -	1,514	(4)	W	-	1,514
Other - - - - -	35	W	W	785	820
Miscellaneous and unspecified	2,540	1,065	418	478	4,501
Total ^{3/} - - - - -	34,349	11,135	789	5,348	51,622
Consumer stocks Dec.31,1969	2,966	1,591	246	671	5,474

First 8 Months of 1969 and 1970 B/

1969					
Total - - - - -	22,681	6,924	425	3,099	33,128
Consumer stocks Aug.31,1969	3,682	1,653	78	601	6,013
1970					
Total - - - - -	20,311	6,371	719	3,094	30,495
Consumer stocks Aug.31,1970	3,856	1,652	318	888	6,714

A/ Source: U. S. Bureau of Mines.

B/ Computed from preliminary figures in U.S. Bureau of Mines "Molybdenum Monthly" reports for the periods.

W Withheld to avoid disclosing individual company confidential data, included in Miscellaneous and unspecified. ^{1/} Includes calcium molybdate. ^{2/} Includes purified molybdenum disulfide, molybdenite concentrate added directly to steel, molybdenum metal powder and molybdenum metal pellets and other molybdenum materials.

^{3/} Data may not add to totals shown due to independent rounding. ^{4/} Less than $\frac{1}{2}$ unit. ^{5/} Includes nonferrous alloys.

TABLE V - U. S. EXPORTS OF MOLYBDENUM ORE AND CONCENTRATE
(INCLUDING ROASTED CONCENTRATE), BY PRINCIPAL COUNTRIES ^{1/}

Country	Molybdenum Content, thousands of pounds and dollars.					
	1967		1968		1969	
	Pounds	Value	Pounds	Value	Pounds	1st 8 Mos. 1970 Pounds
Netherlands	16,287	\$27,602	14,652	\$24,671	24,634	16,230
Canada	3,415	5,312	1,394	1,497	464	351
Japan	2,690	4,916	5,088	9,100	11,446	9,481
West Germany	1,971	3,502	1,989	3,063	7,346	3,962
Belgium-Luxembourg	1,878	3,382	2,330	4,007	1,379	347
France	1,526	2,651	1,117	1,840	2,170	2,355
Sweden	582	950	788	1,172	1,950	1,455
United Kingdom	488	775	719	1,153	3,654	957
Others ^{2/}	1,163	2,344	929	1,567	4,541	2,794
Total	30,000	\$51,434	29,006	\$48,070	57,584	37,932

^{1/} Source: U. S. Bureau of Mines.

^{2/} In 1969, Italy (1,487,000), Austria (794,000), Czechoslovakia (630,000), and East Germany (628,000), took more than Canada. In the 1970 period Australia (603,000), Czechoslovakia (556,000), and Italy (543,000), were ahead of Canada and Belgium-Luxembourg.

TABLE VI - FREE WORLD PRODUCTION OF MOLYBDENUM IN
ORES AND CONCENTRATES^{1/}

Country	Thousands of pounds of Molybdenum					
	1964	1965	1966	1967	1968	1969
United States	65,605	77,372	90,532	90,097	93,477	99,807
Canada ^{2/}	1,225	9,557	20,596	21,377	20,007)	
Chile	8,393	8,142	10,232	10,752	8,521)	
Peru	871	1,499	1,484	2,037	1,750)	43,000 ^{4/}
Other ^{3/}	1,814	1,961	2,144	2,153	1,918 e)	
Free World Total	77,908	98,531	124,988	126,416	125,673	143,000 ^{4/}

e Includes estimates for 3 countries.

^{1/} Source: U. S. Bureau of Mines.

^{2/} Shipments.

^{3/} Includes minor production in South Korea, Norway, Japan, Mexico, the Philippines and Australia, but does not include negligible amounts produced in Argentina, Bolivia, Nigeria, South-West Africa and Spain.

^{4/} Estimate by David Mayers in Mining Annual Review - June 1970 p74, for Free foreign mine production, included in 1969 Free World total.