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HISTORICAL TRENDS OF U. S. MINERAL STATISTICS FOR GOLD, SILVER, AND THE RARE-EARTH ELEMENTS

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Abstract. Production figures on gold, silver and the rare-earth elements by the United States, as well as other statistics for these three commodities, show strong volatility during this century. Major shifts were driven by the Great Depression and the two World Wars, but other major temporal changes also are noted that do not seem to be directly related to global crises. For example, the price of silver exhibited a strong maximum in the 1980's, which is only loosely related to world production, and the same is true for gold. In the case of the rare-earth elements, U. S. exports have varied throughout the second half of the century, by almost a factor of 10. It is possible that such volatility might be explained in part by global economic conditions, at least in the recent decades. Supporting the interpretation of the importance of global picture upon domestic commodity statistics is a close correlation between domestic and world production of silver and gold, but only for the second half of this century. However, only superficial explanations can be advanced for such relations before we have examined information on a large suite of commodities

INTRODUCTION

This report represents the first in a series of planned reports on the statistical analysis of mineral commodities in the United States, Russia, China, and Mongolia. The statistics for gold (Table 1), silver (Table 2), and the rare-earth elements (Table 3) for the United States are presented here. The major sources of information for the report are the annual commodities reports, published in previous years by the former U. S. Bureau of Mines and, since 1996, published by the U. S. Geological Survey—USGS—(Minerals Yearbook, 1882-1997).

These reports represent an enormous effort throughout this century by individual commodity specialists, each monitoring and compiling information about several metal, and non-metal commodities, ranging from mine production, to industrial consumption, to exports and imports, as well as to price. However, as with any report of such scope, compiled by many different authors, and covering so many years and dating back to 1882, the data are, not infrequently, difficult to access. Except for the years 1970 to 1990, the data are available only as a hard copy. For those 20 years, some data can be accessed on the Internet (Compendium, 1991), but in a format that requires considerable editing if one tries to import them into one of the more commonly used computer plotting programs or other statistical packages. Also, data for the different commodities in the Compendium are not uniformly presented; some commodities are treated quite thoroughly, whereas others are treated superficially. The Compendium also is available as a hard copy. Although that publication uses metric units throughout, as do the annual reports printed since 1988, annual reports prior to 1988 use as many as three different units in a single table of data, for example, short tons, long tons, and metric

tons. Also, table formats, as well as the data reported are not consistent through the years, even for a single commodity. For example, in the case of the rare earth elements (REEs), world production into the 1980s was reported as production of monazite; since that time production has been reported as the rare-earth oxide equivalent. We should add that this change-over is quite understandable, owing to the emergence of bastnasite, a rare-earth fluorocarbonate mineral that is mined at Mountain Pass, California, as a dominant world source for REEs in the 1970s and 1980s. Expanded exploitation of bastnasite deposits in China since the mid 1980s has allowed that country to supplant the U. S. as the world's leading producer of REEs in the 1990s. The lack of uniformity in other cases merely reflects a change in focus, or effort, as end use of a particular commodity might have changed through time, or as its importance, source, or overall availability might have changed. Nonetheless, it somewhat complicates easy access and use of the data directly from the Yearbooks.

None of these comments are intended as criticism of the older reports, but are rather intended to point out some problems of the older reports and the need to present this information in a single format, making them readily accessible and in a ready-to-use table that currently available computer plotting programs will accept without significant editing. The use of a single format allows simple editing and updating as more reliable information is gained through literature searches. For example, early production figures for the REEs, now listed in terms of monazite, can be converted to rare-earth oxide equivalent, the current reporting procedure, by a simple multiplication step.

The data are presented in this report in paper copy and are available on floppy disc upon request. Inquiries can be directed to any of the authors, but should perhaps first be sent to the senior author. Upon completion of the series of reports, the data will be made available on CD ROM and the Internet. The latter will eventually carry all additions and updates.

PURPOSE

The purpose of this report is to make available statistics on the precious metals—gold and silver—and the rare-earth elements for this century, in a single format that can be easily accessed by computer without major editing. Subsequent reports will present statistics on (1) iron and the ferroalloy metals, (2) nonferrous metals, and (3) chemical industrial and agricultural minerals. Our aim is to ascertain historical trends in domestic production, overall availability, consumption and use, reserves, and the forces that drive those trends. For example, the major driving force for production must be demand, but short-term trends of a year to several years can be dominated by such factors as politics. These are extremely important, but here we focus more on long-term trends by presenting annual averages of commodity statistics that extend over several decades, rather than monthly, quarterly, or seasonal statistics. Geology, technology, and of course,

demand are perhaps more important determinants of decadal trends than politics or short-term economic swings, although the latter will surely still be important, even for long-term trends. Of course, the sole determinant in every case for all commodities in every country is eventually economics.

For the three major commodities included in this report, each presents a different domestic scenario. For gold, the U. S. is currently (1998) a major exporter; for silver, the U. S. is a net importer, but at the same time being a major producer; and for the REEs, the U. S. has, in the past few decades, produced approximately the same amount as they have consumed. In the cases of gold and silver, this situation and their availability will likely remain much the same through the next two or three decades as it is today (see below). In the case of the REEs, production from domestic sources is increasingly failing to meet a continuously expanding demand and could possibly itself decline significantly in the next few years. How will a change from domestic to foreign sources influence availability, that is, as the less costly recoverable ores of domestic mines are gradually exhausted, or as environmental concerns about mining come to outweigh the benefits of domestic production?

In conjunction with this series of reports on U. S. commodities, we are carrying out a similar, cooperative study with geologists and economists in the Far East—in China, Far East Russia, and Mongolia—to examine similar temporal trends in commodity statistics within those countries. However, much of the commodity data from many countries is not available in easy-to-access sources, although, again, the annual reports of the former U. S. Bureau of Mines and USGS have presented the best data available at the time for many countries, dating back to the early 1960s. The new reports are intended to present historical data for each country, compiled by members of the scientific community within each country. Still, the reports may not be as complete as those for the U. S., despite a willingness on the part of scientists in these countries to carry out this type of cooperative study and their commitment to examine information from the best available domestic sources.

PROBLEMS

In many older reports, and in current reports as well, consumption has been presented as domestic industrial consumption of raw material. In the case of gold, the U. S. exports most of the commodity mined in this country as bullion—to the United Kingdom, Switzerland, and Hong Kong (Minerals Yearbook, 1882-1997). Most is fabricated into jewelry (Kesler, 1994; Craig and others, 1996) in other countries and the jewelry then imported back into the U. S. However, it is not included in statistics of domestic consumption. Thus, do we report only industrial consumption within the U. S., or total end-use consumption of finished goods? For those commodities that have predominantly a single end-use, it might be relatively easy to adjust

consumption figures to reflect total consumption. That would not be the case, however, for those commodities that have multiple uses, for example, silver.

For this report we will maintain the procedures of the annual reports of the former U. S. Bureau of Mines and USGS for reporting consumption. The alternative requires that we go back and examine data of imports of finished goods for all previous years, no small task, in addition to consumption by domestic industry, perhaps a worthy task. Perhaps, it is more important for this report that we maintain, throughout any reporting period, a consistency in the definition of what we report. Consumption by the U. S. public, however, is surely a statistic needed for planning a long-term strategy of metal availability and consumption. Collection of information about total consumption should be one goal of reports that follow this initial report.

COMMODITY STATISTICS

Throughout much of the time of publication of the Yearbooks by the former U. S. Bureau of Mines, statistics for the most recent 5–year period have been published in each Yearbook. This has allowed for revision of information in subsequent Yearbooks, information that was published as estimates, usually, the first year. Such revisions were based on additional information gained in years following the initial publication. In many cases revisions were made throughout the five years that a set of data was published. We have attempted to present here updated, i.e., revised, figures by examining the Yearbooks on a 4–year, or fewer-year, basis. However, the last-published set of data for a commodity may differ slightly from that presented in this report, as statistics for some commodities were adjusted each year. A random examination by us suggests that the differences are less than about 5 percent.

Gold

Production of gold in the U. S. has reached an all time high in recent years (Figure 1a), owing to expanded production of gold from Nevada, in some cases from extremely low grade deposits. This expanded production was made possible in part by the advancement of a technology to extract the metal by low-cost, sodium cyanide, heap-leach methods. Production expanded significantly in this area in the 1960s and, by the 1980s, established Nevada as the leading gold-producing State in the U. S. It has also made the U. S. the second leading producer among the world's gold-producing states. Nevada now produces between 60 and 70 percent of U. S. production. Present estimates of reserves indicate that production there can be maintained at the current level for at least the next two decades (Dobra, 1997). However, several years ago this level of production, and future production, were threatened by possible changes to the General Mining Law, being discussed by the U. S. Congress. These changes were viewed by the

mining community as a discouragement to exploration and future exploitation. As a result, exploration was increased in foreign countries, at the expense of domestic exploration. Mining was viewed as possibly soon-to-be stringently controlled by, what were viewed by the mining community as, burdensome environmental laws and profit-paring taxation. That view has now been reversed, with the apparent demise of federal legislation that would have quite significantly changed the Mining Law of 1874. As a result, identified reserves in Nevada have increased significantly during this decade, driven in part of this change in the political climate of the time. The decline in the price of gold since the 1980s, conversely, could have the opposite effect, that of reducing reserves.

In 1998 approximately 90 percent (93 per cent in 1997) of U. S. gold production comes from gold lode deposits, 1 to 1.5 percent from gold placer deposits, and the balance from base-metal and other precious-metal lode deposits. Placer deposits were relatively much more important up until the 1960s, representing as much as 37 percent of domestic production in 1947. Prior to bringing on-line the very low-grade deposits in Nevada, the major producing States in the U. S. were South Dakota, Utah, California, and Alaska, which together now produce only about 22 percent of U. S. gold, but in 1962 produced more than 75 percent of U.S. production (South Dakota–30 percent, Utah–23 percent, Alaska–13 percent, and California–12 percent).

The Republic of South Africa, which produced approximately 20 percent of the world's gold in 1997, is the world's leading producing state. World production has increased significantly and steadily since World War II, to its present level of over 2,400 metric tons—mt—(Table 1). This increase is likely to continue in the coming years, as exploitation in other countries such as China outpaces the possible decline in production in South Africa.

Consider Russia and the Community of Independent States that formerly were part of the Soviet Union; the latter had been a major gold producer for the past several decades. In the 1980s it produced slightly more than 100 mt annually, but the figure dropped to less that 20 mt in the early 1990s (Benevolski, 1995). Although not as dramatic, production in Russia also dropped by some 15 percent since the 1980s (Benevolski, 1995). However, production in both Russia and the Community of Independent States could recover to the earlier values as these countries become more stable in coming years and foreign investment in exploration and exploitation expands.

China is only now beginning to realize the full potential of its gold resources. It currently produces about the same as Russia. Other major producers are Australia (11 percent and third in the world) and Canada (6 percent).

Exports of gold from the U. S. (Figure 1c) are mostly in the form of refined bullion, 85%. Of the 334 mt exported, 80 percent goes to the United Kingdom, Switzerland, and Hong Kong,

to be used largely in the production of jewelry. Imports come mostly from Canada, which provides about 75 percent of the U. S. import supply.

As is the case for the entire gold industry, consumption in the U. S. (Figure 1d) is largely by the jewelry fabrication industry. Other uses are in electronics (about 10 percent of production), commemorative coins and medals, whose production varies widely from year to year, and dentistry. Hoarding and, the opposite, disinvestment, can be significant but are not considered here. Supply of gold to the world market also can be significantly influenced by official/central bank sales. However, these also vary markedly, for example, from 445 mt in 1993 to 78 mt in 1994 (Minerals Yearbook, 1995).

Secondary production (Figure 1b), that is, production from old scrap, has only been followed since 1980. Unfortunately, it has been lumped with new scrap, scrap produced largely from fabrication, since 1992. The ratio of old to new scrap seems to have remained at about 2:3, for those years when figures for both were reported. Together, they constitute approximately 50 percent of U. S. mine production, not an insignificant amount that has remained relatively constant.

Although the uses of gold in the U. S. change somewhat each year, jewelry fabrication is currently the dominant use and has been the dominant use for the past several decades. It currently represents approximately 55 percent of domestic consumption, but has been as high as 75%. If imports of finished products are included, consumption as jewelry would likely constitute an even larger share of the market.

The price of U. S. gold (Figure 1b) has been allowed to "float" since 1967, at which time the U. S. government ceased controlling the price at $34 per troy oz. Since that time, the price has varied over a rather large range, increasing to a maximum of $605 in 1981 before falling to its present level (late 1998) at slightly less than $300 per troy oz.

Silver

Production of silver in the U. S. (Table 2 and Figure 2a), unlike that of gold, comes largely from the mining of lode deposits of other metals. Of the 25 leading silver production mines in the U.S., only the Sunshine Mine in Idaho produces silver as the primary metal. Perhaps as much as 90 percent is recovered as a byproduct from the mining of gold, lead, copper, and zinc. Except for the Sunshine Mine, the major silver-producing mines have gold as the primary product. As one might expect, Nevada is the leading producing State, at almost 50 percent of total U. S. production. Total production in the U. S. currently is approximately 3,500 mt in 1997, 2,150 mt was from mine production and 1,360 mt from scrap. Production has been extremely volatile throughout this century. In fact, all statistics for silver have exhibited volatility throughout this century. For example, production dropped during World War II to its

lowest level in the century; exceeding the minimum of the Great Depression. Production did not return to the highs of the early part of this century until the late 1980s, from which it has again exhibited a steady decline.

Secondary production (Figure 2c), that is, production from scrap, approximately equals mine production. Throughout the 1970s old scrap approximately equaled mine production. Although production from old scrap has decreased somewhat in recent years, it still represents about 20 percent of mine production. In 1990, the ratio of old to new scrap was 1:4, the only year for which such data have been published.

Although world production in this decade has shown a similar decline in production to that of the U. S. (Table 2), prior to 1989 world production increased continuously from the end of World War II. It has stabilized in the most recent 3 to 4 years. The three leading silver-producing states are Mexico, Peru, and the U. S., which account for approximately 42 percent of world production. Mexico and Peru have roughly maintained their high level of production throughout this decade. Domestic production has been more volatile, but it and world production have apparently been closely linked since about 1958 (Figure 2d), possibly a reflection of overall globalization of markets.

In the 1990s the price of silver returned to 1970s values, following an extreme positive excursion in the 1980s, when it reached a maximum of over $20 per troy oz (Figure 2c). It now sells for slightly over $5 per troy oz ($4.89 in 1997), an increase above a 1992 minimum value of slightly less than $4 per troy oz.

The volatility of the silver market, seems to be reflected by virtually all of the statistics for the U. S. Thus, trends in silver statistics could be extremely important in deciphering factors that drive the overall metal commodities market, owing to the extremely diverse end-use for silver; that is, the behavior of the silver market may be a bellwether for much of the minerals market. The photographic industry has been the major user of silver for many decades, consuming approximately 40 percent of production. However, the electrical industry uses about 25%. Lesser but significant uses are in silverware and electroplated ware, jewelry, brazing alloys and solder, catalysts, bearings, and coins. Unfortunately, we do not present information on trends in the end-use of silver in this report, but such information may be extremely significant for the reason given above. Detracting from the use of silver as an indicator of the commodities market as a whole, is the fact that silver production is dominated by production from gold and base-metal deposits and, as such, is responsive to factors that drive their production, as well as to factors that drive the different demands for silver by the U. S.

During the past two decades, imports of silver by the U. S. (Figure 2b) have exceeded domestic mine production by as much as a factor of 2.5, but average approximately 1.5 times as much. In the past, silver was imported as refined bullion, but in this decade as much as one third

was as waste and scrap. Major suppliers have been Canada and Mexico. As might be expected, exports of silver have tended to be much less that imports, but have been equally volatile, due in large part perhaps to variation in the strength of the dollar, relative to the currency of other, i.e., recipient, countries. The leading countries to which we currently export silver are Switzerland, Japan, and the United Kingdom.

Rare-Earth Elements

Mine production of bastnasite, a rare-earth fluorocarbonate, has increased steadily since the late 1960s (Figure 3a), when mining began in earnest at Mountain Pass, Ca. As a result of this deposit, the U. S. was quickly established as the world's leading producer of REE, a position it held until this decade, when production in China surpassed that in the U. S. Prior to the mining of bastnasite, monazite, a rare-earth and thorium heavy-mineral phosphate, was the primary source of REEs for the U. S. and the world. Monazite was mined at Green Cove Springs Fl. until 1995, but produced a very small percentage of the U. S. requirement compared to that produced from bastnasite at Mountain Pass. Monazite remains a major source of thorium. However, a decreasing demand for thorium in this country since 1990, in part driven by costs to companies mining, processing, and manufacturing thorium products, because of the natural radioactive decay of thorium, contributed to a decline in production of monazite.

In the world market today, monazite is a minor source of REEs. Even though bastnasite and laterite deposits in China and the one bastnasite deposit in the U. S. will increasingly dominate as the primary source of REEs, monazite production will likely continue to increase. The advantage of monazite, and particularly of low-thorium monazite, is that it is recovered at low cost as a by-product to the recovery of other heavy minerals from heavy-mineral sand deposits.

Future sources of REEs might include secondary recovery from some iron ores and sedimentary phosphate deposits. In the case of phosphate deposits, their approximate average concentration of REEs is 300 ppm (Altschuler, 1980). United States production of phosphate alone is 15×10^7 mt annually, which could yield as much as 45,000 mt of REEs, or approximately twice the current production of REEs from bastnasite at Mountain Pass. As is often the case, lack of a low-cost technology necessary to recover REEs from this type of deposit currently precludes exploitation.

The U. S. currently consumes approximately 35 percent of the world production of REEs (Table 3). Applications have varied from their use in lasers and tracer bullets to automotive catalytic converters. The latter uses approximately 45 percent of current production. Other major uses are as petroleum refining catalysts (approximately 25 percent), permanent magnets and glass polishing and ceramics (both about 10%). Individual REEs, following their separation

from the group are of major importance. For example, cerium is used in catalytic converters, samarium and neodymium in permanent magnets, europium in phosphors. The REEs are also used in high-strength, low-alloy steel, and stainless and carbon steel.

FUTURE RESEARCH

We have not included information of temporal changes in uses of each commodity, but this is clearly an area of research that should be pursued. Other sources of data may list this type of information, which could then be incorporated into the tables given here. In the case of gold, the task would be relatively simple as a single end-use, jewelry, now dominates its consumption. The information for silver could be more interesting, as it has several major uses—in photography, jewelry and silverware, electronics, brazing alloys and solder, dentistry and medicine, catalysts, and coins. For the rare earth elements, the task is complicated by production and consumption figures being reported as a rare-earth element oxide equivalent, but use is determined largely by individual REEs. Cerium, fortunately the most abundant of the REEs in all but some sedimentary, agriculture-mineral deposits, and neodymium, the third most abundant REE after lanthanum, seem to be the most important.

Improved technologies in the recovery of different commodities also will have a tremendous impact on the market. Cyanide, heap-leaching techniques that made extremely low grade gold deposits of Nevada profitable, at gold prices above $325 per troy oz, are an excellent example. Similar techniques may be applied to deposits elsewhere in the world in the coming years, which should greatly increase world gold production, and could well influence price. The development of an extraction technique for REEs from sedimentary phosphate deposits could have a similar impact on the REE market.

CONCLUSION

Current world availability for the three commodities—gold, silver and the REEs—seems adequate to meet domestic demand. However, most gold and silver are imported into the U. S. as finished products. In the case of the REEs, the major mine producer of REEs in the U. S., and the second leading producer in the world, at Mountain Pass, Ca., may not be able to continue its high level of production, because of environmental constraints. Regardless, the U. S. is expected to become more dependent on imports of refined REEs, including oxides and other compounds and metals, to supply demand. Thus, in the case of all three commodities, the U. S. must compete in the world market to obtain necessary supplies of finished products and/or refined metal for all three commodities. The most likely sources who will dominant the supply of each commodity to the U. S. are China for REEs and Canada for silver and gold.

There are surely many factors that drive the strong volatility in both domestic and world production, consumption, export and import, and price of these and other commodities. A strong correlation between U. S. domestic and world production of silver, for the last half of this century, supports an interpretation of increased globalization of the commodities markets and of the importance of the global economy to that market. However, we will surely be able to ascertain what the global factors are that drive those markets only after we have examined closely and together statistics for a large suite of commodities, which we are now collecting from published and accessible unpublished sources.

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Table 1. U. S. statistics for gold. Units are in 1000 kilograms, unless otherwise noted. Where blanks occur no information was available.

Year	U. S. Mine Production	Secondary Production (Total Scrap)	Secondary Production (Old Scrap)	Imports	Exports[1]	Consum -ption[2]	World Mine Production[3]	Average Price[4] ($/t oz)	Employ-ment (persons)
1900----									
1901----									
1902----									
1903----									
1904----	122						523		
1905----	133						572		
1906----	146						606		
1907----	132						621		
1908----	138			76	122		666	20.67	
1909----	150			66	200		683	20.67	
1910----	143			89	88		685	20.67	
1911----	146			86	56		695	20.67	
1912----	140			100	71		701	20.67	
1913----	135			96	138		693	20.67	
1914----	137			86	335		661	20.67	
1915----	148			680	47		705	20.67	
1916----	137			1032	234		683	20.67	
1917----	121			831	560	52	631	20.67	
1918----	100			93	62	75	573	20.67	
1919----	86			115	554	114	550	20.67	
1920----	74			628	485	124	507	20.67	
1921----	73			1040	36	76	497	20.67	
1922----	71			414	55	90	481	20.67	
1923----	75			486	43	104	553	20.67	
1924----	76			481	93	99	592	20.67	
1925----	72			193	395	99	592	20.67	
1926----	69			321	174	103	602	20.67	
1927----	66			312	303	89	597	20.67	
1928----	67			254	844	47	603	20.67	
1929----	64			439	175	86	610	20.67	
1930----	66			596	174	64	647	20.67	
1931----	69			921	702		694	20.67	
1932----	72			547	1218	202	753	20.67	
1933----	72			291	552	9	778	20.67	
1934----	97			1785	79		840	20.67	
1935----	115			1547	2	29	921	35.00	
1936----				1017	24	3	1029	35.00	
1937----	137			1450	41	3	1113	35.00	
1938----	161			1759	5	0	1157	35.00	
1939----	145			3171	0.47	7	1228	35.00	
1940----	151			3933	1.00	12	1278	35.00	
1941----	148			872	0.06	33	1253	35.00	
1942----	108			280	0.09	42	1151	35.00	
1943----	42			90	21	77	896	35.00	
1944----	31			89	852	86	818	35.00	
1945----	30			83	176	97	812	35.00	
1946----	49			340	197	137	855	35.00	
1947----	66			1723	168	43	896	35.00	
1948----	63			1719	166	40	933	35.00	
1949----	62			685	68	97	964	35.00	
1950----	74			145	455	87	1017	35.00	
1951----	62			72	546	62	1042	35.00	
1952----	59			657	24	86	1064	35.00	
1953----	61			42	27	67	1048	35.00	
1954----	58			34	15	39	1092	35.00	

Table 1. Table 1 cont.

Year	U. S. Mine Production	Secondary Production (Total Scrap)	Secondary Production (Old Scrap)	Imports	Exports[1]	Consum -ption[2]	World Mine Production[3]	Average Price[4] ($/t oz)	Employ -ment
1955----	58			91	5	40	1132	35.00	
1956----	57			116	23	44	1194	35.00	
1957----	56			240	149	45	1232	35.00	
1958----	54			253	28	57	1263	35.00	
1959----	50			264	2	78	1331	35.00	
1960----	52			290	1	93	1409	35.00	
1961----	48			50	689	86	1474	35.00	
1962----	48			134	338	111	1555	35.00	
1963----	45			40	181	91	1342	35.00	
1964----	45			36	376	149	1394	35.00	
1965----	53			90	1142	164	1438	35.00	
1966----	56			37	406	189	1448	35.00	
1967----	49			29	893	196	1418	35.00	
1968----	46			185	745	205	1436	39.26	
1969----	54			182	11	221	1450	41.51	
1970----	54			207	33	186	1478	36.41	
1971----	46			224	42	216	1446	41.25	
1972----	45			191	46	227	1391	58.60	
1973----	37		55.3	120	93	209	1347	97.81	
1974----	35		59.9	82	120	145	1248	160.00	
1975----	33		83.8	83	109	124	1197	162.00	
1976----	33		77.9	83	110	145	1216	125.00	
1977----	34		76.3	139	270	151	1212	148.00	
1978----	31		43.0	146	171	147	1215	194.00	
1979----	30		52.1	144	513	149	1207	308.00	3200
1980----	30		67.9	141	190	100	1218	613.00	5500
1981----	43		50.1	145	200	102	1283	460.00	7500
1982----	46		44.2	153	92	108	1340	376.00	6800
1983----	62		55.5	143	98	96	1404	424.00	5200
1984----	65		55.0	245	155	98	1460	360.70	
1985----	75		49.8	256	123	96	1532	317.70	
1986----	116		41.8	490	156	111	1607	365.20	
1987----	154		63.3	120	89	113	1661	448.00	
1988----	201		52.8	93	330	112	1848	438.30	
1989----	266		51.9	153	211	115	2013	382.60	
1990----	295	144	44	65	396	118	2127	384.90	16100
1991----	294	153	48.1	147	384	114	2187	363.30	15100
1992----	330	163	53.4	159	308	110	2299	345.00	14800
1993----	331	152	66	144	726	91	2330	360.90	14700
1994----	326	148		114	395	76	2300	385.40	14100
1995----	320			126	347	75	2200	385.00	14700
1996----	325			160	471		2300	390	16900
1997----	360						2400	332	16300

1. Includes refined bullion, dorè, ores, concentrates and precipitates; excludes scrap, coins, monetary gold, and fabricatd items.
2. Publication of consumption has been discontinued.
3. May not include all countries, but the sum production of such countries probably represents less than 10% of world production. Total resources are estimated at 89,000 metric tons, of which approximately 50% is within South Africa; the Unites States holds approximately 12%, or 10,000 metric tons (Minerals Yearbook, 1997).
4. One troy ounce = 31.1035 grams.

Table 2. Statistics for silver in the United States. Units are in metric tonnes, unless otherwise listed.

year	U. S. Mine Production	U. S. Refinery Production	U.S. Secondary Production	U. S. Labor Force (persons)	U. S. Exports	U. S. Imports	Average Price ($/troy oz)
1900----	1791						0.62
1901----	1717						0.60
1902----	1726						0.53
1903----	1689						0.54
1904----	1794						0.58
1905----	1745	1750					0.61
1906----	1757	1784					0.67
1907----	1757	1633					0.66
1908----	1630	1580			2724	2219	0.54
1909----	1701	1782			3143	2520	0.52
1910----	1776	1791			3014	2411	0.54
1911----	1878	1900			3450	2299	0.54
1912----	1984	2053			3293	2215	0.62
1913----	2077	2214			2920	1669	0.61
1914----	2255	2165			2615	1315	0.56
1915----	2333	2130			2982	1918	0.51
1916----	2314	2113			2990	1366	0.67
1917----	2230	2038			2842	1802	0.84
1918----	2118	2109	243		7321	2067	0.98
1919----	1614	1763	184		6056	2265	1.12
1920----	1757	1723	248		3161	2450	1.02
1921----	1440	1648	200		2323	2847	0.63
1922----	1903	1748	189		2621	2954	0.68
1923----	2186	2280	241		3164	3250	0.65
1924----	1990	2034	255		4650	3131	0.67
1925----	2074	2059	282		4266	2908	0.69
1926----	1944	1950	159		4444	3483	0.62
1927----	1854	1878	204		4127	2979	0.57
1928----	1801	1819	270		4544	3573	0.58
1929----	1894	1906	259		4478	3393	0.53
1930----	1483	1580	183		4164	3116	0.38
1931----	930	961	198		4136	2535	0.29
1932----	746	746	208		1306	1844	0.28
1933----	725	715	528		1375	5051	0.35
1934----	1026	1017	803		662	5467	0.48
1935----	1518	1427	1023		177	16209	0.64
1936----	1916	1984	476		121	7380	0.45
1937----	2242	2236			109	4889	0.45
1938----	1956	1950			103	7654	0.43
1939----	2003	2025			681	6030	0.39
1940----	2193	2165			292	5166	0.35
1941----	2093	2249			261	4177	0.35
1942----	1683	1745			44	3359	0.38
1943----	1291	1272			1070	1953	0.45
1944----	1073	1110			4270	1595	0.45
1945----	902	905			2177	1574	0.52
1946----	712	656			1238	1916	0.80
1947----	1113	1200			659	2606	0.72
1948----	1185	1219			168	2644	0.74
1949----	1079	1085			93	2979	0.72
1950----	1322	1316			143	3374	0.74
1951----	1238	1241			199	2519	0.89
1952----	1228	1238			62	2348	0.85
1953----	2743	1169	1172		31	2535	0.85
1954----	1210	1148	1107		53	2827	0.85

Table 2. Cont.

year	U. S. Mine Production	U. S. Refinery Production	U.S. Secondary[2] Production	U. S. Labor Force (persons)	U. S. Exports[3]	U. S. Imports[3]	Average Price[1] ($/troy oz)
1955----	1157	1157	1135		152	2628	0.89
1956----	1148	1210	1207		171	5063	0.91
1957----	1169	1188	1089		320	6410	0.91
1958----	1061	1144	1120		84	5163	0.89
1959----	970	715	1306		286	2149	0.91
1960----	958	1144	1524		827	1888	0.91
1961----	1082	1085	1564		1238	1564	0.92
1962----	1144	1129	1325		407	2376	1.09
1963----	1095	1089			980	1835	1.28
1964----	1129	1151			3402	1608	1.29
1965----	1238	1213			1235	1701	1.29
1966----	1359	1505			2659	1959	1.29
1967----	998	942			2202	1726	1.55
1968----	1018	1060			3912	2199	2.14
1969----	1303	1608			2765	2335	1.79
1970----	1400	2531	1743		859	1938	1.77
1971----	1293	2137	935		380	1804	1.55
1972----	1158	2411	967		922	2034	1.68
1973----	1166	2344	1075		349	3139	2.56
1974----	1051	1970	1744		572	3127	4.71
1975----	1085	1869	1590		1015	2250	4.42
1976----	1067	1691	1562		454	2362	4.35
1977----	1188	1401	1489		697	2462	4.62
1978----	1225	1691	1153		697	2353	5.40
1979----	1185	1579	1236		1106	2873	11.09
1980----	1004	1224	1653	2400	2515	2451	20.63
1981----	1266	1462	1215	3600	868	2927	10.52
1982----	1253	1512	933	2900	792	3653	7.95
1983----	1350	1797	915	2400	994	5595	11.44
1984----	1387	1845	866	2600	760	3576	8.14
1985----	1226	1674	866	3000	760	4717	6.14
1986----	1074	1319	762	2200	781	4507	5.47
1987----	1241	1415	810	1800	843	2545	7.01
1988----	1661	1474	852	2300	998	2757	6.54
1989----	2008	1718	735	2400	1280	3302	5.50
1990----	2120	1611	433	2600	736	2700	4.82
1991----	1860	1880	1700	1900	787	2530	4.04
1992----	1800	2160	1760	1600	1010	2660	3.94
1993----	1640	1790	2020	1100	811	2180	4.31
1994----	1480	1810	1700	1000	967	2060	5.29
1995----	1640			1200	2890	3250	5.15
1996----	1800		2000	1400	2600	3000	5.30
1997----							

1. One troy ounce = 31.1035 grams.
2. From 1991 to the present, secondary production includes both "old" and "new" scrap and, prior to that time, it represents only "old" scrap.
3. Includes refined bullion, plus silver content of ores, concentrates, precipitates, and doré. Excludes coinage and scrap.
4. Balance in Mint only.
5. Commodity Exchange Inc., New York and Chicago Board of Trade.
6. World reserves of silver, in both precious metal and base metal deposits, is approximately 280,000 metric tons.

Table 2. Cont.

year	U.S. Consumption (Indust. + Arts + Coinage)	U. S. Consumption (Indust.+Arts)	Stocks U.S. Treas. Department	Stocks Industry	Stocks Futures Exchange	Stocks Defense Department	National Defense Stockpile	World Mine Production
1900----								5399
1901----								5380
1902----								5063
1903----								5215
1904----								5107
1905----								5359
1906----								5135
1907----								5729
1908----								6316
1909----								6596
1910----								6895
1911----								7035
1912----								6976
1913----								7010
1914----								4995
1915----								5564
1916----								5013
1917----								5100
1918----		1005						6139
1919----		929						5427
1920----		795						5390
1921----		1020						5327
1922----		1076						6525
1923----		1045						765
1924----		953						7448
1925----		930						7626
1926----		914						7893
1927----		883						7899
1928----		774						8021
1929----		961						8117
1930----		833						7735
1931----		756						5993
1932----		448						4976
1933----		336						5343
1934----		355						5984
1935----		162						6882
1936----		594						7887
1937----		861						8447
1938----		628						8325
1939----		1387						8242
1940----		1384						8565
1941----		2252						8176
1942----		3154						7775
1943----		3670						6752
1944----		3735						5791
1945----		3928						4690
1946----		2706						3919
1947----		3063						4876
1948----		3275						5439
1949----		2737						5480
1950----		3421						6192
1951----		3266						6142
1952----		3001						6537
1953----		3297						6898
1954----		2675						6665

Table 2. Cont.

year	U.S. Consumption (Indust. + Arts + Coinage)	U. S. Consumption (Indust.+Arts)	Stocks U.S. Treas. Department	Stocks Industry	Stocks Futures Exchange	Stocks Defense Department	National Defense Stockpile	World Mine Production
1955----		3154						6957
1956----		3110						6973
1957----		2967						7113
1958----	3847	2659						7433
1959----	4429	3141						6904
1960----	4603	3172						7480
1961----	5020	3281						7355
1962----	5841	3433						7539
1963----	6889	3421						7775
1964----	10139	3825						7731
1965----	14222	4261						7974
1966----	7386	5691						8291
1967----	6683	5318						8111
1968----		4519						8562
1969----		4401						9196
1970----		3993	781	2556	3981			9361
1971----		4018	1493	1771	3996		4339	8985
1972----		4699	1425	1613	3123	277	4339	9063
1973----		6108	1403	1195	2852	190	4339	9579
1974----		5474	1369	1532	2715	188	4339	9087
1975----		4901	1275	1061	3863	249	4339	9265
1976----		4553	1235	952	3602	236	4339	9839
1977----	3881	3878	1225	1118	4025	208	4339	10583
1978----	3632	3629	1218	896	3673	201	4339	10711
1979----	3754	3695	1213	498	4141	176	4339	10760
1980----	3688	3623	1210	537	3757	140	4339	10661
1981----	3654	3570	1205	649	3002	119	4277	11184
1982----		3695	1144	637	3303	54	4277	11865
1983----		3623	1075	543	4704	3	4277	12201
1984----		3570	992	660	4281	11	4277	12396
1985----		3688	1015	574	5385	14	4277	13199
1986----		3698	1052	550	5042	78	3960	13290
1987----		3987	1229	471	5279	75	3517	14052
1988----		4100	1201	480	5862	81	3310	14381
1989----		5060	997	544	7795	81	2973	14921
1990----		4360	840	583	8636	31	2870	16600
1991----		3830	1030	618	8760	23	2610	15600
1992----		4060	775	677	9380	29	2260	14600
1993----				735	10500	34	1850	14300
1994----				929	10400	15	1670	13900
1995----					6290	13		14600
1996----			900		5000	20	1450	14800
1997----								

Table 3. United States statistics for the rare-earth elements. Units are in metric tons of rare-earth element oxide equivalent, unless otherwise specified.

Year	U. S.[1] Productiom	U. S. Consumption	U. S. Imports (Monazite)	U. S. Imports[2]	U. S. Exports [2]	U. S. Exports (Ore and Concentrate
1920----						
1921----						
1922----						
1923----						
1924----						
1925----						
1926----						
1927----						
1928----						
1929----						
1930----						
1931----						
1932----						
1933----						
1934----						
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1936----						
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1938----						
1939----						
1940----						
1941----						
1942----						
1943----						
1944----						
1945----						
1946----						
1947----						
1948----						
1949----						
1950----						
1951----						
1952----						
1953----						
1954----						
1955----	160		5880			
1956----	180		3530			
1957----	250		3650			
1958----	260		3260			
1959----	50		1240			
1960----	280		660			
1961----	280		1510			
1962----	470		3750			
1963----	540		3130			
1964----	1300		1020			
1965----	3600		950			
1966----	11500		1210			
1967----	11600		1010			
1968----	10400		2160			
1969----	12800	7947	2110			
1970----	9,105	10,500	1750	4		2071
1971----	9,823	9,300	1630	7		2268

Table 3. Cont.

Year	U. S. Productiom	U. S. Consumption	U. S. Imports (Monazite)	U. S. Imports[2]	U. S. Exports[2]	U. S. Exports (Ore and Concentrate)
1972----	10,707	12,200	430	15		2268
1973----	17,554	14,800	1042	32		4403
1974----	19,913	14,100	654	64		4264
1975----	14,969	11,500	1271	33		3084
1976----	13,038	12,300	1042	44		2449
1977----	15,359	16,800	2716	254		
1978----	14,148	15,800	3793	610		494
1979----	16,515	16,000	3458			4334
1980----	15,986	18,100	2831			4741
1981----	17,082	20,000	4108	1632		5056
1982----	17,501	17,100	3962	1695		2565
1983----	17,083	19,600	2215	1857		2684
1984----	25,311	21,400	3114	2926		4304
1985----	13,428	12,100	3132	1164		4419
1986----	11,094	10,900	1628	1155		3433
1987----	16,710	11,100	617	625		4534
1988----	11,533	16,800	1058	509		4415
1989----	20,787	27,700	426	6125	1889	1891
1990----	22,713	30,000	440	4490	3514	1989
1991----	16500	22100		6110	5793	460
1992----	20700	21400		5330	6014	
1993----	17800	17000		6670	7170	
1994----	20700	18200		7840	10200	
1995----	22200	25400		14100	10600	
1996----	20400	29500		20740	11400	
1997----						
1998----						

1. From the 1970's to the present, production includes only the rare-earth elements derived from bastnasite, as reported by Unocal Corp. and, since 1990, by Molycorp Inc.
2. Includes metals, oxides, compounds, and alloys.
3. World reserves are estimated at 100,000,000 metric tons.

Table 3. Cont.

Year	World Productiom (Monazite)	World Mine Production[3]	Bastnasite Price (Dollars/kg)	Monazite Average Price ($/kg)	Mischmetal Average Price ($/kg)	Employment
1920----				0.43		
1921----				0.36		
1922----				0.30		
1923----				0.289		
1924----				0.28		
1925----				0.28		
1926----				0.24		
1927----				0.24		
1928----				0.25		
1929----				0.19		
1930----				0.12		
1931----				0.12		
1932----				0.12		
1933----				0.12		
1934----				0.11		
1935----				0.12		
1936----				0.14		
1937----				0.14		
1938----				0.14		
1939----				0.14		
1940----				0.13		
1941----				0.12		
1942----				0.12		
1943----				0.13		
1944----				0.12		
1945----				0.12		
1946----				0.14		
1947----				0.25		
1948----				0.35		
1949----				0.45		
1950----				0.51		
1951----				0.70		
1952----				0.71		
1953----			0.46	0.70		
1954----	14146		0.84	0.70		
1955----	10362		0.77	0.70		
1956----	9461		0.66	0.66		
1957----	12073		0.55	0.66		
1958----	14101		0.48	0.66		
1959----	4864		0.48	0.68		
1960----			0.48	0.68		
1961----	805		0.48	0.68		
1962----	14479		0.48	0.68		
1963----	10362		0.48	0.68		
1964----			0.48	0.68		
1965----			0.55	0.40		
1966----			0.77	0.40		
1967----	7929		0.77	0.40		
1968----	8848		0.77	0.31		
1969----	12851		0.77	0.35		
1970----	12440		0.77	0.37		
1971----	12000		0.77	0.38		

Table 3. C ont.

Year	World Productiom (Monazite)	World Mine Production [3]	Bastnasite Price (Dollars/kg)	Monazite Price (Dollars/kg)	Mischmetal Price (Dollars/kg)	Employment
1972----	13800		0.77	0.35		
1973----	11656		0.77	0.40		
1974----	10182		0.84	0.42		
1975----	12936		1.1	0.41		
1976----	11427		1.21	0.36		
1977----	16538		1.59	0.35		
1978----	22084		1.72	0.58		
1979----	22371		2.09	0.76	9.26	325
1980----	20619		2.09	0.81	12.35	250
1981----	19592		2.25	0.83	12.35	275
1982----	16167		2.43	0.75	12.35	303
1983----	25892		2.43	0.71	12.35	266
1984----	30360		2.43	0.64	12.35	321
1985----	32300		2.54	1.09		330
1986----	29500		2.54	1.06		283
1987----	23200		2.54	0.90		301
1988----	25710	64006	2.54	1.15		320
1989---	26740	69500	2.76	1.19		381
1990---	24890	60400	2.87	1.19	11.02	397
1991----	16290	51400	2.87	0.93	11.02	411
1992----	14700	55400	2.87	0.41	12.68	372
1993----	12100	52200	2.87	0.40	12.68	352
1994----	8630	53100	2.87	0.46	12.68	350
1995----	9300	56900	2.87	0.44	9.50	280
1996----		79900	2.87	0.47	9.50	
1997----						
1998----						

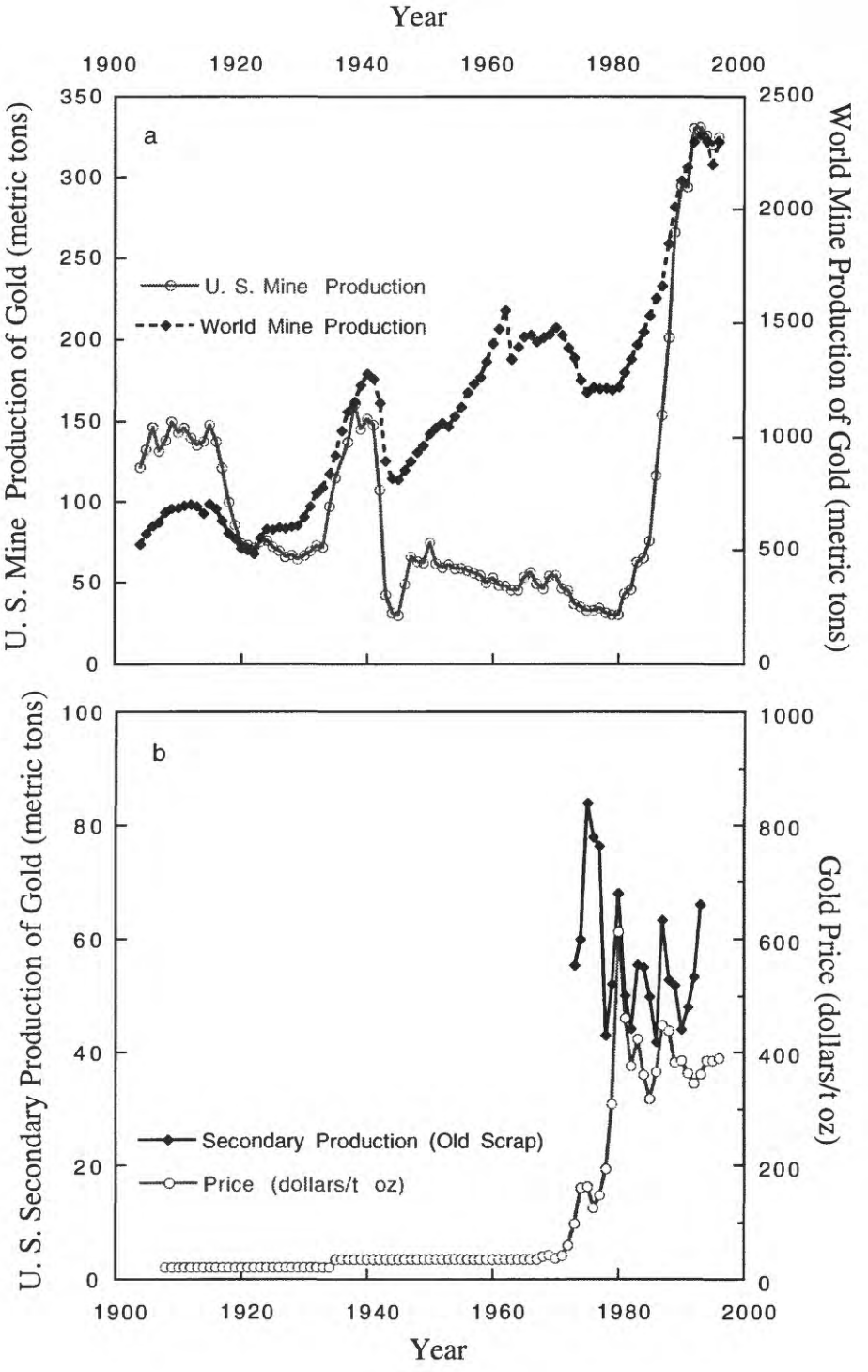

Figure 1. Selected gold statistics for the United States for the 20th century (Minerals Yearbooks, 1882-1997).

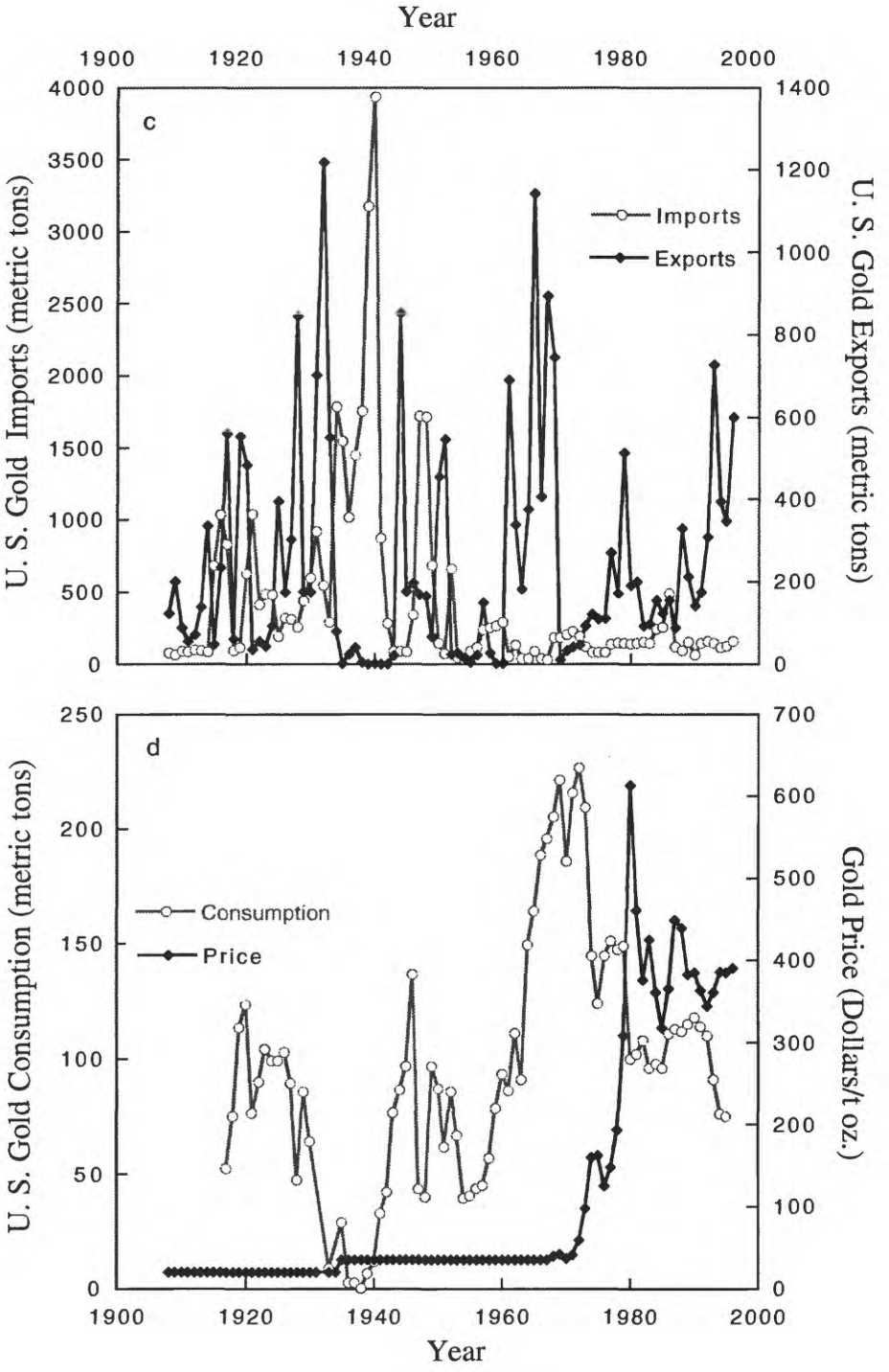

Figure 1. (cont.)

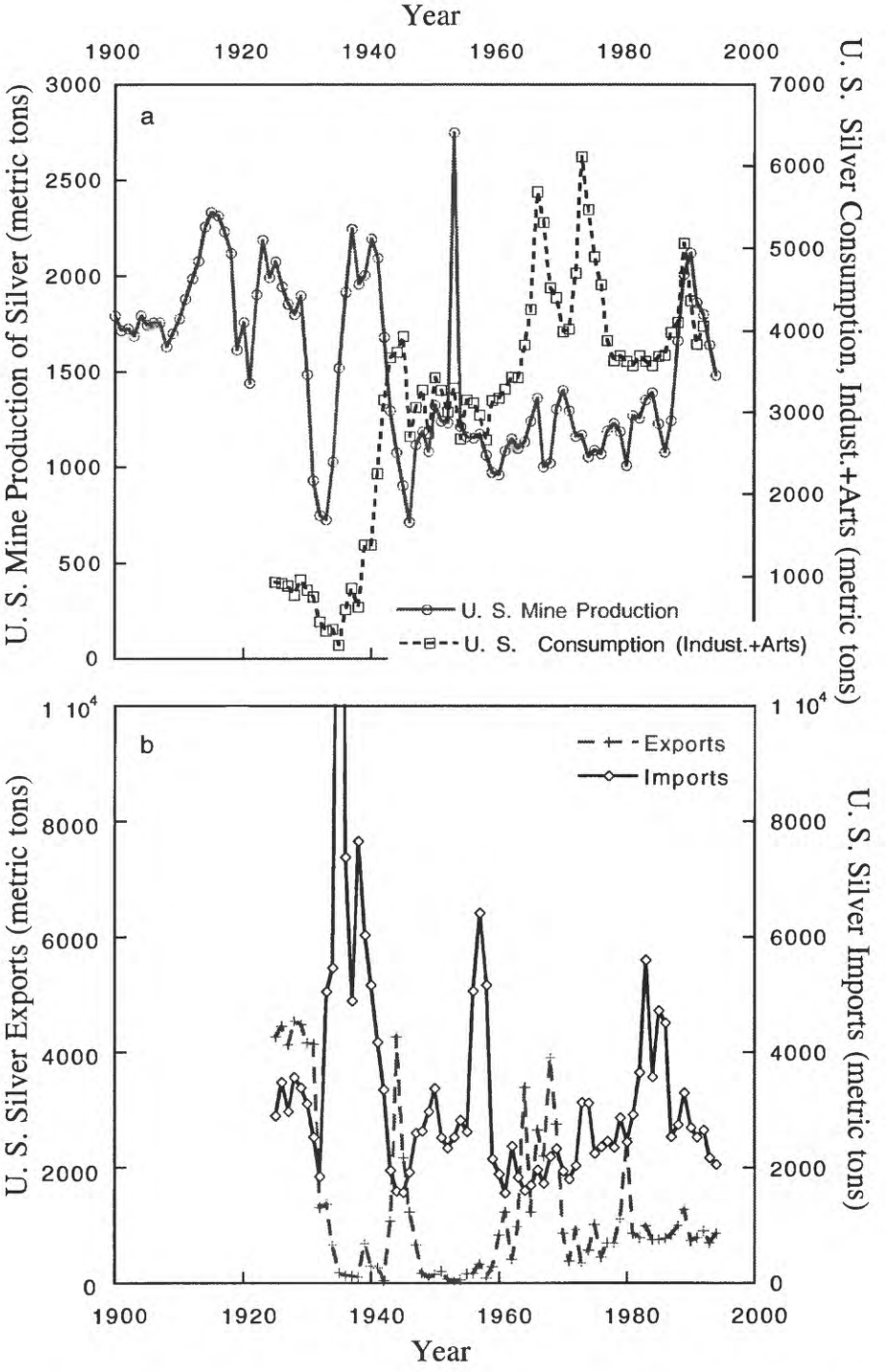

Figure 2. Selected silver statistics for the United States for the 20th century (Minerals Yearbooks, 1882-1997). Correlation coefficients for the curves in figure 2d are 0.80 (post 1958) and 0.27 (pre 1958).

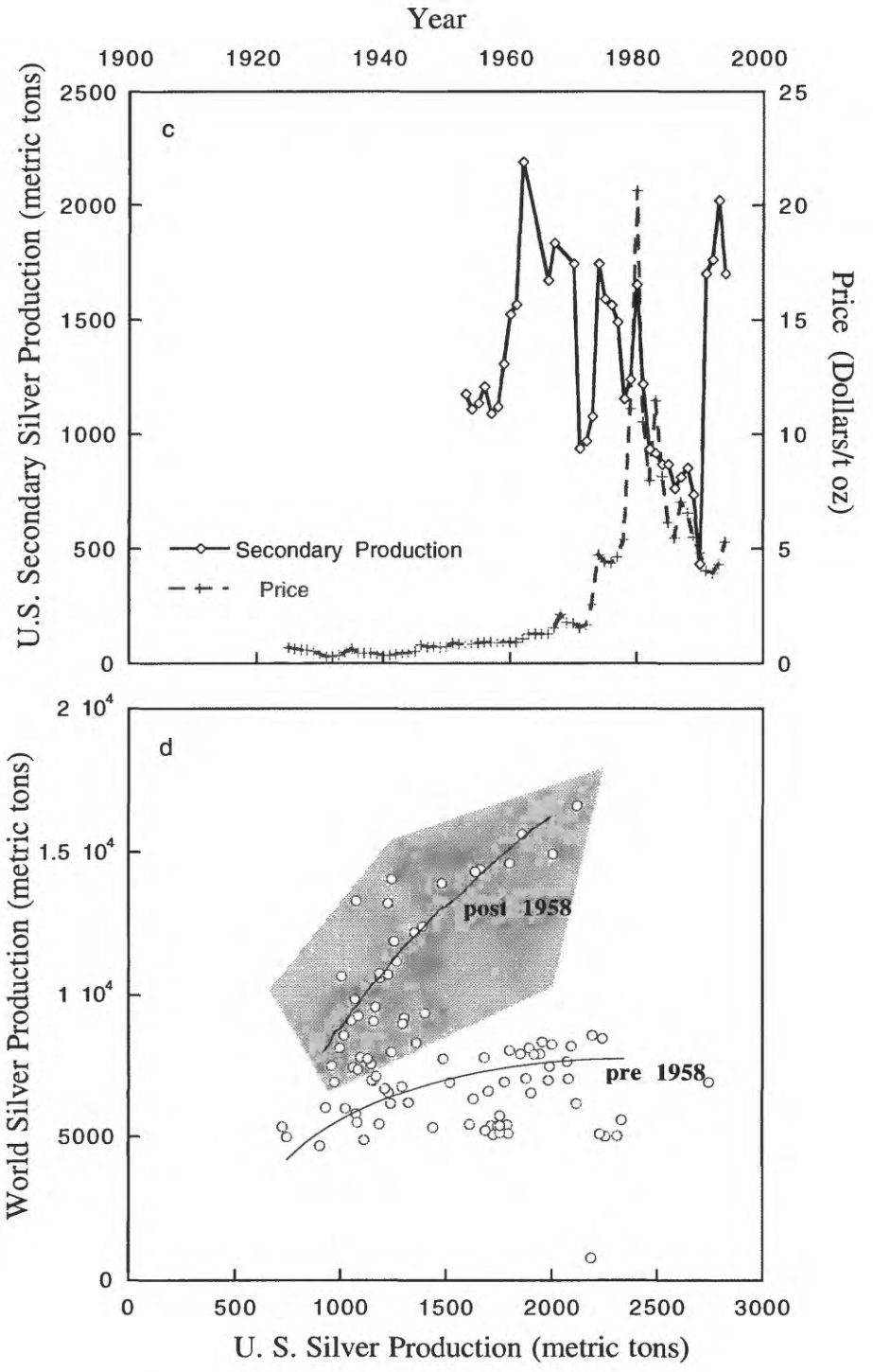

Figure 2. (cont.)

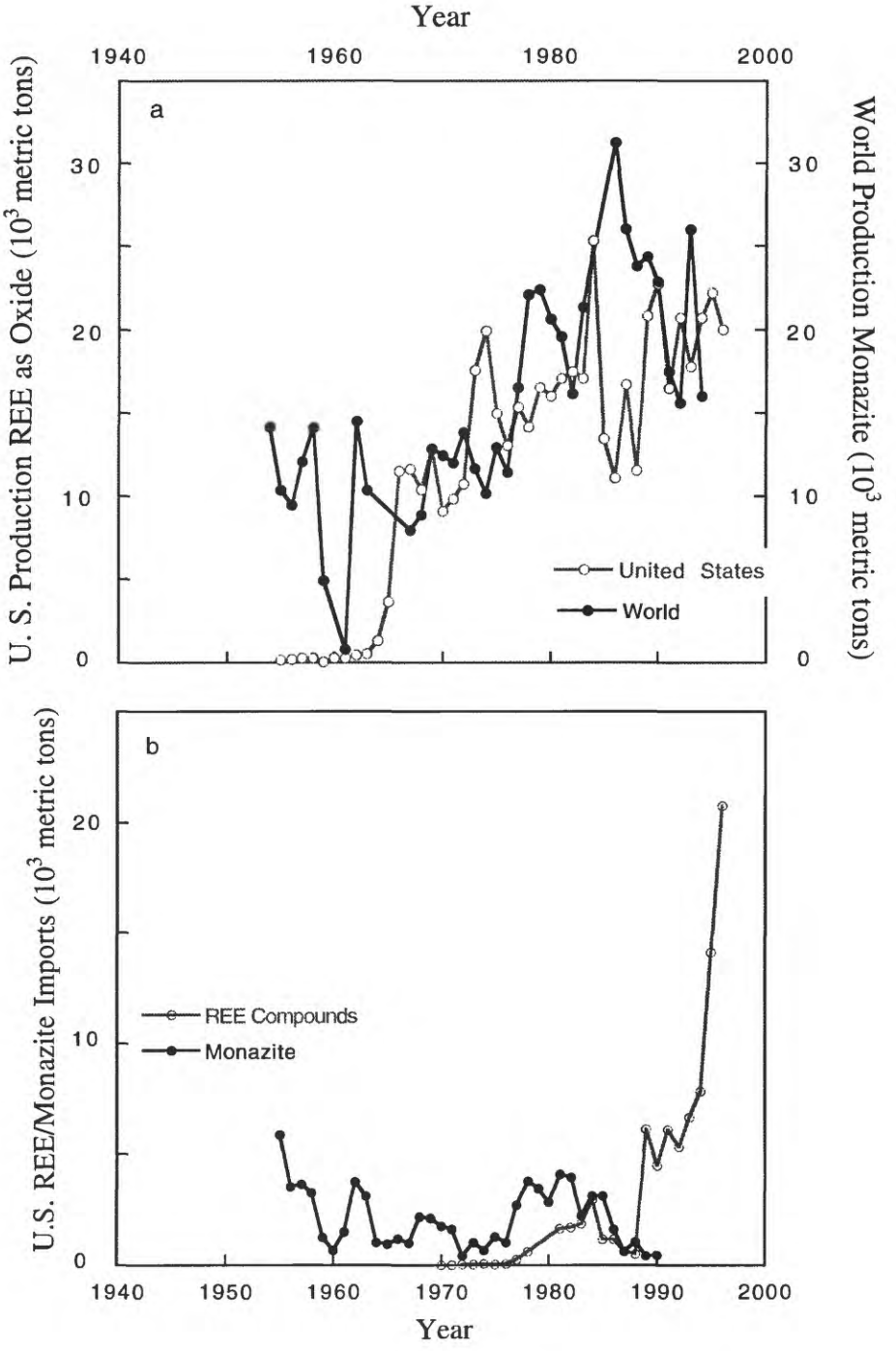

Figure 3. Selected rare-earth element statistics for the Unitled States for the second half of the 20th century (Minerals Yearbooks, 1882-1997).

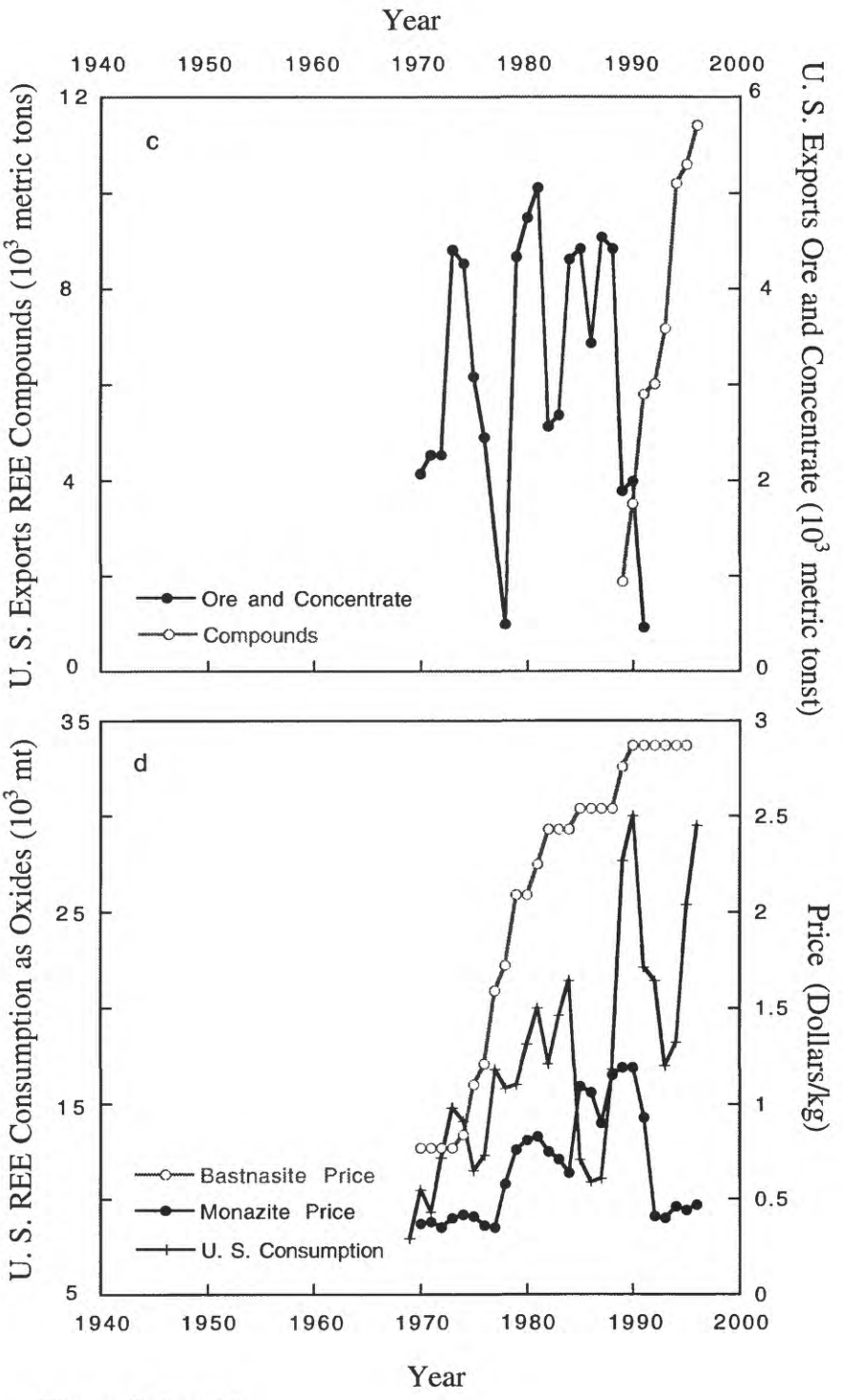

Figure 3. (cont.)