

SEP 04 2018

DEPARTMENT OF
WATER RESOURCES**Exceptions to Forfeiture for Mining Questionnaire- Section 42-223(11), Idaho Code**

This questionnaire should be used as a guide to provide evidence supporting an exception to forfeiture. Each answer will need to have corresponding documents and/or affidavits.

List the adjudication claim number(s) in which an exception to forfeiture under Section 42-223(11), Idaho Code is sought:

94-2113. This right is also claimed as exempt from forfeiture under Section 42-223(6).

- 1) Enter the name of the mine or property in which the water claimed above was historically used. (All of the following questions will refer to the mine or property named below.)

Gem Mill. See attached deed.

- 2) When was the mining, mineral processing or milling at the mine or property suspended?

The Gem Mill processed ore until ~1945. It processed ore from Hecla's mining properties in the vicinity of the Mill.

- 3) Described the reason(s) the mining, mineral processing or milling of minerals at the mine or property was suspended or the mine was closed?

New milling facilities were constructed to manage the ores from other Hecla mining properties, as the mines in vicinity of the Gem Mill curtailed operations based on metals prices.

- 4) Does the mine or property have one or more valuable minerals as defined in Section 47-1205, Idaho Code? If so, please list the mineral(s).

It was a milling facility, primarily processing lead and silver. The nearby mining properties are still owned by Hecla. The minerals available to Hecla include lead, zinc and silver. The Gem Mill could be rebuilt and restarted to handle the minerals from the nearby Hecla properties.

- 5) Please provide a history of the price of the mineral(s) at the mine or property?

USGS – Metal Prices in the United States through 2010 Report

- 6) Explain how the property and mineral rights have been maintained for future mineral production at the mine or property?

Hecla owns the patented mining claims where the facility was located. Hecla owns the patented claims where minerals are located in the vicinity of the Mill. Hecla maintains the Mill site property, conducts annual inspections and maintains access to the mill site. The site has not been converted to other uses and is maintained for future use as a mill site, when mineral prices and economic conditions justify refurbishing and reopening the mill.

Paul Glader Corp. Envl Director

Please print name and title of person completing this questionnaire

8/28/2018
Date

[Signature]
Signature of person completing this questionnaire

THIS INDENTURE, made this 30th., day of December, A. D. 1903,
between the MILWAUKEE MINING COMPANY, a corporation organized and incorporated
under the laws of the State of Idaho, the party of the first part, and the
HECLA MINING COMPANY, a corporation organized and incorporated under the
laws of the State of Washington, party of the second part:-

WITNESSETH: That said party of the first part, for and in
consideration of the sum of Fifty thousand (\$50,000.) dollars to it in
hand paid, by ^{said} the party of the second part, the receipt whereof is hereby
acknowledged, has granted, bargained and sold, and by these presents does
grant, bargain, sell and convey, unto the said party of the second part,
its successors and assigns, all the surface and surface rights into and
upon the following described real estate situated in Lelande Mining
District, Shoshone County, Idaho, to-wit:-

The "Chief" and "Josie" Lode mining claims, a United States
patent for which said claims is of record in the office of the Recorder
of the County of Shoshone, State of Idaho, in Book One of deeds, at page
165, reference to which patent and the record thereof, in said Recorder's
office, is hereby made for a more definite and specific description of said
claims, and each thereof, together with the concentrating building, machinery,
assay office, and all property located and situated on said "Josie" and
"Chief" mineral claims, saving and excepting therefrom a strip of land
fifteen (15) wide over the said mineral claims above described, for a wagon
road, as now located and used, and also excepting what is known as the
"Upper Bell" water right, located just below the Bell mine, and also
excepting a right of way across said claims, extending from the railway
line of the O. R. & N. Railway Company, to the portal of what is known
as the No. 3 or lower tunnel of the Gem mine, together with the use of
a portion of the surface of the dump, at the portal of said tunnel, with
the privilege ~~of~~ conveying mining materials, tools and ore across said
reserved right of way. None of said reservations, however, shall be ^{so} used at
any time, as to interfere in any way with the free and complete use of
the concentrating mills, or other works hereby conveyed, or any of the
railway sidings or roads leading thereto. And this conveyance is made
subject also to any rights or easements heretofore conveyed, by the grantor

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herein, to the Frisco Consolidated Mining Company, Limited. Also conveying a certain water right, located in 1889 claiming the waters of Canon Creek, said water right having its source just above the Frisco Mill. Also a certain water right, located in 1891, to the waters of the small stream in Bell Gulch, both of said water rights being of record in the office of the Recorder of Shoshone County.

TO HAVE AND TO HOLD the surface and surface rights, water rights, and tenements, hereditaments hereby conveyed unto the said party of the second part, its successors and assigns forever.

And the said party of the first part, for itself, its successors and assigns, does hereby covenant and agree, with the said party of the second part, its successors and assigns, that the said premises, and every part thereof, are free and clear of and from any and all liens, incumbrances, trusts and taxes, and that it, the said party of the first part, its successors and assigns, unto the said party of the second part, its successors and assigns, the said premises and property, and every part thereof, against itself its successors and assigns, and every other person lawfully claiming or to claim the same or any part thereof, shall and will warrant and for-ever defend, always saving and excepting the same provisos, reservations and limitations contained in the patent of the United States issued for said survey lots, and saving and excepting the other reservations heretofore mentioned in this conveyance.

IN WITNESS WHEREOF the said Milwaukee Mining Company has caused these presents, to be executed by its Vice-President, attested by its Secretary, and its corporate seal to be hereto affixed, the day and year first above written.

MILWAUKEE MINING COMPANY,

By John A. Finch
As its Vice-President.

Attest: H. R. Allen
As its Secretary.

Metal Prices in the United States Through 2010



Aluminum	Germanium	Mercury	Silver
Antimony	Gold	Molybdenum	Tantalum
Arsenic	Hafnium	Nickel	Tellurium
Beryllium	Indium	Niobium	Thallium
Bismuth	Iron and Steel	Platinum-Group Metals	Tin
Cadmium	Iron and Steel Scrap	Rare-Earth Metals	Titanium
Cesium	Iron Ore	Rhenium	Tungsten
Chromium	Lead	Rubidium	Vanadium
Cobalt	Lithium	Selenium	Zinc
Copper	Magnesium	Silicon	Zirconium
Gallium	Manganese		

Scientific Investigations Report 2012–5188

Copper (Cu)

by Daniel L. Edelstein

Copper, the first metal used by humans more than 10,000 years ago, is one of the most important materials in the development of civilization. Though copper is usually found in nature in association with sulfur, native copper metal found in a few places around the world was the most likely source of early copper used first for decorative and then for utilitarian purposes. The alloying of copper with tin to form bronze, a harder, stronger, and more readily cast metal, gave rise to an era bearing its name. With the dawn of the industrial revolution in Europe and the first transmission of electricity in the 18th century, demand for greater quantities and higher purity led to significant improvements in the mining, processing, and refining of copper metal. Its relatively low-cost availability and excellent electrical conductivity (second only to silver), combined with its properties of high ductility and thermal conductivity, malleability, and corrosion resistance, have resulted in copper becoming a major industrial metal that ranks third after iron and aluminum in terms of quantities used. Currently, more than 70 percent of copper used is in electric and electronic applications distributed throughout all sectors of the economy, and it is ubiquitous in our lives through use in the generation and distribution of electricity and the circuitry of all of our electronic items. Other uses include plumbing tube, heat exchangers, building hardware and roofing, and coinage. New uses of copper are found in such applications as silicon-based computer chips, solar and wind power generation, superconducting cables for the electric grid, antimicrobial touch surfaces, and rotors in energy-efficient motors.

Historically, wirebar was the dominant form of copper traded, and the price for refined copper wirebar was the "bellwether" price for copper. By the mid-1970s, however, technology had changed to continuous casting and drawing of wire rod directly from refined cathode, thus bypassing the need to cast wirebar. Even though more than 50 percent of primary copper produced in the United States is traded as rod by integrated mine producers, the high-grade copper cathode price is used as the "base" price for most transactions.

About 60 percent of domestic primary refined copper is produced from a multistage process, beginning with the mining and concentrating of ores, and followed by smelting and electrolytic refining to produce a high-grade cathode. The remaining 40 percent is produced from acid leaching of copper ores and wastes and solvent extraction and electrowinning of refined copper from the pregnant solution. Though historically most domestic producers have had a high degree of vertical integration, copper products from each stage of processing have their own independent markets and are traded globally. Each product has its own pricing procedure that is linked,

for the most part, to its copper content and the market price for refined copper. For example, copper concentrates, which contain between 20 percent and 35 percent copper, are purchased on the basis of the refined copper market value of their recoverable copper content, with charges taken for smelting and refining. Penalties may be assessed by the smelter/refiner for unwanted contaminants or low grade, and credits may be given for recoverable byproducts. Even though the smelting and refining charges are driven by processing cost factors, they may fluctuate significantly according to the market balance for concentrates and may be influenced by copper prices in protected markets and price sharing arrangements with miners. Similarly, prices for copper scrap are discounted from the refined value of the recoverable copper content to allow for processing costs and profit. Though the discount from refined copper must be sufficient to account for processing costs, market conditions for each type of scrap will affect the price.

Until the late 1970s, domestic copper prices were generally referenced to the U.S. producer price (fig.1; table 1). The traditional U.S. producer price, which normally included a charge for delivery and insurance, was based on annually negotiated sales contracts, with prices changing at least quarterly. The producer price system offered stability and served the interests of both the producer and the consumer. Producer prices tended to be higher than commodity exchange prices during weak markets and less than the exchange prices during high demand periods. During periods of tight supply, U.S. mills, most of which were producer-owned subsidiaries, were given allocations assuring them of reasonably priced supplies. Although the producer pricing provided stability for contract purchases, it created a two-tiered price structure, where spot purchases and exchange prices were significantly different from producer prices. During the peak demand period of the Vietnam War, 1964–69, the average London Metal Exchange Ltd. spot price was \$0.575 per pound, compared with only \$0.38 per pound for the domestic producer price.

Beginning with the nationalization of foreign production in Africa and Chile in the 1960s and early 1970s, the U.S. producers' influence on domestic and world markets weakened, and domestic producer pricing became more market sensitive, changing frequently to track global prices. Periods of surplus supply, which took place from the mid-1970s to the mid-1980s also contributed to the decreased influence of U.S. producer prices on world markets as surplus supplies flowed to the exchanges. As a result, U.S. producers abandoned classic producer pricing, some in 1978 and others in the early 1980s, and changed to a COMEX-based pricing system. Using the first-position COMEX price as a base, producers began to

quote premiums that generally included transportation and insurance costs (Jolly, 1991). The producer price quote came to reflect a weighted average of the delivered price of copper to domestic consumers by domestic producers. Since the adoption of COMEX-based pricing, the producer price margin has averaged about 5 cents per pound of copper, generally increasing at times of low prices and decreasing during high prices and ranging between an annual average of 2 cents and 7 cents per pound. During the high-price period from 2004 to 2010, the producer premium averaged 5.6 cents per pound, not significantly different from the 30-year average. While the traditional producer prices provided a buffer to price shifts, speculative influence on a COMEX-based pricing system has resulted in increased price volatility, especially during tight markets, such as from late 1987 through 1989, 1995 through 1997, and 2003 through 2010. Periods of stock surpluses and generally lower prices tend to create greater price stability. In response to the greater volatility of COMEX-based pricing, producers and consumers have increasingly used futures markets to hedge their sales and purchases.

Strike periods that take place with expiration of labor contracts have a significant effect on copper prices. The two 6-month strikes in 1946 and 1959, the 9-month strike in 1967–68, and the 5-month strike in 1980 were of particular significance. The 1967–68 strike had the most significant impact because it coincided with a period of high international demand occasioned by the Vietnam War and an unusually high period of worldwide economic growth. Government releases of stockpile material were used to alleviate shortages during each of these incidents, with the exception of the 1980 strike, which took place during a period of high commercial inventories and low Government stocks.

Since at least 1990, mines with capacities that are larger than 100,000 metric tons per year (t/yr) of copper have constituted from 65 percent to 70 percent of global copper mine capacity, and the largest 20 copper mines have accounted for about 40 percent of global capacity. Given a frequently close balance between production and consumption, disruptions to production at any given large mine can affect prices. For example, from 1989 to 1991, a series of events tempered what might have otherwise been a modest oversupply period. These events included political insurgencies and labor strikes at foreign producers that closed a 180,000-t/yr mine in Papua New Guinea and severely reduced production in Zaire [now Congo (Kinshasa)]. In 2003, in the face of high global inventories, the leading global copper mine producer altered its mine plan by processing lower grade ores and effectively reducing its capacity by 200,000 t/yr of copper. Similarly, a pit wall failure in Indonesia and a mine strike in Mexico reduced production and contributed to a price spike in 2006.

Governments' interventions in economic policies or directly in copper markets have had significant effects on copper prices. The U.S. Government has taken action during periods of war and national emergency to control prices and levy tariffs, to impose export quotas, to provide price supports, to lend monies for expansion and exploration, to guarantee pro-

duction purchases, and to buy and sell for the national stockpile. Most of these strategies, including the use of price controls (1971–74) were applied most recently during the Vietnam War. Beginning in the mid-1960s with the nationalization of copper mines in Chile, Congo (Kinshasa), and Zambia, the private copper mining industry (principally U.S. owned) lost a significant share of its net equity and influence in copper and its ability to adjust production at times of surplus. In 1978 and 1983, which were periods of depressed copper prices, the U.S. industry unsuccessfully filed suit with the International Trade Commission to restrict imports of "low-priced" copper. Currency devaluations by copper-exporting countries had served to lower their costs and maintain production levels. In 1967, the Intergovernmental Council of Copper Exporting Countries (CIPEC) was formed by countries accounting for about 40 percent of global copper mine production. Its attempt to intervene in the depressed copper market in 1975 by limiting production of member countries to 90 percent of normal production and by reducing CIPEC-country copper exports by 15 percent was not fully observed and was unsuccessful in stimulating a price rise (Mikesell, 1979, p. 187–215).

Although the price of copper has been influenced by business cycles, government policy, and technological changes, production costs and the balance or imbalance between supply and demand have ultimately been the principal determinants. The above influences, combined with the large capital investment and long lead times required to develop new mines, have resulted in a highly cyclical copper industry. World mine production reached a peak in 1974 at the height of a major economic recession; this followed capacity growth stimulated by the high-demand Vietnam War years. The resulting oversupply kept prices depressed for 4 years. Strong growth in consumption in the latter part of the 1970s led to tight supplies, high prices, and expansions in global capacity. When a sharp economic recession began in 1981, world mine production and capacity were again reaching peak levels. The resulting oversupply depressed prices for 5 years and resulted in the initial shutdown of about one-third of U.S. mine production. The large surplus and low prices discouraged new production for 3 years and set the stage for the tight supplies and high prices that ensued from 1987 to 1990. Similarly, a recession in 2001 led to a large inventory surplus and a sustained period of low prices.

World copper inventories began to rise in 1990 with the onset of a global recession and, except for a dip in 1992, continued to rise through most of 1993. Though relatively high by historical standards, copper prices declined as copper inventories rose. In 1992, a short-lived dip in inventories that was attributed to a bottleneck in smelter capacity caused prices to spike upward for several months before resuming their downward trend. Despite rising London Metal Exchange (LME) inventories, a second spike in prices took place in mid-1993; a spot shortage of copper developed that was attributed to market control by several large market participants. Prices plummeted in September when the LME intervened to limit

price backwardation (forward prices selling at a discount to spot prices).

Prices rose sharply in 1994 following a strong growth in world demand, which had stagnated during the preceding 3 years, and the onset of a production deficit. The rapid growth in world demand, fueled by the United States and Asia, stimulated a surge in new capacity development, particularly in South America. Changing political/investment climates, including increased government stability and privatization efforts, made foreign investment more attractive to companies that sought to protect themselves from future downturns by investing in lower cost production. An anticipated surplus in production was delayed, in part, by higher-than-expected consumption and by production disruptions, including political strife in Africa, which reduced expected output. In June 1996, copper prices plummeted from the high level of the previous 18 months, the producer price falling to \$0.94 per pound, following revelations by Sumitomo that it had lost several billion dollars on unauthorized copper trades and speculation by industry that Sumitomo held large unreported copper inventories (Platt's Metals Week, 1996). Following the sharp drop in prices, however, an increasingly tight copper supply caused prices to rise to \$1.20 per pound.

With the onset of the Asian economic crises in 1997, demand failed to keep pace with production increases, and a global copper surplus developed. Yearend 1998 inventories held in global metal exchange warehouses (COMEX, LME, and the Shanghai Futures Exchange) rose to 760,000 metric tons (t) from 457,000 t at yearend 1997. The constant dollar copper price in 1998 fell to the lowest level since the Great Depression of the 1930s. Prices continued their downward trend for the first half of 1999, and exchange warehouse stocks reached a new record high of almost 900,000 t. Prices trended upward in the second half of 1999 to about \$0.80 per pound as stocks stabilized and North American and South American producers announced production cutbacks.

In 2000, strong consumption growth (led by Asia) and mine production cutbacks resulted in the global production-to-consumption balance shifting from a surplus to a deficit. Combined yearend inventories on the global exchanges fell by more than one-half to about 524,000 t, and the monthly average COMEX price ranged between \$0.77 and \$0.91 per pound. The deficit market, however, was short lived owing to the onset of a global recession in 2001. Demand for refined copper in 2001 declined for the first time in 10 years, inventories rose, and the COMEX price fell below \$0.70 per pound of copper. Global exchange inventories continued to rise through April 2002, peaking at more than 1.5 million metric tons (Mt). By yearend, however, inventories began to fall owing to cutbacks in production and the emergence of China as the leading global consumer of refined copper, displacing the United States. Apparent consumption of copper in China rose to 2.8 Mt in 2002 from only 1.5 Mt in 1999. Though trending downward through the first three quarters of 2003 to below 1 Mt, large overhanging exchange inventories kept prices relatively

low, and the COMEX copper price averaged only about \$0.77 per pound for the first three quarters of 2003.

In October 2003, in response to a continued slide in global exchange inventories and concerns over supply disruptions, prices began a steep climb, the COMEX price peaking at yearend at \$1.04 per pound. This marked the beginning of an upward trend in copper prices to increasingly higher record levels that persisted until the onset of the global financial crisis during the fourth quarter of 2008. By yearend 2004, global exchange inventories had fallen to 124,000 t, and the COMEX copper price had risen to a then record-high monthly average of \$1.43 per pound. Though volatile, copper prices on average continued to climb. In May 2006, the COMEX price reached a new record daily high of \$4.08 per pound of copper, and in April 2008 reached a new record monthly average high of \$3.94 per pound. According to data compiled by the International Copper Study Group (ICSG) (2010, p. 9), the balance between refined copper production and consumption showed an almost continuous production deficit and a cumulative production deficit (2003–07) of almost 1.4 Mt of refined copper. Though trending slightly upward from yearend 2004, global exchange inventories remained very low by historical standards.

Several factors contributed to the market imbalance and rise in prices. According to ICSG data (International Copper Study Group, 2010, p. 25), global consumption of refined copper rose by 16 percent (2.5 Mt) from 2003 to 2007, led by a 60-percent growth (1.9 Mt) in China's apparent consumption of refined copper. Meanwhile, despite a 2.7-million-metric-ton-per-year (Mt/yr) growth in global mine production capacity (International Copper Study Group, 2011b, p. 13), mine production rose by only 1.7 Mt. Factors that contributed to a lower mine capacity utilization rate (85.4 percent in 2007 compared with 89.7 percent in 2003) included shortages of equipment, supplies, utilities, and labor that accompanied the coincident production growth and demand increases for copper and other mineral and agricultural commodities; technical problems associated with capacity expansion and startup of new operations; and labor and political unrest, at least in part attributed to higher copper prices. The above limitations reduced miners' ability to produce additional copper at any price. Despite a significant increase in production costs, prices rose significantly above marginal production costs as increased investment interest in commodities spurred a global runup in prices across mineral commodities.

Global copper consumption and prices continued their upward trend through the first 9 months of 2008. In October, however, with the onset of the global financial crisis, prices began a sharp downward spiral that did not come to a halt until December 24, when the COMEX price fell to \$1.25 per pound of copper, the lowest level since September 2004. Despite a year-on-year growth for the first 8 months of 2008, global consumption of copper for the full-year 2008 was down slightly from that of the previous year.

Copper prices trended sharply upward in 2009 and 2010, the COMEX price rebounding to an average monthly price of \$3.19 per pound in December 2009, and a new record-high daily price and monthly average price of \$4.27 and \$4.17 per pound, respectively, in December 2010. Though global exchange inventories rose to almost 790,000 t at yearend 2009, cutbacks in production in response to the economic crises and a 38-percent growth (2008–09) in China's apparent consumption spurred concerns over future supply adequacy and renewed speculative interest (International Copper Study Group, 2011a, p. 19). Global recovery outside of China in 2010, which helped sustain a renewed growth in global copper consumption and a continuing downward trend in mine capacity utilization, led to a decline in global exchange inventories, increased speculative interest, and the runup in prices.

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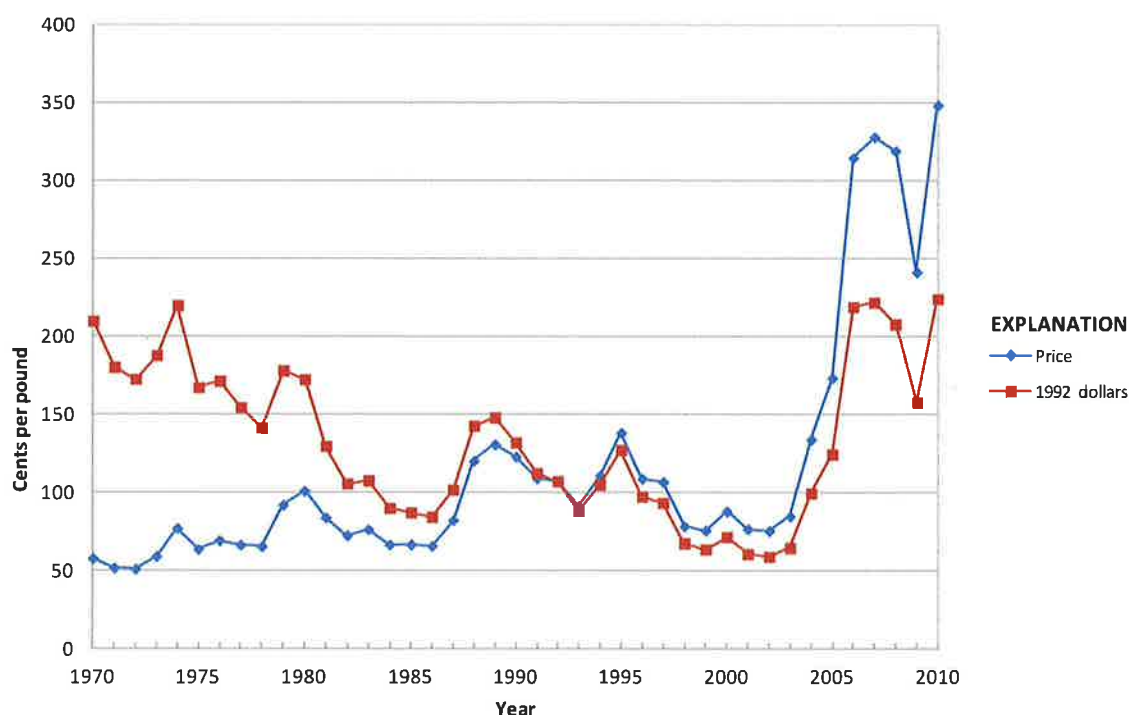


Figure 1. Annual average U.S. producer copper prices.

Significant events affecting copper prices since 1970

1970–73	Continued high wartime demand, though export controls and set-asides instituted to meet defense needs were eased; two-tier pricing generates Government concern; price controls limit price rise; nationalization of U.S.-owned Chilean properties; the Organization of Petroleum Exporting Countries oil embargo begins
1974	End of price controls and strong demand caused first-half price rise before second-half economic reversal; last wartime-related stockpile release (229,000 metric tons); fixed exchange rates abandoned
1975–77	Demand dropped precipitously owing to recession; copper inventories rose to record levels; high price volatility
1978–80	Record copper consumption and lower stock levels; rising precious metals prices; 5-month labor strike; beginning of Commodity Exchange, Inc. (COMEX)-based pricing
1981	Large growth in domestic and world production; rising inventories
1982–84	Recession; inventory buildup; U.S. production sharply curtailed; expansion of COMEX-based pricing
1985–6	Drawdown of high copper inventories; cutback in capacity at U.S. mines; cost cutting and efficiency moves
1987–89	Historically low inventories; growing world consumption; prices peaked at \$1.68 in December 1988
1990–92	Global supply constraints balanced recession; dissolution of the Soviet Union and political turmoil in Africa; precarious supply/demand balance led to price volatility
1993	Stagnant world demand and rising inventories; London Metal Exchange (LME) intervention in market caused sharp price drop in September
1994–95	Strong global demand growth, sharp inventory decline, highest annual price to date; LME opened U.S. warehouses
1996	Sumitomo Corp. revealed huge trading losses, and prices plummeted at midyear despite global inventory decline
1997–98	Asian economic crises and rapid expansion of global capacity combined to generate large global surplus
1999–2000	Asian demand growth and production cutbacks reduced oversupply and encouraged higher prices
2001–02	Global recession reduced demand and led to large inventory buildup; China displaced the United States as leading world consumer of refined copper
2004–07	Explosive growth in China's demand, production disruptions, and delays in new capacity constrained supply; global exchange inventories fell to minimal levels and copper prices rose to new record-high levels, buoyed by investment interest
2008	Onset of global economic crisis in fourth quarter caused prices to plummet and inventories to rise
2009–10	Copper prices rebounded owing to extraordinary growth in China's apparent consumption, continued supply constraints, and renewed interest in commodity investment; China accounted for 38 percent to 39 percent of world demand, up from 12 percent in 2000

Gold (Au)

by Micheal W. George

Gold was highly regarded by ancient civilizations that possessed it because of its scarcity, durability, and malleability. In ancient times, gold was used for jewelry, craft, or ceremonial purposes and not for its monetary value. Its characteristic yellow color was reminiscent of the sun, which was worshiped as a deity. Because of its high specific gravity, it was first recovered from streambed gravels as nuggets or flakes, where it occurred in metallic form, and thus required no complicated metallurgical extraction from ores; it was essentially imperishable and was easily worked.

These beautiful and seemingly indestructible nuggets were prized possessions that could be fashioned into bars of different set weights, and into ornaments and items of adornment that also served as portable wealth. At first crude, but increasingly refined and specialized over the years, these manufactured forms eventually diverged, at least partly, into jewelry and money. For more than five millennia, until well into the 20th century, they were the only quantitatively important uses of gold.

During that time, there remained, and in some developing countries remains today, a functional overlap between jewelry and money; that is, items of gold jewelry have been used as money, and gold money has been made into items of jewelry. Crude forms of jewelry/money appear to have originated soon after the founding of the first cities. The invention of money is commonly ascribed to the Mesopotamians or, more specifically, the Sumerians, who lived in what is now southern Iraq. The art of working gold and silver into jewelry and (or) money seems to have arisen in Crete, Egypt, and Sumer at roughly the same time—probably around 3000 B.C. From the beginning, the universal perception of gold as a store of wealth has been implicit in its use as money and jewelry (Green, 2007).

Increases in gold price have had a good basis in history. From 1344 to 1717, the price for gold almost quadrupled, reaching the equivalent of \$20.67 per troy ounce. That price was maintained for more than 200 years until the enactment of the Gold Reserve Act, which increased the price of gold to \$35 per troy ounce, on January 30, 1934. Pressure for still another increase in price gathered momentum less than 15 years later. Prices as high as \$105 per troy ounce had been proposed, and world trade brought prices up to \$70 per troy ounce (Colorado School of Mines, 1959).

In November 1961, the London gold pool, in which central banks of the United States and seven other nations agreed to buy and sell gold to support the \$35-per-troy-ounce price, was established (Ryan and McBreen, 1962, p. 607). On March 17, 1968, the governors of the member central banks

announced that they would no longer buy and sell gold in the private market but would sell gold to each other for \$35 per troy ounce. Thus, a two-tier market was established—an official market and a private market—in which the price was determined by supply and demand (Ryan, 1969, p. 535).

Following the establishment of the two-tier price system, a fixed price of \$35 per troy ounce for official monetary transactions and a floating market price for private transactions, the U.S. Government asked Engelhard Minerals and Chemicals Corp. (known today as Engelhard), to quote a daily price. Engelhard initiated a buying quotation—the lowest price at which it could obtain sufficient gold of 99.95 percent purity to meet its requirements. A selling quotation \$0.60 above the buying price, later reduced to \$0.40, was also established (Ryan, 1969, p. 535). Thus, the basis for the average domestic market price for gold shown in the table was established (fig. 1; table 1).

On August 15, 1971, the President announced the suspension of convertibility of dollars into gold. Following provisions of Public Law 92–268, the Par Value Modification Act, enacted March 31, 1972, the official price of gold was increased to \$38 per troy ounce on May 8, 1972 (West, 1975, p. 557).

Following amendments to the Par Value Modification Act contained in Public Law 93–110, enacted on September 21, 1973, the dollar's par value was devalued by 10 percent, to 0.829848 Special Drawing Rights [a unit of account in the International Monetary Fund (IMF)]. This fixed the official price of gold at \$42.22 per troy ounce effective at 12:01 a.m., October 18, 1973. That price remains unchanged (West, 1975, p. 560).

Gold occupies a unique position among the world's commodities; it is an internationally traded commodity and a long-established, universally acceptable storehouse of value, considered by many people worldwide to be superior to fiat paper currencies with fleeting longevity or fluctuating unpredictable value. It has been said many times that gold is "forever;" its high intrinsic and monetary value usually dictates that, in time, most of it will be recycled to serve again. Because of its historically high value, much of the gold mined throughout history is still in circulation in one form or another (Lucas, 1993, p. 505).

As a consequence of the dual roles played by gold, as commodity and as money, its price cannot be viewed as one would view the price of other goods or services in a free market. Gold also cannot be viewed strictly from the standpoint of the U.S. market alone because international political and

economic events that may influence the market for gold as a commodity may be outweighed by developments perceived to favor gold as a medium of exchange.

During 1969 and 1970, the United States experienced a mild recession, while the Republic of South Africa was permitted to sell gold to the IMF at \$35 per troy ounce or less to meet its foreign exchange needs (Hoyt, 1971, p. 521).

By December 1971, the U.S. dollar had been devalued by 7.9 percent per exchange agreements reached during the Smithsonian Accords in Washington, D.C. Affected by previous year's devaluation, the official U.S. gold price was raised to \$38 per troy ounce on May 8, 1972; speculative buying was encouraged by monetary policy changes made by the European Economic Community and by restricted supplies of newly mined gold (West, 1974, p. 567).

In 1973, the gold market was influenced by a weakening and devaluation of the U.S. dollar, lowered confidence in currency values, higher inflation rates, unsettled world trade, and, for the third consecutive year, lower mine production. The official U.S. gold price was increased to \$42.22 per troy ounce on September 21. An embargo was begun on petroleum shipments to the United States by the Organization of Petroleum Exporting Countries (OPEC) in mid-October. The two-tier gold price system, begun in 1968, was terminated on November 13, 1973 (West, 1975, p. 557).

The OPEC embargo contributed to rising oil prices, worldwide inflation, and general economic uncertainty in 1974. Following provisions of Public Law 93-373, enacted August 14, 1974, the President was given the authority to repeal the prohibition on the holding of gold by private citizens, and effective December 31, 1974, the prohibition was repealed and gold prices rose on speculation. The gold price trend was reversed in December by the U.S. Treasury's announcement that it would offer 62,200 kilograms (kg) (2 million troy ounces) of Treasury gold for public sale beginning on January 6, 1975. Investor and speculator interest was diminished by the announcement by the IMF that it would sell 778,000 kg (25 million troy ounces) of gold on the open market beginning in 1976. The Treasury, however, was able to sell 38,900 kg (1.25 million troy ounces) from its gold stock during 1975 (West, 1977, p. 669).

Monthly IMF auctions were begun in midyear 1976 to provide capital for low-interest loans to developing countries. The IMF planned to sell a total of one-sixth of its gold stocks, or 778,000 kg (25 million troy ounces), during a 5-year period, and planned to restore an equal portion to member countries. In addition, a reduced inflation outlook drove prices down until October, when the low gold price and renewed anxiety about the economy served to reverse price trends. The Treasury gold stock was down at yearend owing to its use in Bicentennial medals, which were made by the Bureau of the Mint (West and Butterman, 1978, p. 591).

The world economy was stagnant in 1977. Limited success in controlling inflation led to higher gold prices, which benefitted the IMF auctions that continued throughout the

year. There was a hiatus in Treasury sales (Butterman, 1980, p. 428).

IMF auctions continued during 1978, and the Treasury resumed gold stock selling (Butterman, 1980, p. 428). Middle East oil-producing countries and investors began purchasing gold with their eroding dollar assets.

Economic conditions worsened during the next 3 years. Political events in Iran, Afghanistan, and elsewhere propelled the price of gold to a high of \$850 per troy ounce by January 21, 1980. The IMF completed its 5-year auction program in May 1980. The Treasury sold no more gold in 1980 or 1981 (Lucas, 1981, p. 347). After the U.S. hostages were released by Iran on January 20, 1981, political tension was lessened, which led to less hoarding and reduced gold prices. The Japanese began to invest in the gold market.

Although the U.S. strict monetary policy contributed to a recession and high interest rates in 1982, the advent of computer trading contributed to short-term volatility in the gold price. Lingering effects of the world economic recession on the mineral industry led to profit taking during the first part of 1983. Speculative gold trading to midyear strengthened price but was followed by profit taking (Lucas, 1984, p. 385). Oil prices weakened, while gold supplies from mines and official sources increased.

In 1984, the price declined owing to increasing strength of the U.S. dollar and investor selling. Weakened price and a favorable market outlook contributed to increases in demand for gold-bearing fabricated products. The U.S. dollar weakened in the first quarter of 1985 against major European currencies and the Japanese yen. It continued weakening in 1986, which encouraged gold investment (Lucas, 1988, p. 441) as oil prices declined sharply.

By 1987, there was a sharp reversal in world stock markets with a continued weakness of the U.S. dollar combined with growing concern regarding U.S. budget and trade deficits and increasing U.S. private and Third World debt. Stability of the international monetary arrangements was questioned. Volatile investment markets generated increased gold-trading activity (Lucas, 1988, p. 441). During 1988, gold prices declined in response to a variety of factors, such as the withdrawal of the Soviet troops from Afghanistan, which gave investors the perception that political stability was at hand; weakening oil prices combined with an increase in interest rates by the U.S. Federal Reserve led to reduced inflationary expectations, increasing U.S. dollar strength, as well as improving U.S. trade results (Lucas, 1989, p. 64-65).

Official sector gold sales increased in 1989 as central banks adopted a more aggressive policy of gold management. In addition, a change of attitude developed toward gold, aided by concerns about the security of bonds and other financial assets and a setback in the U.S. stock markets in mid-October (Gold Fields Mineral Services Limited, 1990, p. 8).

The rise in Japanese interest rates in 1990 provided alternate investment havens. The former Soviet Union was reported to have sold significant amounts of gold for hard

currency. The Chinese sold out of equity swap agreements that were negotiated in mid-1989. The gold price drifted down as a result of the Persian Gulf War and the recession (Gold Fields Mineral Services Limited, 1991, p. 8–9).

The brief multination conflict that started in 1991 in the Persian Gulf did little to affect the perception of moderating political stability generally or to influence the price of gold for any sustained period of time. The collapse and restructuring of the Soviet Union, however, did much to reduce investor interest in gold (Gold Fields Mineral Services Limited, 1992, p. 5).

The end of the 1992 bear market encouraged a return of European and U.S. investor confidence. In 1993, the high gold price, which particularly affected the local currencies of the Middle East and Asia, resulted in reduced hoarding of coins and large amounts of gold scrap being introduced into the market (Roskill Information Services Ltd., 1995, p. i).

During 1994, the gold market held onto the gains achieved during the previous year, but the U.S. dollar price lacked direction and volatility. Hoarding of gold continued to be reduced as investors deserted the market (Roskill Information Services Ltd., 1995, p. i).

The average dollar price of gold remained almost unchanged between 1994 and 1996. Late in the fourth quarter of 1996, the Dutch Government provided a key catalyst by selling one-third of its reserves (Gold Fields Mineral Services Limited, 1997, p. 5). Fears that other central banks might sell their gold reserves followed (CRU International Ltd., 1996, p. 19).

During 1997 through 2001, central banks of several countries sold large shares of gold holdings to meet common-currency criteria for the European Union or to demonetize. Bank failures or insolvencies in East and Southeast Asian countries created uncertainty in investment circles. The price of gold returned to the low levels of 1979 (Gold Fields Mineral Services Limited, 1998, p. 5).

The gold price started to increase in late 2001 after the terrorist attacks on September 11, and continued to climb into 2010. The annual average price of gold in 2001, the lowest level since 1978, was \$272.22 per troy ounce. After 9 continuous years of near-double-digit-percentage yearly increases, the average annual price in 2010 was \$1,227.51 per troy ounce or 351 percent greater than the 2001 price. The driving force behind the price surge has been the increased investments, lack of sales from central banks, producer dehedging, and decreased mine production. Many investors turned to gold as a safe haven investment because of the multiple wars, global economic downturns, and devaluation of the U.S. dollar.

In 2003, a gold exchange traded fund (ETF) first appeared. Gold ETFs have gained popularity with many investors. According to some industry analysts, investing in gold in the traditional manner is not as accessible and carries higher costs owing to insurance, storage, and higher markups. The claimed advantage of the ETF is that the investor can purchase gold ETF shares through a stockbroker without being concerned about these problems, and the ETFs are treated by regulators as securities. Each share represents one-tenth of

an ounce of allocated gold. With the advancement of ETFs, investors had easier access to gold as an investment. By the end of 2010, there were 23 ETFs and 2 physically backed Canadian funds, which had physical gold holdings of 2,190 metric tons (CPM Group, 2011, p. 41–46).

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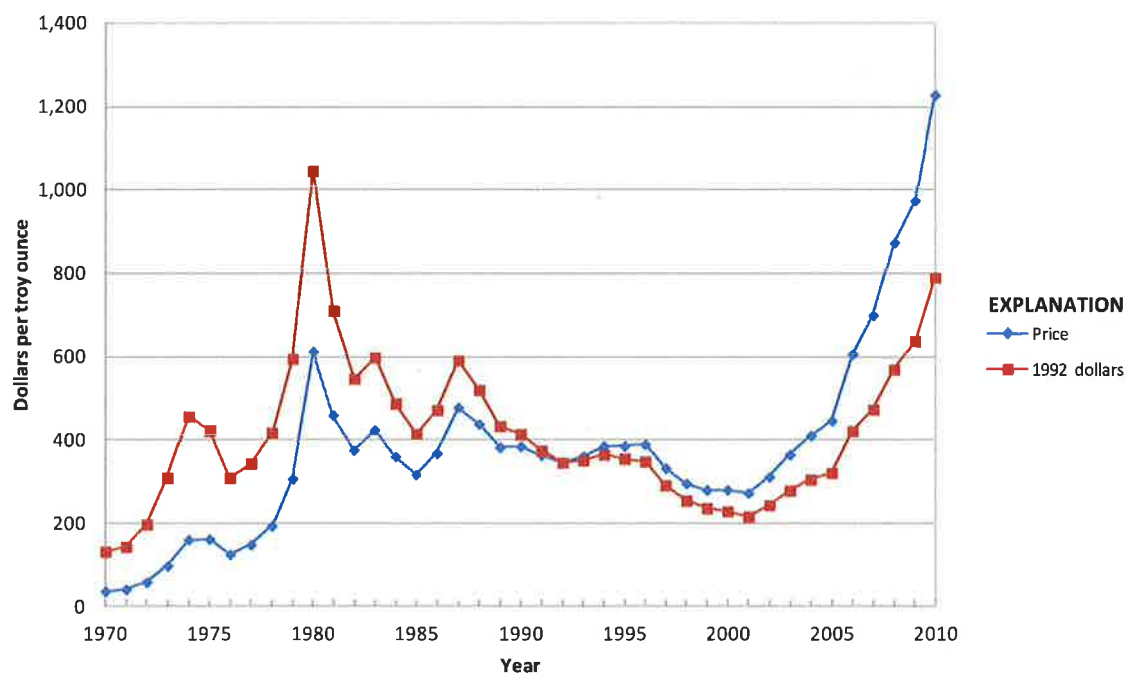


Figure 1. Annual average gold price.

Significant events affecting U.S. gold prices since 1970

1971	President suspended convertibility of dollar into gold; dollar devalued by 7.9 percent
1972	Official U.S. gold price increased to \$38 per troy ounce
1973	Official U.S. gold price increased to \$42.22 per troy ounce, dollar devalued, two-tier gold price terminated, Organization of Petroleum Exporting Countries (OPEC) oil embargo begins
1974	U.S. citizens allowed to hold gold bullion and coins for the first time in 40 years
1975	U.S. Treasury began public sales of gold stocks
1976	International Monetary Fund (IMF) began 5-year gold sales program; IMF auctions and lower inflation outlook drove gold prices down
1977	Hiatus in U.S. Treasury gold sales
1978	U.S. Treasury resumed selling gold; Middle Eastern investors increased gold purchases
1979	Soviet Union invaded Afghanistan; political upheaval in Iran; taking of U.S. hostages
1980	Gold price peaked at an historic daily high of \$850 per troy ounce on January 21; IMF completes 5-year gold sales program
1982–88	Fluctuating world currency exchange rates, increasing concern about U.S. trade and budget deficits and banking problems, and Third World debt
1989–91	Conflict in the Persian Gulf and the breakup of the Soviet Union; erosion of gold's role as a safe haven for investors; generally weak economic growth worldwide
1992–96	Gold price remained relatively stable
1997–2001	Central banks of several countries sold large shares of gold holdings to meet common-currency criteria for European Union or to demonetize; bank failures or insolvencies in East and Southeast Asian countries
2001	September 11 terrorist attacks
2002–10	Prices surged because of increase in investment in gold stemming from political and economic concerns

Table 1. Annual average gold price.

[Values in dollars per troy ounce]

Year	Price	Year	Price	Year	Price	Year	Price
1968	40.06	1979	307.50	1990	384.93	2001	272.22
1969	41.51	1980	612.56	1991	363.29	2002	311.33
1970	36.41	1981	459.64	1992	344.97	2003	364.80
1971	41.25	1982	375.91	1993	360.91	2004	410.52
1972	58.60	1983	424.00	1994	385.41	2005	446.20
1973	97.81	1984	360.66	1995	385.50	2006	605.83
1974	159.74	1985	317.66	1996	389.08	2007	698.95
1975	161.49	1986	368.24	1997	332.38	2008	873.50
1976	125.32	1987	477.95	1998	295.24	2009	974.68
1977	148.31	1988	438.31	1999	279.91	2010	1,227.51
1978	193.55	1989	382.58	2000	280.10		

Notes:

1968–93, Englehard domestic market price, 99.95-percent-pure gold, in Metals Week.

1994–2010, Englehard domestic market price, 99.95-percent-pure gold, in Platts (Platt's) Metals Week.

Lead (Pb)

by David E. Guberman

Lead is a very dense, ductile, malleable, corrosion resistant, blue-gray metal that has been used for at least 5,000 years. Early uses of lead were in building materials, water pipes, and pigments for glazing. The castles and cathedrals of Europe contain considerable quantities of lead in roofs, windows, pipes, and decorative fixtures (Shea, 1996, p. 1). In the United States, lead was first mined in Virginia in 1621. During the colonial period, lead was mined in New York, North Carolina, and several New England States. By the late 1860s, most of the mine production of lead came from the lower and upper Mississippi Valley regions. A westward expansion of mining began soon thereafter. Many gold and silver mines were developed, some of which contained significant concentrations of lead. In addition, the Missouri Lead Belt, in southeastern Missouri, was developed, as well as the Tri-State Lead District, which included Kansas, Missouri, and Oklahoma. By the late 1950s, depletion of lead reserves in the Lead Belt and discontinuation of mining in the Tri-State region encouraged the discovery and development of the Viburnum Trend mining region in southeast Missouri, thus establishing the framework for the current domestic primary lead industry. Missouri has been the foremost lead-mining State since 1907 and has retained that status throughout the century, except for 1962 when mine output was curtailed by a prolonged strike (Hofman, 1918, p. 1–6; Howe, 1980, p. 1–5).

In conjunction with the mining of lead, numerous primary lead smelters and refineries have been operated in the United States since primary lead production was first recorded in 1825. By 1887, annual production of primary refined lead had reached 132,000 metric tons (t). By 1926, production increased to a high of 725,000 t, representing 87 percent of the total refined lead production. As the production of secondary lead increased, production of refined lead from primary sources gradually decreased. In 1997, annual production of primary refined lead was 343,000 t, representing 24 percent of the total refined lead production. The price of primary refined lead increased from \$0.04 per pound in the early 1900s to \$0.12 per pound in 1959, reaching a high of about \$0.18 per pound during the post-World War II economic boom from 1946 to 1948 and the Korean conflict in the early 1950s (table 1). Between 1959 and 1973, lead prices remained fairly stable, ranging from \$0.12 to \$0.16 per pound. This stability was due, in part, to the enactment of Public Law 87–374, the Lead and Zinc Mining Stabilization Program, in 1961. The program, which remained in effect through 1969, authorized payments to qualified miners when the market price of lead dropped below \$0.145 per pound. In the early 1970s, movement in the price of lead was restrained by anti-inflation price controls.

With the lifting of price controls in December 1973, the price of lead quickly increased, reaching a historic high in 1979 during the post-Vietnam War economic boom (fig. 1). By the late 1990s, the price of lead had increased tenfold compared with the price at the beginning of the century. In terms of 1992 dollars, however, the price of primary refined lead was \$0.39 per pound in 1998, compared with \$0.59 per pound in 1959.

Historically, lead has not been and is not a price-elastic commodity. Its significant uses in any given era have not depended on price and, for the most part, other metals cannot substitute for lead in these cases. Prior to the early 1900s, uses of lead were primarily for shot, bullets, water lines and pipes, pewter, brass, glazes, paints or other protective coatings, burial vault liners, and leaded glass or crystal. With the advent of the electrical age and communications accelerated by technological developments in World War I, cable lead and solders became preeminent. With the growth in production of public and private motorized vehicles and the associated use of starting lighting ignition (SLI) lead-acid storage batteries andterne metal for gas tanks after World War I, demand for lead increased. In addition to their continued use in SLI applications, new uses of storage batteries have included motive sources of power for industrial forklifts, airport ground equipment, mining equipment, and a variety of other electrically powered nonroad utility vehicles, as well as stationary sources of power in industrial-type applications, such as uninterruptible electrical power supply equipment for hospitals, computer and telecommunications networks, and load-leveling equipment for commercial electrical power systems. Most of these uses continued to expand with the population and the national economy, and total demand accelerated further with electronic developments (primarily television and video display tubes) and demand for leaded gasoline after World War II, peaking between 1977 and 1979. With the near phaseout of lead in gasoline, paints, solders, and water systems, and the imposition of expensive environmental production controls, the industry experienced hard times between 1982 and 1986. However, the industry made a dramatic recovery by the late 1980s, owing to massive retrenchment in the primary and secondary producing sectors with attendant cost reductions, and to expansion in demand for industrial-type battery systems, and record SLI battery shipments. Growth in the battery industry continued into the 1990s. By 1997, lead-acid storage batteries represented a record high 87 percent of reported U.S. consumption of lead. Demand for lead in the battery sector is associated, to a significant extent, with the demand for replacement automotive batteries. In 1997 and 1998, there was some softness in the price of lead owing to 2 consecutive years

of moderate temperatures in the more-populated regions of the United States that reduced the rate of failure of automotive-type batteries.

The lead market in the United States evolved from 1998 to 2010. During this time, secondary lead became an increasingly important component of total domestic lead consumption and production, and reliance on mined lead declined. Domestic secondary refined lead, produced principally from spent lead-acid batteries, accounted for a greater percentage of total reported lead consumption in 2010 than it had in 1998. In 1998, the 1.06 million metric tons (Mt) of secondary lead produced was equivalent to about 65 percent of reported domestic lead consumption. In 2010, about 1.14 Mt of secondary lead was produced—nearly 80 percent of reported domestic lead consumption. During the same time period, annual recoverable mined lead production in the United States declined by 28 percent, to 356,000 t from 493,000 t, and annual production of primary refined lead decreased 66 percent, to 115,000 t from 337,000 t. One of two primary lead smelters operating in the United States closed in 2003, and the other smelter curtailed production levels in 2009. The balance of the lead concentrates that were not smelted and refined domestically were exported directly from mines to China and other foreign consumers. The increased reliance on secondary lead meant that the price and availability of lead scrap became an important component affecting lead prices. Domestic secondary refineries frequently competed with foreign producers for this scrap.

The development of emerging economies in Asia, specifically China, had a significant impact on lead prices. According to the International Lead and Zinc Study Group, refined lead consumption in China was 4.21 Mt in 2010, an increase of 734 percent from 505,000 t consumed in 1998. This increase in consumption was attributed to rapid growth in the lead-acid battery industry for automotive and industrial uses and the increased popularity of battery-operated electric bicycles. Mine and refined lead production also increased in China during this period. In contrast to China, refined lead consumption in the United States declined slightly during the corresponding period. The strong demand for lead in China intensified

between 2004 and 2007, and this was a major factor behind lead price increases during that period. China removed a value-added tax rebate and imposed a 10 percent tax on exports of refined lead, leading to significantly decreased exports. As a result, an appreciable shortage of refined lead was evident in the world market during 2007, which led to a substantial price increase.

Lead prices declined in the second half of 2008 as the global economic downturn began to slow global lead consumption. The average North American Producer prices in September 2008 were nearly 30 percent lower than they were at the beginning of the year. The global lead market moved into a state of surplus in 2008, where it remained through year-end 2010. The automotive market was adversely affected during this period, and shipments of lead-acid batteries declined. On a global basis, multiple lead-producing zinc mines closed or were placed on temporary care-and-maintenance status owing to declining zinc and lead prices. Domestically, a lead-producing zinc mine in northeastern Washington was placed on care-and-maintenance status owing to reduced demand for zinc. North American shipments of lead-acid batteries increased in 2010 compared with those of the previous year, and North American Producer prices began to increase in the third quarter of 2010. By yearend 2010, the price of lead was 9 percent greater than it had been at the end of 2009.

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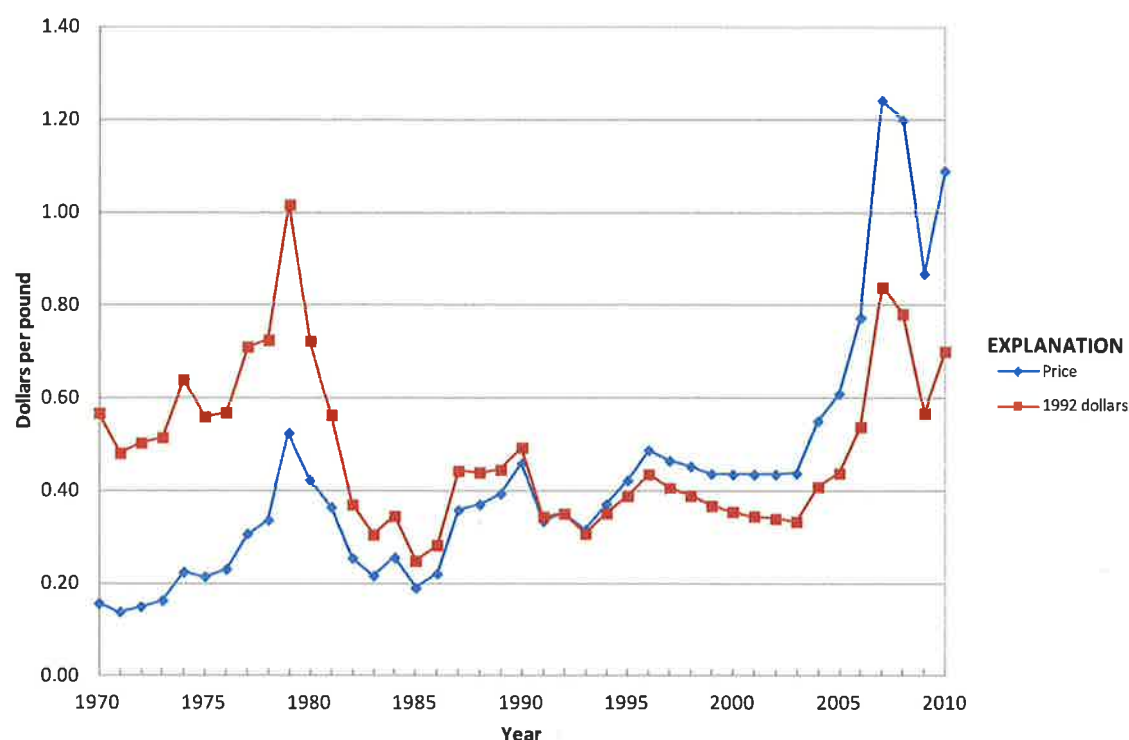


Figure 1. Annual average lead price.

Significant events affecting lead prices since 1970

1971–73	Price controls in the United States
1976–79	Post Vietnam War boom—highest historical price
1982–86	More stringent environmental controls imposed on production
1986–91	Industry retrenchment with attendant cost reductions
1992–96	Increasing demand, particularly in lead-acid battery sector
1997–98	Moderate weather in more populated regions—demand for replacement automotive batteries slowed
1998	Consolidation of the primary and secondary lead industries in the United States
2001–10	Significant annual increases in consumption and production of lead in China and emerging nations
2003	One of two primary lead smelters operating in the United States closed
2004–07	Prices increased owing to strong demand in China; global deficit of refined lead
2008–09	Economic downturn; global surplus of refined lead; prices declined

Table 1. Annual average lead price.

[Values in dollars per pound]

Year	Price	Year	Price	Year	Price	Year	Price
1909	0.043	1935	0.041	1961	0.109	1987	0.359
1910	0.044	1936	0.047	1962	0.096	1988	0.371
1911	0.044	1937	0.060	1963	0.111	1989	0.394
1912	0.045	1938	0.047	1964	0.136	1990	0.460
1913	0.044	1939	0.051	1965	0.160	1991	0.335
1914	0.039	1940	0.052	1966	0.151	1992	0.351
1915	0.047	1941	0.058	1967	0.140	1993	0.317
1916	0.069	1942	0.065	1968	0.132	1994	0.372
1917	0.088	1943	0.065	1969	0.149	1995	0.423
1918	0.074	1944	0.065	1970	0.157	1996	0.488
1919	0.058	1945	0.065	1971	0.139	1997	0.465
1920	0.080	1946	0.081	1972	0.150	1998	0.453
1921	0.045	1947	0.147	1973	0.163	1999	0.437
1922	0.057	1948	0.180	1974	0.225	2000	0.436
1923	0.073	1949	0.154	1975	0.215	2001	0.436
1924	0.081	1950	0.133	1976	0.231	2002	0.436
1925	0.090	1951	0.175	1977	0.307	2003	0.438
1926	0.084	1952	0.165	1978	0.337	2004	0.551
1927	0.068	1953	0.135	1979	0.526	2005	0.61
1928	0.063	1954	0.141	1980	0.425	2006	0.774
1929	0.068	1955	0.151	1981	0.365	2007	1.240
1930	0.055	1956	0.160	1982	0.255	2008	1.200
1931	0.042	1957	0.147	1983	0.217	2009	0.869
1932	0.032	1958	0.121	1984	0.256	2010	1.090
1933	0.039	1959	0.122	1985	0.191		
1934	0.039	1960	0.119	1986	0.221		

Notes:

1909–36, Primary producer price, New York (common lead, 99.94-percent pure), *in* Engineering and Mining Journal.1937–66, Primary producer price, New York (common lead, 99.94-percent pure), *in* Engineering and Mining Journal, Metal and Mineral Markets.1967–70, Primary producer price, New York (common lead, 99.94-percent pure), *in* Metals Week.1971–85, Primary producer price, delivered (minimum 99.97-percent pure), *in* Metals Week.1986–93, North American producer price, delivered (minimum 99.97-percent pure), *in* Metals Week.1994–2010, North American producer price, delivered (minimum 99.97-percent pure), *in* Platts (Platt's) Metals Week.

Lithium (Li)

by Brian W. Jaskula

Production of lithium minerals was first reported in the United States in 1898. Spodumene and amblygonite from California and South Dakota were exported for conversion to lithium chemicals. It was not until about 1916, during World War I, that lithium chemical production began in the United States (Schaller, 1917). Shortly thereafter, the United States became the largest producer of lithium minerals and chemicals in the world (Schaller, 1917). Dominant production sites shifted from the original States to North Carolina in 1942 (Broadhurst, 1956, p. 11) and Nevada in 1966 (Skillings Mining Review, 1968). In 1976, the U.S. Bureau of Mines reported that the United States provided nearly 80 percent of the world lithium demand (Quan, 1978). In 1984, lithium carbonate production began in Chile (Foote Prints, 1984). Lithium carbonate production shifted from the United States to South America in the mid-1990s, with two new operations coming onstream—a second operation in Chile in 1996 (Minsal S.A., 1996)—and a facility in Argentina in 1997 (FMC Corporation, 1999, p. 28).

The majority of lithium end uses requires lithium as one of its compounds rather than in the metallic form. Although a few lithium chemicals require lithium metal for their production, the metal used to produce the chemicals is produced and converted by the same company and so is not sold and does not enter the market or affect the prices of commercial lithium metal products (Lithium Corporation of America, 1985, p. 4). Although lithium metal prices were first reported in trade publications in 1952, demand was very low. Small quantities were used as scavengers in the production of low-oxygen copper alloys, but other uses were just beginning to be investigated (Arundale and Mentch, 1955).

From 1952 to 1974, lithium prices remained flat in terms of current dollars; in terms of constant dollars, however, prices decreased (table 1). The potential use of lithium in batteries for electric vehicles was first discussed in the Minerals Yearbook in 1972 (Wininger, 1974). The downward trend in lithium metal prices reversed in 1974. At about the same time, research efforts increased for identifying aluminum lithium alloys for use in aerospace applications. Increased demand for lithium in batteries and alloys resulted in steadily increasing lithium metal prices until 1998 (fig. 1).

From 1999–2006, prices trended downward, but increased in 2007–08 owing to lithium's increased use in battery applications and a temporarily constrained supply. In 2009, lithium metal prices decreased again (Jaskula, 2011). The 1999 price drop was likely the result of the shifting of lithium compound production to the lower cost South American brine-based salars in the mid-1990s, which resulted

in lower cost feedstock for lithium metal production. The decline in 2009–10 was the consequence of the worldwide economic downturn that began in late 2008.

The demand for lithium metal, however, cannot be quantified. Because lithium has been a small industry with very few major producers, published information on lithium metal production and markets is hard to find. From 2001–05, lithium metal prices were not published.

The use of lithium in batteries is expected to continue to expand but not necessarily in the form of lithium metal. The requirement for lithium metal for those batteries may grow more slowly as battery makers search for the optimum battery chemistry, balancing energy density, cost, and safety.

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Silver (Ag)

by William E. Brooks

Silver has been traded and used for thousands of years as ornaments and utensils, and as the basis of many monetary systems. The metal has played an important part in world history. Silver from the mines at Laurion, Greece, for example, financed the Greek victory over the Persians in 480 B.C. Silver from Potosi, Bolivia, helped Spain become a world power in the 16th and 17th centuries. Also, silver from the gold-silver ores at the Comstock Lode in Virginia City, Nev., helped keep the Union solvent during the Civil War.

The primary source of silver is argentiferous galena, as it is relatively abundant and relatively easy to smelt. However, there are many other ores of silver, including acanthite, anglesite, argentite, cerargyrite, cerussite, proustite, pyragyrite and stephanite, and it also occurs as a native metal. Silver may be present in many geologic environments, and byproduct silver may be obtained from the processing of copper, gold, and lead-zinc ores. More than two-thirds of U.S. and world resources are contained in such polymetallic deposits and the remainder is found in silver deposits.

Pure silver has the whitest color, the highest optical reflectivity, and the highest thermal and electrical conductivity of all the metals. Silver halides are photosensitive; however, the use of silver in photographic applications has declined since its peak in 1999 because of increased use of digital cameras. Owing to its physical properties, silver has many industrial applications, such as in brazing and soldering, catalytic converters, food packaging, wood preservatives, and increasing use in electronics applications. It is a biocide and its use in wound care and medical applications has also increased. It is also used as a catalyst in oxidation reactions; for example, in the production of formaldehyde from methanol and air (Butts and Cox, 1967, p. 1–15).

Most of the silver mined today is produced as a byproduct of precious or base metals, primarily lead and zinc. Leading silver-producing countries include Mexico, Peru, and China. In the United States, the leading silver-producing State is Alaska, where silver is produced as a byproduct from lead-zinc mining.

There are two types of markets for silver—physical markets and futures exchanges. It is possible for these markets to overlap if the buyers of futures contracts take delivery of silver metal when the contracts mature. A notable example of this was in the early 1980s when two buyers and their associates took delivery of millions of ounces of silver when their futures contract matured. Physical markets are operated by bullion dealers, banks, and commodity dealers. Silver is bought from mines and refineries and sold to consumers and brokers to supply industrial and investment demand. The London Bullion

Market, which had its origins in the 17th century, was the leading physical market until about 1960, when it was overtaken in importance by the New York Market. The London Market fixes a daily price, at which all orders to buy or sell silver can be matched. The New York Market price for silver is the Handy & Harman quote for unfabricated silver, which the company announces daily at noon. That is the lowest price at which offers can be obtained by Handy & Harman for silver in commercial bar form. The Handy & Harman price and the London fixing are for 99.9-percent-pure silver.

Prior to World War II, the major uses for silver, other than in coinage, were for jewelry and sterlingware. During the war, technological advances were made in electronics and photography and after the war, this technology was used to develop new consumer products. Owing to the shortage of copper during World War II, 13,500 tons of silver was borrowed from the U.S. Treasury. The silver was processed and used as conductive wiring, in place of copper, in the electromagnets necessary for uranium enrichment as a part of atomic bomb production. The silver was recovered and then returned to the Treasury.

As the demand for consumer goods increased, so did the demand for silver, and, as a result, the market price increased. The higher market price, however, did not result in increased mine production. The Silver Act of 1946 authorized the U.S. Treasury to purchase domestically mined silver at \$0.905 per troy ounce and to sell its silver holdings at \$0.91 per ounce. Through the first half of the 1950s, the market price remained below \$0.91 per ounce, so domestic mine operators sold their silver to the Treasury (table 1). In the second half of the 1950s, the continued increase in industrial demand for silver and static mine production resulted in the market price increasing to \$0.91 per ounce and Treasury silver sales were the largest source of silver for industrial consumers (National Academy of Sciences, 1968).

In the late 1950s and early 1960s, a second component was added to the demand side of the supply-demand equation—the investor speculator. The silver certificates authorized by the Silver Purchase Act of 1934 were redeemable for silver held by the Treasury. At a market price above \$1.29, a profit could be made by redeeming the silver certificates, receiving 0.77 ounce of silver from the Treasury, and then selling the silver. In addition, at a market price above \$1.38, a profit could be made by melting U.S. circulating coinage for its silver content. Realizing that it could not continue to supply industrial consumers with silver, mint coinage, and maintain a stock of silver for redemption of silver certificates, the Government began a program to demonetize silver. Public Law 88–36, which repealed the Silver Purchase Act of 1934 and authorized

the printing of Federal Reserve Notes not redeemable in silver, was passed in mid-1963. The Coinage Act of 1965 eliminated the use of silver in dimes and quarters and reduced the silver content of half dollars. In 1967, silver coins were withdrawn from circulation, and holders of silver certificates were given 1 year, until June 24, 1968, to redeem the certificates for silver (Silver Institute, The, 1990, p. 6–7).

With the ending of the relationship between silver and the U.S. monetary system in 1968, investor/speculator activities and industrial demand became the main determinants of movement in the silver market price. From 1968 through 1971, the price declined, owing in part to an economic recession in the United States and an attempt by the Government to stabilize the price of silver. From 1972 through 1975, the average price increased, owing to such factors as the devaluation of the U.S. dollar and an embargo of oil exports by the Organization of Petroleum Exporting Countries (fig. 1). Prices also increased from 1976 through 1980. Analysts attributed this 5-year period of higher average prices to such factors as a high domestic inflation rate combined with slow growth in U.S. economic activity, another “oil crisis,” a U.S. economic recession that began in 1979, and an attempt by a group of investors to “corner” the silver market (Roskill Information Services Ltd., 1984, p. 190–203). By early 1981, the silver market was beginning to adjust to the upward pressure placed on prices in 1979 through 1980. Owing to worldwide recession and reaction to higher silver prices, industrial demand for silver was in decline, and investment demand for silver fell sharply. Supply also fell as the surge of secondary recovery from old scrap and coin remelting subsided. Silver prices reached a cyclical low of \$4.88 per ounce in June 1982, 10 percent of the \$48 peak 30 months earlier. Because of panic in the financial markets and fear of inflation, investment demand for silver increased sharply in late 1982 and the first quarter of 1983. This influx of investor buying helped push silver prices from the low of \$4.88 in June 1982 to a peak of \$14.74 in February 1983. In March, this rapid rise in price (the price nearly tripled in 9 months) was reversed as investors took profits and industrial users developed new methods that reduced their per-unit use of silver, substituting lower priced materials for silver. Prices recovered during the summer, but the trend was downward from the fourth quarter of 1983 through 1986. Lower prices discouraged the secondary recovery of silver and forced less-efficient mines to close. On the demand side, lower prices relieved the pressure to use less silver or to use lower cost substitutes for silver in products. After starting 1987 at \$5.44 per ounce, prices reached a low of \$5.36 on January 7. Prices increased through the remainder of the year, reaching a high of \$10.20 on April 27 but closing out the year at \$7.20. The annual average price for 1987 was \$7.01 per ounce, the first increase in 4 years.

Owing to various market and economic conditions, the annual average price of silver declined from \$7.01 per ounce in 1987 to a low of \$3.94 in 1992 before increasing slightly to \$4.30 in 1993. Prices began to increase in the first quarter of 1994, reaching \$5.75 per ounce on March 28. The upward

momentum was caused by political unrest in Mexico, the world’s largest producer, and reports of large shipments to India. In April 1994, prices slipped rapidly to around \$5.00 per ounce as Indian demand slowed and large supplies from Russia and other East European countries appeared in the market. In September, prices increased again to \$5.71 per ounce before collapsing to \$4.90 on November 30. Prices in 1995 were not quite as volatile as in 1994, but the downward trend that began in April 1994 continued (Silver Institute, The, 1995, p. 8–15).

For centuries, the price of silver has been closely coupled with the price of gold, but the demonetization of both metals in much of the world has weakened the link. Throughout most of 1996, the price of silver was adversely affected by the poor performance of gold. Toward the end of 1996, however, the price of silver began to deviate from the price of gold, owing to investors’ and speculators’ adoption of distinctly different positions in the two markets. This decoupling process continued into 1997, and although the gold market continued to influence the price of silver, the trend in the metals’ prices indicated that a total decoupling may have been in the making.

In the first 2 months of 1997, the price of gold decreased by 2 percent and the price of silver also decreased to a 2-year low of \$4.65 per ounce in the first week of January. By early July, the gold price had decreased to \$315 per ounce, a 12-year low, and silver decreased to \$4.21 per ounce on July 17, its low for the year. By October 1997, gold fell to a 12-year low of \$308 per ounce; however, the price for silver closed above \$4.60 per ounce. By late November, gold fell below \$300 per ounce while the silver price increased to more than \$5.30. By December 1, the price of silver had increased to \$5.83, as above-ground stocks of silver declined to the lowest level in many years. The price of silver reached its high on December 24 at \$6.24 per ounce and the yearend price was \$5.95 per ounce.

In early February 1998, silver prices rose to a 9-year high of \$7.13 per ounce after it became known that a U.S. investment firm had purchased 3,978 metric tons of the metal after having made its first purchase in July 1997, when the price was less than \$4.50 per ounce. By the end of the month, the silver price was \$6.15 per ounce and prices continued to fall to a low of about \$4.70 at the end of August. The yearend silver price was \$5.05 per ounce.

In early 1999, the silver price increased to \$7.80 per ounce; however, by yearend, the price was less than \$5.00 per ounce. The price continued in the \$5.00- to \$6.00-per-ounce range until 2004, when the price increased to as much as \$8.29 in March; however, by yearend the price was less than \$7.00 per ounce.

In 2005, the average silver price was \$7.34 per ounce, which was 10 percent above the 2004 average price of \$6.69 per ounce. Prices for copper, gold, and silver all rose significantly during 2005 as part of a boom in mineral commodity investment, and consumption increased at a faster rate than production.

In April 2006, the silver exchange traded fund (ETF) started trading on the American Stock Exchange. Investors expanded their silver holdings in expectation that the price would increase dramatically upon opening of the ETF. In response, the price of silver increased before the ETF was launched. The silver ETF gave easy access to many investors who had been reluctant or unable to buy silver, and the growth of ETFs has led to an increase in silver investment. One of the most notable effects of the ETF has been the rise in silver prices (Silver Institute, The, 2007, p. 20).

Silver prices have increased owing to investment demand as well as silver's expanded role in the global industrial market. Supply does not appear to be an issue as domestic mine production generally increased from 1,160 metric tons (t) in 2006 to approximately 1,280 t in 2010. In 1990, industrial demand was 8,490 t, or 39 percent of total fabrication demand, and in 2007, industrial demand had risen to 14,460 t or 55 percent of total silver fabrication demand (Silver Institute, The, 2010, p. 5). The industrial applications of silver include batteries, brazing alloys and solders, catalytic converters, electronics, food packaging, medical uses and wound care, nanosilver, photovoltaics, polyester production from ethylene oxide, radio frequency identification devices (RFIDs), silver inks, supercapacitors, and water purification. The daily price of silver for the month of December peaked at \$30.64 on December 31; however, the average price of silver at yearend 2010 was \$17.75.

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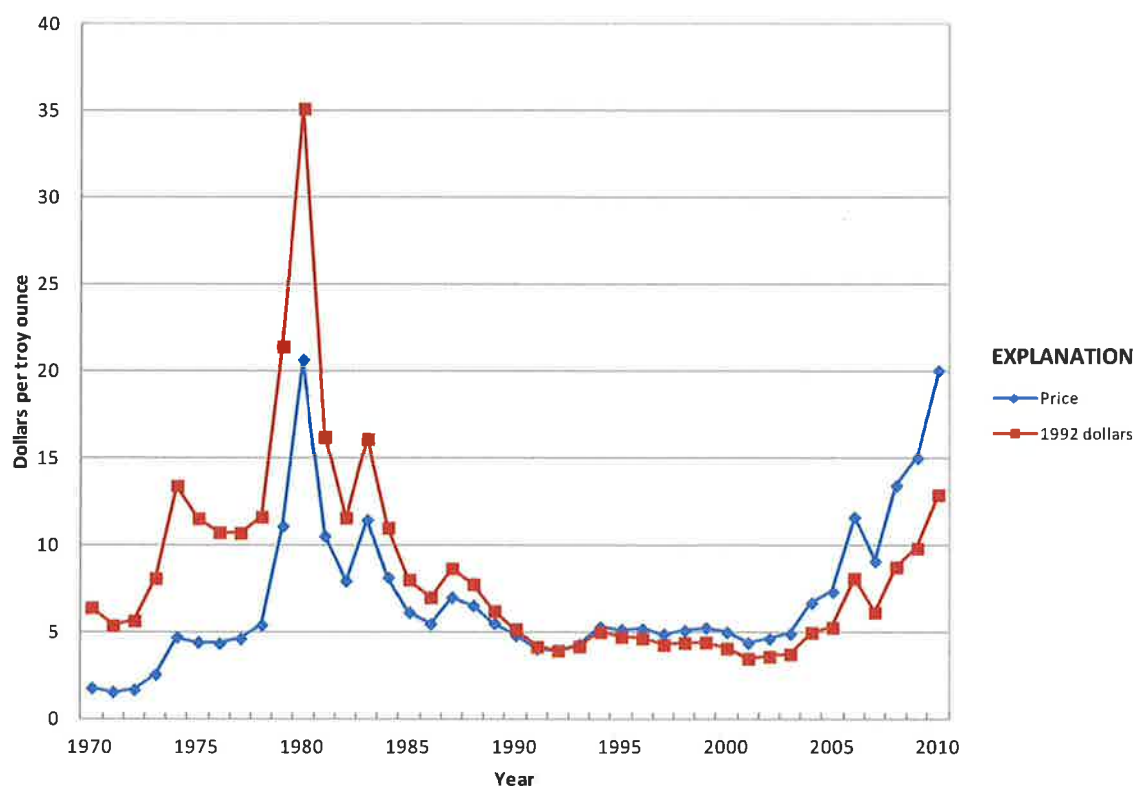


Figure 1. Annual average silver price.

Significant events affecting silver prices since 1970

1979–80	Individual investors attempted to corner the silver market
1985	U.S. Mint authorized to begin minting a silver bullion coin
1982–97	U.S. Government disposed of silver in the National Defense Stockpile, using it for production of commemorative coins
1998	Price increased in the first quarter of 1998 following disclosure that an investment firm had accumulated approximately 4,000 metric tons (t) of silver
2006	Highest average price since 1983 owing to investment interest in newly established silver exchange-traded fund (ETF)
1999–2010	Price increased mainly because of investment demand and increased industrial use

Table 1. Annual average silver price.

[Values in dollars per troy ounce]

Year	Price	Year	Price	Year	Price	Year	Price
1900	0.62	1928	0.58	1956	0.91	1984	8.14
1901	0.60	1929	0.53	1957	0.91	1985	6.14
1902	0.53	1930	0.38	1958	0.89	1986	5.47
1903	0.54	1931	0.29	1959	0.91	1987	7.01
1904	0.58	1932	0.28	1960	0.91	1988	6.53
1905	0.61	1933	0.35	1961	0.92	1989	5.50
1906	0.67	1934	0.48	1962	1.09	1990	4.82
1907	0.66	1935	0.64	1963	1.28	1991	4.04
1908	0.53	1936	0.45	1964	1.29	1992	3.94
1909	0.52	1937	0.45	1965	1.29	1993	4.30
1910	0.54	1938	0.43	1966	1.29	1994	5.29
1911	0.54	1939	0.39	1967	1.55	1995	5.15
1912	0.62	1940	0.35	1968	2.14	1996	5.19
1913	0.61	1941	0.35	1969	1.79	1997	4.89
1914	0.56	1942	0.38	1970	1.77	1998	5.54
1915	0.51	1943	0.45	1971	1.55	1999	5.25
1916	0.67	1944	0.45	1972	1.68	2000	5.00
1917	0.84	1945	0.52	1973	2.56	2001	4.39
1918	0.98	1946	0.80	1974	4.71	2002	4.62
1919	1.12	1947	0.72	1975	4.42	2003	4.91
1920	1.02	1948	0.74	1976	4.35	2004	6.69
1921	0.63	1949	0.72	1977	4.62	2005	7.34
1922	0.68	1950	0.74	1978	5.40	2006	11.57
1923	0.65	1951	0.89	1979	11.09	2007	13.41
1924	0.67	1952	0.85	1980	20.63	2008	15.00
1925	0.69	1953	0.85	1981	10.52	2009	14.69
1926	0.62	1954	0.85	1982	7.95	2010	20.20
1927	0.57	1955	0.89	1983	11.44		

Notes:

1900–74, New York price of 99.9-percent-pure silver, *in* Silver, U.S. Bureau of Mines Minerals Yearbook 1974.1974–93, New York price of 99.9-percent-pure silver, *in* Metals Week.1993–2010, New York price of 99.9-percent-pure silver, *in* Platts (Platt's) Metals Week.

Tantalum (Ta)

by John F. Papp

Tantalum is a refractory metal that is easily fabricated, has a high melting point, is highly resistant to corrosion by acids, and is a good conductor of heat and electricity. Tantalum's first commercial usage was as filament material in incandescent electric lamps in the early 1900s (Miller, 1959). Currently, the major use for tantalum, as tantalum metal powder, is in the production of electronic components, mainly tantalum capacitors. Alloyed with other metals, tantalum is also used in making carbide tools for metalworking equipment and in the production of superalloys for jet engine components. Substitutes, such as aluminum, rhenium, titanium, tungsten, and zirconium, exist for tantalum but are usually made at either a performance or economic penalty.

Tantalum ore (tantalite) is the leading source of tantalum, and the price for tantalum products is mostly affected by events in the supply of and demand for tantalite. Thus, the price for tantalum metal products generally follows the pattern for that of tantalum ore. The price for tantalum metal products is also affected by the size of the order/contract and material specification. The yearend 1998 price for tantalum ore was about \$41.50 per pound of contained tantalum compared to the selling price for the following tantalum metal products (per pound of contained tantalum)—vacuum-grade metal for superalloys, \$75 to \$95; sheet, \$100 to \$150; capacitor-grade metal powder, \$135 to \$240; and capacitor-grade wire, \$180 to \$250.

Australia is the leading producer of tantalum ore. U.S. tantalum mining has not been significant since 1959. The United States satisfies its tantalum requirements primarily by importing tantalum ore from Australia and Brazil and quantities of metal and powders from various countries. Many of the applications for tantalum are either directly or indirectly defense related because of its use in the aerospace, communications, energy, and transportation industries. Thus, tantalum was classified as critical and strategic by the Government of the United States, and during the years, various tantalum materials have been purchased for the National Defense Stockpile (NDS).

A significant activity during the 1950s was the U.S. Government's worldwide program for the purchase of about 6,800 metric tons (t) of combined niobium and tantalum oxides contained in niobium-tantalum ores. The purchase program was terminated in 1958 (Cunningham, 1985a, b). The program, which was initiated to encourage increased production of niobium-tantalum ores and concentrates of domestic and foreign origin, largely governed the market price for tantalum ore. It also resulted in the discovery of large low-grade domestic and foreign deposits of tantalum minerals. The program, however, was less successful in developing domestic

tantalum mineral production. The low grade of the discoveries precluded their development at the 1958 price or, at that time, expected future prices.

By 1960, tantalum demand for use in aerospace applications, capacitors, corrosion-resistant chemical and nuclear applications, high-temperature alloys, and machine cutting tools had increased substantially. Price peaks in 1961 and 1966 were occasioned by a sudden increase in demand for tantalum, which outstripped the supply, thus driving prices up (table 1). Increased demand stimulated tantalum production. After a leveling off of demand, however, overproduction ensued, resulting in a decline in tantalum prices. The higher cost operations, which had opened in response to the increased demand, closed down, and supply reverted back to previous levels.

The 1970s was a decade of increasing tantalum demand, ore shortages, escalating prices, and substitution. The record price levels during this period were attributed, in part, to a state of panic buying influenced by anticipated increases in tantalum demand amidst concerns of shrinking world tantalum supply (fig. 1). As demand for tantalum increased, some processors foresaw the coming production shortfall and began to stockpile inventories. The net effect was very competitive buying of tantalum feed materials to meet customer needs with associated spiraling prices. The high prices brought about substitution for tantalum and more-widespread search for and development of new tantalum supply sources.

During 1979 to 1980, the price for tantalum ore exploded. Tantalum ore production could not meet market demand, resulting in sustained inventory reduction. With optimistic forecasts of market growth, processors found themselves locked into a bidding contest for available tantalum ore. By yearend 1982, large high-cost inventories of tantalum ore were accumulated as a hedge against perceived future shortages.

During the late 1970s and early 1980s, processors, faced with runaway tantalum ore prices, were forced to pass along a large part of the price increases to end users. Because of escalating tantalum prices, consumers began to substitute alternate products, to decrease tantalum content in products, and to increase recycling to substitute for virgin tantalum materials. These demand-reducing activities were accelerated by the price volatility and resulted in increased inventories. In the consumer electronics sector, tantalum was designed out of some circuits and replaced primarily with aluminum-bearing electronic components.

The tantalum ore price reached a peak at midyear 1980, about \$118 per pound of contained tantalum pentoxide. By yearend 1980, prices began declining and, by yearend 1986, were the lowest since yearend 1976. The downturn in prices

Zinc (Zn)

By Amy C. Tolcin

Zinc use before zinc smelting involved the use of zinc compounds that resulted from the smelting of lead and copper ores. Zinc's presence in early bronze was most likely accidental and dependent on the ores used. By the time brass was developed and manufactured, zinc compounds were recognized and deliberately mixed with copper by the process of cementation. In the sixth century, the Chinese were credited with producing the first articles of zinc metal, and by the 13th century, zinc was smelted on a large scale in India. Zinc smelting technology was thought to have been brought to Europe from Asia around 1730. By the end of the 18th century, large-scale commercial smelting had begun in Europe. In the United States, the first zinc metal was produced in 1835 at the Arsenal in Washington, D.C., for the manufacture of brass standard units of weights and measures. The U.S. zinc mining industry commercially began around 1850 with the production of compounds from zinc ores in New Jersey and Pennsylvania. By the turn of the century, U.S. zinc smelting activity had grown rapidly, mainly developing in Illinois, Kansas, Missouri, and Pennsylvania. The development of the vast Joplin, Mo., zinc mining district in the early 1870s was stimulated by the growing use of zinc by U.S. industry. During the first half of the 20th century, two pricing centers emerged—St. Louis, Mo., and New York, N.Y. The New York price was usually higher because it included shipping charges. Because the prevailing method of production was pyrometallurgical, yielding Prime Western (PW) zinc, both prices were based on that grade. Higher grades of zinc cost more because of the expense of additional refining.

During the 1960s, the East St. Louis, Ill., price of zinc remained stable, which can be attributed partially to Government policies pertaining to stockpile programs and import quotas and tariffs (table 1). The price increase in this decade was about 13 percent. In 1965, import quotas were lifted, and Public Law 89-322, authorizing the first of the annual zinc disposals from the Government stockpile, was enacted. In 1971, the importance of the East St. Louis price diminished when a major producer began to include shipping charges in its price quotation. The emergence of the New York price coincided with Metals Week becoming the main pricing medium for zinc in the United States.

Because price controls were in force from 1971 through 1973 and any increase of price had to be approved by the U.S. Cost of Living Council, zinc prices increased only gradually (fig. 1). After price controls were abolished, the price for high-grade (HG) zinc metal rose abruptly, nearly doubling by mid-1975. For the next 11 years, the annual average price fluctuated within an \$0.18-per-pound band (Jolly, 1993).

By 1980, more than a decade after electrolytic refining had become dominant in the production of domestic zinc, HG was made the base grade for pricing purposes, and Metals Week introduced its weighted average price, which it based on daily sales of HG. The largest increase in the history of the zinc price began with a small \$0.04-per-pound increase in November 1987, and escalated to a \$0.20 increase in February 1989. The main impetus for this steep increase was tightness of supply brought about by strong world demand; strikes, technical problems at some smelters, and hurricane-related delays of zinc shipments from Mexico were also contributing factors. In the 1980s, U.S. refinery production supplied only about one-third of domestic demand. As a result, world price became the dominant factor in setting the domestic price.

Outside of the United States, the world pricing basis for zinc has essentially been the price quoted by the London Metal Exchange Ltd. (LME), which introduced its first zinc contract in 1915. In order to stabilize the sometimes volatile LME prices, a group of non-U.S. zinc producers established the European Producer Price (EPP) in 1964. Later, dissatisfaction with the EPP pricing system, mainly as it related to the settlement price of zinc concentrate and the determination of smelter treatment charges, led to the reemergence of LME zinc quotations as the principal basis for world zinc pricing (Jolly, 1997, p. 218–221). The choice of an LME basis was further solidified when the LME switched from British pounds to U.S. dollars for all its transactions in 1998.

During the 1990s, the price for refined zinc remained rather stable, reflecting the supply and demand of the market.

In 2000, zinc prices fell sharply during the last quarter of the year as U.S. economic activity slowed during that time. In 2001, prices continued to decrease owing to an oversupply in the metal market, mainly caused by substantial Chinese exports and low global demand. Many Chinese smelters were prompted to export zinc metal to take advantage of higher international prices as compared with those in the domestic market. Prices were also suppressed during this time by a significant decline in automobile sales in the United States. In 2002, the price of zinc on the LME reached its lowest level in 15 years. Smaller companies that operated small underground mines or low-capacity smelters could not absorb prolonged financial losses and were forced to either temporarily suspend production or close entire operations. Larger companies with ample financial resources and diversified production were in better position to withstand the downturn of the zinc industry. Some even increased production in order to take advantage of economies of scale. In 2003, zinc prices shifted upward, coinciding with the metal market moving out of a supply surplus

and into balance. Increased global demand for zinc was largely supported by China's rapidly growing economy and infrastructure, while production was constrained by curtailments and mine closures that were implemented as a result of low prices during the late 1990s and early 2000s. In 2005, zinc metal consumption between January and November was almost 1 percent higher than that of the similar period of 2004, which was enough to push the supply-demand balance into a deficit.

A rapid price increase took place in 2006 as a result of several factors—a 15-year low in LME stocks of zinc, increased world demand, tight world supply, and investment buying. Many zinc mines reopened or expanded during this time, causing the supply deficit for refined zinc to narrow, and by 2008, the metal market was back in surplus. However, monthly average zinc prices strengthened during the first quarter of 2008 in conjunction with most other base metals. Global monthly zinc consumption continued to increase during the first half of 2008 owing predominantly to increasing consumption in China, which offset decreases reported in Europe and the United States as economic activity slowed in these areas. Thereafter, global consumption began to deteriorate, moderately in the third quarter, then more sharply during the fourth quarter as the financial crisis spread globally. Sharply lower vehicle sales and a slowdown in the construction industry largely were responsible for the decline in zinc consumption during this period.

Declining zinc prices in 2008 led to several mine closures, mostly during the second half of the year. Junior mining companies were also unable to advance projects owing to reduced access to capital. Investment in new mining projects declined along with falling zinc prices. Global economic activity continued to contract during the first half of 2009, with the notable exception of China and India. Global zinc consumption began to recover during the second quarter of 2009. As global economic activity began recovering during the third quarter, global demand for zinc began to increase. Despite the zinc metal market being in surplus during 2009, average monthly zinc prices increased during the course of the year, possibly owing to speculative investment. Prices then began to decline in the first half of 2010, and then rebounded during the second half of the year. Global economic activity expanded during 2010, albeit at a sluggish pace.

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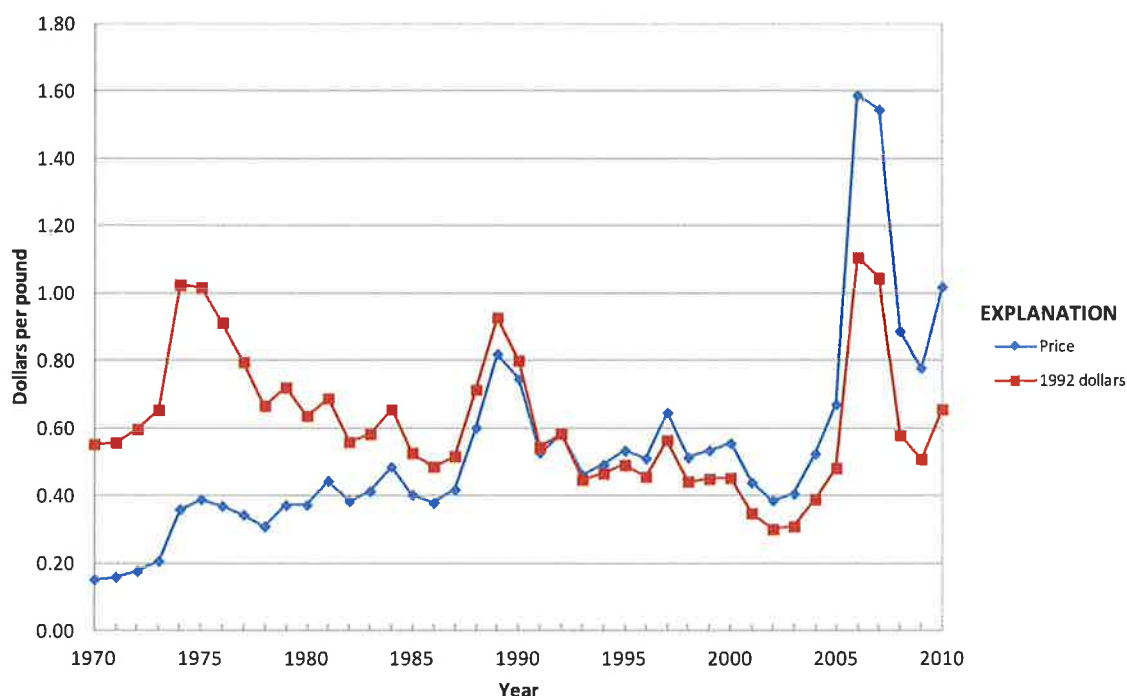


Figure 1. Annual average zinc price.

Significant events affecting zinc prices since 1970

1971–73	Price controls in the United States; slow price increase
1975–82	Stockpile sales terminated; declining production
1982	Recession; prices decreased
1983–89	Period of sustained economic growth; stagnating domestic production; high zinc imports and prices
1987–89	Limited supply of zinc metal; strong world demand
2002–06	Increasing zinc consumption in China outpaces production; prices increased
2008–09	Global economic crisis; prices declined

Table 1. Annual average zinc price.

[Values in dollars per pound]

Year	Price	Year	Price	Year	Price	Year	Price
1875	0.070	1909	0.054	1943	0.083	1977	0.344
1876	0.072	1910	0.054	1944	0.083	1978	0.310
1877	0.060	1911	0.056	1945	0.083	1979	0.373
1878	0.049	1912	0.068	1946	0.087	1980	0.374
1879	0.052	1913	0.055	1947	0.105	1981	0.446
1880	0.055	1914	0.051	1948	0.136	1982	0.385
1881	0.052	1915	0.142	1949	0.122	1983	0.414
1882	0.053	1916	0.136	1950	0.139	1984	0.486
1883	0.045	1917	0.089	1951	0.180	1985	0.404
1884	0.044	1918	0.080	1952	0.162	1986	0.380
1885	0.043	1919	0.070	1953	0.109	1987	0.419
1886	0.044	1920	0.078	1954	0.107	1988	0.602
1887	0.046	1921	0.047	1955	0.123	1989	0.820
1888	0.049	1922	0.057	1956	0.135	1990	0.746
1889	0.050	1923	0.066	1957	0.114	1991	0.528
1890	0.055	1924	0.063	1958	0.103	1992	0.584
1891	0.050	1925	0.076	1959	0.115	1993	0.462
1892	0.046	1926	0.073	1960	0.130	1994	0.493
1893	0.040	1927	0.062	1961	0.116	1995	0.534
1894	0.035	1928	0.060	1962	0.116	1996	0.511
1895	0.036	1929	0.065	1963	0.120	1997	0.646
1896	0.039	1930	0.046	1964	0.136	1998	0.514
1897	0.041	1931	0.036	1965	0.145	1999	0.535
1898	0.046	1932	0.029	1966	0.145	2000	0.556
1899	0.058	1933	0.040	1967	0.139	2001	0.440
1900	0.044	1934	0.042	1968	0.135	2002	0.386
1901	0.041	1935	0.043	1969	0.147	2003	0.406
1902	0.048	1936	0.049	1970	0.153	2004	0.525
1903	0.054	1937	0.065	1971	0.161	2005	0.671
1904	0.051	1938	0.046	1972	0.178	2006	1.589
1905	0.059	1939	0.051	1973	0.207	2007	1.544
1906	0.061	1940	0.063	1974	0.360	2008	0.889
1907	0.058	1941	0.075	1975	0.390	2009	0.779
1908	0.046	1942	0.083	1976	0.370	2010	1.020

Notes:

1875–1904, New York price for Prime Western zinc (98-percent-pure), *in* Ingalls, W.R., *Lead and Zinc in the United States*, McGraw-Hill, N.Y., 1980, p. 342.1905–70, St. Louis/East St. Louis producer price for Prime Western zinc, *in* American Metal Market/Metal Statistics.1971–79, U.S. Dealers Prime Western delivered price, *in* Metals Week.1980–93, U.S. Dealers High Grade zinc (99.9-percent-pure) delivered price, *in* Metals Week.1994–98, U.S. Dealers Special High Grade zinc (99.99-percent-pure) delivered price, *in* Platt's Metals Week.1999–2010, North American Special High Grade zinc (99.995-percent-pure) delivered price, *in* Platts Metals Week.