

## Events Affecting the U.S. Nonfuel Minerals Industry 1900-2000

At the beginning of the century, some minerals and metals industries were well established, such as those of copper, gold, lead, lime, and salt; some industries were just beginning, such as aluminum and lithium; and some materials, such as germanium, magnesium, and titanium, had not been commercially produced. Mining was labor intensive and could be dangerous. In 1900, U.S. minerals consumption was less than 100 million metric tons. By 2000, U.S. minerals consumption had increased to more than 3.3 billion metric tons, and included not only the materials that constitute the bulk of consumption—crushed stone and steel—but some of the materials for which there were no uses in 1900. Improved safety measures and technological advancements in mining and processing methods have made mining safer and increased efficiency.

The time line showing events that have affected the U.S. minerals industry during the 20th century is a representative list of individual events that have influenced the production and/or consumption of a single commodity or a group of commodities. In many cases, changes to the U.S. minerals industry were evolutionary and not marked by a single event. For example, the development of the electrical power generation and distribution industries throughout the first half of the 20th century provided new markets for aluminum, copper, and steel, but no one event in this time period is considered to be pivotal. Horton (1982) provides additional information on the sources of the mineral statistics and events used to construct the time line; information on mineral statistics and events for the last 20 years primarily was from the mineral commodity chapters of the Minerals Yearbook series. For more information on events that affected individual commodities, see the 2000 Minerals Yearbook mineral commodity chapters, available via <http://minerals.usgs.gov/minerals>.

Data on U.S. recessions, shown in red on the time line, were obtained from the National Bureau of Economic Research. Recessions are signaled by a period of significant decline in total output, income, employment, and trade, usually lasting from 6 months to 1 year, and marked by widespread contractions in many sectors of the Nation's economy (National Bureau of Economic Research, undated, US business cycle expansions and contractions, accessed September 20, 2001, at <http://www.nber.org/cycles.html>).

### Reference Cited

Horton, R.C., 1982, Foreword, *in* U.S. Bureau of Mines Minerals Yearbook 1981, v. I: U.S. Bureau of Mines, p. iii-iv.

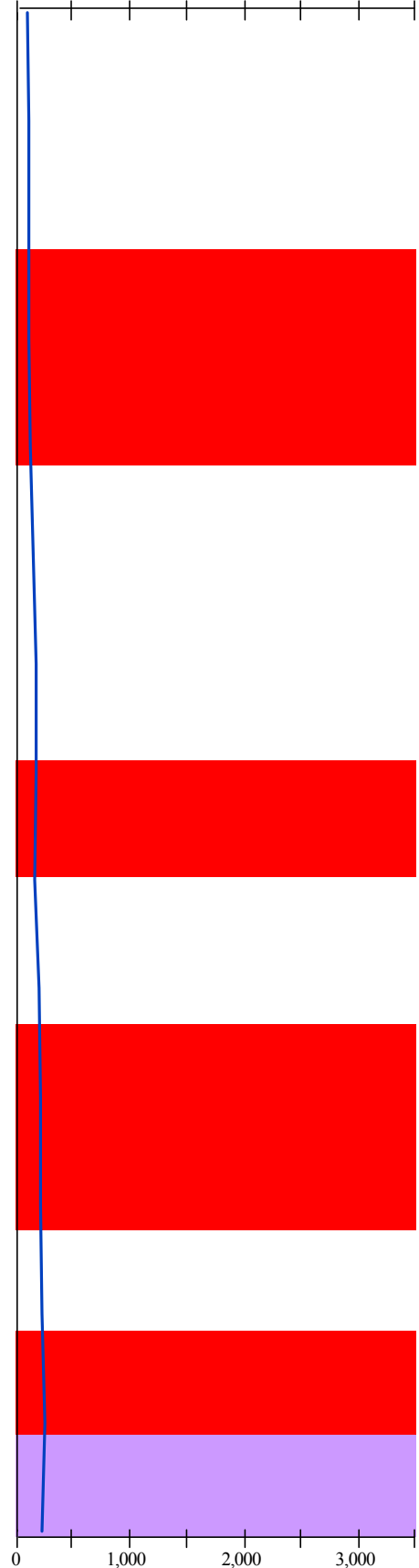
## Events affecting the U.S. nonfuel minerals industry, 1900-2000

- indicates war and major conflict years.
- indicates recessions.
- overlap of recession and war years.

U.S. minerals consumption,  
million metric tons

0 1,000 2,000 3,000

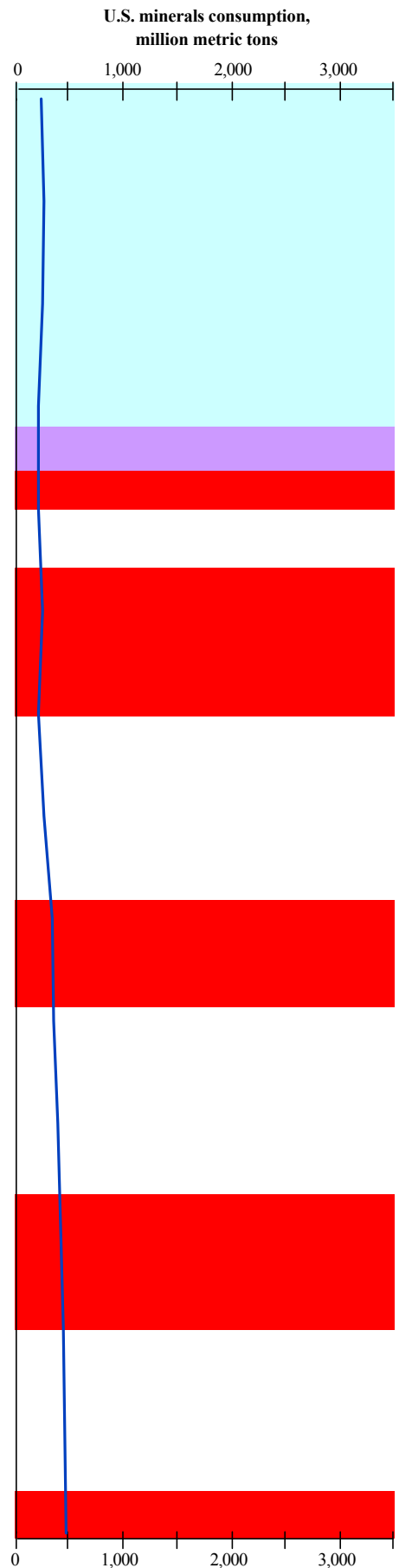
- 1900** Gold Standard Act of 1900 was established, which directed the Secretary of the Treasury to maintain all forms of money in parity with this standard; gold was valued at \$20.67 per ounce. Nickel-iron storage battery was developed by Edison (1900-10). Nernst glowers (mixture of yttrium and zirconium oxides) were used for bright white incandescent lighting.
- 1901** Elmore received a patent for oil flotation, which came into widespread use for recovery of metals such as copper, gold, lead, silver, and zinc from low-grade ores. U.S. production of arsenic trioxide began. Pepto-Bismol®, the most widely known use for bismuth, was invented. Cobalt was first used as a paint drier. Ferrochromium production began in Ohio.
- 1902** First U.S. patent was issued for flat glass manufacture using molten glass poured on liquid metal bath (silica, soda ash, feldspar).
- 1903** Jackling introduced new bulk mining methods and concentrators for processing low-grade Utah copper ores. U.S. commercial production of tantalite ore began, and commercial Frasch-process sulfur production began in Louisiana. Tungsten filaments for incandescent lamps were first produced. Wright Brothers completed the first heavier-than-air, machine-powered flight.
- 1904** First commercial production of peat in the United States was reported. Owens and Libbey developed an automatic bottle manufacturing machine.
- 1905** U.S. lithium chemical production began. The Mina Ragra vanadium deposit in Peru was discovered and became the first vanadium mine in the western hemisphere. Cobalt was added to high-speed tool steels.
- 1906** Froth flotation was patented and came into widespread use for processing metals (such as copper, lead, and zinc) and industrial minerals (such as feldspar, fluorite, phosphate, and silica). This development enabled processing of lower grade and complex ores.
- 1907** U.S. commercial production of cadmium and ferrovanadium began. First commercial phosphate rock production was reported in Idaho, Utah, and Wyoming. The United States became the world's largest producer and consumer of zinc. Use of recycled lead was first reported. Stellite alloy was patented, which was a superalloy precursor.
- 1908** First Model T automobile was sold; as the first low-priced, mass-produced automobile, it led to the development of the U.S. auto industry. Chlorination of public water supplies began in Jersey City, NJ. Large-scale metallurgical use of rare earths as a lighter flint in an ignition system for gas lamps began.
- 1909** Electric furnace production of steel began.
- 1910** Production of ductile titanium by the Hunter process started. The U.S. Bureau of Mines was established, which led to significant developments in safety and mining and mineral processing technology.
- 1911**
- 1912**
- 1913** Austenitic stainless steel was developed, which became a significant use for chromium and nickel. Ford's use of the assembly line for automobile production lowered car prices allowing for mass market ownership, which opened large, new market for materials such as steel, aluminum, and lead (for batteries).
- 1914** Beginning of World War I (1914-18) led to rapid expansion of foreign and domestic markets for steel. Price controls and trade restrictions were established for many metals. First U.S. electrolytic zinc plant in Montana began operation. Commercial production of cobalt metal began. Molybdenum's use in steel began. World's first passenger flight from Tampa to St. Petersburg, FL.



## Events affecting the U.S. nonfuel minerals industry, 1900-2000

- indicates war and major conflict years.
- indicates recessions.
- overlap of recession and war years.

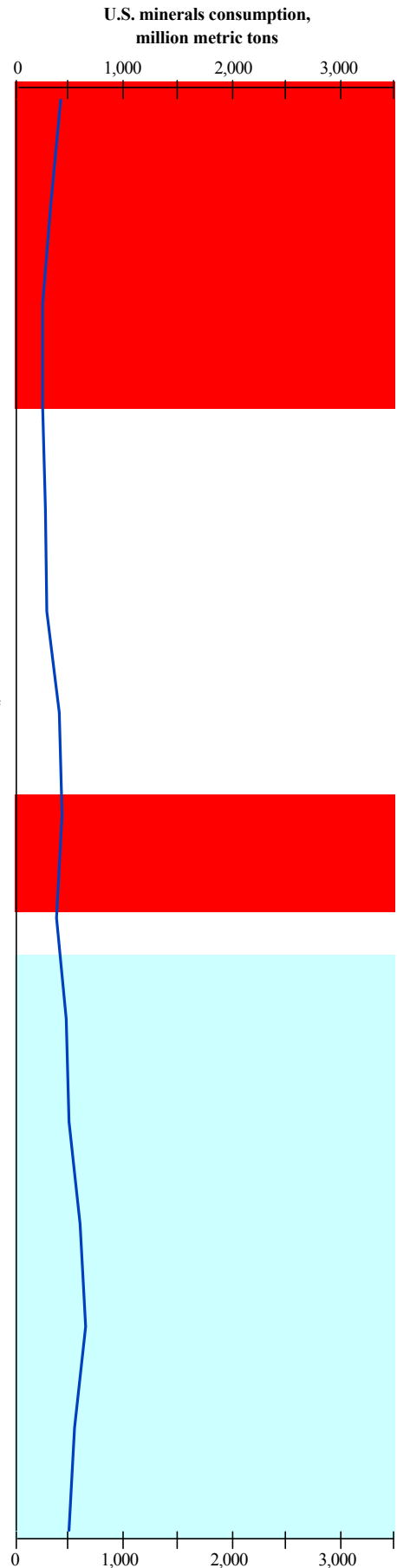
- 1915** Commercial U.S. production of magnesium began. U.S. population reaches 100 million.
- 1916** Sheetrock® (gypsum wallboard) was first produced.
- 1917** First magnesite mine opened in the United States. The United States became the world's largest cadmium producer. Lead was used in lead-acid batteries for automobiles, which would become a significant use for lead. The first regulations on licensing explosives purchases were implemented by the Federal Explosives Act of 1917.
- 1918** Haber received the Nobel prize in chemistry for his ammonia production process, which became the basis for ammonia production around the world.
- 1919** Electroplating with cadmium was invented and was the most important use of cadmium until the commercial development of the nickel-cadmium battery.
- 1920** Use of silicon in aluminum casting alloys began. Dragline was first used to mine phosphate rock. First primary platinum deposit was discovered in South Africa. The Mining Leasing Act of 1920 provided that nonmetallic minerals be acquired through a leasing system. The first commercial radio broadcast occurred.
- 1921**
- 1922** Ilmenite (titanium ore) was first mined in Florida. First application of germanium was reported in treating anemia.
- 1923** Cemented carbides were patented and became a significant use for cobalt and tungsten.
- 1924** Iodized salt was recommended to treat goiter.
- 1925** Commercial use of columbium as a substitute for tungsten in tool steels began. Domestic production of pure TiO<sub>2</sub> pigment by the sulfate process began in Niagara Falls, NY. Hafnium metal was first produced by van Arkel and de Boer. Rhenium was discovered.
- 1926** U.S. production of indium started. Production of soda ash at Searles Lakes, CA, began. Semon and Goodrich discovered polyvinyl chloride (PVC) plastic, which led to an increase in salt consumption.
- 1927**
- 1928** Flotation was first used to process phosphate ore. The heat-treatment effect on perlite was discovered.
- 1929** Phosphate rock mining began in Montana. Tantalum carbide was produced in the United States for use in cutting tools. On "Black Thursday" (October 29), the U.S. stock market crashed.



## Events affecting the U.S. nonfuel minerals industry, 1900-2000

- indicates war and major conflict years.
- indicates recessions.
- overlap of recession and war years.

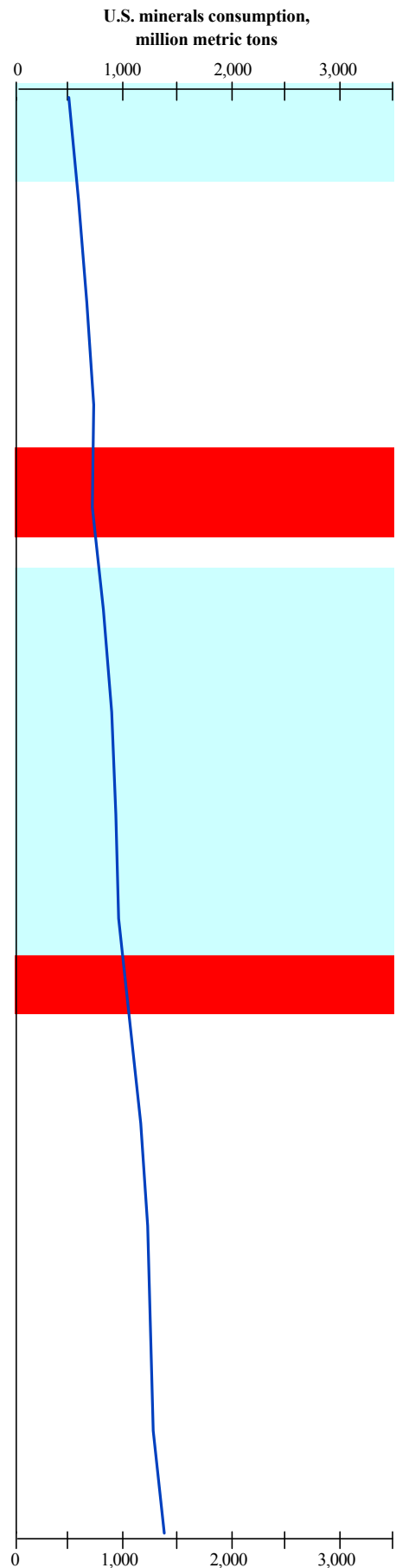
- 1930** Beginning of Great Depression (1930-39); demand for most metals and minerals fell. Beginning of significant commercial uses for tellurium. Peat became widely used in horticultural applications. First all-metal aircraft was developed for the U.S. Air Force.
- 1931** Synthetic refrigerant dichlorodifluoromethane (freon or CFC 12) was first produced, and fluorspar demand increased. Rare-earth metals were first prepared in pure form. Highest level of dimension stone (all types) production in the United States in the 20th century was reported; 6 million metric tons.
- 1932** Commercial production of beryllium-copper alloys began in the United States.
- 1933** Columbium (niobium) was first used in stainless steel. Indium was first commercially used in dental alloys.
- 1934** Gold Reserve Act of 1934 was enacted, and the Federal Government acquired title to all gold held by Federal Reserve Bank. Official U.S. gold price was increased to \$35 per ounce.
- 1935** Hoover Dam was completed using 4.36 million cubic yards of concrete (composed of cement and aggregate). The first superalloys were developed, consisting of various combinations of Fe, Ni, Co, and Cr, as well as lesser quantities of W, Mo, Ta, Nb, Ti, and Al (1935-40). The Rural Electrification Administration was created to provide farms with inexpensive electric lighting and power.
- 1936** The first of the Alnico (aluminum-nickel-cobalt) series of permanent magnets was developed. Vitalium, a cobalt-based alloy, was developed for dental work and later modified for high-temperature applications in aircraft engines.
- 1937** Electrolytic tinplating was developed. Low-temperature superconductivity in lanthanum was discovered. The Golden Gate Bridge in San Francisco was completed, using 389,000 cubic yards of concrete and more than 75,000 metric tons of structural steel.
- 1938** Electrolytic manganese was commercialized. Key process for making silicones was developed. First U.S. recovered sulfur production data was reported. The world's largest trona deposit was discovered in Green River, WY.
- 1939** With the beginning of World War II (1939-45), the first U.S. legislation was enacted to establish stockpiles of strategic and critical materials for national defense. Many metals were also subject to price controls. Production of pure TiO<sub>2</sub> pigment by the chloride process in New Johnsonville, TN, began. First successful flight of a jet-powered aircraft.
- 1940** Tantalum capacitors had been perfected, and consumption of tantalum increased sharply with the introduction of radar and military radio communications during World War II. Sintered-plate nickel-cadmium battery was commercially produced. The Kroll process to produce titanium was patented. The invention of the crystal diode sparked germanium production.
- 1941** Pilot-plant operation recovered germanium dioxide from zinc ores. Rutile TiO<sub>2</sub> pigments were first produced for commercial use.
- 1942** Nonessential gold mining was curtailed by the U.S. Government in order to free up miners to produce critical minerals, such as copper, needed for World War II. The first artificial nuclear reactor was built by Fermi and co-workers and brought on line on December 2.
- 1943** The U.S. Government built a plant in Cuba to extract nickel; it was the first commercial extraction facility to combine pyro- and hydrometallurgical processing to recover nickel from laterites. Commercial-scale recovery of gallium began in the United States. Spiral separation was first commercially used to recover chromite from sand in Coos County, OR.
- 1944** The Bretton Woods Agreement was established and went into effect in 1947. It created a currency agreement that established fixed exchange rates for major currencies, set the price of gold at \$35 an ounce, and started the International Monetary Fund and what would become known as the World Bank. Lowest level of U.S. dimension stone production was reported; 649,000 metric tons.



## Events affecting the U.S. nonfuel minerals industry, 1900-2000

- indicates war and major conflict years.
- indicates recessions.
- overlap of recession and war years.

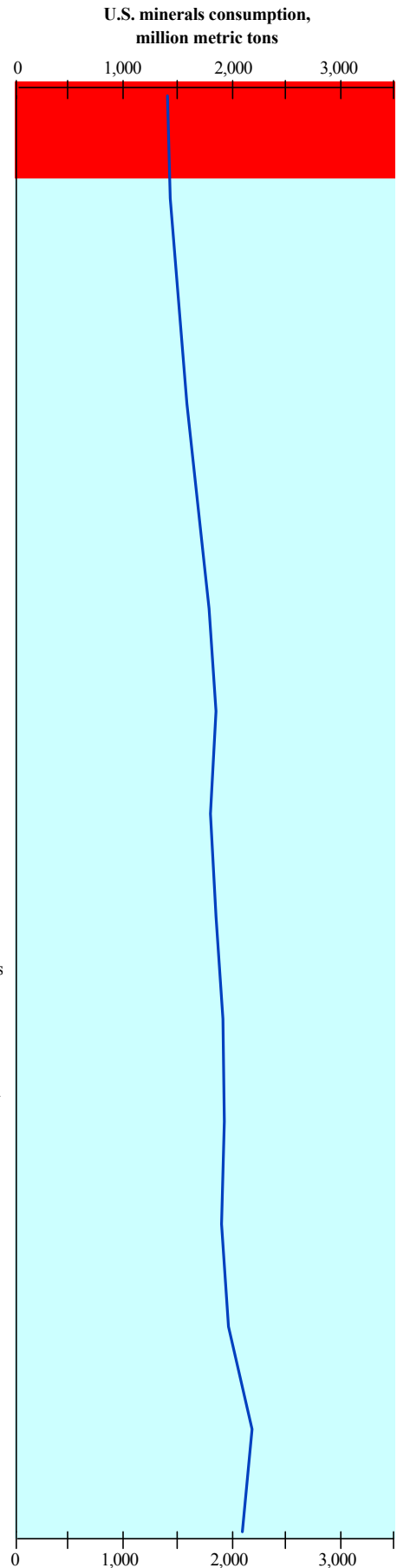
- 1945** Kroll process was modified to make zirconium metal. First nuclear (plutonium) bomb was detonated in New Mexico.
- 1946** Stock Piling Act was passed, strengthening the previous legislation for acquiring strategic and critical materials and encouraging development of U.S. sources. Gold production, curtailed in 1942, resumed. First commercial feldspar flotation plant began operation in North Carolina. The United States became the principal supplier of beryllium products for the world.
- 1947** First separation of rare-earths by ion exchange was reported. Scientists at Bell Laboratories invented the transistor, originally made from germanium, but later made from silicon.
- 1948** E.I. du Pont de Nemours & Co. Inc. first commercially produced titanium metal by the Kroll process. Electrolytic manganese dioxide was commercialized. Commercial kitty litter production started, a new use for fuller's earth. Cobalt catalysts were first used by the chemical and petroleum industries.
- 1949** Commercial production of perlite began in Superior, AZ. Production of high-purity silicon for semiconductor devices began. USGS geologists discovered the first world-class rare-earth deposit in Mountain Pass, CA. Titanium metal was first used in aircraft.
- 1950** Beginning of Korean conflict (1950-53); price controls were established for many metals. Defense Production Act of 1950 provided specific authority for priorities and allocations of strategic and critical materials. Use of magnesium ferrosilicon for making nodular cast iron began. Tin chemicals were developed, which became a major end use (1950-60).
- 1951** First hafnium metal produced by Kroll process; hafnium was selected as control rod material for the U.S. Navy's nuclear reactor program.
- 1952** Molybdenum Corp. of America began production of rare earths at Mountain Pass, CA. The United States detonated the first hydrogen (fusion) bomb on Eniwetok Atoll in the South Pacific.
- 1953** First large-scale wollastonite production began in New York.
- 1954**
- 1955** First large-scale taconite (iron ore) processing plants began operations in Minnesota and Michigan. First steel production using the basic-oxygen furnace; this became a large market for lime and bentonite. World's largest fluorspar mine, in Mexico, began production. General Electric Co. produced the first synthetic diamond. Xerography began predominance as a selenium end use.
- 1956** Federal-Aid Highway Act of 1956 was enacted, paving the way for interstate highways and enabling the construction of more than 42,000 miles of paved roads and 55,000 bridges (a significant use for cement, crushed stone, and steel).
- 1957** New applications were found for beryllium metal in aircraft and aerospace components. The first artificial satellite, Sputnik, was launched by the U.S.S.R.
- 1958** Aluminum beverage can was introduced. The laser was invented. Large sedimentary deposits containing zeolites were discovered.
- 1959** Significant U.S. tantalum and columbium (niobium) mining ceased.



## Events affecting the U.S. nonfuel minerals industry, 1900-2000

- indicates war and major conflict years.
- indicates recessions.
- overlap of recession and war years.

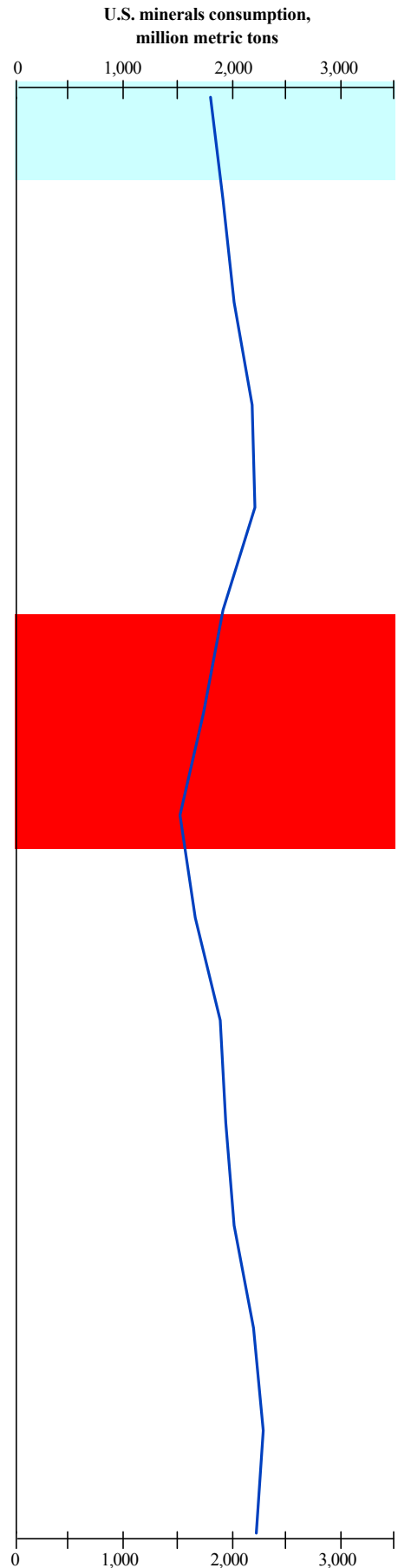
- 1960** Production of copper, lead, silver and zinc began from the Viburnum Trend mining district in southeast Missouri.
- 1961** Start of the U.S. involvement in the Vietnam conflict (1961-75), which became a period of extraordinary growth of copper consumption. Last commercial production of chromite ore reported in the United States. The U.S.S.R.'s Gagarin completed the world's first manned space flight.
- 1962**
- 1963** Public Law 88-36 was passed, repealing the Silver Purchase Act of 1934 and authorizing the printing of Federal Reserve Notes not redeemable in silver. First promethium metal was prepared.
- 1964** Minnesota passed a constitutional amendment that stated that for the next 25 years, taxes assessed against taconite (iron ore) mining companies would not be increased above the general corporate level. The Verrazano Narrows Bridge opened, which was the longest U.S. suspension bridge and was constructed of more than 725,000 cubic yards of concrete and 146,000 metric tons of steel.
- 1965** Steel mini-mills were introduced, based on a scrap feed and eventually captured a significant share of the market. Coinage Act of 1965 eliminated silver from all U.S. coins except the half dollar. Invention of the light-emitting diode led to a significant increase in U.S. gallium consumption.
- 1966** High-strength rare-earth cobalt magnets were discovered, which enabled miniaturization of many electronic devices. The SR-71 reconnaissance aircraft entered service, which was the most titanium-intensive aircraft ever constructed.
- 1967** Rhenium-platinum catalysts were used in unleaded gasoline production. Strontium ferrite ceramic magnets were developed.
- 1968** Commercial solvent extraction-electrowinning process to recover copper from leaching of copper ores began. Production of steel using the Bessemer furnace ceased. U.S. population reaches 200 million.
- 1969** A bertrandite mine was established in Utah providing the first significant U.S. beryllium raw materials source. Strontium replaced barium in color television faceplate glass to block X-ray emissions. The United States accomplished the world's first manned moon landing.
- 1970** Clean Air Act was passed requiring control of SO<sub>2</sub> emissions, which would become the second-largest market for lime and encourage the use of flash copper smelting technology. Antimony-based flame retardants were developed. The first of the low-loss optical fibers was created using germanium.
- 1971** Mercury was declared a hazardous air pollutant by U.S. Environmental Protection Agency (EPA). Opposition to the use of asbestos began, causing a downward spiral in sales (1971-2000). Color television faceplate glass became the dominant end use for strontium.
- 1972** Federal Insecticide, Fungicide, Rodenticide Act (FIFRA) banned many pesticides containing mercury. Federal Water Pollution Control Act authorized EPA to regulate mercury discharges into waterways. Cyanide heap leaching technology to extract gold began in Nevada.
- 1973** Start of Organization of Petroleum Exporting Countries (OPEC) oil embargo. Lead in paint was banned under Federal Hazardous Substances Act. Phaseout of lead in gasoline began under the Clean Air Act.
- 1974** U.S. citizens again were allowed to buy and hold gold. Japan surpassed the United States as the world's leading producer of cadmium. U.S. Frasch sulfur production peaked. Safe Drinking Water Act authorized EPA to set standards for hazardous substances in drinking water, including many metals. Crushed stone supplanted sand and gravel as the largest tonnage U.S.-produced mineral.



## Events affecting the U.S. nonfuel minerals industry, 1900-2000

- indicates war and major conflict years.
- indicates recessions.
- overlap of recession and war years.

- 1975** Catalytic converters became required equipment in automobiles, which eventually grew to be the most significant use for platinum-group metals.
- 1976** First flash copper smelter was commissioned in the United States.
- 1977** Blast-furnace production of ferromanganese ended. Clean Water Act was established, requiring mining operations to meet standards for surface water quality and controlling discharges to surface water.
- 1978** Resource Conservation And Recovery Act (RCRA) established regulations for disposal of mercury-bearing waste. Silicon overtook germanium in electronics applications, but germanium began to be used in fiber optics.
- 1979** Phosphate mining ended in Wyoming. Development work began on the Ovonic nickel-metal hydride battery.
- 1980** Gold price peaked at an historic daily high of \$850 per ounce on January 21. New steelmaking technologies began to lower manganese needs. Record-high silver price of \$49.45 per ounce was recorded. Comprehensive, Environmental Response, Compensation, and Liability Act (CERCLA) established Superfund to clean toxic waste sites, including some from old mining operations.
- 1981** Domestic production of thallium ceased.
- 1982** Recovered sulfur production, resulting from implementation of the Clean Air Act, surpassed that of Frasch for the first time.
- 1983** Aluminum almost completely replaced steel in the beverage can market.
- 1984**
- 1985** Domestic arsenic production ceased. After 29 years, the International Tin Agreement collapsed. Development of indium phosphide semiconductors and indium-tin-oxide thin films boosted indium consumption.
- 1986** Last synthetic soda ash plant closed in Syracuse, NY. Underground operations at the Stillwater Mine platinum-group metals mine began in Montana. Rare-earth-containing ceramic (oxide) superconductors were discovered, for which the Nobel Prize in physics was awarded in 1987.
- 1987** Montreal Protocol was adopted to phase out production of chlorofluorocarbons; the last U.S. production was in 1996, which led to dramatic decrease in fluor spar consumption. High-temperature superconductivity in Y-Ba-Cu-O compounds was discovered. Rhenium was added to nickel-based superalloys for use in jet aircraft engines.
- 1988** The first transatlantic fiber-optic cable was installed.
- 1989**



## Events affecting the U.S. nonfuel minerals industry, 1990-2000

- indicates war and major conflict years.
- indicates recessions.
- overlap of recession and war years.

- 1990** Last U.S. primary mercury mine closed.
- 1991** The Soviet Union was dissolved, and the United States became the market for many metals and minerals produced or stockpiled there. Last "natural ore" (direct-shipping iron ore) mine in the Lake Superior District halted production. Open-hearth furnace steel production ended. Phosphate mining ended in Tennessee. Clumping bentonite cat litter was introduced.
- 1992** Thin films of indium-tin oxide for liquid crystal displays became the largest use of indium.
- 1993** The National Defense Authorization Act established new disposal targets for the national defense stockpile. Most metals and minerals goals were reduced to zero. Phosphate mining ended in Montana. The use of cobalt in rechargeable batteries began a rapid growth (1993-2000).
- 1994**
- 1995** Last U.S. fluorspar mine closed in Illinois.
- 1996** Research showed link between selenium supplementation and lower incidence of cancer in humans.
- 1997** Last U.S. primary bismuth production plant closed in Nebraska. Automakers began commercial production of the first hybrid electric automobiles.
- 1998** The Transportation Equity Act for the 21st Century (Public Law 105-178) appropriated \$205 billion through 2003 for transportation, including road construction and repair. Last U.S. spodumene (lithium ore) mine closed. Commercial ferrochromium production from chromite ore ended in the United States, and the last U.S. high-carbon ferrochromium plant in South Carolina was closed.
- 1999**
- 2000** Last U.S. Frasch sulfur mine closed because of low prices, high fuel costs, and technical problems.

