[Template:Redirect](/wiki/Template:Redirect" \o "Template:Redirect) [Template:About](/wiki/Template:About) [Template:Pp-move-indef](/wiki/Template:Pp-move-indef) [Template:Use dmy dates](/wiki/Template:Use_dmy_dates) [Template:Infobox gold](/wiki/Template:Infobox_gold) **Gold** is a [chemical element](/wiki/Chemical_element) with the symbol **Au** (from [Template:Lang-la](/wiki/Template:Lang-la)) and the [atomic number](/wiki/Atomic_number) 79. In its purest form, it is a bright, slightly reddish yellow, dense, soft, [malleable](/wiki/Malleable) and [ductile](/wiki/Ductile) [metal](/wiki/Metal). Chemically, gold is a [transition metal](/wiki/Transition_metal) and a [group 11 element](/wiki/Group_11_element). It is one of the least reactive chemical elements, and is solid under [standard conditions](/wiki/Standard_conditions_for_temperature_and_pressure). The metal therefore occurs often in free elemental (native) form, as [nuggets](/wiki/Gold_nugget) or grains, in [rocks](/wiki/Rock_(geology)), in [veins](/wiki/Vein_(geology)) and in [alluvial deposits](/wiki/Alluvial_deposit). It occurs in a [solid solution](/wiki/Solid_solution) series with the native element [silver](/wiki/Silver) (as [electrum](/wiki/Electrum)) and also naturally [alloyed](/wiki/Alloy) with [copper](/wiki/Copper) and [palladium](/wiki/Palladium). Less commonly, it occurs in minerals as gold compounds, often with [tellurium](/wiki/Tellurium) ([gold tellurides](/wiki/Gold_telluride)).

Gold's atomic number of 79 makes it one of the higher atomic number elements that occur naturally in the [universe](/wiki/Universe). It is thought to have been produced in [supernova nucleosynthesis](/wiki/Supernova_nucleosynthesis) and from the [collision](/wiki/Stellar_collision#Types_of_stellar_collisions_and_mergers) of [neutron stars](/wiki/Neutron_star)[[1]](#cite_note-1) and to have been present in the [dust](/wiki/Solar_nebula) from which the [Solar System](/wiki/Solar_System) formed. Because the Earth was molten [when it was just formed](/wiki/History_of_Earth), almost all of the gold present in the [early Earth](/wiki/Early_Earth) probably sank into the [planetary core](/wiki/Core_(geology)). Therefore, most of the gold that is present today in the Earth's [crust](/wiki/Crust_(geology)) and [mantle](/wiki/Mantle_(geology)) is thought to have been delivered to Earth later, by [asteroid impacts](/wiki/Asteroid_impact) during the [Late Heavy Bombardment](/wiki/Late_Heavy_Bombardment), about 4 billion years ago.[Template:Citation needed](/wiki/Template:Citation_needed)

Gold resists attack by individual [acids](/wiki/Acid), but [aqua regia](/wiki/Aqua_regia) (literally "royal water", a mixture of [nitric acid](/wiki/Nitric_acid) and [hydrochloric acid](/wiki/Hydrochloric_acid)) can dissolve it. The acid mixture causes the formation of a soluble [tetrachloroaurate](/wiki/Chloroauric_acid) [anion](/wiki/Anion). It is insoluble in [nitric acid](/wiki/Nitric_acid), which dissolves silver and [base metals](/wiki/Base_metal), a property that has long been used to [refine](/wiki/Refining_(metallurgy)) gold and to confirm the presence of gold in metallic objects, giving rise to the term [*acid test*](/wiki/Acid_test_(gold)). Gold also dissolves in [alkaline](/wiki/Alkaline) solutions of [cyanide](/wiki/Cyanide), which are used in [mining](/wiki/Gold_cyanidation) and [electroplating](/wiki/Electroplating). Gold dissolves in [mercury](/wiki/Mercury_(element)), forming [amalgam](/wiki/Amalgam_(chemistry)) alloys, but this is not a [chemical reaction](/wiki/Chemical_reaction).

Gold is a [precious metal](/wiki/Precious_metal) used for [coinage](/wiki/Coin), [jewelry](/wiki/Jewelry), and other [arts](/wiki/Work_of_art) throughout [recorded history](/wiki/Recorded_history). In the past, a [gold standard](/wiki/Gold_standard) was often implemented as a [monetary policy](/wiki/Monetary_policy) within and between nations, but gold coins ceased to be minted as a circulating currency in the 1930s, and the world gold standard was abandoned for a [fiat currency](/wiki/Fiat_currency) system after 1976. The historical value of gold was rooted in its relative rarity, easy handling and minting, easy smelting and fabrication, resistance to [corrosion](/wiki/Corrosion) and other [chemical reactions](/wiki/Chemical_reaction) ([nobility](/wiki/Noble_metal)), and distinctive color.

A total of 183,600 [tonnes](/wiki/Tonne) of gold is in existence above ground, as of 2014.[[2]](#cite_note-2) This is equivalent to 9513 m3 of gold. The world consumption of new gold produced is about 50% in jewelry, 40% in [investments](/wiki/Investment), and 10% in [industry](/wiki/Industry).[[3]](#cite_note-3) Gold's high malleability, ductility, resistance to corrosion and most other chemical reactions, and conductivity of electricity have led to its continued use in corrosion resistant [electrical connectors](/wiki/Electrical_connector) in all types of computerized devices (its chief industrial use). Gold is also used in [infrared](/wiki/Infrared) shielding, [colored-glass](/wiki/Colored_glass) production, [gold leafing](/wiki/Gold_leaf), and [tooth restoration](/wiki/Restorative_dentistry). Certain [gold salts](/wiki/Gold_salts) are still used as [anti-inflammatories](/wiki/Anti-inflammatories) in medicine.

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## Etymology[[edit](/index.php?title=(none)&action=edit&section=1)]

"Gold" is [cognate](/wiki/Cognate) with similar words in many [Germanic languages](/wiki/Germanic_languages), deriving via [Proto-Germanic](/wiki/Proto-Germanic) [\**gulþą*](/wiki/Wikt:Appendix:Proto-Germanic/gulþą) from [Proto-Indo-European](/wiki/Proto-Indo-European) [\**ǵʰelh₃-*](/wiki/Wikt:Appendix:Proto-Indo-European/ǵʰelh₃-) ("to shine, to gleam; to be yellow or green").[[4]](#cite_note-4)[[5]](#cite_note-5) The symbol *Au* is from the [Template:Lang-la](/wiki/Template:Lang-la), the Latin word for "gold".[[6]](#cite_note-6) The Proto-Indo-European ancestor of *aurum* was *\*h₂é-h₂us-o-*, meaning "glow". This word is derived from the same [root](/wiki/Root_(linguistics)) (Proto-Indo-European *\*h₂u̯es-* "to dawn") as [*\*h₂éu̯sōs*](/wiki/Wikt:Appendix:Proto-Indo-European/h₂éwsōs), the ancestor of the Latin word [Aurora](/wiki/Aurora), "dawn".[[7]](#cite_note-7) This etymological relationship is presumably behind the frequent claim in scientific publications that *aurum* meant "shining dawn".<ref name=Brathwaite>Christie, A and Brathwaite, R. (Last updated 2 November 2011) [Mineral Commodity Report 14 — Gold](http://web.archive.org/web/20130208092020/http://www.nzpam.govt.nz/cms/pdf-library/minerals/publications/Commodity%20Reports/report14_gold.pdf), Institute of geological and Nuclear sciences Ltd – Retrieved 7 June 2012</ref>

## Characteristics[[edit](/index.php?title=(none)&action=edit&section=2)]

Gold is the most [malleable](/wiki/Malleable) of all metals; a single gram can be beaten into a sheet of 1 square meter, and an [ounce](/wiki/Ounce) into 300 square feet. Gold leaf can be beaten thin enough to become transparent. The transmitted light appears greenish blue, because gold strongly reflects yellow and red.[[8]](#cite_note-8) Such semi-transparent sheets also strongly reflect infrared light, making them useful as infrared (radiant heat) shields in visors of heat-resistant suits, and in sun-visors for [spacesuits](/wiki/Spacesuit).[[9]](#cite_note-9) Gold is a good [conductor of heat](/wiki/Conduction_(heat)) and [electricity](/wiki/Electrical_conductor) and reflects [infrared radiation](/wiki/Infrared_radiation) strongly.

In addition, gold is very dense: it has a density of 19,300 kg/m3. By comparison, the density of [lead](/wiki/Lead) is 11,340 kg/m3, and that of the densest element, [osmium](/wiki/Osmium), is 22,588 ± 15 kg/m3.[[10]](#cite_note-10)

## Chemistry[[edit](/index.php?title=(none)&action=edit&section=3)]

[thumb|right|Gold (III) chloride solution in water](/wiki/File:Gold(III)_chloride_solution.jpg) Although gold is the most noble of the [noble metals](/wiki/Noble_metal),[[11]](#cite_note-11)[[12]](#cite_note-12) it still forms many diverse compounds. The [oxidation state](/wiki/Oxidation_state) of gold in its compounds ranges from −1 to +5, but Au(I) and Au(III) dominate its chemistry. Au(I), referred to as the aurous ion, is the most common oxidation state with soft [ligands](/wiki/Ligand) such as [thioethers](/wiki/Thioether), [thiolates](/wiki/Thiolate), and tertiary [phosphines](/wiki/Phosphine). Au(I) compounds are typically linear. A good example is [Au(CN)2−](/wiki/Gold_cyanidation), which is the soluble form of gold encountered in mining. The binary [gold halides](/wiki/Gold_halide), such as [AuCl](/wiki/Gold(I)_chloride), form zigzag polymeric chains, again featuring linear coordination at Au. Most drugs based on gold are Au(I) derivatives.[[13]](#cite_note-13) Au(III) (auric) is a common oxidation state, and is illustrated by [gold(III) chloride](/wiki/Gold(III)_chloride), Au2Cl6. The gold atom centers in Au(III) complexes, like other d8 compounds, are typically [square planar](/wiki/Square_planar), with [chemical bonds](/wiki/Chemical_bond) that have both [covalent](/wiki/Covalent) and [ionic](/wiki/Ion) character.

Gold does not react with oxygen at any temperature;[[14]](#cite_note-14) similarly, it does not react with ozone[Template:Citation needed](/wiki/Template:Citation_needed). Gold is strongly attacked by fluorine at dull-red heat[[15]](#cite_note-15) to form [gold(III) fluoride](/wiki/Gold(III)_fluoride).

Some free [halogens](/wiki/Halogen) react with gold.[[16]](#cite_note-16) Powdered gold reacts with chlorine at 180 °C to form [AuCl3](/wiki/Gold(III)_chloride).[[17]](#cite_note-17) Gold reacts with bromine at 140 °C to form [gold(III) bromide](/wiki/Gold(III)_bromide), but reacts only very slowly with iodine to form the [monoiodide](/wiki/Gold(I)_iodide).

Gold does not react with sulfur directly,[[18]](#cite_note-18) Gold has the highest [Pauling electronegativity](/wiki/Electronegativity) of any metal, with a value of 2.54, making the auride anion relatively stable.

Gold(II) compounds are usually [diamagnetic](/wiki/Diamagnetic) with Au–Au bonds such as [Au(CH2)2P(C6H5)2]2Cl2. The evaporation of a solution of [Template:Chem](/wiki/Template:Chem) in concentrated [Template:Chem](/wiki/Template:Chem) produces red crystals of gold(II) sulfate, Au2(SO4)2. Originally thought to be a mixed-valence compound, it has been shown to contain [Template:Chem](/wiki/Template:Chem) cations, analogous to the better-known [mercury(I)](/wiki/Mercury(I)) ion, [Template:Chem](/wiki/Template:Chem) .[[20]](#cite_note-20)[[21]](#cite_note-21) A gold(II) complex, the [tetraxenonogold(II)](/wiki/Tetraxenonogold(II)) cation, which contains [xenon](/wiki/Xenon) as a ligand, occurs in [AuXe4](Sb2F11)2.[[22]](#cite_note-22) [Gold pentafluoride](/wiki/Gold_pentafluoride), along with its derivative anion, [Template:Chem](/wiki/Template:Chem), and its [difluorine complex](/wiki/Difluorine_complex), [gold heptafluoride](/wiki/Gold_heptafluoride), is the sole example of gold(V), the highest verified oxidation state.[[23]](#cite_note-23) Some gold compounds exhibit [*aurophilic bonding*](/wiki/Aurophilicity), which describes the tendency of gold ions to interact at distances that are too long to be a conventional Au–Au bond but shorter than [van der Waals bonding](/wiki/Van_der_Waals_force). The interaction is estimated to be comparable in strength to that of a [hydrogen bond](/wiki/Hydrogen_bond).

### Mixed valence compounds[[edit](/index.php?title=(none)&action=edit&section=5)]

Well-defined cluster compounds are numerous.<ref name=Holleman/> In such cases, gold has a fractional oxidation state. A representative example is the octahedral species {Au([P(C6H5)3](/wiki/Triphenylphosphine))}62+. [Gold chalcogenides](/wiki/Gold_chalcogenides), such as gold sulfide, feature equal amounts of Au(I) and Au(III).

### Color[[edit](/index.php?title=(none)&action=edit&section=6)]

[thumb|left|Different colors of Ag-Au-Cu alloys](/wiki/File:Ag-Au-Cu-colours-english.svg) Whereas most other pure metals are gray or silvery white, gold is slightly reddish yellow.[[24]](#cite_note-24) This color is determined by the density of loosely bound (valence) electrons; those electrons oscillate as a collective "plasma" medium described in terms of a [quasiparticle](/wiki/Quasiparticle) called a [plasmon](/wiki/Plasmon). The frequency of these oscillations lies in the ultraviolet range for most metals, but it falls into the visible range for gold due to subtle [relativistic effects](/wiki/Relativistic_quantum_chemistry) that affect the [orbitals](/wiki/Atomic_orbital) around gold atoms.[[25]](#cite_note-25)[[26]](#cite_note-26) Similar effects impart a golden hue to metallic [caesium](/wiki/Caesium).

Common [colored gold](/wiki/Colored_gold) alloys such as rose gold can be created by the addition of various amounts of copper and silver, as indicated in the triangular diagram to the left. Alloys containing palladium or nickel are also important in commercial jewelry as these produce white gold alloys. Less commonly, addition of [manganese](/wiki/Manganese), [aluminium](/wiki/Aluminium), [iron](/wiki/Iron), [indium](/wiki/Indium) and other elements can produce more unusual colors of gold for various applications.<ref name=coloredgold>[Template:Cite web](/wiki/Template:Cite_web)</ref>

### Isotopes[[edit](/index.php?title=(none)&action=edit&section=7)]

[Template:Main article](/wiki/Template:Main_article) Gold has only one stable [isotope](/wiki/Isotope), [Template:Chem](/wiki/Template:Chem), which is also its only naturally occurring isotope, so gold is both a [mononuclidic](/wiki/Mononuclidic_element) and [monoisotopic](/wiki/Monoisotopic_element) element. Thirty-six [radioisotopes](/wiki/Radioisotopes) have been synthesized ranging in [atomic mass](/wiki/Atomic_mass) from 169 to 205. The most stable of these is [Template:Chem](/wiki/Template:Chem) with a [half-life](/wiki/Half-life) of 186.1 days. The least stable is [Template:Chem](/wiki/Template:Chem), which decays by [proton emission](/wiki/Proton_emission) with a half-life of 30 µs. Most of gold's radioisotopes with atomic masses below 197 decay by some combination of [proton emission](/wiki/Proton_emission), [α decay](/wiki/Alpha_decay), and [β+ decay](/wiki/Beta_decay#β+_decay). The exceptions are [Template:Chem](/wiki/Template:Chem), which decays by electron capture, and [Template:Chem](/wiki/Template:Chem), which decays most often by electron capture (93%) with a minor [β− decay](/wiki/Beta_decay#β−_decay) path (7%).[[27]](#cite_note-27) All of gold's radioisotopes with atomic masses above 197 decay by β− decay.[[28]](#cite_note-28) At least 32 [nuclear isomers](/wiki/Nuclear_isomer) have also been characterized, ranging in atomic mass from 170 to 200. Within that range, only [Template:Chem](/wiki/Template:Chem), [Template:Chem](/wiki/Template:Chem), [Template:Chem](/wiki/Template:Chem), [Template:Chem](/wiki/Template:Chem), and [Template:Chem](/wiki/Template:Chem) do not have isomers. Gold's most stable isomer is [Template:Chem](/wiki/Template:Chem) with a half-life of 2.27 days. Gold's least stable isomer is [Template:Chem](/wiki/Template:Chem) with a half-life of only 7 ns. [Template:Chem](/wiki/Template:Chem) has three decay paths: β+ decay, [isomeric transition](/wiki/Isomeric_transition), and alpha decay. No other isomer or isotope of gold has three decay paths.[[28]](#cite_note-28)

## Modern applications[[edit](/index.php?title=(none)&action=edit&section=8)]

The world consumption of new gold produced is about 50% in jewelry, 40% in investments, and 10% in industry.[[3]](#cite_note-3)

### Jewelry[[edit](/index.php?title=(none)&action=edit&section=9)]

[Template:Main article](/wiki/Template:Main_article) [thumb|](/wiki/File:MocheGoldNecklace.jpg)[Moche](/wiki/Moche_(culture)) gold necklace depicting feline heads. [Larco Museum](/wiki/Larco_Museum) Collection. Lima-Peru Because of the softness of pure (24k) gold, it is usually [alloyed](/wiki/Alloy) with base metals for use in jewelry, altering its hardness and ductility, melting point, color and other properties. Alloys with lower [karat rating](/wiki/Fineness), typically 22k, 18k, 14k or 10k, contain higher percentages of copper or other base metals or silver or palladium in the alloy. [Copper](/wiki/Copper) is the most commonly used base metal, yielding a redder color.[[29]](#cite_note-29) Eighteen-karat gold containing 25% copper is found in antique and Russian jewelry and has a distinct, though not dominant, copper cast, creating [rose gold](/wiki/Rose_gold). Fourteen-karat gold-copper alloy is nearly identical in color to certain [bronze](/wiki/Bronze) alloys, and both may be used to produce police and other [badges](/wiki/Badge). Blue gold can be made by alloying with [iron](/wiki/Iron) and purple gold can be made by alloying with [aluminium](/wiki/Aluminium), although rarely done except in specialized jewelry. Blue gold is more brittle and therefore more difficult to work with when making jewelry.[[29]](#cite_note-29) Fourteen- and eighteen-karat gold alloys with silver alone appear greenish-yellow and are referred to as [green gold](/wiki/Green_gold). White gold alloys can be made with [palladium](/wiki/Palladium) or [nickel](/wiki/Nickel). White 18-karat gold containing 17.3% nickel, 5.5% zinc and 2.2% copper is silvery in appearance. Nickel is toxic, however, and its release from nickel white gold is controlled by legislation in Europe.[[29]](#cite_note-29) Alternative [white gold](/wiki/White_gold) alloys are available based on palladium, silver and other white metals,[[29]](#cite_note-29) but the palladium alloys are more expensive than those using nickel. High-karat white gold alloys are far more resistant to corrosion than are either pure silver or [sterling silver](/wiki/Sterling_silver). The Japanese craft of [Mokume-gane](/wiki/Mokume-gane) exploits the color contrasts between laminated colored gold alloys to produce decorative wood-grain effects.

By 2014 the gold jewelry industry was escalating despite a dip in gold prices. Demand in the first quarter of 2014 pushed turnover to $23.7 billion according to a [World Gold Council](/wiki/World_Gold_Council) report.

### Investment[[edit](/index.php?title=(none)&action=edit&section=10)]

[thumb|325px|Gold-nominal-constant-usd|Gold prices (US$ per troy ounce), in nominal US$ and inflation adjusted US$.](/wiki/File:Gold-nominal-constant-usd.svg) [Template:Main article](/wiki/Template:Main_article)

Many holders of gold store it in form of [bullion](/wiki/Bullion) coins or [bars](/wiki/Gold_bar) as a hedge against [inflation](/wiki/Inflation) or other economic disruptions. However, economist [Martin Feldstein](/wiki/Martin_Feldstein) does not believe gold serves as a hedge against inflation or currency depreciation.[[30]](#cite_note-30) The [ISO 4217](/wiki/ISO_4217) currency code of gold is XAU.[[31]](#cite_note-31) Modern [bullion coins](/wiki/Bullion_coin) for investment or collector purposes do not require good mechanical wear properties; they are typically fine gold at 24k, although the [American Gold Eagle](/wiki/American_Gold_Eagle) and the British [gold sovereign](/wiki/Sovereign_(British_coin)) continue to be minted in 22k (0.92) metal in historical tradition, and the South African [Krugerrand](/wiki/Krugerrand), first released in 1967, is also 22k (0.92).[[32]](#cite_note-32) The *special issue* [Canadian Gold Maple Leaf](/wiki/Canadian_Gold_Maple_Leaf) coin contains the highest purity gold of any [bullion coin](/wiki/Bullion_coin), at 99.999% or 0.99999, while the *popular issue* Canadian Gold Maple Leaf coin has a purity of 99.99%.

Several other 99.99% pure gold coins are available. In 2006, the [United States Mint](/wiki/United_States_Mint) began producing the [American Buffalo](/wiki/American_Buffalo_(coin)) gold bullion coin with a purity of 99.99%. The [Australian](/wiki/Australia) Gold Kangaroos were first coined in 1986 as the [Australian Gold Nugget](/wiki/Australian_Gold_Nugget) but changed the reverse design in 1989. Other modern coins include the [Austrian](/wiki/Austria) [Vienna Philharmonic bullion coin](/wiki/Euro_gold_and_silver_commemorative_coins_(Austria)#Vienna_Philharmonic_Coin) and the [Chinese Gold Panda](/wiki/Chinese_Gold_Panda).

### Electronics connectors[[edit](/index.php?title=(none)&action=edit&section=11)]

Only 10% of the world consumption of new gold produced goes to industry,[[3]](#cite_note-3) but by far the most important industrial use for new gold is in fabrication of corrosion-free [electrical connectors](/wiki/Electrical_connectors) in computers and other electrical devices. For example, according to the World Gold council, a typical cell phone may contain 50 mg of gold, worth about 50 cents. But since nearly one billion cell phones are produced each year, a gold value of 50 cents in each phone adds to $500 million in gold from just this application.[[33]](#cite_note-33) Though gold is attacked by free chlorine, its good conductivity and general resistance to oxidation and corrosion in other environments (including resistance to non-chlorinated acids) has led to its widespread industrial use in the electronic era as a thin-layer coating on [electrical connectors](/wiki/Electrical_connector), thereby ensuring good connection. For example, gold is used in the connectors of the more expensive electronics cables, such as audio, video and [USB](/wiki/USB) cables. The benefit of using gold over other connector metals such as [tin](/wiki/Tin) in these applications has been debated; gold connectors are often criticized by audio-visual experts as unnecessary for most consumers and seen as simply a marketing ploy. However, the use of gold in other applications in electronic sliding contacts in highly humid or corrosive atmospheres, and in use for contacts with a very high failure cost (certain [computers](/wiki/Computer), communications equipment, [spacecraft](/wiki/Spacecraft), [jet aircraft](/wiki/Jet_aircraft) engines) remains very common.[[34]](#cite_note-34) Besides sliding electrical contacts, gold is also used in [electrical contacts](/wiki/Switch#Contacts) because of its resistance to [corrosion](/wiki/Corrosion), [electrical conductivity](/wiki/Electrical_conductivity), [ductility](/wiki/Ductile) and lack of [toxicity](/wiki/Toxicity).[[35]](#cite_note-35) Switch contacts are generally subjected to more intense corrosion stress than are sliding contacts. Fine gold wires are used to connect [semiconductor devices](/wiki/Semiconductor_device) to their packages through a process known as [wire bonding](/wiki/Wire_bonding).

The concentration of free electrons in gold metal is 5.90×1022 cm−3. Gold is highly [conductive](/wiki/Electrical_conductivity) to electricity, and has been used for [electrical wiring](/wiki/Electrical_wiring) in some high-energy applications (only silver and copper are more conductive per volume, but gold has the advantage of corrosion resistance). For example, gold electrical wires were used during some of the [Manhattan Project's](/wiki/Manhattan_Project) atomic experiments, but large high-current silver wires were used in the [calutron](/wiki/Calutron) isotope separator magnets in the project.

### Non-electronic industry[[edit](/index.php?title=(none)&action=edit&section=12)]

[thumb|Mirror for the future](/wiki/File:James_Webb_Space_Telescope_Mirror33.jpg) [James Webb Space Telescope](/wiki/James_Webb_Space_Telescope) coated in gold to reflect infrared light [upright|thumb|The](/wiki/File:Toi_250kg_gold_bar.jpg) [world's largest gold bar](/wiki/World's_largest_gold_bar) has a mass of 250 kg. [Toi museum](/wiki/Toi_Gold_Museum), [Japan](/wiki/Japan). [upright|thumb|A gold nugget of 5 mm in diameter (bottom) can be expanded through hammering into a](/wiki/File:Small_gold_nugget_5mm_dia_and_corresponding_foil_surface_of_half_sq_meter.jpg) [gold foil](/wiki/Gold_foil) of about 0.5 square meters. [Toi museum](/wiki/Toi_gold_mine), [Japan](/wiki/Japan).

* Gold [solder](/wiki/Solder) is used for joining the components of gold jewelry by high-temperature hard soldering or [brazing](/wiki/Brazing). If the work is to be of [hallmarking](/wiki/Hallmark) quality, gold solder must match the carat weight of the work, and alloy formulas are manufactured in most industry-standard carat weights to color match yellow and white gold. Gold solder is usually made in at least three melting-point ranges referred to as Easy, Medium and Hard. By using the hard, high-melting point solder first, followed by solders with progressively lower melting points, goldsmiths can assemble complex items with several separate soldered joints.
* Gold can be made into [thread](/wiki/Gold_thread) and used in [embroidery](/wiki/Embroidery).
* Gold produces a deep, intense red color when used as a coloring agent in [cranberry glass](/wiki/Cranberry_glass).
* In photography, gold toners are used to shift the color of [silver bromide](/wiki/Silver_bromide) black-and-white prints towards brown or blue tones, or to increase their stability. Used on [sepia-toned](/wiki/Sepia_tone) prints, gold toners produce red tones. Kodak published formulas for several types of gold toners, which use gold as the chloride.[[36]](#cite_note-36)\* Gold is a good reflector of [electromagnetic radiation](/wiki/Electromagnetic_radiation) such as [infrared](/wiki/Infrared) and [visible light](/wiki/Visible_spectrum), as well as [radio waves](/wiki/Radio_frequency). It is used for the protective coatings on many artificial [satellites](/wiki/Satellite), in infrared protective faceplates in thermal-protection suits and astronauts' helmets, and in [electronic warfare](/wiki/Electronic_warfare) planes such as the [EA-6B Prowler](/wiki/EA-6B_Prowler).
* Gold is used as the reflective layer on some [high-end CDs](/wiki/Gold_CD).
* Automobiles may use gold for heat shielding. [McLaren](/wiki/McLaren) uses gold foil in the engine compartment of its [F1](/wiki/McLaren_F1) model.[[37]](#cite_note-37)\* Gold can be manufactured so thin that it appears transparent. It is used in some aircraft cockpit windows for [de-icing](/wiki/Deicing) or anti-icing by passing electricity through it. The heat produced by the resistance of the gold is enough to deter ice from forming.<ref name=gbc215>[Template:Cite news](/wiki/Template:Cite_news)</ref>

### Commercial chemistry[[edit](/index.php?title=(none)&action=edit&section=13)]

Gold is attacked by and dissolves in alkaline solutions of potassium or sodium [cyanide](/wiki/Cyanide), to form the salt gold cyanide—a technique that has been used in extracting metallic gold from ores in the [cyanide process](/wiki/Cyanide_process). Gold cyanide is the [electrolyte](/wiki/Electrolyte) used in commercial [electroplating](/wiki/Electroplating) of gold onto base metals and [electroforming](/wiki/Electroforming).

Gold chloride ([chloroauric acid](/wiki/Chloroauric_acid)) solutions are used to make colloidal gold by reduction with [citrate](/wiki/Citrate) or [ascorbate](/wiki/Ascorbate) [ions](/wiki/Ions). Gold chloride and gold oxide are used to make cranberry or red-colored glass, which, like [colloidal](/wiki/Colloid) gold suspensions, contains evenly sized spherical [gold nanoparticles](/wiki/Gold_nanoparticle).[[38]](#cite_note-38)

### Medicine[[edit](/index.php?title=(none)&action=edit&section=14)]

Metallic and gold compounds have been used for medicinal purposes historically and are still in use. The apparent paradox of the actual toxicology of the substance suggests the possibility of serious gaps in the understanding of the action of gold in physiology.[[39]](#cite_note-39) Gold (usually as the metal) is perhaps the most anciently administered medicine (apparently by shamanic practitioners)[[40]](#cite_note-40) and known to [Dioscorides](/wiki/Dioscorides).[[41]](#cite_note-41)[[42]](#cite_note-42) In medieval times, gold was often seen as beneficial for the health, in the belief that something so rare and beautiful could not be anything but healthy. Even some modern [esotericists](/wiki/Esotericism) and forms of [alternative medicine](/wiki/Alternative_medicine) assign metallic gold a healing power.[[43]](#cite_note-43) In the 19th century gold had a reputation as a "nervine," a therapy for nervous disorders. [Depression](/wiki/Depression_(mood)), [epilepsy](/wiki/Epilepsy), [migraine](/wiki/Migraine), and glandular problems such as [amenorrhea](/wiki/Amenorrhea) and [impotence](/wiki/Impotence) were treated, and most notably [alcoholism](/wiki/Alcoholism) (Keeley, 1897).[[44]](#cite_note-44) Only salts and radioisotopes of gold are of pharmacological value, since elemental (metallic) gold is inert to all chemicals it encounters inside the body (i.e., ingested gold cannot be attacked by stomach acid). Some gold salts do have [anti-inflammatory](/wiki/Anti-inflammatory) properties and at present two are still used as pharmaceuticals in the treatment of arthritis and other similar conditions in the US ([sodium aurothiomalate](/wiki/Sodium_aurothiomalate) and [auranofin](/wiki/Auranofin)). These drugs have been explored as a means to help to reduce the pain and swelling of [rheumatoid arthritis](/wiki/Rheumatoid_arthritis), and also (historically) against [tuberculosis](/wiki/Tuberculosis) and some parasites.[[45]](#cite_note-45) Gold alloys are used in [restorative dentistry](/wiki/Restorative_dentistry), especially in tooth restorations, such as [crowns](/wiki/Crown_(dentistry)) and permanent [bridges](/wiki/Bridge_(dentistry)). The gold alloys' slight malleability facilitates the creation of a superior molar mating surface with other teeth and produces results that are generally more satisfactory than those produced by the creation of porcelain crowns. The use of gold crowns in more prominent teeth such as incisors is favored in some cultures and discouraged in others.

[Colloidal gold](/wiki/Colloidal_gold) preparations (suspensions of [gold nanoparticles](/wiki/Gold_nanoparticle)) in water are intensely red-[colored](/wiki/Color), and can be made with tightly controlled particle sizes up to a few tens of nanometers across by reduction of gold chloride with [citrate](/wiki/Citrate) or [ascorbate](/wiki/Ascorbate) ions. Colloidal gold is used in research applications in medicine, biology and [materials science](/wiki/Materials_science). The technique of [immunogold labeling](/wiki/Immunogold_labeling) exploits the ability of the gold particles to adsorb protein molecules onto their surfaces. Colloidal gold particles coated with specific antibodies can be used as probes for the presence and position of antigens on the surfaces of cells.[[46]](#cite_note-46) In ultrathin sections of tissues viewed by [electron microscopy](/wiki/Electron_microscope), the immunogold labels appear as extremely dense round spots at the position of the [antigen](/wiki/Antigen).[[47]](#cite_note-47) Gold, or alloys of gold and [palladium](/wiki/Palladium), are applied as conductive coating to biological specimens and other non-conducting materials such as plastics and glass to be viewed in a [scanning electron microscope](/wiki/Scanning_electron_microscope). The coating, which is usually applied by [sputtering](/wiki/Sputtering) with an [argon](/wiki/Argon) [plasma](/wiki/Plasma_(physics)), has a triple role in this application. Gold's very high electrical conductivity drains [electrical charge](/wiki/Electric_charge) to earth, and its very high density provides stopping power for electrons in the [electron beam](/wiki/Electron_beam), helping to limit the depth to which the electron beam penetrates the specimen. This improves definition of the position and topography of the specimen surface and increases the [spatial resolution](/wiki/Angular_resolution) of the image. Gold also produces a high output of [secondary electrons](/wiki/Secondary_emission) when irradiated by an electron beam, and these low-energy electrons are the most commonly used signal source used in the scanning electron microscope.[[48]](#cite_note-48) The isotope [gold-198](/wiki/Gold-198) ([half-life](/wiki/Half-life) 2.7 days) is used, in [nuclear medicine](/wiki/Nuclear_medicine), in some [cancer](/wiki/Cancer) treatments and for treating other diseases.[[49]](#cite_note-49)[[50]](#cite_note-50)

### Food and drink[[edit](/index.php?title=(none)&action=edit&section=15)]

* Gold can be used in food and has the [E number](/wiki/E_number) 175.<ref name=FSA>[Template:Cite news](/wiki/Template:Cite_news)</ref> In 2016, the [European Food Safety Authority](/wiki/European_Food_Safety_Authority) published an opinion on the re-evaluation of gold (E 175) as a food additive. Concerns included the possible presence of minute amounts of gold nanoparticles in the food additive, and that gold nanoparticles have been shown to be [genotoxic](/wiki/Genotoxic) in mammalian cells [in vitro](/wiki/In_vitro).[[51]](#cite_note-51)\* [Gold leaf](/wiki/Gold_leaf), flake or dust is used on and in some gourmet foods, notably sweets and drinks as decorative ingredient.[[52]](#cite_note-52) Gold flake was used by the nobility in [medieval Europe](/wiki/Medieval_Europe) as a decoration in food and drinks, in the form of leaf, flakes or dust, either to demonstrate the host's wealth or in the belief that something that valuable and rare must be beneficial for one's health.
* Danziger Goldwasser (German: Gold water of Danzig) or [Goldwasser](/wiki/Goldwasser) ([Template:Lang-en](/wiki/Template:Lang-en)) is a traditional German herbal [liqueur](/wiki/Liqueur)[[53]](#cite_note-53) produced in what is today [Gdańsk](/wiki/Gdańsk), [Poland](/wiki/Poland), and [Schwabach](/wiki/Schwabach), Germany, and contains flakes of gold leaf. There are also some expensive (~$1000) cocktails which contain flakes of gold leaf.[[54]](#cite_note-54) However, since metallic gold is inert to all body chemistry, it has no taste, it provides no nutrition, and it leaves the body unaltered.[[55]](#cite_note-55)\* [Vark](/wiki/Vark) is a [foil](/wiki/Metal_leaf) composed of a pure metal that is sometimes gold,[[56]](#cite_note-56) and is used for [garnishing](/wiki/Garnish_(food)) sweets in South Asian cuisine.

## Monetary exchange (historical)[[edit](/index.php?title=(none)&action=edit&section=16)]

[thumb|right|Gold is commonly formed into bars for use in monetary exchange.](/wiki/File:Gold_Bars.jpg) [thumb|right|Two golden 20 kr coins from the](/wiki/File:Two_20kr_gold_coins.jpg) [Scandinavian Monetary Union](/wiki/Scandinavian_Monetary_Union), which was based on a [gold standard](/wiki/Gold_standard). The coin to the left is [Swedish](/wiki/Sweden) and the right one is [Danish](/wiki/Denmark).

Gold has been [widely used](/wiki/History_of_money) throughout the world as [money](/wiki/Money), for efficient indirect exchange (versus [barter](/wiki/Barter)), and to store wealth in [hoards](/wiki/Hoard). For exchange purposes, [mints](/wiki/Mint_(coin)) produce standardized [gold bullion](/wiki/Bullion) [coins](/wiki/Coins), [bars](/wiki/Gold_bar) and [other units](/wiki/Good_delivery) of fixed weight and purity.

The first known coins containing gold were struck in Lydia, Asia Minor, around 600 BC.[[57]](#cite_note-57) The [*talent*](/wiki/Talent_(measurement)) coin of gold in use during the periods of Grecian history both before and during the time of the life of Homer weighed between 8.42 and 8.75 grams.[[58]](#cite_note-58) From an earlier preference in using silver, European economies re-established the minting of gold as coinage during the thirteenth and fourteenth centuries.[[59]](#cite_note-59) [Bills](/wiki/Real_bills_doctrine) (that mature into gold coin) and [gold certificates](/wiki/Gold_certificates) (convertible into gold coin at the issuing bank) added to the circulating stock of [gold standard](/wiki/Gold_standard) money in most 19th century industrial economies. In preparation for [World War I](/wiki/World_War_I) the warring nations moved to fractional gold standards, inflating their currencies to finance the war effort. Post-war, the victorious countries, most notably Britain, gradually restored gold-convertibility, but international flows of gold via bills of exchange remained embargoed; international shipments were made exclusively for bilateral trades or to pay war reparations.

After [World War II](/wiki/World_War_II) gold was replaced by a system of nominally [convertible currencies](/wiki/Convertible_currency) related by fixed exchange rates following the [Bretton Woods system](/wiki/Bretton_Woods_system). [Gold standards](/wiki/Gold_standard) and the direct convertibility of currencies to gold have been abandoned by world governments, led in 1971 by the United States' refusal to redeem its dollars in gold. [Fiat currency](/wiki/Fiat_currency) now fills most monetary roles. [Switzerland](/wiki/Switzerland) was the last country to tie its currency to gold; it backed 40% of its value until the Swiss joined the [International Monetary Fund](/wiki/International_Monetary_Fund) in 1999.[[60]](#cite_note-60) Central banks continue to keep a portion of their liquid reserves as gold in some form, and metals exchanges such as the [London Bullion Market Association](/wiki/London_Bullion_Market_Association) still clear transactions denominated in gold, including future delivery contracts. Today, [gold mining](/wiki/Gold_mining) output is declining.[[61]](#cite_note-61)With the sharp growth of economies in the 20th century, and increasing foreign exchange, the world's [gold reserves](/wiki/Gold_reserve) and their trading market have become a small fraction of all markets and fixed exchange rates of currencies to gold have been replaced by floating prices for gold and gold [future contract](/wiki/Futures_contract). Though the gold stock grows by only 1 or 2% per year, very little metal is irretrievably consumed. Inventory above ground would satisfy many decades of industrial and even artisan uses at current prices.

The gold content of alloys is measured in [carats](/wiki/Carat_(purity)) (k). Pure gold is designated as 24k. English gold coins intended for circulation from 1526 into the 1930s were typically a standard 22k alloy called [crown gold](/wiki/Crown_gold),[[62]](#cite_note-62) for hardness (American gold coins for circulation after 1837 contained the slightly lower amount of 0.900 fine gold, or 21.6 kt).[[63]](#cite_note-63) Although the prices of some [platinum](/wiki/Platinum) group metals can be much higher, gold has long been considered the most desirable of [precious metals](/wiki/Precious_metal), and its value has been used as the standard for many [currencies](/wiki/Currency). Gold has been used as a symbol for purity, value, royalty, and particularly roles that combine these properties. Gold as a sign of wealth and prestige was ridiculed by [Thomas More](/wiki/Thomas_More) in his treatise [*Utopia*](/wiki/Utopia_(book)). On that imaginary island, gold is so abundant that it is used to make chains for slaves, tableware, and lavatory seats. When ambassadors from other countries arrive, dressed in ostentatious gold jewels and badges, the Utopians mistake them for menial servants, paying homage instead to the most modestly dressed of their party.

## Cultural history[[edit](/index.php?title=(none)&action=edit&section=17)]

[thumb|The](/wiki/File:TurinPapyrus1.jpg) [Turin Papyrus Map](/wiki/Turin_Papyrus_Map) [thumb|upright|](/wiki/File:Tuthankhamun_Egyptian_Museum.jpg)[Funerary mask of Tutankhamun](/wiki/Tutankhamun's_mask) [thumb|upright|](/wiki/File:Jason_Pelias_Louvre_K127.jpg)[Jason](/wiki/Jason) returns with the golden fleece on an [Apulian](/wiki/Apulia) [red-figure](/wiki/Red-figure_pottery) [calyx krater](/wiki/Krater), ca. 340–330 BC. [thumb|upright|Ancient golden](/wiki/File:Golden_crown_Armento_Staatliche_Antikensammlungen_01.jpg) [Kritonios Crown](/wiki/Kritonios_Crown), funerary or marriage material, 370–360 BC. From a grave in [Armento](/wiki/Armento), [Campania](/wiki/Campania) [thumb|150px|left|An illustration of distinctive clothing of a](/wiki/File:Ancient_Filipina.png) [Tagalog](/wiki/Tagalogs) woman which is belonged to a [Maharlika](/wiki/Maharlika) caste, in the [Philippines](/wiki/Philippines) which is adorned with gold. Gold artifacts found at the [Nahal Kana](/wiki/Nahal_Qana) cave cemetery dated during the 1980s, showed these to be from within the [Chalcolithic](/wiki/Chalcolithic), and considered the earliest find from the Levant (Gopher *et al.* 1990).[[64]](#cite_note-64) Gold artifacts in the [Balkans](/wiki/Balkans) also appear from the 4th millennium BC, such as those found in the [Varna Necropolis](/wiki/Varna_Necropolis) near Lake Varna in [Bulgaria](/wiki/Bulgaria), thought by one source (La Niece 2009) to be the earliest "well-dated" find of gold artifacts.[[65]](#cite_note-65) Gold artifacts such as the [golden hats](/wiki/Golden_hats) and the [Nebra disk](/wiki/Nebra_disk) appeared in Central Europe from the 2nd millennium BC [Bronze Age](/wiki/European_Bronze_Age).

[Egyptian hieroglyphs](/wiki/Egyptian_hieroglyph) from as early as 2600 BC describe gold, which King [Tushratta](/wiki/Tushratta) of the [Mitanni](/wiki/Mitanni) claimed was "more plentiful than dirt" in Egypt.[[66]](#cite_note-66) Egypt and especially [Nubia](/wiki/Nubia) had the resources to make them major gold-producing areas for much of history. One of the earliest known maps, known as the [Turin Papyrus Map](/wiki/Turin_Papyrus_Map), shows the plan of a [gold mine](/wiki/Gold_mine) in Nubia together with indications of the local [geology](/wiki/Geology). The primitive working methods are described by both [Strabo](/wiki/Strabo) and [Diodorus Siculus](/wiki/Diodorus_Siculus), and included [fire-setting](/wiki/Fire-setting). Large mines were also present across the [Red Sea](/wiki/Red_Sea) in what is now [Saudi Arabia](/wiki/Saudi_Arabia).

The legend of the [golden fleece](/wiki/Golden_fleece) may refer to the use of fleeces to trap gold dust from [placer deposits](/wiki/Placer_deposit) in the ancient world. Gold is mentioned frequently in the [Old Testament](/wiki/Old_Testament), starting with [Genesis](/wiki/Book_of_Genesis) 2:11 (at [Havilah](/wiki/Havilah)), the story of [The Golden Calf](/wiki/The_Golden_Calf) and many parts of the temple including the [Menorah](/wiki/Menorah_(Temple)) and the golden altar. In the [New Testament](/wiki/New_Testament), it is included with the gifts of the [magi](/wiki/Magi) in the first chapters of Matthew. The [Book of Revelation](/wiki/Book_of_Revelation) 21:21 describes the city of [New Jerusalem](/wiki/New_Jerusalem) as having streets "made of pure gold, clear as crystal". Exploitation of gold in the south-east corner of the [Black Sea](/wiki/Black_Sea) is said to date from the time of [Midas](/wiki/Midas), and this gold was important in the establishment of what is probably the world's earliest coinage in [Lydia](/wiki/Lydia) around 610 BC.[[67]](#cite_note-67) From the 6th or 5th century BC, the [Chu (state)](/wiki/Chu_(state)) circulated the [Ying Yuan](/wiki/Ying_Yuan), one kind of square gold coin.

In [Roman metallurgy](/wiki/Roman_metallurgy), new methods for extracting gold on a large scale were developed by introducing [hydraulic mining](/wiki/Hydraulic_mining) methods, especially in [Hispania](/wiki/Hispania) from 25 BC onwards and in [Dacia](/wiki/Dacia) from 106 AD onwards. One of their largest mines was at [Las Medulas](/wiki/Las_Medulas) in [León (Spain)](/wiki/León_(province)), where seven long [aqueducts](/wiki/Aqueduct_(watercourse)) enabled them to sluice most of a large alluvial deposit. The mines at [Roşia Montană](/wiki/Roşia_Montană) in [Transylvania](/wiki/Transylvania) were also very large, and until very recently, still mined by opencast methods. They also exploited smaller deposits in [Britain](/wiki/Roman_Britain), such as placer and hard-rock deposits at [Dolaucothi](/wiki/Dolaucothi). The various methods they used are well described by [Pliny the Elder](/wiki/Pliny_the_Elder) in his [encyclopedia](/wiki/Encyclopedia) [Naturalis Historia](/wiki/Naturalis_Historia) written towards the end of the first century AD.

During [Mansa Musa's](/wiki/Mansa_Musa) (ruler of the [Mali Empire](/wiki/Mali_Empire) from 1312 to 1337) [hajj](/wiki/Hajj) to [Mecca](/wiki/Mecca) in 1324, he passed through [Cairo](/wiki/Cairo) in July 1324, and was reportedly accompanied by a [camel train](/wiki/Camel_train) that included thousands of people and nearly a hundred camels where he gave away so much gold that it depressed the price in Egypt for over a decade.[[68]](#cite_note-68) A contemporary Arab historian remarked:

[Template:Quote](/wiki/Template:Quote)

The European exploration of the Americas was fueled in no small part by reports of the gold ornaments displayed in great profusion by [Native American](/wiki/Indigenous_peoples_of_the_Americas) peoples, especially in [Mesoamerica](/wiki/Mesoamerica), [Peru](/wiki/Peru), [Ecuador](/wiki/Ecuador) and [Colombia](/wiki/Colombia). The [Aztecs](/wiki/Aztec) regarded gold as the product of the gods, calling it literally "god excrement" (*teocuitlatl* in [Nahuatl](/wiki/Nahuatl)), and after [Moctezuma II](/wiki/Moctezuma_II) was killed, most of this gold was shipped to Spain.[[69]](#cite_note-69) However, for the [indigenous peoples of North America](/wiki/Indigenous_peoples_of_North_America) gold was considered useless and they saw much greater value in other [minerals](/wiki/Minerals) which were directly related to their utility, such as [obsidian](/wiki/Obsidian), [flint](/wiki/Flint), and [slate](/wiki/Slate).[[70]](#cite_note-70) Rumors of cities filled with gold fueled legends of [El Dorado](/wiki/El_Dorado).

Gold played a role in western culture, as a cause for desire and of corruption, as told in children's [fables](/wiki/Fable) such as [Rumpelstiltskin](/wiki/Rumpelstiltskin), where the peasant's daughter turns hay into gold, in return for giving up her child when she becomes a princess; and the stealing of the hen that lays golden eggs in [Jack and the Beanstalk](/wiki/Jack_and_the_Beanstalk).

The top prize at the [Olympic games](/wiki/Olympic_games) is the [gold medal](/wiki/Gold_medal).

75% of the presently accounted for gold has been extracted since 1910. It has been estimated that the currently known amount of gold internationally would form a single cube 20 m (66 ft) on a side (equivalent to 8,000 m3).[[71]](#cite_note-71) [thumb|right|100px|alt=Sun symbol|](/wiki/File:Sun_symbol.svg)[Circled dot](/wiki/Circled_dot), the alchemical symbol for gold One main goal of the [alchemists](/wiki/Alchemy) was to produce gold from other substances, such as [lead](/wiki/Lead) — presumably by the interaction with a mythical substance called the [philosopher's stone](/wiki/Philosopher's_stone). Although they never succeeded in this attempt, the alchemists did promote an interest in systematically finding out what can be done with substances, and this laid the foundation for today's [chemistry](/wiki/Chemistry). Their symbol for gold was the [circle with a point at its center](/wiki/Circled_dot) (☉), which was also the [astrological](/wiki/Astrology) symbol and the ancient [Chinese character](/wiki/Chinese_character) for the [Sun](/wiki/Sun).

Golden treasures have been rumored to be found at various locations, following tragedies such as the Jewish temple treasures in the Vatican, following the temple's destruction in 70 AD, a gold stash on the [Titanic](/wiki/Titanic), the [Nazi gold](/wiki/Nazi_gold) train – following [World War II](/wiki/World_War_II).

The [Dome of the Rock](/wiki/Dome_of_the_Rock) on the Jerusalem temple site is covered with an ultra-thin golden glasure.[Template:Clarify](/wiki/Template:Clarify) The [Sikh](/wiki/Sikh) Golden temple, the [Harmandir Sahib](/wiki/Harmandir_Sahib), is a building covered with gold. Similarly the [Wat Phra Kaew](/wiki/Wat_Phra_Kaew) emerald [Buddhist](/wiki/Buddhism) [temple](/wiki/Temple) ([wat](/wiki/Wat)) in [Thailand](/wiki/Thailand) has ornamental gold-leafed statues and roofs. Some European king and queen's [crowns](/wiki/Crown_(headgear)) were made of gold, and gold was used for the [bridal crown](/wiki/Bridal_crown) since antiquity. An ancient Talmudic text circa 100 AD describes [Rachel, wife of Rabbi Akiva](/wiki/Rachel,_wife_of_Rabbi_Akiva), receiving a "Jerusalem of Gold" (diadem). A Greek burial crown made of gold was found in a grave circa 370 BC.

## Occurrence[[edit](/index.php?title=(none)&action=edit&section=18)]

[thumb|This](/wiki/File:Stringer156_nugget.jpg) [Template:Convert](/wiki/Template:Convert) [nugget](/wiki/Gold_nugget), known as the [Mojave Nugget](/wiki/Mojave_Nugget), was found by an individual prospector in the Southern California Desert using a metal detector.

Gold's [atomic number](/wiki/Atomic_number) of 79 makes it one of the higher [atomic number](/wiki/Atomic_number) elements that occur naturally. Traditionally, gold is thought to have formed by the R-process in [supernova nucleosynthesis](/wiki/Supernova_nucleosynthesis),[[72]](#cite_note-72) but a relatively recent paper suggests that gold and other elements heavier than [iron](/wiki/Iron) may also be produced in quantity by the collision of [neutron stars](/wiki/Neutron_star).[[73]](#cite_note-73) In both cases, satellite spectrometers only indirectly detect the resulting gold: "we have no spectroscopic evidence that [such] elements have truly been produced."[[74]](#cite_note-74) These gold nucleogenesis theories hold that the resulting explosions scattered metal-containing dusts (including [heavy elements](/wiki/Heavy_metal_(chemistry)) such as gold) into the region of space in which they later condensed into our [solar system](/wiki/Solar_system) and the Earth.[[75]](#cite_note-75) Because the Earth was molten when it was just formed, almost all of the gold present on Earth sank into the core. Most of the gold that is present today in the Earth's crust and mantle is thought to have been delivered to Earth later, by asteroid impacts during the [Late Heavy Bombardment](/wiki/Late_Heavy_Bombardment).[[76]](#cite_note-76)[[77]](#cite_note-77) [thumb|left|500 px|A schematic diagram of a NE (left) to SW (right) cross-section through the 2.020 billion year old](/wiki/File:Vredefort_crater_cross_section_2.png) [Vredefort impact crater](/wiki/Vredefort_crater) in [South Africa](/wiki/South_Africa) and how it distorted the contemporary geological structures. The present erosion level is shown. [Johannesburg](/wiki/Johannesburg) is located where the [Witwatersrand Basin](/wiki/Witwatersrand_Basin) (the yellow layer) is exposed at the "present surface" line, just inside the crater rim, on the left. Not to scale.

The asteroid that formed [Vredefort crater](/wiki/Vredefort_crater) 2.020 billion years ago is often credited with seeding the [Witwatersrand basin](/wiki/Witwatersrand_basin) in [South Africa](/wiki/South_Africa) with the richest gold deposits on earth.[[78]](#cite_note-78)[[79]](#cite_note-79)[[80]](#cite_note-80)[[81]](#cite_note-81) However, the gold-bearing [Witwatersrand](/wiki/Witwatersrand) rocks were laid down between 700 and 950 million years before the Vredefort impact.<ref name=McCarthy>McCarthy, T., Rubridge, B. (2005). ‘’The Story of Earth and Life.’’ p. 89–90, 102–107, 134–136. Struik Publishers, Cape Town</ref>[[82]](#cite_note-82) These gold-bearing rocks had furthermore been covered by a thick layer of Ventersdorp lavas and the [Transvaal Supergroup](/wiki/Transvaal_Basin) of rocks before the meteor struck. What the Vredefort impact achieved, however, was to distort the [Witwatersrand basin](/wiki/Witwatersrand_basin) in such a way that the gold-bearing rocks were brought to the present [erosion surface](/wiki/Erosion_surface) in [Johannesburg](/wiki/Johannesburg), on the [Witwatersrand](/wiki/Witwatersrand), just inside the rim of the original 300 km diameter crater caused by the meteor strike. The discovery of the deposit in 1886 launched the [Witwatersrand Gold Rush](/wiki/Witwatersrand_Gold_Rush). Some 22% of all the gold that is ascertained to exist today on Earth has been extracted from these Witwatersrand rocks.[[82]](#cite_note-82) On Earth, gold is found in [ores](/wiki/Ore) in rock formed from the Precambrian time onward.[[65]](#cite_note-65) It most often occurs as a [native metal](/wiki/Native_metal), typically in a metal [solid solution](/wiki/Solid_solution) with silver (i.e. as a gold silver [alloy](/wiki/Alloy)). Such alloys usually have a silver content of 8–10%. [Electrum](/wiki/Electrum) is elemental gold with more than 20% silver. Electrum's color runs from golden-silvery to silvery, dependent upon the silver content. The more silver, the lower the [specific gravity](/wiki/Specific_gravity).

Native gold occurs as very small to microscopic particles embedded in rock, often together with [quartz](/wiki/Quartz) or [sulfide minerals](/wiki/Sulfide_mineral) such as "Fool's Gold", which is a [pyrite](/wiki/Pyrite).[[83]](#cite_note-83) These are called [lode](/wiki/Lode) deposits. The metal in a native state is also found in the form of free flakes, grains or larger [nuggets](/wiki/Gold_nugget)[[65]](#cite_note-65) that have been eroded from rocks and end up in [alluvial](/wiki/Alluvial) deposits called [placer deposits](/wiki/Placer_deposit). Such free gold is always richer at the surface of gold-bearing veins[Template:Clarify](/wiki/Template:Clarify) owing to the [oxidation](/wiki/Oxidation) of accompanying minerals followed by weathering, and washing of the dust into streams and rivers, where it collects and can be welded by water action to form nuggets.

[thumb|Relative sizes of an 860 kg block of gold ore, and the 30 g of gold that can be extracted from it.](/wiki/File:Gold_30g_for_a_860kg_rock.jpg) [Toi gold mine](/wiki/Toi_gold_mine), [Japan](/wiki/Japan). [thumb|Gold left behind after a](/wiki/File:GoldinPyriteDrainage_acide.JPG) [pyrite](/wiki/Pyrite) cube was oxidized to [hematite](/wiki/Hematite). Note cubic shape of cavity.

Gold sometimes occurs combined with [tellurium](/wiki/Tellurium) as the [minerals](/wiki/Mineral) [calaverite](/wiki/Calaverite), [krennerite](/wiki/Krennerite), [nagyagite](/wiki/Nagyagite), [petzite](/wiki/Petzite) and [sylvanite](/wiki/Sylvanite) (see [telluride minerals](/wiki/Telluride_mineral)), and as the rare bismuthide [maldonite](/wiki/Maldonite) (Au2Bi) and antimonide [aurostibite](/wiki/Aurostibite) (AuSb2). Gold also occurs in rare alloys with [copper](/wiki/Copper), [lead](/wiki/Lead), and [mercury](/wiki/Mercury_(element)): the minerals [auricupride](/wiki/Auricupride) (Cu3Au), [novodneprite](/wiki/Novodneprite) (AuPb3) and [weishanite](/wiki/Weishanite) ((Au, Ag)3Hg2).

Recent research suggests that microbes can sometimes play an important role in forming gold deposits, transporting and precipitating gold to form grains and nuggets that collect in alluvial deposits.[[84]](#cite_note-84) Another recent study has claimed water in faults vaporizes during an earthquake, depositing gold. When an earthquake strikes, it moves along a [fault](/wiki/Fault_(geology)). Water often lubricates faults, filling in fractures and jogs. About 6 miles (10 kilometers) below the surface, under incredible temperatures and pressures, the water carries high concentrations of carbon dioxide, silica, and gold. During an earthquake, the fault jog suddenly opens wider. The water inside the void instantly vaporizes, flashing to steam and forcing silica, which forms the mineral quartz, and gold out of the fluids and onto nearby surfaces.[[85]](#cite_note-85)

### Seawater[[edit](/index.php?title=(none)&action=edit&section=19)]

The world's [oceans](/wiki/Ocean) contain gold. Measured concentrations of gold in the Atlantic and Northeast Pacific are 50–150 [femtomol](/wiki/Femtomolar)/L or 10–30 parts per [quadrillion](/wiki/Quadrillion) (about 10–30 g/km3). In general, gold concentrations for south Atlantic and central Pacific samples are the same (~50 femtomol/L) but less certain. Mediterranean deep waters contain slightly higher concentrations of gold (100–150 femtomol/L) attributed to wind-blown dust and/or rivers. At 10 parts per quadrillion the Earth's [oceans](/wiki/Oceans) would hold 15,000 tonnes of gold.[[86]](#cite_note-86) These figures are three orders of magnitude less than reported in the literature prior to 1988, indicating contamination problems with the earlier data.

A number of people have claimed to be able to economically recover gold from [sea water](/wiki/Sea_water), but so far they have all been either mistaken or acted in an intentional deception. Prescott Jernegan ran a gold-from-seawater swindle in the [United States](/wiki/United_States) in the 1890s. A British fraudster ran the same scam in [England](/wiki/England) in the early 1900s.[[87]](#cite_note-87) [Fritz Haber](/wiki/Fritz_Haber) (the German inventor of the [Haber process](/wiki/Haber_process)) did research on the extraction of gold from sea water in an effort to help pay [Germany's](/wiki/Germany) reparations following [World War I](/wiki/World_War_I).[[88]](#cite_note-88) Based on the published values of 2 to 64 ppb of gold in seawater a commercially successful extraction seemed possible. After analysis of 4,000 water samples yielding an average of 0.004 ppb it became clear that the extraction would not be possible and he stopped the project.[[89]](#cite_note-89) No commercially viable mechanism for performing gold extraction from sea water has yet been identified. [Gold synthesis](/wiki/Gold_synthesis) is not economically viable and is unlikely to become so in the foreseeable future.

### Specimens of crystalline native gold[[edit](/index.php?title=(none)&action=edit&section=20)]

<gallery heights="160px" widths="160px" perrow="5"> File:Native gold nuggets.jpg|Native [gold nuggets](/wiki/Gold_nugget) File:Gold-tt48a.jpg|"Rope gold" from [Lena River](/wiki/Lena_River), [Sakha Republic](/wiki/Sakha_Republic), Russia. Size: 2.5×1.2×0.7 cm. File:Gold-mz4b.jpg|Crystalline gold from Mina Zapata, [Santa Elena de Uairen](/wiki/Santa_Elena_de_Uairen), Venezuela. Size: 3.7×1.1×0.4 cm. File:Gold-37466.jpg|Gold leaf from Harvard Mine, [Jamestown, California](/wiki/Jamestown,_California), USA. Size 9.3×3.2× >0.1 cm. </gallery>

## Production[[edit](/index.php?title=(none)&action=edit&section=21)]

[Template:Main article](/wiki/Template:Main_article) [thumb|The entrance to an underground gold mine in](/wiki/File:Gold_mine.jpg) [Victoria](/wiki/Victoria,_Australia), [Australia](/wiki/Australia) [thumb|Pure gold precipitate produced by the](/wiki/File:golddust.jpg) [aqua regia](/wiki/Aqua_regia) refining process [thumb|lang=en|Time trend of gold production](/wiki/File:Gold_-_world_production_trend.svg) The World Gold Council states that as of the end of 2014, "there were 183,600 tonnes of stocks in existence above ground". This can be represented by a cube with an edge length of about 21 meters.[[90]](#cite_note-90) compared to 2,300 tonnes for 2008.<ref name=USGS-ds140-2015>[Template:Cite web](/wiki/Template:Cite_web)</ref>

## Mining[[edit](/index.php?title=(none)&action=edit&section=22)]

[Template:Main article](/wiki/Template:Main_article)

Since the 1880s, South Africa has been the source for a large proportion of the world's gold supply, with about 50% of the presently accounted for gold having come from [South Africa](/wiki/South_Africa). Production in 1970 accounted for 79% of the world supply, producing about 1,480 tonnes. In 2007 [China](/wiki/China) (with 276 tonnes) overtook South Africa as the world's largest gold producer, the first time since 1905 that South Africa has not been the largest.[[91]](#cite_note-91) As of 2013, China was the world's leading gold-mining country, followed in order by Australia, the United States, Russia, and Peru. South Africa, which had dominated world gold production for most of the 20th Century, had declined to sixth place.[[92]](#cite_note-92) Other major producers are the [Ghana](/wiki/Ghana), [Burkina Faso](/wiki/Burkina_Faso), [Mali](/wiki/Mali), Indonesia and Uzbekistan.

In South America, the controversial project [Pascua Lama](/wiki/Pascua_Lama) aims at exploitation of rich fields in the high mountains of [Atacama Desert](/wiki/Atacama_Desert), at the border between [Chile](/wiki/Chile) and [Argentina](/wiki/Argentina).

Today about one-quarter of the world gold output is estimated to originate from artisanal or small scale mining.[[93]](#cite_note-93) The city of [Johannesburg](/wiki/Johannesburg) located in South Africa was founded as a result of the [Witwatersrand Gold Rush](/wiki/Witwatersrand_Gold_Rush) which resulted in the discovery of some of the largest natural gold deposits in recorded history. The gold fields are confined to the northern and north-western edges of the [Witwatersrand basin](/wiki/Witwatersrand_basin), which is a 5–7 km thick layer of [archean](/wiki/Archean) rocks located, in most places, deep under the [Free State](/wiki/Free_State_(South_African_province)), [Gauteng](/wiki/Gauteng) and surrounding provinces.<ref name=Truswell>Truswell, J.F. (1977). ‘’The Geological Evolution of South Africa’’. pp. 21–28. Purnell, Cape Town.</ref> These Witwatersrand rocks are exposed at the surface on the [Witwatersrand](/wiki/Witwatersrand), in and around Johannesburg, but also in isolated patches to the south-east and south-west of Johannesburg, as well as in an arc around the [Vredefort Dome](/wiki/Vredefort_crater) which lies close to the center of the Witwatersrand basin.[[94]](#cite_note-94)[[95]](#cite_note-95) From these surface exposures the basin [dips](/wiki/Strike_and_dip) extensively, requiring some of the mining to occur at depths of nearly 4000 m, making them, especially the [Savuka](/wiki/Mining#Records) and [TauTona](/wiki/TauTona) mines to the south-west of Johannesburg, the deepest mines on earth. The gold is found only in six areas where [archean](/wiki/Archean) rivers from the north and north-west formed extensive pebbly [braided river deltas](/wiki/Braided_river) before draining into the "Witwatersrand sea" where the rest of the Witwatersrand sediments were deposited.[[95]](#cite_note-95) The [Second Boer War](/wiki/Second_Boer_War) of 1899–1901 between the [British Empire](/wiki/British_Empire) and the [Afrikaner](/wiki/Afrikaner) [Boers](/wiki/Boer) was at least partly over the rights of miners and possession of the gold wealth in South Africa.

### Prospecting[[edit](/index.php?title=(none)&action=edit&section=23)]

[Template:Main article](/wiki/Template:Main_article)

During the 19th century, [gold rushes](/wiki/Gold_rush) occurred whenever large gold deposits were discovered. The first documented discovery of gold in the United States was at the [Reed Gold Mine](/wiki/Reed_Gold_Mine) near Georgeville, North Carolina in 1803.[[96]](#cite_note-96) The first major gold strike in the United States occurred in a small north Georgia town called [Dahlonega](/wiki/Dahlonega,_Georgia).[[97]](#cite_note-97) Further gold rushes occurred in [California](/wiki/California_Gold_Rush), [Colorado](/wiki/Pike's_Peak_Gold_Rush), the [Black Hills](/wiki/Black_Hills_Gold_Rush), [Otago](/wiki/Central_Otago_Gold_Rush) in New Zealand, [Australia](/wiki/Australian_gold_rushes), [Witwatersrand](/wiki/Witwatersrand_Gold_Rush) in South Africa, and the [Klondike](/wiki/Klondike_Gold_Rush) in Canada. [thumb|A miner underground at](/wiki/File:Miner_underground_at_Pumsaint_gold_mine_(1294028).jpg) [Pumsaint](/wiki/Pumsaint) gold mine [Wales](/wiki/Wales); c. 1938?.

## Bioremediation[[edit](/index.php?title=(none)&action=edit&section=24)]

A sample of the fungus [*Aspergillus niger*](/wiki/Aspergillus_niger) was found growing from gold mining solution; and was found to contain cyano metal complexes; such as gold, silver, copper iron and zinc. The fungus also plays a role in the solubilization of heavy metal sulfides.[[98]](#cite_note-98)

## Extraction[[edit](/index.php?title=(none)&action=edit&section=25)]

[Template:Main article](/wiki/Template:Main_article)

[Gold extraction](/wiki/Gold_extraction) is most economical in large, easily mined deposits. Ore grades as little as 0.5 mg/kg (0.5 parts per million, ppm) can be economical. Typical ore grades in [open-pit](/wiki/Open-pit_mining) mines are 1–5 mg/kg (1–5 ppm); ore grades in underground or [hard rock](/wiki/Underground_mining_(hard_rock)) mines are usually at least 3 mg/kg (3 ppm). Because ore grades of 30 mg/kg (30 ppm) are usually needed before gold is visible to the naked eye, in most gold mines the gold is invisible.

The average gold mining and extraction costs were about US$317/oz in 2007, but these can vary widely depending on mining type and ore quality; global mine production amounted to 2,471.1 tonnes.[[99]](#cite_note-99)

### Refining[[edit](/index.php?title=(none)&action=edit&section=26)]

After initial production, gold is often subsequently refined industrially by the [Wohlwill process](/wiki/Wohlwill_process) which is based on [electrolysis](/wiki/Electrolysis) or by the [Miller process](/wiki/Miller_process), that is chlorination in the melt. The Wohlwill process results in higher purity, but is more complex and is only applied in small-scale installations.[[100]](#cite_note-100)[[101]](#cite_note-101) Other methods of assaying and purifying smaller amounts of gold include parting and inquartation as well as [cupellation](/wiki/Cupellation), or refining methods based on the dissolution of gold in aqua regia.[[102]](#cite_note-102)

## Synthesis from other elements[[edit](/index.php?title=(none)&action=edit&section=27)]

Gold was synthesized from [mercury](/wiki/Mercury_(element)) by neutron bombardment in 1941, but the [isotopes of gold](/wiki/Isotopes_of_gold) produced were all [radioactive](/wiki/Radioactive).[[103]](#cite_note-103) In 1924, a Japanese physicist, Hantaro Nagaoka, accomplished the same feat.[[104]](#cite_note-104) Gold can currently be manufactured in a nuclear reactor by [irradiation](/wiki/Irradiation) either of [platinum](/wiki/Platinum) or mercury.

Only the mercury isotope 196Hg, which occurs with a frequency of 0.15% in natural mercury, can be converted to gold by [neutron capture](/wiki/Neutron_capture), and following [electron capture](/wiki/Electron_capture)-decay into 197Au with [slow neutrons](/wiki/Slow_neutron). Other mercury isotopes are converted when irradiated with slow neutrons into one another, or formed mercury isotopes which [beta decay](/wiki/Beta_decay) into [thallium](/wiki/Thallium).

Using [fast neutrons](/wiki/Fast_neutron), the mercury isotope 198Hg, which composes 9.97% of natural mercury, can be converted by splitting off a neutron and becoming 197Hg, which then disintegrates to stable gold. This reaction, however, possesses a smaller activation cross-section and is feasible only with un-moderated reactors.

It is also possible to eject several neutrons with very high energy into the other mercury isotopes in order to form 197Hg. However such high-energy neutrons can be produced only by [particle accelerators](/wiki/Particle_accelerator).[Template:Clarify](/wiki/Template:Clarify)

## Consumption[[edit](/index.php?title=(none)&action=edit&section=28)]

The consumption of gold produced in the world is about 50% in jewelry, 40% in investments, and 10% in industry.[[3]](#cite_note-3)[[105]](#cite_note-105) According to [World Gold Council](/wiki/World_Gold_Council), China is the world's largest single consumer of gold in 2013 and toppled India for the first time with Chinese consumption increasing by 32 percent in a year, while that of India only rose by 13 percent and world consumption rose by 21 percent. Unlike India where gold is used for mainly for jewellery, China uses gold for manufacturing and retail.[[106]](#cite_note-106)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Gold jewelry consumption by country in tonnes[[107]](#cite_note-107)[[108]](#cite_note-108)[[109]](#cite_note-109) | | | | | |
| **Country** | **2009** | **2010** | **2011** | **2012** | **2013** |
| align=left|[Template:Flag](/wiki/Template:Flag) | 442.37 | 745.70 | 986.3 | 864 | 974 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 376.96 | 428.00 | 921.5 | 817.5 | 1120.1 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 150.28 | 128.61 | 199.5 | 161 | 190 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 75.16 | 74.07 | 143 | 118 | 175.2 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 77.75 | 72.95 | 69.1 | 58.5 | 72.2 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 60.12 | 67.50 | 76.7 | 81.9 | 73.3 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 67.60 | 63.37 | 60.9 | 58.1 | 77.1 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 56.68 | 53.43 | 36 | 47.8 | 57.3 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 41.00 | 32.75 | 55 | 52.3 | 68 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 31.75 | 27.35 | 22.6 | 21.1 | 23.4 |
| align=left|Other Persian Gulf Countries | 24.10 | 21.97 | 22 | 19.9 | 24.6 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 21.85 | 18.50 | −30.1 | 7.6 | 21.3 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 18.83 | 15.87 | 15.5 | 12.1 | 17.5 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 15.08 | 14.36 | 100.8 | 77 | 92.2 |
| align=left|[Template:Flag](/wiki/Template:Flag) | 7.33 | 6.28 | 107.4 | 80.9 | 140.1 |
| align=left|**Total** | **1508.70** | **1805.60** |  |  |  |
| align=left|*Other Countries* | *251.6* | *254.0* | *390.4* | *393.5* | *450.7* |
| align=left|**World Total** | **1760.3** | **2059.6** | **3487.5** | **3163.6** | *3863.5* |

## Pollution[[edit](/index.php?title=(none)&action=edit&section=29)]

[Template:Further](/wiki/Template:Further) Gold production is associated with contribution to hazardous pollution.[[110]](#cite_note-110)[[111]](#cite_note-111) Low-grade gold ore may contain less than one [ppm](/wiki/Parts_per_million) gold metal; such ore is [ground](/wiki/Milling_(grinding)) and mixed with [sodium cyanide](/wiki/Sodium_cyanide) dissolve the gold. Cyanide is a highly poisonous chemical, which can kill living creatures when exposed in minute quantities. Many [cyanide spills](/wiki/List_of_gold_mining_disasters)[[112]](#cite_note-112) from gold mines have occurred in both developed and developing countries which killed aquatic life in long stretches of affected rivers. Environmentalists consider these events major environmental disasters.[[113]](#cite_note-113)[[114]](#cite_note-114) Thirty tons of used ore is dumped as waste for producing one troy ounce of gold.<ref name=NYT>[Behind gold's glitter, torn lands and pointed questions](http://www.nytimes.com/2005/10/24/international/24GOLD.html?pagewanted=1&_r=0), New York Times, 24 October 2005</ref> Gold ore dumps are the source of many heavy elements such as cadmium, lead, zinc, copper, [arsenic](/wiki/Arsenic), [selenium](/wiki/Selenium) and mercury. When sulfide bearing minerals in these ore dumps are exposed to air and water, the sulfide transforms into [sulfuric acid](/wiki/Sulfuric_acid) which in turn dissolves these heavy metals facilitating their passage into surface water and ground water. This process is called [acid mine drainage](/wiki/Acid_mine_drainage). These gold ore dumps are long term, highly hazardous wastes second only to [nuclear waste](/wiki/Nuclear_waste) dumps.<ref name=NYT/>

It was once common to use mercury to recover gold from ore, but today the use of mercury is largely limited to small-scale individual miners.[[115]](#cite_note-115) Minute quantities of mercury compounds can reach water bodies, causing heavy metal contamination. Mercury can then enter into the human food chain in the form of [methylmercury](/wiki/Methylmercury). [Mercury poisoning](/wiki/Mercury_poisoning) in humans causes incurable brain function damage and severe retardation.

Gold extraction is also a highly energy intensive industry, extracting ore from deep mines and grinding the large quantity of ore for further chemical extraction requires nearly 25 [kW·h](/wiki/Kilowatt-hour) of electricity per gram of gold produced.[[116]](#cite_note-116)

## Toxicity[[edit](/index.php?title=(none)&action=edit&section=30)]

Pure metallic (elemental) gold is non-toxic and non-irritating when ingested[[117]](#cite_note-117) and is sometimes used as a food decoration in the form of [gold leaf](/wiki/Gold_leaf). Metallic gold is also a component of the alcoholic drinks [Goldschläger](/wiki/Goldschläger), [Gold Strike](/wiki/Gold_Strike_(drink)), and [Goldwasser](/wiki/Goldwasser). Metallic gold is approved as a [food additive](/wiki/Food_additive) in the EU ([E175](/wiki/E_number) in the [Codex Alimentarius](/wiki/Codex_Alimentarius)). Although the gold ion is toxic, the acceptance of metallic gold as a food additive is due to its relative chemical inertness, and resistance to being corroded or transformed into soluble salts (gold compounds) by any known chemical process which would be encountered in the human body.

Soluble compounds ([gold salts](/wiki/Gold_salts)) such as [gold chloride](/wiki/Gold(I,III)_chloride) are toxic to the liver and kidneys. Common [cyanide](/wiki/Cyanide) salts of gold such as potassium gold cyanide, used in gold [electroplating](/wiki/Electroplating), are toxic by virtue of both their cyanide and gold content. There are rare cases of lethal gold poisoning from [potassium gold cyanide](/wiki/Potassium_gold_cyanide).[[118]](#cite_note-118)[[119]](#cite_note-119) Gold toxicity can be ameliorated with [chelation therapy](/wiki/Chelation_therapy) with an agent such as [dimercaprol](/wiki/Dimercaprol).

Gold metal was voted [Allergen of the Year](/wiki/Allergen_of_the_Year) in 2001 by the American Contact Dermatitis Society. Gold contact allergies affect mostly women.[[120]](#cite_note-120) Despite this, gold is a relatively non-potent contact allergen, in comparison with metals like [nickel](/wiki/Nickel).[[121]](#cite_note-121)

## Price[[edit](/index.php?title=(none)&action=edit&section=31)]

[Template:Further](/wiki/Template:Further) [thumb|300px|Gold price history in 1960–2011](/wiki/File:Gold_price_in_USD.png)

As at December 2015, gold is valued at around US$39,000 per kilogram (US$1,200 per troy ounce).

Like other precious metals, gold is measured by [troy weight](/wiki/Troy_weight) and by grams. When it is alloyed with other metals the term [*carat*](/wiki/Carat_(purity)) or *karat* is used to indicate the purity of gold present, with 24 carats being pure gold and lower ratings proportionally less. The purity of a [gold bar](/wiki/Gold_bar) or coin can also be expressed as a decimal figure ranging from 0 to 1, known as the [millesimal fineness](/wiki/Millesimal_fineness), such as 0.995 being very pure.

### History[[edit](/index.php?title=(none)&action=edit&section=32)]

The price of gold is determined through trading in the gold and [derivatives](/wiki/Derivative_(finance)) markets, but a procedure known as the [Gold Fixing](/wiki/Gold_Fixing) in [London](/wiki/London), originating in September 1919, provides a daily benchmark price to the industry. The afternoon fixing was introduced in 1968 to provide a price when US markets are open.[[122]](#cite_note-122) Historically gold [coinage](/wiki/Mint_(coin)) was widely used as currency; when [paper money](/wiki/Paper_money) was introduced, it typically was a [receipt](/wiki/Receipt) redeemable for gold coin or [bullion](/wiki/Bullion). In a [monetary](/wiki/Monetary) system known as the [gold standard](/wiki/Gold_standard), a certain [weight](/wiki/Weight) of gold was given the name of a unit of currency. For a long period, the United States government set the value of the US dollar so that one [troy ounce](/wiki/Troy_ounce) was equal to $20.67 ($664.56/kg), but in 1934 the dollar was devalued to $35.00 per troy ounce ($1125.27/kg). By 1961, it was becoming hard to maintain this price, and a pool of US and European banks agreed to manipulate the market to prevent further [currency devaluation](/wiki/Devaluation) against increased gold demand.[[123]](#cite_note-123) On 17 March 1968, economic circumstances caused the collapse of the gold pool, and a two-tiered pricing scheme was established whereby gold was still used to settle international accounts at the old $35.00 per troy ounce ($1.13/g) but the price of gold on the private market was allowed to fluctuate; this two-tiered pricing system was abandoned in 1975 when the price of gold was left to find its free-market level.[Template:Citation needed](/wiki/Template:Citation_needed) [Central banks](/wiki/Central_bank) still hold historical [gold reserves](/wiki/Official_gold_reserves) as a [store of value](/wiki/Store_of_value) although the level has generally been declining.[Template:Citation needed](/wiki/Template:Citation_needed) The largest gold depository in the world is that of the [U.S. Federal Reserve Bank](/wiki/Federal_Reserve_System) in [New York](/wiki/New_York_City), which holds about 3%[[124]](#cite_note-124) of the gold ever mined, as does the similarly laden [U.S. Bullion Depository](/wiki/United_States_Bullion_Depository) at [Fort Knox](/wiki/Fort_Knox). In 2005 the [World Gold Council](/wiki/World_Gold_Council) estimated total global gold supply to be 3,859 tonnes and demand to be 3,754 tonnes, giving a surplus of 105 tonnes.[[125]](#cite_note-125) Sometime around 1970[Template:Vague](/wiki/Template:Vague) the price began in trend to greatly increase,[[126]](#cite_note-126) and between 1968 and 2000 the price of gold ranged widely, from a high of $850/oz ($27,300/kg) on 21 January 1980, to a low of $252.90/oz ($8,131/kg) on 21 June 1999 (London Gold Fixing).[[127]](#cite_note-127) Prices increased rapidly from 2001, but the 1980 high was not exceeded until 3 January 2008 when a new maximum of $865.35 per [troy ounce](/wiki/Troy_weight) was set.[[128]](#cite_note-128) Another record price was set on 17 March 2008 at $1023.50/oz ($32,900/kg).[[128]](#cite_note-128) In late 2009, gold markets experienced renewed momentum upwards due to increased demand and a weakening US dollar.[Template:Citation needed](/wiki/Template:Citation_needed) On 2 December 2009, Gold reached a new high closing at $1,217.23.[[129]](#cite_note-129) Gold further rallied hitting new highs in May 2010 after the European Union debt crisis prompted further purchase of gold as a safe asset.[[130]](#cite_note-130)[[131]](#cite_note-131) On 1 March 2011, gold hit a new all-time high of $1432.57, based on [investor](/wiki/Gold_as_an_investment) concerns regarding ongoing [unrest](/wiki/Arab_Spring) in [North Africa](/wiki/North_Africa) as well as in the [Middle East](/wiki/Middle_East).[[132]](#cite_note-132) From April 2001 to August 2011, spot gold prices more than quintupled in value against the US dollar, hitting a new all-time high of $1,913.50 on 23 August 2011,[[133]](#cite_note-133) prompting speculation that the long [secular bear market](/wiki/Secular_bear_market) had ended and a [bull market](/wiki/Bull_market) had returned.[[134]](#cite_note-134) However, the price then began a slow decline to the $1200-per-ounce range in late 2014 and 2015.

## Symbolism[[edit](/index.php?title=(none)&action=edit&section=33)]

[Template:Refimprove](/wiki/Template:Refimprove) [thumb|Gold bars at the Emperor Casino in](/wiki/File:GoldBarAtGrandEmperorCasino.JPG) [Macau](/wiki/Macau)

Great human achievements are frequently rewarded with gold, in the form of [gold medals](/wiki/Gold_medal), golden [trophies](/wiki/Trophy) and other decorations. Winners of athletic events and other graded competitions are usually awarded a gold medal. Many awards such as the [Nobel Prize](/wiki/Nobel_Prize) are made from gold as well. Other award statues and prizes are depicted in gold or are [gold plated](/wiki/Gold_plated) (such as the [Academy Awards](/wiki/Academy_Awards), the [Golden Globe Awards](/wiki/Golden_Globe_Awards), the [Emmy Awards](/wiki/Emmy_Awards), the [Palme d'Or](/wiki/Palme_d'Or), and the [British Academy Film Awards](/wiki/British_Academy_Film_Awards)).

[Aristotle](/wiki/Aristotle) in his [ethics](/wiki/Aristotelian_ethics) used gold symbolism when referring to what is now commonly known as the [golden mean](/wiki/Golden_mean_(philosophy)). Similarly, gold is associated with perfect or divine principles, such as in the case of the [golden ratio](/wiki/Golden_ratio) and the [golden rule](/wiki/Golden_rule).

Gold is further associated with the wisdom of aging and fruition. The fiftieth [wedding anniversary](/wiki/Wedding_anniversary) is golden. Our most valued or most successful latter years are sometimes considered "golden years". The height of a civilization is referred to as a "[golden age](/wiki/Golden_age)".

In some forms of [Christianity](/wiki/Christianity) and [Judaism](/wiki/Judaism), gold has been associated both with [holiness](/wiki/Sacred) and [evil](/wiki/Evil). In the [Book of Exodus](/wiki/Book_of_Exodus), the [Golden Calf](/wiki/Golden_Calf) is a symbol of [idolatry](/wiki/Idolatry), while in the [Book of Genesis](/wiki/Book_of_Genesis), [Abraham](/wiki/Abraham) was said to be rich in gold and [silver](/wiki/Silver), and Moses was instructed to cover the [Mercy Seat](/wiki/Mercy_Seat) of [the Ark of the Covenant](/wiki/Ark_of_the_Covenant) with pure gold. In [Byzantine](/wiki/Eastern_Christianity) [iconography](/wiki/Icon) the [halos](/wiki/Halo_(religious_iconography)) of [Christ](/wiki/Christ), [Mary](/wiki/Virgin_Mary) and the Christian [saints](/wiki/Saints) are often golden.

According to [Christopher Columbus](/wiki/Christopher_Columbus), those who had something of gold were in possession of something of great value on Earth and a substance to even help souls to paradise.[[135]](#cite_note-135) [Wedding rings](/wiki/Wedding_ring) have long been made of gold. It is long lasting and unaffected by the passage of time and may aid in the ring symbolism of eternal vows before God and the perfection the marriage signifies. In [Orthodox Christian](/wiki/Eastern_Orthodox_Church) wedding ceremonies, the wedded couple is adorned with a golden crown (though some opt for wreaths, instead) during the ceremony, an amalgamation of symbolic rites.

In popular culture gold has many connotations but is most generally connected to terms such as good or great, such as in the phrases: "has a heart of gold", "that's golden!", "golden moment", "then you're golden!" and "golden boy". It remains a cultural symbol of wealth and through that, in many societies, success.

## See also[[edit](/index.php?title=(none)&action=edit&section=34)]

[Template:Colbegin](/wiki/Template:Colbegin)

* [Bulk leach extractable gold](/wiki/Bulk_leach_extractable_gold)
* [Chrysiasis](/wiki/Chrysiasis) (dermatological condition)
* [Commodity fetishism](/wiki/Commodity_fetishism) (Marxist economic theory)
* [Digital gold currency](/wiki/Digital_gold_currency)
* [Gold Anti-Trust Action Committee](/wiki/Gold_Anti-Trust_Action_Committee)
* [Gold fingerprinting](/wiki/Gold_fingerprinting)
* [Gold phosphine complex](/wiki/Gold_phosphine_complex)
* [Gold Prospectors Association of America](/wiki/Gold_Prospectors_Association_of_America)
* [List of countries by gold production](/wiki/List_of_countries_by_gold_production)
* [Mining in Roman Britain](/wiki/Mining_in_Roman_Britain)
* [Prospecting](/wiki/Prospecting)
* [Tumbaga](/wiki/Tumbaga)

[Template:Colend](/wiki/Template:Colend)

## References[[edit](/index.php?title=(none)&action=edit&section=35)]

[Template:Reflist](/wiki/Template:Reflist)

## Further reading[[edit](/index.php?title=(none)&action=edit&section=36)]

* Hart, Matthew, [''Gold : the race for the world's most seductive metal"](https://books.google.com/books?id=kSI5AAAAQBAJ&printsec=frontcover), New York : Simon & Schuster, 2013. ISBN 9781451650020

## External links[[edit](/index.php?title=(none)&action=edit&section=37)]

[Template:Wikiquote](/wiki/Template:Wikiquote) [Template:Commons](/wiki/Template:Commons) [Template:Wiktionary](/wiki/Template:Wiktionary)

* [Template:Cite EB1911](/wiki/Template:Cite_EB1911)
* [Chemistry in its element podcast](http://web.archive.org/web/20080417110808/http://www.rsc.org/chemistryworld/podcast/element.asp) (MP3) from the [Royal Society of Chemistry's](/wiki/Royal_Society_of_Chemistry) [Chemistry World](/wiki/Chemistry_World): [Gold](http://www.rsc.org/images/CIIE_Gold_48k_tcm18-118269.mp3) www.rsc.org
* [Gold](http://www.periodicvideos.com/videos/079.htm) at [*The Periodic Table of Videos*](/wiki/The_Periodic_Table_of_Videos) (University of Nottingham)
* [*Getting Gold* 1898 book](http://www.lateralscience.co.uk/gold/auriferous.html), www.lateralscience.co.uk
* [Template:Wayback](/wiki/Template:Wayback), www.epa.gov
* [Picture in the Element collection from Heinrich Pniok](http://www.pniok.de/au.htm), www.pniok.de
* [The Art of Precolumbian Gold: The Jan Mitchell Collection](http://libmma.contentdm.oclc.org/cdm/compoundobject/collection/p15324coll10/id/119785/rec/1), an exhibition catalog from The Metropolitan Museum of Art (fully available online as PDF)

[Template:Compact periodic table](/wiki/Template:Compact_periodic_table) [Template:Gold compounds](/wiki/Template:Gold_compounds) [Template:Jewellery](/wiki/Template:Jewellery)

[Template:Authority control](/wiki/Template:Authority_control)

[Category:Gold](/wiki/Category:Gold) [Category:Chemical elements](/wiki/Category:Chemical_elements) [Category:Cubic minerals](/wiki/Category:Cubic_minerals) [Category:Dental materials](/wiki/Category:Dental_materials) [Category:Electrical conductors](/wiki/Category:Electrical_conductors) [Category:Noble metals](/wiki/Category:Noble_metals) [Category:Precious metals](/wiki/Category:Precious_metals) [Category:Transition metals](/wiki/Category:Transition_metals) [Category:Warrants issued in Hong Kong Stock Exchange](/wiki/Category:Warrants_issued_in_Hong_Kong_Stock_Exchange) [Category:Native element minerals](/wiki/Category:Native_element_minerals)