Gold

Gold is a rare precious metal. It is used in jewellery, as an international monetary standard, for decoration, in dentistry and in many electrical and mechanical components increasingly in the form of nanomaterials.

How is gold formed?

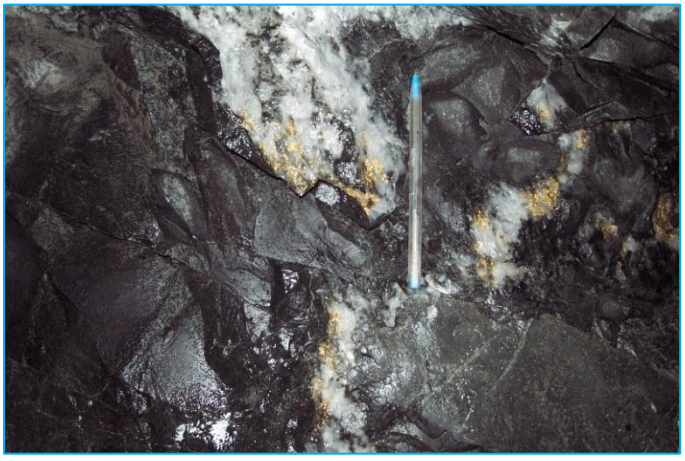
The source of the world's gold can be divided into two major types; primary deposits from hydrothermal fluids and secondary deposits produced by weathering and erosion of primary deposits.

Primary gold deposits form deep in the Earth's crust when hot fluids containing carbon and sulphur moved upwards, dissolving gold and other ore components from the rocks through which they passed. These fluids travelled along faults, fractures and other weaknesses in the rocks, carrying the gold in solution. When these waters cooled or reacted with other rocks the dissolved gold precipitated (came out of the water) in cracks or fractures forming veins.

Secondary gold deposits form from the erosion of rocky outcrops exposed at the surface of the earth and subjected to the natural elements of weathering and erosion, causing eventual breakdown of rock into fragments which are carried away by wind water or ice and redeposited into river systems, lakes or in the sea.

In Australia, the concentration of gold took place in the Earth hundreds of millions of years ago in the eastern states and in Western Australia thousands of millions of years ago.

In Western Australia, since primary gold deposits formed, the land has been uplifted and eroded in a continually changing climate. Under humid tropical conditions, primary gold was dissolved by rainwater and precipitated in horizontal layers just below the water table. About 15 million years ago, the climate became increasingly arid and the water table dropped. The gold dissolved in the saline groundwater and was carried downwards. During periods when the water table was stable, gold concentrated at this level. Changes in the position of the water table have resulted in a series of layers of concentrated gold.



Gold can be discovered in soils as eluvial deposits, in stream systems as alluvial deposits, in deep leads which were originally stream beds or as nuggets which are rich fragments which have been transported and deposited in sediments.

How is gold mined?

During the days of the gold rushes in the 1800s gold was mined by panning, dry blowing and later shaft mining. Today most of the gold is mined from large open cut pits or extensive underground operations.

Open cut projects are best suited to gold near the surface. Underground mining is for ore bodies that extend below 300 metres from the surface. Many open cut mines progress to underground techniques if the gold grade is sufficient and continuous lodes or ore-shoots are found.

Both underground and open cut projects require ore to be blasted, loaded into trucks and taken to the crusher for the first stage in separating the gold from the waste material.

What happens after mining?

After mining, processing areas and other work sites are cleared, recontoured and revegetated.

Waste dumps are recontoured to form low hills which are covered with fertile topsoil and planted with local native vegetation. Native ecosystems are established in the often harsh, arid environment of many gold producing areas.

Many decommissioned mines are retained by the companies for possible reworking in the case of high gold prices. Material from waste rock dumps and tailings dams can be reprocessed to recover traces of gold.

How is gold processed?

Most gold ore is processed, with the collected gold smelted to over 75% purity at or near the mine site.

Gold is mainly separated from ore using the "carbon in pulp" process. Ore is crushed to a fine silt, then mixed with water and sodium cyanide to form a slurry. The gold reacts to form a gold cyanide complex which dissolves in the solution. Where gold is trapped in sulphides such as pyrite, roasting is required to convert the sulphides to oxides before being mixed with sodium cyanide.

The slurry is filtered to remove non-soluble waste material, then mixed with carbon pellets to which the gold cyanide complex attaches. The carbon pellets are removed from the process tanks and the gold stripped from them using a small volume of hot cyanide solution.

The gold is collected from the cyanide solution by electrolysis. Steel wool cathodes became coated in gold in response to electricity being passed through the hot cyanide solution. Excess steel wool is dissolved using hydrochloric acid.

The collected gold is purified by smelting. It is heated until it melts, impurities are skimmed off when they float to the surface. The molten gold is cast into bars, and transported to the refinery.

Interesting Facts

- The chemical symbol for gold is **Au** - from the latin word - Aurum meaning 'shining dawn'.
- Gold is the only **yellow metal**, it is named after the old English word for yellow - Geolu.
- It has a very high **specific gravity** - 19.3- nearly twice that of lead.
- Gold does not **oxidise** at ordinary temperatures, so no oxide film dulls its surface.
- It is highly **resistant** to attack by acids, gold can only be dissolved in 'aqua regia'.
- Gold is highly **malleable**. That is it can be rolled into very thin gold leaf.
- Gold is extremely **ductile**. It can be drawn into thin wires, and is used for neurosurgical probes and in electrical circuitry.
- It is an excellent **conductor of electricity** and is used in microchips.
- The world's largest gold nugget, weighing 70 kilograms was found in Australia on 5 February 1869 by prospectors John Deason and Richard Oates at Moliagul, Victoria.
- The biggest nugget from Western Australia was found at Larkinville, near Widgiemooltha in 1931. It weighed 32.177kg and was found just 45 cm below the surface.

Refining is the final stage - the gold bars are remelted in a crucible aerated with chlorine gas. The melted impurities, such as silver, nickel and copper, form chloride compounds which are skimmed off the surface for reprocessing. The remaining gold is poured into moulds.

Recent advances in technology have developed biological oxidation of sulphide ores. Bacteria oxidises the sulphides releasing the gold and removing the necessity of roasting, hence also reducing sulphur dioxide atmospheric pollution.

What are the uses of gold?

Because of its properties, gold is a very useful metal. Common uses of gold are in jewellery, as an international monetary standard as a store of wealth, and for decoration. However its ability to conduct both heat and electricity make it highly suitable in modern electronics. Its electrical conductivity is surpassed only by copper and silver but it has the added advantage in that it does not tarnish.

As it is resilient to corrosion it is ideal as a coating for contacts and connections in electrical circuits. Gold is also ductile; one ounce can be drawn into 80km of gold wire. This makes it suitable for bonding wire in electronics. As it is compatible with the human body i.e. not toxic it is a material of choice as a dental alloy and implants that are at risk of infection such as the inner ear. Tiny nanoparticles of gold are used in many medical applications e.g. the delivery of drugs to cancerous tissues, also in the making of fuel calls, and the control of pollution and water purification.

Gold Vein: Charters Towers Image courtesy of Citigold

History

6000 BC - Gold first mined - one of the earliest known metals.

500 BC - Alchemy - the attempt to change base metals into gold.

1492 AD - Christopher Columbus set off in search of gold.

1848 - First gold rush sparked by the discovery of gold in California.

1851 Feb - First discovery of gold in Australia at Hill End near Bathurst, NSW.

1851 Dec - Rich discoveries made at Bendigo and Ballarat, Victoria.

1870 - Charters Towers and Palmer River, North Queensland.

1885 - Gold was first discovered in Western Australia at Halls Creek.

1888 - Southern Cross, Western Australia. The first of the major gold finds on the Yilgarn Block.

1892 - Bayley and Ford discovered the phenomenal riches at Coolgardie, Western Australia.

1893 - Kalgoorlie, Western Australia - last and most significant gold rush in Australia.

1995 - Western Australia experienced another gold boom – output jumping from 15 tonnes in 1980 to 189 tonnes in 1995.

2008 – Whilst gold averaged US$697/oz in 2007, in January 2008, prices broke through the previous record of US$850/oz set in 1980. In March 2008, gold was set at US$1033.90/oz.

2011- Gold sets record highs US$1625.49/oz (Dec 2011)

Australian gold production 2004 to 2008

	2004 (t)	2005 (t)	2006 (t)	2007 (t)	2008 (t)
New South Wales	29.14	28.05	27.04	34.89	31
Victoria	3.46	5.24	6.27	6.42	5
Queensland	23.16	23.99	21.47	20.81	18
South Australia	5.12	6.24	6.75	6.92	7
Western Australia	164.32	173.14	165.10	155.29	134
Tasmania	10.60	8.34	5.10	4.19	5
Northern Territory	22.27	16.55	14.03	16.54	15
Australia	258.07	261.53	245.76	245.04	215

Source: ABARE Australian Commodity Statistics 2008 and ABARE Australian Mineral Statistics, December Quarter 2008

Further Information

- For more detailed facts on **latest mineral discoveries and mining operations** in Australia click here.
- For the **latest uses of gold in science and technology** click here.
- For **latest gold price** (scroll down bottom of page) click here.

The Chamber of Minerals and Energy Western Australia is acknowledged as a significant contributor to this resource.

Last updated December 2011.