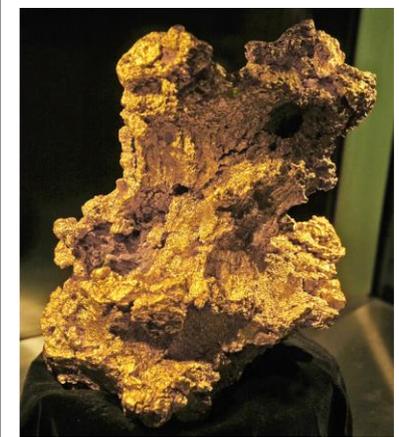




Gold properties

- One of the densest minerals on Earth, it has a specific gravity of 19.32
- Un-reactive, it does not readily combine with other substances and therefore doesn't corrode or tarnish
- It is almost always found as pure gold = 'native gold'
- Excellent conductor of electricity
- Malleable and ductile
- 2.5 – 3 on Moh's Scale
- Produces a gold streak on tile. 'Fools gold' (pyrite, chalcopyrite) produces a black streak.
- Purity of gold is measured in carats. Pure gold is 24 carats (24/24). 18 carat gold means that it is 18/24 parts gold and 6/24 parts other metals such as silver and copper.



Alluvial gold mass found near Kalgoorlie (Wikimedia Commons)

Although widely dispersed in the Earth's crust (makes up ~5/10,000,000), gold is rarely found in deposits large enough to make mining worthwhile.

Each gold deposit has its own chemical fingerprint due to trace amounts of metals such as tellurium, silver and copper. This allows forensic identification of gold to determine its source and ownership.

Types of gold deposit

Primary gold is deposited directly from hydrothermal gold bearing fluids. These hot mineralised liquids seep through faults and shear lines into breccias to form lodes and veins. It is also found as aureoles where surrounding rock has been altered by mineralising fluids.

In Kalgoorlie, thin veins containing gold and quartz cut across earlier gold deposits indicating they are younger. Gold has often bonded itself into earlier, sulfide rich minerals such as pyrite to create gold/pyrite complexes or 'refractory ore' which used to be difficult to refine using traditional cyanidation processes but is now accessible using CIP (carbon in pulp) and CIL (carbon in leach) technology. The Fimiston Super pit extends over 2,000 ore lodes of primary gold.

The Lachlan Orogen in New South Wales contains a variety of gold deposits. Copper-gold deposits are associated with Ordovician volcanic belts mined at Cadia and Northparkes. Silurian volcanic basins yield base metal, silver and gold deposits such as those at Sunny Corner and Captains Flat. Early Devonian rocks around Cobar formed during basin closure and contain base metals with some gold.



Alluvial gold is eroded from rock and soils by running water and deposited in river sediments. Early gold rushes were generated when sudden rain exposed alluvial nuggets lying in an old creek bed.

The first traces of gold were found in 1823 near Bathurst and 1841 in the Blue Mountains. These finds were quickly hushed up for fear of a gold rush. In 1851 Edward Hargraves found gold near Bathurst and publicised it. Within a month, a thousand people were prospecting in the area and Australia's gold rushes had begun. Within 10 years Australia's population had tripled thanks to gold.

The Geology of Kalgoorlie

The events summarised...

- ~2800Ma the Kalgoorlie Terrane began to form, this would become part of the Eastern Goldfields Superterrane, part of the Yilgarn Craton (host to around 30% of the world's economically recoverable reserves of gold.)
- ~2710Ma mafic and ultramafic lavas erupted onto the surface. There is evidence (e.g. pillow lavas) this occurred on the seafloor with a break in extrusion resulting in the formation of mud and siltstones.
- ~2690Ma formation of a package of felsic volcanogenic sandstones, siltstones and some conglomerates (Black Flag Group, in some places over 10 km thick).
- All of these rocks were deformed (studies suggest at least six major phases) and then eroded. In places they were overlain by younger sedimentary rocks.
- During this time granites intruded at depth and there was intrusion of mafic sills (such as the Golden Mile Dolerite). The Golden Mile Dolerite is the host of most of Kalgoorlie's gold and is divided into 10 units.
- Gold mineralisation is structurally controlled, often associated with major faults and/or intrusion of granites at depth.
- Continued weathering and erosion



When you read about the Kalgoorlie region you often come across the term 'Greenstone Belts'. These represent a sequence of igneous and sedimentary rocks forming a relatively thin layer above continental crust. This area has undergone multiple regional metamorphic events.



Greenstone belts are generally Archaean terranes comprising intrusive and extrusive mafic-ultramafic igneous rocks, felsic volcanic and sedimentary rocks. They are usually sandwiched between regions dominated by granitoids and gneiss. Greenstones are generally of low to moderate metamorphic grade. The term greenstone comes from the green colour of the abundant chlorite. Common rocks of greenstone belts include; komatiite (volcanic flows or sills), basalt, dolerite, conglomerate, shale, greywacke, chert and granitoids (intruded). Greenstone belts are often relatively shallow (6-9km) and overlie uniformly thick crust.



There is still much debate about how these belts form. One proposal suggests that these only formed in Archaean times as the Earth's mantle was far hotter, allowing the abundance of komatiitic lavas. Another suggestion is that greenstone belts are oceanic plateaus generated by a mantle plume. Another idea, that is rapidly accumulating evidence, is that greenstones formed in volcanic arcs or back-arc basins so greenstone belts represent collages of oceanic crust, island arcs, accretionary prisms and possible plateaus.

Fimiston Super Pit (Kalgoorlie Consolidated Gold Mines)

The Super Pit was the largest open pit gold mine in the world until 2016, when it was surpassed by the Newmont Boddington gold mine.

Fimiston Super Pit extends over 2,000 ore lodes of primary gold in the Golden Mile Dolerite in an area which spreads over 5km long by 2km wide by 1km deep.



The mineralising fluid was a low salinity water-carbon dioxide mixture. Mineralisation occurs in breccias, veins and in alteration haloes in the Golden Mile Dolerite. The NNW/SSE Golden Mile Fault splits the deposit into two separate zones. The best ore comes from areas where lodes converge and form alteration haloes.

Crosscutting the Fimiston lodes are a suite of quartz veins, which are also mineralised. Where these veins reach sufficient density, an economic ore body may be formed. Due to the structure of the area these quartz veins are localised in a unit of the Golden Mile Dolerite.

Mineralisation is 30% native gold, 25% telluride gold, 35% gold included in pyrite and 10% fine gold in pyrite.

Gold grades in the lodes (now largely mined out) were up to hundreds or thousands of grams per tonne, but grades in alteration haloes are up to a few tens of grams per tonne, and ore averages ~2.5 grams per tonne.

The ore is mined by drilling and blasting before it is loaded into Haulpack trucks.

Crushing, grinding, flotation, filtering and ultra-fine grinding are carried out at Fimiston whilst milling (replacing roasting) is carried out at Gidji. Next is CIP (carbon-in-pulp) recovery, elution, electrowinning and finally smelting.

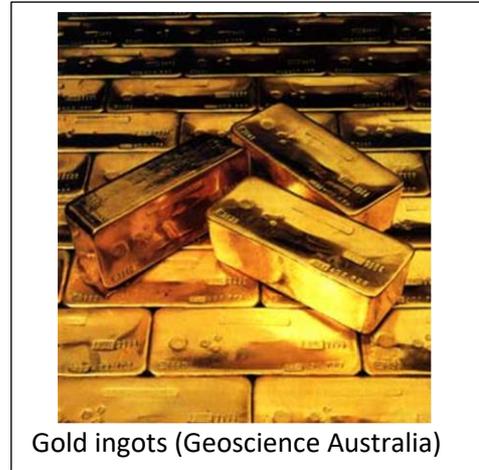


Kalgoorlie (A) and the Fimiston Pit (B) from space (NASA)



Uses of gold

- Money – gold was used to produce coins for many thousands of years, but is rarely used today. Institutions and individuals use gold as a store of wealth, often in the form of gold ingots.
- Jewellery – 18 carat gold is commonly used for jewellery. Gold is alloyed with metals such as silver, nickel, copper or palladium to increase its hardness and change the colour.
- Decorative uses – gold leaf is very thin and durable. It is used to coat decorative letters, book edges, picture frames and statues.



Gold ingots (Geoscience Australia)



Apollo 14 lunar module on the moon
(NASA/JSC)

- Electronics – due to its ductility and conduction, gold is widely used for computer electronics. It is particularly useful for wiring that is difficult to repair (underwater, space) because it is durable and not easily corroded.
- Shielding – because gold is dense and reflective, it is useful as a protective shield against heat and light. Gold was used as a film coating the Apollo 14 lunar module.
- Health – gold is used for filling or replacing teeth, in arthritis treatments and in medical lasers to focus light energy.

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