

McPhillamys Gold Project

#10 Open cut gold mining and processing

Open cut mining

Open cut mining is a surface mining technique of extracting rock or minerals from the earth by their removal from an open pit. It is the most common method used throughout the world for mineral mining and does not require tunnels.

Open cut mines are dug using benches. The depth of each bench depends on the deposit being mined, the mineral being mined and the size of machinery being used.

Access to the benches is via a system of ramps or from a main haul road.

The walls of the open pit are mined on an angle less than vertical which is a safety feature to control the risk of the walls collapsing.

Open cut mining also involves bulldozing and ripping of the soft ground and then drilling and blasting the hard rock so that it can be dug out and loaded into trucks.

How drilling and blasting works

- A number of holes are drilled into the rock.
- The rock from the drill hole is tested to see if it is ore (that is, has sufficient gold in it) or it is waste (has insufficient gold in it).
- The lower part of the drill hole is then filled with explosives and the top part of the drill hole is filled with crushed rock to prevent the explosive force from escaping out of the top of the hole when it is blasted.
- The explosives in each of the holes are then detonated, causing the rock to fracture and break.
- The blasted rock is then loaded into the trucks using an excavator.
- Then, the ore is transported to the processing plant and the waste is taken to the waste rock emplacement area.

Below: An open cut mine at Moolart Well, WA



Crushing and grinding the rock

The crushing plant reduces the size of the rock from up to 1 metre to less than 10 mm, in three stages. The first stage crushes rocks up to 1 metre in size down to less than 300 mm. The second stage crushes the rocks to around 50 mm in size and the third stage crushes the rocks down to less than 10 mm in size.

Shaker screens are positioned in between crushing stages to divert larger rocks back to the same crusher and to allow rocks that have been crushed to the correct size to proceed to the next stage.

The crushed ore is then mixed with water and fed into a grinding mill. The grinding mill is basically a large steel cylinder which is half filled with steel balls between 50 mm and 100 mm in size. It rotates at about 15 or so revolutions per minute.

The rotating action of the steel cylinder causes the steel balls to land on the rock particles. This process causes them to be ground down to a size of less than about 1/6 of a millimetre, similar to fine beach sand.

This fine beach sand size material and water when mixed together is called a slurry, which is a mud-like mixture capable of being pumped through pipes.

Leaching

The ground slurry mixture is then fed into a series of large steel cylindrical leach tanks which are approximately 15 metres in diameter and 15 metres high. This is where dilute cyanide solution is added along with oxygen to separate the gold from the ore particles.

Separating the gold from the waste

The leach tanks also contain activated carbon particles made from roasted coconut shell and are similar to those used for air and water purification.

The dissolved gold particles attach to the surface of the activated carbon particles, which are about 2-4mm in size.

The dissolved gold particles which attach to the activated carbon particle surface at a lower temperature (0°C to 40°C) are then passed through hot water (>100°C). This causes the gold to desorb or unstick from the activated carbon.

The waste slurry, which has now had most of the gold removed from it, is fed into a tailings thickener. This makes the slurry thicker, releasing water for reuse in the grinding section.

The thickened slurry is then passed through a cyanide detoxification plant, which destroys the free cyanide in the slurry.

The ground slurry, which has had the gold recovered and the free cyanide destroyed, is called tailings.

These tailings are then pumped to the tailings storage facility, where the settling action of the solids from the slurry releases more water for reuse in the grinding mill.

Electrowinning

The gold in solution, which has been desorbed or removed from the activated carbon particle surface, is then electroplated as a sludge onto stainless steel wool, where it can then be washed off and dried ready for smelting.

Bullion production

The gold sludge is then put into a furnace for smelting. After several hours, the molten material is poured into moulds to produce bars of doré bullion.

These gold bars are then sent to a refinery for further processing into high purity gold bullion.

Below L-R: Gold pour, raw gold and a high purity gold bullion bar



Image courtesy The Perth Mint

