

Gold production and mine-site rehabilitation processes

The process of producing gold

The process of producing gold can be divided into six main phases:

- finding the orebody;
- creating access to the orebody;
- removing the ore by mining or breaking the orebody;
- transporting the broken material from the mining face to the plants for treatment;
- processing; and
- refining.

This basic process applies to both underground and surface operations.

Finding the orebody

AngloGold Ashanti's global exploration group identifies targets and undertakes exploration, on its own or in conjunction with joint venture partners.

Creating access to the orebody

There are two types of mining which take place to access the orebody:

- underground mining: a vertical or decline shaft (designed to transport people and/or materials) is sunk deep into the ground, after which horizontal development takes place at various levels of the main shaft or decline. This allows for further on-reef development of specific mining areas where the orebody has been identified; and
- open-pit mining: where the top layers of topsoil or rock are removed in a process called 'stripping' to uncover the reef.

Removing the ore by mining or breaking the orebody

- In underground mining, holes are drilled into the orebody, filled with explosives and then blasted. The blasted 'stopes' or 'faces' are then cleaned and the ore released is then ready to be transported out of the mine.

- In open-pit mining, drilling and blasting may also be necessary to release the gold-bearing rock; excavators then load the material onto the ore transport system.

Transporting the broken material from the mining face to the plants for treatment

- Underground ore is transported by means of vertical and/or horizontal transport systems. Once on surface, conveyor belts usually transport the ore to the treatment plants.
- Open-pit mines transport ore to the treatment plants in vehicles capable of hauling large, heavy loads.

Services

Mining activities require extensive services, both on the surface and underground, including:

- mining engineering services;
- mine planning;
- ventilation;
- provision of consumable resources;
- engineering services;
- financial, administration and human resource services; and
- environmental/sustainable development services.

Processing

- Comminution is the process of breaking up ore to make gold available for treatment. Conventionally, this process occurs in multi-stage crushing and milling circuits. Modern technology is to use large mills fed directly with run-of-mine material.
- Gold ores can typically be classified into:
 - refractory ores, where the gold is locked within a sulphide mineral and not readily available for recovery by the cyanidation process; or
 - free milling, where the gold is readily available for recovery by the cyanidation process.
- Refractory ore treatment: after fine grinding, the sulphide materials are separated from the barren gangue material using

flotation to produce a high-grade sulphide concentrate. The sulphide concentrate is oxidised by either roasting as at AngloGold Ashanti Mineração or bacterial oxidation (BIOX) as at Obuasi. The oxidation process oxidises the sulphide minerals, liberating the gold particles and making them amenable to recovery by the cyanidation process.

- Free milling and oxidised refractory ores are processed for gold recovery by leaching the ore in agitated tanks in an alkaline cyanide leach solution. This is generally followed by adsorption of the gold cyanide complex onto activated carbon-in-pulp (CIP).
- An alternative process is the heap-leach process. This process is generally considered applicable to high-tonnage, low-grade ore deposits, but it can be successfully applied to medium-grade deposits where the ore deposit tonnage cannot economically justify constructing a process plant. Run-of-mine ore is crushed and heaped on a leach pad. Low strength alkaline cyanide solution is applied, generally as a drip, to the top of the heap for periods of up to three months. The dissolved gold bearing solution is collected from the base of the heap and transferred to carbon-in-solution (CIS) columns where the gold cyanide complex is adsorbed onto activated carbon. The stripped solution is recycled to the top of the heaps.
- Gold adsorbed onto activated carbon is recovered by a process of re-dissolving the gold from the activated carbon (elution), followed by precipitation in electro-winning cells and subsequent smelting of that precipitate into doré bars that are shipped to the gold refineries.
- Retreatment of tailing stockpile from previous decades' operations is also practiced by AngloGold Ashanti. The old tailings are mined by water sluicing followed by agitator leaching in alkaline cyanide solution and recovery of dissolved gold onto activated carbon.
- At AngloGold Ashanti operations, the main by-products produced are:
 - silver, which is associated with gold in ratios ranging from 0.1:1 to 200:1 silver to gold;

- sulphuric acid which is produced from the gases generated by the roasting plants; and
- uranium which is recovered in a process which involves initial acid leaching followed by recovery of the leached uranium onto resin and subsequent stripping with ammonium hydroxide and precipitation of crude yellow cake.
- The tailings from the process operations are stored in designated tailings storage facilities designed to enhance water recovery and prevent contaminant seepage into the environment.

Refining

The doré bars are transported to a refinery for further refining, to as close to pure gold as possible. This is known as good delivery status. This gives the assurance that the bar contains the quantity and purity of gold as stamped on the bar.

The process of mine-site rehabilitation

In all the jurisdictions in which the company operates, it is required to conduct closure and rehabilitation activities to return the land to a productive state once mining has been completed. Additionally, the company is required to provide financial assurance, in a form prescribed by law, to cover some or all of the costs of the anticipated closure and rehabilitation costs for the operation. Rehabilitation refers to the process of reclaiming mined land to the condition that existed prior to mining or to a pre-determined post-mining use.

Closure plans are devised prior to the commencement of operation and are regularly reviewed to take into account life-of-mine projections. Although the final cost of closure cannot be fully determined ahead of closure, appropriate provision is made during the mine's economic operation.