

# Mining

**Mining** is the extraction of [valuable minerals](#) or other [geological](#) materials from the earth, usually (but not always) from an [ore](#) body, [vein](#) or (coal) seam. Basically all mining methods entail two fundamental tasks regardless of scale: breaking the ore, and transporting it to the beneficiation or processing plant.

Materials recovered by mining include [bauxite](#), [coal](#), [copper](#), [gold](#), [silver](#), [diamonds](#), [iron](#), [precious metals](#), [lead](#), [limestone](#), [nickel](#), [phosphate](#), [oil shale](#), [rock salt](#), [tin](#), [uranium](#) and [molybdenum](#).

**Prospecting or Exploration** to find and then define the extent and value of [ore](#) where it is located ("ore body")

**Conduct [resource estimation](#)** to mathematically estimate the size and grade of the deposit

**Conduct a [pre-feasibility](#) study** to determine the theoretical economics of the ore deposit. This identifies, early on, whether further investment in estimation and engineering studies is warranted and identifies key risks and areas for further work.

**Conduct a [feasibility study](#)** to evaluate the financial viability, technical and financial risks and robustness of the project and make a decision as whether to develop or walk away from a proposed mine project. This includes mine planning to evaluate the economically recoverable portion of the deposit, the [metallurgy](#) and ore recoverability, marketability and payability of the ore concentrates, engineering, milling and infrastructure costs, finance and equity requirements and a cradle to grave analysis of the possible mine, from the initial excavation all the way through to reclamation.

**Development** to create access to an ore body and building of mine plant and equipments.

**[Reclamation](#)** to make land where a mine had been suitable for future use

**Mining techniques** can be divided into two basic [excavation](#) types:

1. [Surface mining](#)
2. [Sub-surface mining](#) (underground mining)

**Surface mining** is a type of mining in which soil and rock overlying the mineral deposit (the overburden) are removed. It is the opposite of underground mining, in which the overlying rock is left in place, and the mineral removed through shafts or tunnels.

Surface mining is used when deposits of commercially useful minerals or rock are found near the surface; that is, where the overburden is relatively thin or the material of interest is structurally unsuitable for tunneling (as would usually be the case for sand, cinder, and gravel). Where minerals occur deep below the surface—where the overburden is thick or the mineral occurs as veins in hard rock— underground mining methods are used to extract the valued material. Surface mines are typically enlarged until either the mineral deposit is exhausted, or the cost of removing larger volumes of overburden makes further mining uneconomic.

**Types of surface mining:**

[Open-pit mining](#)

[Quarrying](#)

[Strip mining](#)

[Placer mining](#)

**"Open-pit mining"** refers to a method of extracting **rock** or **minerals** from the earth through their removal from an open pit.

Open-pit mines are used when deposits of commercially useful [minerals](#) or [rock](#) are found near the surface; that is, where the *overburden* (surface material covering the valuable deposit) is relatively thin or the material of interest is structurally unsuitable for tunneling (as would be the case for sand, cinder, and gravel).

Grade and tonnage of material available will determine pit limits and how much waste rock can be stripped. The ultimate limit to the pit is determined by the economics of removing overburden (STRIPPING RATIO [ORE/WASTE]). For minerals that occur deep below the surface—where the overburden is thick or the mineral occurs as veins in hard rock— underground mining methods extract the valued material.



## **Strip mining**

"Strip mining" is the practice of mining a seam of mineral by first removing a long strip of overlying soil and rock (the overburden). It is most commonly used to mine coal or tar sand. Strip mining is only practical when the ore body to be excavated is relatively near the surface.

**QUARRYING or Quarry Mining** is usually restricted to mining dimension stone - prismatic blocks of marble, granite, limestone, sandstone, slate, etc. that are used for primary construction of buildings or decorative facing materials for exterior and interior portions of buildings.

## **Underground mining (hard rock)**

Underground hard rock mining refers to various underground [mining](#) techniques used to excavate hard minerals, mainly those minerals containing metals such as ore containing [gold](#), [copper](#), [zinc](#), [nickel](#) and [lead](#), but also involves using the same techniques for excavating ores of gems such as [diamonds](#).

## **Underground access**

### **Development mining vs. production mining**

There are two principal phases of underground mining: **development mining and production mining.**

**Development:** underground work carried out for the purpose of opening up a mineral deposit below the earth surface.

Four basic components of rock excavation are involved in normal mine developments and includes shaft sinking, ramp driving, drifting and raising.

**Shaft:** a vertical passageway to an underground mine for moving personnel, equipment, supplies and material including ore and waste rock, to ventilate the mine.

- the purpose is to provide access to underground workings
- the main shaft is usually vertical
- the profile can be rectangular, circular or elliptical
- a mine shaft is normally sunk to a depth that will ensure many years of production already in the initial stages of development
- shaft sinking in comparison with other development operations, a complex procedure
- the sinking requires a complete set of machinery, matched to the project
- shaft sinking is therefore treated as a special project and assigned to a contractor

**Drift:** a horizontal tunnel driven alongside an orebody, from either an adit or shaft, to gain access to the ore, used for exploration.

**Ramp:** An inclined underground tunnel that provides access to an ore body for exploration, ventilation and/or mining purposes in an underground mine.

**Raise** - A vertical hole between mine levels used to move ore or waste rock or to provide ventilation.

**Development mining** is composed of excavation almost entirely in (non-valuable) waste rock in order to gain access to the orebody. There are six steps in development mining: remove previously blasted material (muck out round), Scaling (removing any unstable slabs of rock hanging from the roof and sidewalls to protect workers and equipment from damage), support excavation, drill rock face, load explosives, and blast explosives.

**Production mining** is further broken down into two methods, **long hole and short hole**.

**Short hole mining** is similar to development mining, except that it occurs in ore. There are several different methods of long hole mining. Typically long hole mining requires two excavations within the ore at different elevations below surface, (15 m – 30 m apart). Holes are drilled between the two excavations and loaded with explosives. The holes are blasted and the ore is removed from the bottom excavation.

## **Ventilation**

One of the most important aspects of underground hard rock mining is [ventilation](#). Ventilation is required to clear toxic fumes from blasting and removing exhaust fumes from diesel equipment. In deep hot mines ventilation is also required for cooling the workplace for miners. Ventilation raises are excavated to provide ventilation for the workplaces, and can be modified for use as emergency escape routes. The primary sources of heat in underground hard rock mines are virgin rock temperature, machinery, auto compression, and fissure water. Other small contributing factors are human body heat and blasting.

## **Underground Mining methods**

**Cut-and-fill:** a method of underground mining in which ore is removed in slices or lifts, and then the excavation is filled with rock or other waste material (backfill) before the subsequent slice is mined.

**Drift and Fill** is similar to cut and fill, except it is used in ore zones which are wider than the method of drifting will allow to be mined.

[Shrinkage Stopping](#) is a short hole mining method which is suitable for steeply dipping orebodies. The method is similar to cut and fill mining with the exception that after being blasted, broken ore is left in the stope where it is used to support the surrounding rock and as a platform from which to work.

**Room and Pillar mining :** Room and pillar mining is commonly done in flat or gently dipping bedded ore bodies. Pillars are left in place in a regular pattern while the rooms are mined out.

**Block Caving** is used to mine massive steeply [dipping](#) orebodies (typically low grade) with high [friability](#).

**Stoping** is the removal of the wanted [ore](#) from an underground [mine](#) leaving behind an open space known as a stope. Stopping is used when the [country rock](#) is sufficiently strong not to cave into the stope, although in most cases artificial support is also provided.

**A spoil tip is** a pile built of accumulated *spoil*, which is a by-product of **mining**.



## **Placer mining**

**Placer mining** is the mining of alluvial deposits for minerals. This may be done by open-pit (also called open-cast mining) or by various forms of tunneling into ancient riverbeds. Excavation may be accomplished using water pressure (hydraulic mining), surface excavating equipment or tunneling equipment.

### ***Methods***

**Panning:** The traditional prospectors gold pan is an efficient device for washing and separating the heavy minerals in placer deposits and is commonly used as a prospecting and testing tool for evaluating placer deposits.

**Sluicing:** in sluicing placer gravel is shoveled, along with a stream of water, into the head of an inclined elongated sluice box with RIFFLES positioned across the bottom. These trap the heavy minerals and the lighter minerals are washed over the top and out as relatively barren waste. Sometimes fine gold is trapped as an amalgam when mercury is placed within the riffles or on a copper plate at

the exit of the sluice box. The gold in the amalgam is recovered by retorting off the mercury.

### **Trommel**

A trommel is composed of a slightly-inclined rotating metal tube (the 'scrubber section') with a screen at its discharge end.

The ore is fed into the elevated end of the trommel. Water, often under pressure, is provided to the scrubber and screen sections and the combination of water and mechanical action frees the valuable minerals from the ore.

### **Dredging**

"Dredging" is a method often used to bring up underwater mineral deposits. Although dredging is usually employed to clear or enlarge waterways for boats, it can also recover significant amounts of underwater minerals relatively efficiently and cheaply.

### **Hydraulic mining**

**Hydraulic mining**, or **hydraulicking**, is a form of mining that uses high-pressure jets of water to dislodge rock material or move sediment. In the placer mining of gold or tin, the resulting water-sediment slurry is directed through sluice boxes to remove the metal.

The modern form of hydraulicking, using jets of water directed under very high pressure through hoses and nozzles.

**In-situ leach** is a particular mining technique that is used to mine minerals ([potash](#), [potassium chloride](#), [sodium chloride](#), [sodium sulphate](#) and [uranium oxide](#)) which dissolve in water.

Environmental issues can include [erosion](#), formation of [sinkholes](#), loss of [biodiversity](#), and contamination of [groundwaters](#) and surface water by chemicals from the mining process and products.

**Acid mine drainage (AMD)**, or **acid rock drainage (ARD)**, refers to the outflow of [acidic](#) water from (usually) abandoned [metal mines](#) or [coal mines](#). However, other areas where the earth has been disturbed (e.g. construction sites, subdivisions, transportation corridors, etc.) may also contribute acid rock drainage to the environment.

**[Tailings](#) piles or ponds** may also be a source of acid rock drainage.

Metal mines may generate highly acidic discharges where the [ore](#) is a sulfide or is associated with pyrites. In these cases the predominant metal [ion](#) may not be [iron](#) but rather [zinc](#), [copper](#), or [nickel](#).

## Tailings

Tailings (also known as slimes, tailings pile, tails, leach residue, or slickens) are the materials left over after the process of separating the valuable fraction from the worthless fraction (gangue) of an ore.