# AN OVERVIEW OF MINING METHODS

**Technical Report** · February 2016

DOI: 10.13140/RG.2.2.15761.63845



**1 author:**

A. Balasubramanian
University of Mysore
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# AN OVERVIEW OF MINING METHODS

**By**
Prof. A. Balasubramanian
Centre for Advanced Studies in Earth Science,
University of Mysore, Mysore

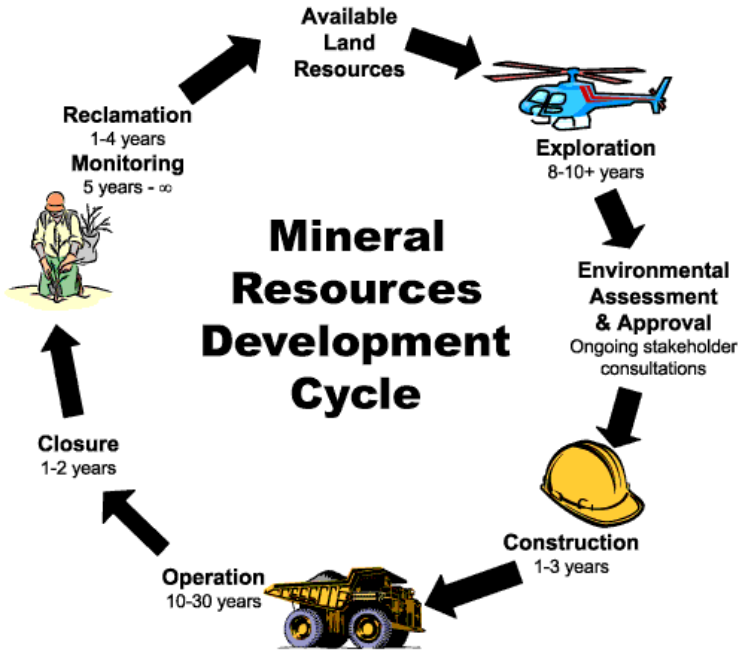
**Abstract:**

Mining is the extraction of economically valuable minerals or other geological materials from the earth surface. It may be from an ore body, lode, vein, seam, reef or placer deposits. Since the beginning of civilization, people have used stone, ceramics and, later, metals found close to the Earth's surface. Minerals are the major sources of energy as well as raw materials for industries. earth's natural materials are used as fertilizers and for the production of metals like steel. These were used to make early tools and weapons. This report provides the details of the widely adopted methods of mining, both surface and underground and to have an overview of all the operations that are made to explore the economic mineral resources.

## 1. Introduction:

Today, mining is one of the essential industries which involves both exploration and processing removal of minerals from the earth, economically and with minimum damage to the environment.
Mining is necessary for nations to have adequate and dependable supplies of minerals and materials to meet their economic and defense needs . Some of the nonfuel minerals mined, such as stone, which is a non-metallic or industrial mineral, can be used directly from the earth.

Metallic minerals, which are also nonfuel minerals, are usually combined in nature with other materials as ores. These ores must be treated, generally with chemicals or heat to produce the metal of interest. Most bauxite ore, for example, is converted to aluminium oxide, which is used to make aluminium metal via heat and additives. Fuel minerals, such as coal and uranium, must also be processed using chemicals and other treatments to produce the quality of fuel desired.




## 2. Stages in the life of a mine

The life cycle of mining begins with exploration, continues through production, and ends with closure and post mining land use. New technologies can benefit the mining industry and consumers in all stages of this life cycle.

The three major components of mining (exploration, mining, and processing) overlap somewhat. After a mineral deposit has been identified through exploration, the industry must make a considerable investment in mine development before production begins. Further exploration near the deposit and further development drilling within the deposit are done while the mining is ongoing.
The overall sequence of activities in modern mining is often compared with the five stages in the life of a mine.
They are: *Prospecting*, *Exploration*, *Development*, *Exploitation*, and *Reclamation*. (in short PEDER).

### a. Prospecting and exploration

Prospecting and exploration are the precursors to actual mining. Bothe are linked and sometimes combined. Many mineral discoveries since the 1950s can be attributed to geophysical and geochemical technologies developed by both industry and government. Modern mineral exploration has been driven largely by technology. Today, new technologies, such as tomographic imaging and GPS (developed by the defense community), are employed to mineral exploration. Research in basic geological sciences, geophysical and geochemical methods, and drilling technologies could improve the effectiveness and productivity of mineral exploration. Geologists and mining engineers often share responsibility for these two stages. The Geologists are more involved with the mining engineers in the execution works.

b. Likewise, **development and exploitation** are closely related stages; they are usually considered to constitute mining proper and are the main province of the mining engineer.

**c. Reclamation** has been added to these stages since the first edition, to reflect the times. Closure and reclamation of the mine site has become a necessary part of the mine life cycle because of the demands of society for a cleaner environment and stricter laws regulating the abandonment of a mine.

**3. Prospecting**

Prospecting is the first stage in the utilization of a mineral deposit. It is the search for ores or other valuable minerals (coal or non metallics). Because mineral deposits may be located either at or below the surface of the earth, both direct and indirect prospecting techniques are employed.

The direct method of discovery, normally limited to surface deposits, consists of visual examination of either the exposure (outcrop) of the deposit or the loose fragments (float) that have weathered away from the outcrop.

**Geologic studies** of the entire area augment this simple, direct technique. By means of aerial photography, geologic maps, and structural assessment of an area, the geologist gathers evidence by direct methods to locate mineral deposits. Precise mapping and structural analysis plus microscopic studies of samples also enable the geologist to locate the hidden as well as surface mineralization.

The most valuable scientific tool employed in the indirect search for hidden mineral deposits is **geophysics**, the science of detecting anomalies using physical measurements of gravitational, seismic, magnetic, electrical, electromagnetic, and radiometric variables of the earth. The methods are applied from the air, using aircraft and satellites; on the surface of the earth; and beneath the earth, using methods that probe below the topography.

**4. Geochemistry**, the quantitative analysis of soil, rock, and water samples, and geobotany, the analysis of plant growth patterns, can also be employed as prospecting tools. Once a location shows evidence for an economic deposit, samples are drilled and sent for geochemical analysis. At this time, the exact mineral composition of the samples and ore grade is determined. Economic feasibility of the mine depends on weighing the cost of extracting and refining the ore to how much of the ore is composed of the valuable element.

**5. Exploration**

The second stage in the life of a mine is exploration. It determines as accurately as possible, the size and value of a mineral deposit, utilizing techniques similar to but more refined than those used in prospecting.

Exploration focuses to surface and subsurface locations, using a variety of measurements to obtain a more positive picture of the extent and grade of the ore body.

Representative samples may be subjected to chemical, metallurgical, X ray, spectrographic, or radiometric evaluation techniques that are meant to enhance the investigator's knowledge of the mineral deposit. Samples are obtained by chipping outcrops, trenching, tunneling, and drilling; in addition, borehole logs may be provided to study the geologic and structural makeup of the deposit. Rotary, percussion, or diamond drills can be used for exploration purposes.

**6. Development**

In the third stage, development, the work of opening a mineral deposit for exploitation is performed. With it begins the actual mining of the deposit, now called the ore. Access to the deposit must be gained either
(1) by stripping the overburden, which is the soil and/or rock covering the deposit, to expose the near-surface ore for mining or

(2) by excavating openings from the surface to access more deeply buried deposits to prepare for underground mining.

**7. Preliminary development works**

In either case, certain preliminary development work, such as acquiring water and mineral rights, buying surface lands, arranging for financing, and preparing permit applications and an environmental impact statement (EIS), will generally be required before any development takes place.

When these steps have been achieved, the provision of a number of requirements—access roads, power sources, mineral transportation systems, mineral processing facilities, waste disposal areas, offices, and other support facilities—must precede actual mining in most cases.
Stripping of the overburden will then proceed if the minerals are to be mined at the surface.

**8. Economic and legal considerations :**

Economic considerations determine the stripping ratio, the ratio of waste removed to ore recovered. Some non-metallic mines have no overburden to remove; the mineral is simply excavated at the surface. The type of mineral being mined and surrounding environmental conditions are taken into account when determining the machinery, ventilation systems, disposal systems, power supply, and water supply of the facilities. Permits for the proposed mine are obtained through the local government. Any Mine setup costs include expenses from everything from feasibility studies to constructing facilities.

**9. Exploitation**

Exploitation, the fourth stage of mining, is associated with the actual recovery of minerals from the earth in quantity. Although development may continue, the emphasis in the production stage is on production. Usually only enough development is done prior to exploitation to ensure that production, once started, can continue uninterrupted throughout the life of the mine.
Geologic conditions, such as the dip, shape, and strength of the ore and the surrounding rock,play a key role in selecting the method.

**Traditional exploitation methods** fall into the following broad categories based on locale.

**10. Open-Pit Mining**:

Surface Mining is one of the oldest methods of mining**.** Surface mining is the predominant exploitation procedure worldwide. Most of these are mined by open pit or open cast methods.
Ores closer to the surface are accessed by creating an open pit and then excavating the ore below for further processing. In most cases, a significant amount of overburden, which is a layer of rock or soil that covers the deposit, must be removed. Surface mining includes mechanical excavation methods such as open pit and open cast (strip mining),and aqueous methods such as placer and solution mining.

The open pit mining is a mechanical extraction method. in This method, any thick deposit is mined in series of benches and any thin deposit may require only a single bench or face.
Open pit is also called as open cast mining . It is usually employed to exploit a near-surface deposit or ore that has a low stripping ratio. It often requires a large capital investment but generally results in high productivity, low operating cost and good safety conditions.

**11. Underground Mining**:

Ores in buried bedrock deposits are usually accessed through the construction of access shafts and tunnels. They provide for less waste rock removal and they offer less environmental impact than open-pit mining because these deposits typically have much higher ore grades.

**13. In-Situ Leach (ISL) Mining:**

Some ore bodies, due to ore concentration or the surrounding material, can only be accessed by dissolving the ore body using water soluble acids or alkalis and then pumping out the solution. The ore body is then recovered as a precipitate. This method is common when extracting minerals near aquifers. It is also used if ores are not locally concentrated but spread over a wide area.

**14. Solution and Placer mining**

**Solution mining** includes both **borehole mining**, such as the methods used to extract sodium chloride or sulfur, and **leaching**, either through drillholes or in dumps or heaps on the surface.

**Placer mining** is used to exploit loosely consolidated deposits like common sand and gravel or gravels containing gold, tin, diamonds, platinum, titanium,or coal.

**Placer and solution mining** are among the most economical of all mining methods but can only be applied to limited categories of mineral deposits.

**The aqueous extraction methods** depend on water or another liquid (e.g.,dilute sulfuric acid, weak cyanide solution, or ammonium carbonate) to extract the mineral.

**15. Heap Leaching**:

Very low-grade ore is treated by heap leaching. In this process, the ore is stacked upon an impermeable pad and irrigated with acid or an alkaline solution over several weeks. The solution is then collected and treated using ionic exchange to recover the metal. The tailings are toxic and require safe storage.

**16. Brine mining**:

Brines are saline waters with high concentrations of dissolved salts. Brines, which are by-products of geothermal or oil wells, can be extracted and pumped into evaporation ponds to be evaporated under controlled conditions to eliminate deleterious elements and compounds. The remaining precipitate is then processed for element removal.

**17. Hydraulicking and Dredging**

**Hydraulicking** utilizes a high-pressure stream of water that is directed against the mineral deposit (normally but not always a placer), undercutting it,and causing its removal by the erosive actions of the water.

**Dredging** is performed from floating vessels, accomplishes the extraction of the minerals mechanically or hydraulically.

**18. Underground Mining Methods:**

Underground mining is usually classified in three categories of methods: unsupported, supported, and caving. The principal openings may be shafts, slopes, or adits; each must be planned to allow passage of workers, machines, ore, waste, air, water, and utilities. Many metal mines are located along steeply dipping deposits and thus are opened from shafts, while drifts, winzes, and raises serve the production

areas. Many coal and non-metallic mines are found in nearly horizontal deposits. Their primary openings may be drifts or entries, which may be distinctly different from those of metal mines.

As stated already, the underground mining methods include unsupported, supported, and caving methods. These are differentiated by the type of wall and roof supports used, the configuration and size of production openings,and the direction in which mining operations progress.

**19. The unsupported methods**

The **unsupported methods** of mining are used to extract mineral deposits that are roughly tabular (plus flat or steeply dipping) and are generally associated with strong ore and surrounding rock.

These methods are termed **unsupported** because they do not use any artificial pillars to assist in the support of the openings. However, generous amounts of roof bolting and localized support measures are often used.

**a. Room-and-pillar mining** is the most common unsupported method, used primarily for flat-lying seams or bedded deposits like coal, trona, limestone, and salt. Support of the roof is provided by natural pillars of the mineral that are left standing in a systematic pattern.

**b. Stope-and-pillar mining** (a stope is a production opening in a metal mine) is a similar method used in noncoal mines where thicker, more irregular ore bodies occur; the pillars are spaced randomly and located in low-grade ore so that the high-grade ore can be extracted. These two methods account for almost all of the underground mining in horizontal deposits in the United States and a very high proportion of the underground tonnage as well. Two other methods applied to steeply dipping deposits are also included in the unsupported category.

**c. In shrinkage stoping**, mining progresses upward, with horizontal slices of ore being blasted along the length of the stope. A portion of the broken ore is allowed to accumulate in the stope to provide a working platform for the miners and is thereafter withdrawn from the stope through chutes.

**d. Sublevel stoping** differs from shrinkage stoping by providing sublevels from which vertical slices are blasted. In this manner,the stope is mined horizontally from one end to the other. Shrinkage stoping is more suitable than sublevel stoping for stronger ore and weaker wall rock.

**20. Supported mining methods** are often used in mines with weak rock structure.

**a. Cut-and-fill stoping** is the most common of these methods and is used primarily in steeply dipping metal deposits. The cut-and-fill method is practiced both in the overhand (upward) and in the underhand (downward) directions. As each horizontal slice is taken, the voids are filled with a variety of fill types to support the walls. The fill can be rock waste,tailings, cemented tailings, or other suitable materials. Cut-and-fill mining is one of the more popular methods used for vein deposits.

**b. Square-set stoping** also involves backfilling mine voids; however,it relies mainly on timber sets to support the walls during mining. An underground mining method used in steeply dipping orebodies, under difficult wall rock conditions. Once the ore has been drilled and blasted, the stope is supported with large square timber sets that provide the platform for the next cycle.

**c. Stull stoping** is a supported mining method using timber or rock bolts in tabular,pitching ore bodies. It is one of the methods that can be applied to ore bodies that have dips between 10° and 45°. It often utilizes artificial pillars of waste to support the roof.

**21. Caving Methods:**

Caving methods are varied and versatile and involve caving the ore and/or the overlying rock. Subsidence of the surface normally occurs afterward.

**a. Longwall mining** is a caving method particularly well adapted to horizontal seams, usually coal, at some depth. In this method, a face of considerable length (a long face or wall) is maintained, and as the mining progresses, the overlying strata are caved, thus promoting the breakage of the coal itself.

**b. A different method, sublevel caving**,is employed for a dipping tabular or massive deposit. As mining progresses downward, each new level is caved into the mine openings, with the ore materials being recovered while the rock remains behind.

**c. Block caving** is a large-scale or bulk mining method that is highly productive, low in cost, and used primarily on massive deposits that must be mined underground. It is most applicable to weak or moderately strong ore bodies that readily break up when caved. Both block caving and longwall mining are widely used because of their high productivity.

**22. Reclamation**

The final stage in the operation of most mines is reclamation. It is the process of closing a mine and recontouring, revegetating, and restoring the water and land values. The best time to begin the reclamation process of a mine is before the first excavations are initiated. In planning for the reclamation of any given mine, there are many concerns that must be addressed.

The first of these is the safety of the mine site, particularly if the area is open to the general public. The removal of office buildings, processing facilities, transportation equipment, utilities, and other surface structures must generally be accomplished. The mining company is then required to seal all mine shafts,adits, and other openings that may present physical hazards.

Any existing highwalls or other geologic structures may require mitigation to prevent injuries or death due to geologic failures. The second major issue to be addressed during reclamation of a mine site is restoration of the land surface,the water quality, and the waste disposal areas so that long-term water pollution,soil erosion,dust generation,or vegetation problems do not occur. The restoration of native plants is often a very important part of this process.

**23. Environmental problems**

Mining is commonly associated with a variety of environmental problems including water pollution, radioactive tailings, erosion, sinkholes, biodiversity loss, and soil contamination . Additionally, groundwater and surface water can be contaminated by chemicals from processing and/or leakage. Mine workers are potentially subject to dangerous conditions, including exposure to hazardous gases, radioactivity exposure, loss of power (in particular in underground mines), collapsing tunnels, dust inhalation and toxic runoff.

**24. Safe Mining:**

In recent decades another factor has been a growing awareness of the adverse environmental and ecological impacts of mining. Unexpected geological conditions during the mining process can threaten worker safety and may decrease productivity. The precautionary steps of mining extraction technology include the invention of the safety lamp, and safe use of dynamite for fragmentation, the safe use of electricity, the development of continuous miners for cutting coal, the invention of rock bolts for ground support, open-pit mining.

**25. Today's Mining Operations**:

As mining progresses to greater depths the increase in rock stress requires innovative designs for ensuring the short-term and long-term stability of the mine structure. Continuous mining requires innovative fragmentation and material-handling systems. In addition, sensing, analyzing, and communicating data and information are also important. Mining environments pose unique challenges to the design and operation of equipment. Since mining is composed of a large number of heavy and mechanical components, mining systems must be extremely reliable.

Geological problems encountered in mining can include local thinning or thickening of the deposit, the loss of the deposit itself, unexpected dikes and faults, and intersections of gas and water reservoirs. Even with detailed advanced exploration at closely spaced intervals, mining operations have been affected by many problems, such as gas outbursts, water inundations, dangerous strata conditions, and severe operational problems, that can result in injuries to personnel, as well as major losses of equipment and decreases in production.

**26. Conclusion:**

The mining method selected for exploitation is determined mainly by the characteristics of the mineral deposit and the limits imposed by safety, technology, environmental concerns, and economics. The major Factors that will determine the mining operation are deposit occurrence, physical and mechanical properties of minerals and barren country rocks. It varies for metallic/ non-metallic/ others. There are significant differences in the mining techniques and environmental effects of mining metallic, industrial, and fuel minerals. Safety is a major consideration in mining operations.