



Mining Operation: An Introduction and Overview

Bidesh Gazi

M.A. in Environmental Studies, Rabindra Bharati University, Salt Lake City, Sector-II, Kolkata, West Bengal, Pin-700091

Abstract:

The term mining operation consists of seven elements like, mining activities, connected activities at a local site, constructing a site for mining activities or connected activities at a local site, activities to close, make safe or decommission a mineral extraction site or a mineral exploration site, educational or tourist activities in connection with mining activities at a local site or in connection with former mining activities at the same site, activities specified by the Minister in the Gazette and the activities prescribed by the regulations. The objectives of the present study were to explain the types of mines & mining techniques, identify the types of drilling & drilling mechanism, explore the instruments used for drilling & mining process and explain the process of mine exploration. The study was a review-based exploration. Secondary data have been used for this study. Information has been collected from the existing research papers, academic news, reviews available on websites and journals. From this study it was concluded that this attempts connects the research gap in the literature and boost the learners to develop more realistic and comprehensive knowledge on different aspects of mining operations.

Keywords: Mining operation, mining techniques, mine exploration, drilling, instruments.

Introduction:

Mining is the process of excavating ore minerals along with minimum waste rocks from Earth's crust for the benefit of human kind. The activities consist of handling loose ground, drilling and blasting of hard rocks, removal of broken materials from the workplace, and supporting the ground for safe operations. Various mining methods are available to exploit different types of deposits. According to Khayal & Elagab (2022), "Mining is the extraction of valuable minerals or other geological materials from the Earth, usually from an ore body, lode, vein, seam, reef, or placer deposit. These deposits form a mineralized commodity that is of economic interest to the miner". The term mining operation consists of seven elements like, mining activities, connected activities at a local site, constructing a site for mining

activities or connected activities at a local site, activities to close, make safe or decommission a mineral extraction site or a mineral exploration site, educational or tourist activities in connection with mining activities at a local site or in connection with former mining activities at the same site, activities specified by the Minister in the Gazette and the activities prescribed by the regulations. Mining process includes combinations of estimating, drilling, blasting, excavating, hoisting, crushing and hauling, as well as measures for quality control, health and safety, financial risks and environmental impacts (Kozan & Liu, 2011).

Objectives of the study:

The objectives of the study were:

- To explain the types of mines & mining techniques
- To identify the types of drilling & drilling mechanism
- To explore the instruments used for drilling and mining process
- To explain the process of mine exploration

Methodology:

- ❑ Type of Study: Review-based exploration
- ❑ Secondary data have been used for this study. Information has been collected from the existing research papers, academic news, reviews available on websites and journals.

❖ Types of mines & mining techniques:

➤ Types of mines:

Mines can be divided into two common types- Surface mining or open pit mining and underground mining or close pit mining.

- Surface mining is done by removing surface vegetation, dirt and if necessary, layers of bedrock in order to reach the buried ore deposits. In this technique bench, haul road, ramp is constructed to move the ore minerals from their source area to sorting yard, ore beneficiation plant by maintaining the inter ramp slope angle, overall slope angle. Here each bench has particular height and width depending upon some factor like carrying cost reduction and other safety factors. In general, most of the iron ores are excavated using this process.

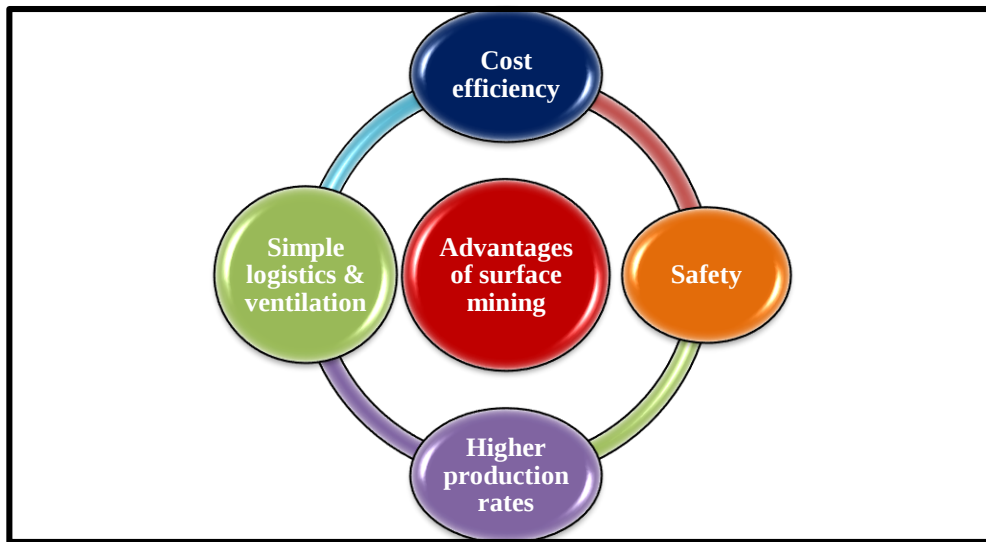


Fig. 1: Advantages of surface mining

- Underground mining consists of digging tunnels or shafts into the earth to reach buried ore deposits. Ore for processing and gangue for disposal are brought to the surface through tunnels and shafts. Underground mining can be classified on the basis of access of shafts, extraction method or the technique used to reach the ore deposit. During this industrial visit we observed Open cast mining. It helped us to understand the detailed information about open- cast mining.

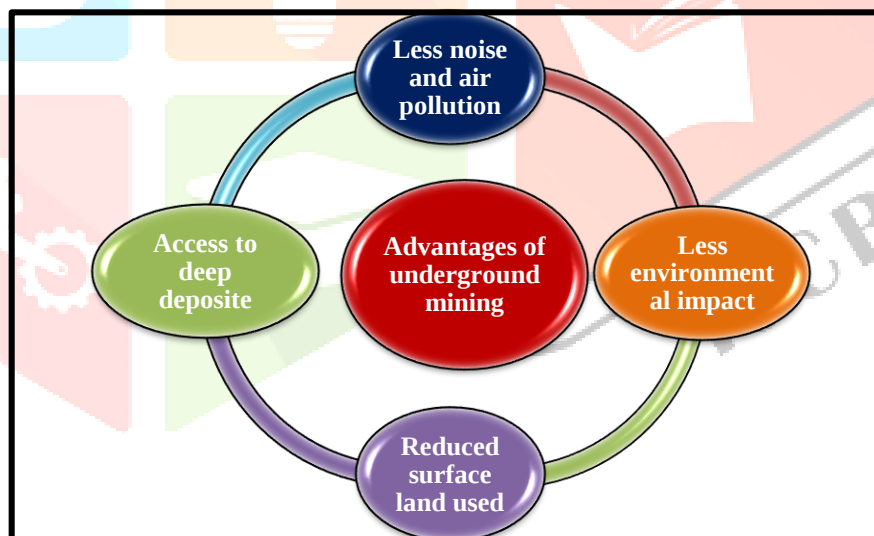


Fig. 2: Advantages of underground mining

➤ Mining techniques:

The excavation process is mainly done by Bench & cut method.

Open-cast mines are dug on benches, which describe vertical levels of the hole. The interval of the benches depends on the deposit being mined, the mineral being mined, and the size of the machinery that is being used. Generally, large mine benches are 12 to 15 meters thick. In contrast, many quarries do not use benches, as they are usually shallow.

Mining can be conducted on more than one bench at a time, and access to different benches is done with a system of ramps. The width of each bench is determined by the size of the equipment being used, generally 20–40 meters wide. Most walls of the pit are generally mined on an angle less than vertical. Waste rock is stripped when the pit becomes deeper, therefore this angle is a safety precaution to prevent and minimize damage and danger from rock falls. The walls are stepped. The inclined section of the wall is known as the batter, and the flat part of the step is known as the bench or berm. The steps in the walls help prevent rock falls continuing down the entire face of the wall. In some instances, additional ground support is required and rock bolts, cable bolts and shotcrete are used (Altit, Rawashdeh & Alnawafleh, 2021).

❖ **Types of drilling & drilling mechanism:**

➤ **Types of drilling:**

Drilling could be rotary or percussion type. There are mainly two board types of exploration drilling done namely- conventional drilling and wire-line drilling.

- **Conventional Drilling** - In this type of drilling, the core is lifted after every 3m of hole have been drilled. For this, the whole barrel is lifted each time; this reduces the efficiency of the process.
- **Wire-Line Drilling**- Wire-line core drilling is special kind of drilling process that allows the core barrel to be removed from the base of the hole without taking out the drill rod. With Wireline coring, the drill rod only has to be with drawn up to the surface when the drill bit needs to be changed.

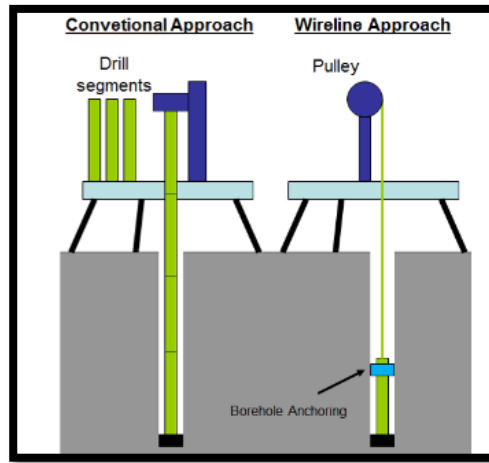


Fig.3: Conventional drill approach and Wireline drill approach (Paulsen et al. 2013)

➤ Drilling mechanism:

Rotary drilling is used to form a deep observation borehole or for obtaining representative samples of rock. The drilling method involves a powered rotary cutting head on the end of a shaft, driven into the ground as it rotates. The system requires lubrication (air, water or drilling mud) to keep the cutting head cool. Diamond core drilling utilizes an annular diamond impregnated drill bit attached to the end of hollow drill rods to cut a cylindrical core of solid rock. Diamond drilling is much slower than reverse circulation. (Bagirov & Aliyer, 2022; Amadike et al. 2024).

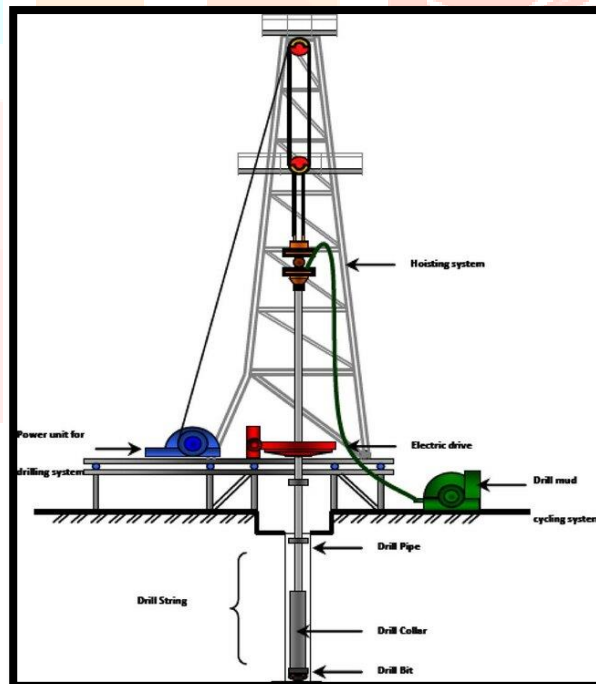


Fig. 4: Schematic diagram of rotary drill (Mansour, 2009)

❖ Instruments used for drilling & mining:

The different types of instruments used for drilling & mining are as follows (Messaoud, 2006; Kirmanli & Ercelebi, 2009; Orpen, 2018; Amadike et al. 2024):

- **Drill Bits:** A drill bit is a tool designed to produce a generally cylindrical hole (wellbore) in the earth's crust by the rotary drilling method for the discovery and extraction of hydrocarbons such as crude oil and natural gas.
- **Reaming Shell:** A Reaming Shell typically sits just above the drill bit and helps maintain hole diameter, reducing the possibility of stuck tubes down the hole. It also acts as a stabilizer for the drill string at the bottom of the hole to prevent vibrations during drilling.
- **Core Lifter:** Core Lifters are used to break off the core sample at the end of a core run and then to retain the sample within the core barrel to the surface. They are used together with a Core Lifer Case and are available in several different types to suit ground conditions.
- **Core-Lifter case:** The core lifter case is essential when it is time to break the core sample. Its tapered interior prevents the core lifter from moving and allows it to keep its grip on the core sample.
- **Core barrel:** Core barrel is the complete drilling tool assembly; it's the part of machinery used for drilling extremely hard formations like mineral site or water well with rock bottom. Two types of core barrel are used: chrome barrel and iron barrel.
- **Hoisting plug:** A hoisting plug is the appropriate tool to set the rods in their drilling position and to help extracting the drill string. On its upper part (Hoist) is fitted to the rig main winch cable and in its lower part (Thread) to the rod to be placed or extracted from the hole.
- **Water swivel:** A device connecting the water hose to the drill-rod string and designed to permit the drill string to be rotated in the borehole while water is pumped into it to create the circulation needed to cool the bit and remove the cuttings produced.
- **Rock-roller bit:** A rock-roller bit is a drill bit used for drilling through rock, for example when drilling for oil and gas.

The various types of instruments used during mining are as follows:

- **Excavator:** Excavator is a self-propelled machine, on tires or tracks, with a structure capable of rotating at least 360 ° (in one direction or in another, and without interruption) that excavates land, or load, lift, rotate and unloads materials by the action of the spoon, fixed to a set formed by boom and arm or rocker arm, without the supporting structure or chassis moving.
- **Bulldozer:** Bulldozer is mainly used for earthmoving, digging and pushing other machines. Although the blade allows a vertical movement of elevation, with this machine it is not possible to load materials on trucks or hoppers, so the movement of the earth is done by dragging.
- **Dump truck:** Dump trucks are heavy machinery used to transport large volumes of loose materials such as dirt, sand, ores, gravel, and demolition waste across mining, civil or major construction sites. If your next construction or mining project requires the transportation of loose material, chances are

you're going to need a dump truck. The two most popular dump trucks for hire include rigid rear dump trucks and articulated dump trucks.

- **Conveyor belt:** A conveyor belt is a central aspect of to a successful mining operation. Used to transport material which is too bulky or heavy to be carried long distances, its importance can often be overlooked on mine sites.
- **Drill rigs:** Drill rigs are mining vehicles that drill holes into the surface of a coal bed that explosives can be inserted into and detonated. These vehicles are modular, meaning they can be disassembled, transported, and reassembled with ease.
- **Vibratory separator:** A Vibratory separator enables for powders and granules to separate products from two up to five different sizes or fractions. The Vibratory separator is equipped with one to up to four different aperture size of the mesh on top of each other.

❖ **Process of mine exploration:**

The various stages through which a mine is created are as follows (International Environmental Law Research Centre, 2015; Singh, 2015):

• **Reconnaissance (G4):**

Reconnaissance is grass roots exploration for identifying the existence of mineral potential or initial targets on a regional scale. Activities incorporate remote sensing, airborne and ground geophysical survey, regional geological overview, geological mapping on 1:250,000 and 1:50,000 scales, geo chemical survey by chip sampling of rocks and weathered profiles, and limited scouting, reverse circulation, diamond drilling to identify the possible extent of mineralization.

• **Prospecting (G3):**

Prospecting is the systematic process of searching promising mineral targets identified during reconnaissance. Activities include mapping on a 1: 50,000 and 1:25,000 scale, linking maps with a Universal Transversal Mercator (UTM), lithology, structure, surface signature, analysis of history of mining, if it exists, ground geophysics, geochemical orientation survey, sampling of rock of background and anomaly area, pitting, reverse circulation and diamond drilling at a 100-1000 m section at one level depending on mineral type, core sampling, petro graphic and mineral graphic studies, borehole geophysical logging, and baseline environment.

• **General exploration (G2):**

General exploration is the initial delineation of an identified deposit. Methods include mapping on a 1:25,000, 1:5000, or larger scale for narrowing down the drill interval along the strike (100-400 m) and depth (50-100 m), detailed sampling of the core obtained and analysis of primary and secondary commodities, value added trace and deleterious penalty elements, analysis for quality control, borehole geophysical survey, bulk sampling for laboratory and bench-scale beneficiation tests, and recoveries and collection of geo-environmental base line parameters. The activity ends with preparation of broad order of economic or prefeasibility or scoping studies.

- **Detailed exploration (G1):**

Detailed exploration is conducted before the start of the mining phase or mine development. It involves three dimensional delineation to outline firm contacts of the ore body, rock quality designation (RQD) for mine stability, & planning and preparation of samples for pilot plant metallurgical test work. The works envisaged are mapping at 1:5000 and 1:1000 scales, close space diamond drilling (100*50, 50*50 m), borehole geophysics, a trial pit in case of surface mining, and sub surface entry with mine development at one or more levels in case of underground mining.

Conclusion:

This study presented a comprehensive view of types of mines & mining techniques, identify the types of drilling & drilling mechanism, explore the instruments used for drilling & mining process and explain the process of mine exploration. From this study it was concluded that this study connects the research gap in the literature and boost the learners to develop more realistic and comprehensive knowledge on different aspects of mining operations.

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