



**SCMS**

# 1. Introduction to the Mining Industry

Unit 1.1 - Introduction to Mining Sector

Unit 1.2 - Basic knowledge about Mining

Unit 1.3 - Mining Equipments

Unit 1.4- Duties and Responsibilities of a Mine Welder



## Key Learning Outcomes

**At the end of this module, you will be able to:**

1. Explain the key features of the Indian mining sector
2. Discuss various mining methods
3. Discuss the various phases and types of mining
4. List the various mining equipment and the precautions necessary to use them
5. Explain some basic electrical concepts
6. List the duties, responsibilities and key competencies of a Mine Welder

## UNIT 1.1: Introduction to Mining Sector

### Unit Objectives

**At the end of this unit, you will be able to:**

1. Describe the mining industry in India
2. Describe the growth expected in the mining industry
3. Explain the various kinds of minerals available in various parts of India
4. Describe the key workforce requirement in the mining sector
5. List various mining acts, legislation and key bodies in India

### 1.1.1 The Mining Industry

Minerals are valuable natural resources. They are available in limited quantities on Earth. They provide the raw materials for many basic industries and are a major resource for our development.

Mining and mineral extraction in India go back to ancient times. The wide availability of the minerals in India in the form of abundant rich reserves made it very conducive for the growth and development of the mining sector in India. The following shows mining operations in progress.



*Fig. 1.1.1. A View of Mining Operations*

India has huge resources of many metallic and non-metallic minerals and mining remained a key sector since India's independence. India produces as many as 87 minerals, including:

- 4 Fuel
- 10 metallic minerals
- 47 non-metallic minerals
- 3 atomic minerals
- 23 minor minerals (including building and other materials)

### 1.1.2 Growth of the Mining Industry

Overall, mineral production in India has been growing. The Indian Mining sector registered a growth of 2.6% during the 9 year period 2004-05 to 2013-14 and contributed approximately 1.9% (1.07 lakh crore) to the national GDP.

The Indian mining industry is characterized by a large number of small operational mines. These include mines for mineral production, minor minerals, petroleum (Crude), natural gas and atomic minerals and others. The states which have the most number of mines includes the following as shown in the following figures:

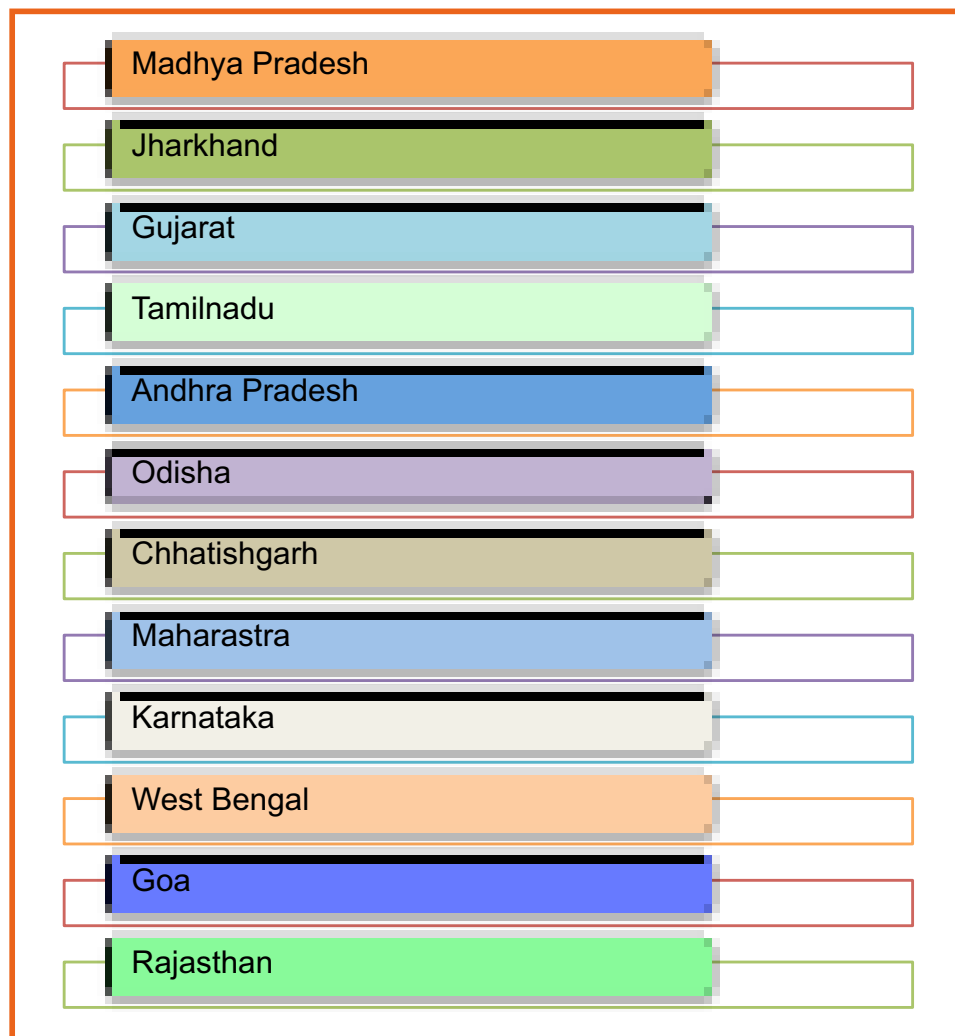


Fig. 1.1.2. The key mining states in India

These 12 states together accounted for 95% of total number of mines in the country in 2015-16.

The major strength of the mining sector in India include following:

1. Vast availability of mineral deposit: India currently produces 89 minerals
2. **High Production of mineral and metal together:** In 2012, India ranked 3rd in the world in production of coal, lignite and Chromite production, 5th in iron ore, 6th in Bauxite; in terms of metal production, the country ranked 3rd in Zinc (slab) and 4th in Steel (crude/liquid) Production.

3. **Self-sufficiency in key minerals for domestic consumption:** India is wholly self-sufficient in minerals such as Bauxite, Chromite, Limestone, Zinc etc.
4. **Beneficial Policy / regulatory frameworks for the mineral sector:** Various policies for exploration , mining, mineral processing and metallurgy for all non-fuel and atomic minerals encourage growth of the mining sector in India.
- 5 **Availability of financial incentives:** These include concessions on export profits from specified minerals and ores, which further encourage mining.

### 1.1.3 Minerals in India

The following figure indicates the key mines in India and their location in various states of India:

Mineral	States	Mineral	States	
Asbestos	Andhra Pradesh	Iron Ore	Andhra Pradesh	
	Odisha		Chattishgarh	
Bauxite	Chattishgarh		Goa	
	Goa		Jharkhand	
	Gujarat		Karnataka	
	Jharkhand		Kerala	
	Karnataka		Madhya Pradesh	
	Kerala		Maharashtra	
	Madhya Pradesh		Odisha	
Odisha	Rajasthan			
Tamilnadu	Lead & Zinc	Andhra Pradesh		
Chromite	Karnataka	Madhya Pradesh		
	Maharashtra	Odisha		
	Manipur	Rajasthan		
	Odisha	Maganese Ore		
	Copper Ore		Gujarat	Andhra Pradesh
Jharkhand			Goa	
Karnataka			Gujarat	
Madhya Pradesh			Karnataka	
Rajasthan			Madhya Pradesh	
Sikkim	Maharashtra			
Diamond	Madhya Pradesh		Odisha	
	Gold		Rajasthan	Rajasthan
			Andhra Pradesh	Ruby*
		Jharkhand	Odisha	
Karnataka		Sappire*	Jammu & Kashmir	
Rajasthan				

\* Precious Stone

Fig. 1.1.3. The key minerals in India

The Indian mining sector employed approximately 23.25 lakh people in 2011-12 across the organised and unorganised sector (including self-employed). The estimated demand in mining sector over the period 2014-22 is anticipated to be approximately 2.59 lakh people.

### 1.1.4 Mining Acts, Legislations and Bodies

The Government of India has multiple legal provisions and laws to protect the rights of mine workers and ensure proper mining processes and procedures.

#### 1.1.4.1 The Mines Act, 1952

The Mines Act, 1952 is a Central Government Act. The following figure shows the provision defined by the Mine Act, 1952:

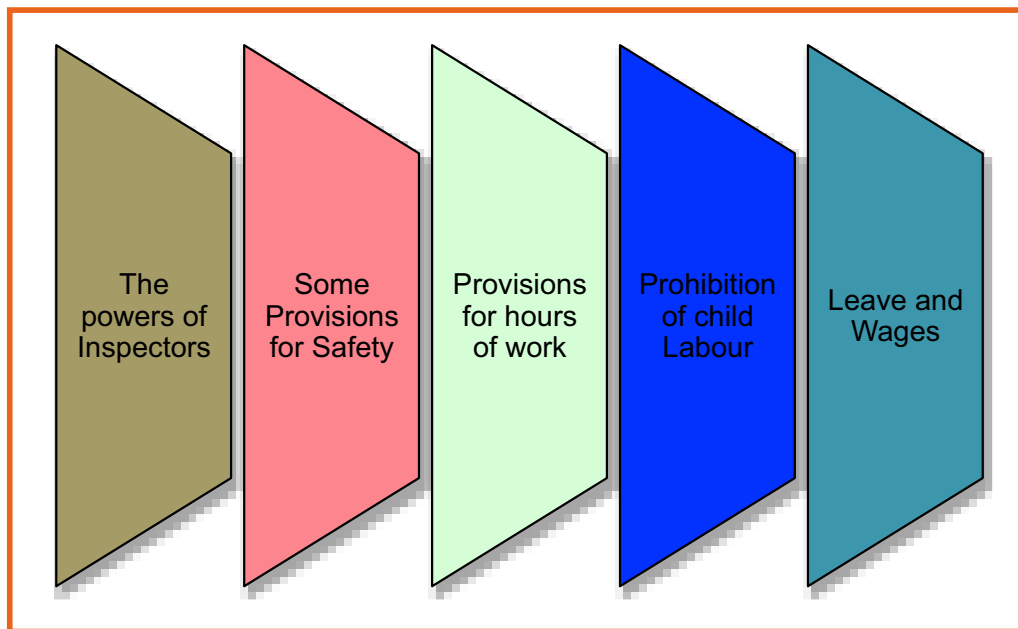


Fig. 1.1.4. Provisions in the mines act

The Mines Act {Section 2 (I)} defines a mine as “any excavation where any operation for the purpose of searching for or obtaining minerals has been or is being carried on and includes:

- i. all borings, bore holes, oil wells and accessory crude conditioning plants, including the pipe conveying mineral oil within the oilfields;
- ii. all shafts, in or adjacent to and belonging to a mine, where in the course of being sunk or not;
- iii. all levels and inclined planes in the course of being driven;
- iv. all opencast workings;
- v. all conveyors or aerial ropeways provided for the bringing into or removal from a mine of minerals or other articles or for the removal of refuse therefrom;
- vi. all adits, levels, planes, machinery works, railways, tramways and sidings in or adjacent to and belonging to a mine;
- vii. all Protective works being carried out in or adjacent to a mine;
- viii. all workshop and store situated within the precincts of a mine and the same management and used primarily for the purpose connected with that mine or a number of mines under the same management.

ix. all power stations, transformer sub-stations converter stations, rectifier stations and accumulator storage stations for supplying electricity solely or mainly for the purpose of working the mine or a number under the same management;

x. any premises for the time being used for depositing sand or other material for use in a mine or for depositing refuse from a mine or in which any operations in connection with such and refuse or other material is being carried on, being premises exclusively occupied by the owner of the mine.

### 1.1.4.2 Mine Rescue Rules

The mine Rescue rules, 1985 were framed in order to provide for rescue of worker in the event of explosion, fire etc. in mines. These apply to coal and metalliferous underground mines. The rescue Rules provide for the establishment of rescue stations and conduct of rescue work in mines affected by an explosion or fire, an inrush of water or influx of gases to operate under these conditions, services of specially trained men with special rescue apparatuses are required.

### 1.1.4.3 The Directorate General of Mines Safety (DGMS)

The Directorate General of Mines Safety, DGMS in short, is a Regulatory Agency under the Ministry of labour and employment, Government of India. The responsibility for enforcement of occupational safety, health provisions and welfare of workers in mines, as provided in the Mines Act with the Directorate General of Mines Safety (DGMS).

### 1.1.4.4 International Labour Organisation (ILO) and world Organisation (WHO) Standards

The ILO and WHO have a common definition of occupational health of employees. they recommend that organisations are required to provide a healthy, safe and secure working environment for the following causes as shown in the following figure:

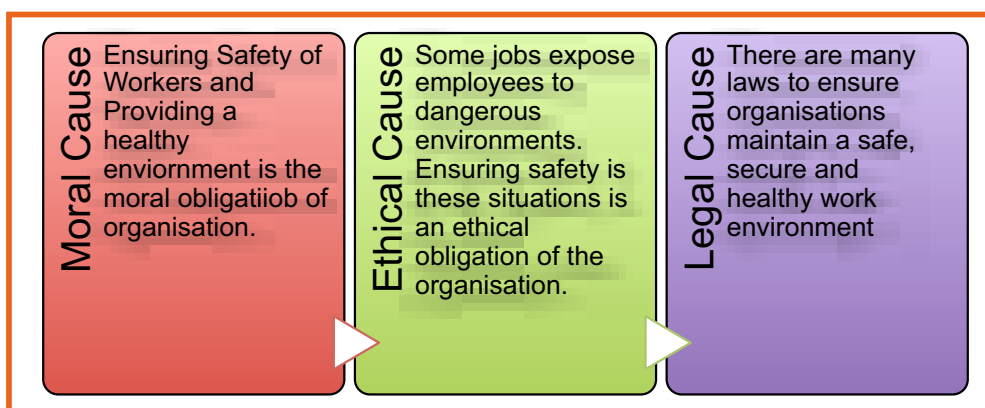


Fig. 1.1.4.4 Causes for organisations to ensure a safe and healthy work environment

The main focus in occupational health is in three different objectives:

1. The maintenance and promotion of worker's health and working capacity.
2. The improvement of working environment and work to become conducive to safety and health.
3. The development of work organisations and working cultures in direction which supports health and safety at work, and in doing so also promotes a positive social climate and smooth operations, and may enhance productivity of the undertakings.

Working culture here means a set of essential value systems adopted by an organisation to ensure a healthy and safe environment to its employees by improving its managerial systems, personnel policy, principles for participation, training policies and quality management systems.

#### **1.1.4.5 Indian Bureau of Mines (IBM)**

IBM is the principal governing agency responsible for compiling exploration data and mineral maps, and for providing latest information regarding mineral resources in India.

#### **1.1.4.6 The Department of Mines and Geology**

The Department of Mines is responsible for survey and exploration of all minerals (other than natural gas and petroleum) for mining and administration of the Mines and Minerals and (Development and Regulation) Act, 1957, in respect of all mines and minerals, other than coal, natural gas and petroleum.

#### **1.1.4.7 Geological Survey of India (GSI)**

The GSI is the key agency for assessment of geological and regional mineral resources in India. It was established in 1851.

#### **1.1.4.8 Central Mine Planning & Design Institute Limited**

Central Mine Planning & Design Institute Limited (CMPDI) is a Government of India enterprise having its corporate headquarters at Ranchi in India. It is fully owned subsidiary of Coal India Limited (CIL).

The function of CMPDI is the consultancy and support for mineral exploration, mining, infrastructure engineering, environmental management, and management systems, especially to the mineral, mining and allied sectors.



### 1.1.4.9 The Marble Development and Conversion Rules, 2002

These rules cover the conservation, systematic development and scientific mining to conserve the marble resources in India, and to provide a uniform framework for systematic and scientific exploitation of marble in India. It also provides provisions for employment in mines and adopting environment-friendly mining methods.

There are several other bodies and laws which ensure smooth operation of mining activities in India.

### 1.1.4.10 Skill Council for Mining (SCMS)

The Skill Council for Mining Sector (SCMS), promoted by the federation of Indian Mineral Industries (FIMI) and supported by Ministry of Mines, was established to develop skill competency standards and qualifications in Mining sector, benchmark it with national and international standards and to work with the mining industry.

SCMS aims at training and up-skilling approximately 4.50 lakh people for mining industry including 50 thousand new inductees to make them employable within a period of 10 years.

## UNIT 1.2: Basic knowledge about mining

### 1.1.2 Mining Basics

Let us get familiar with some basic terms:

- **Minerals:** Naturally occurring chemical elements. The following shows examples of minerals.

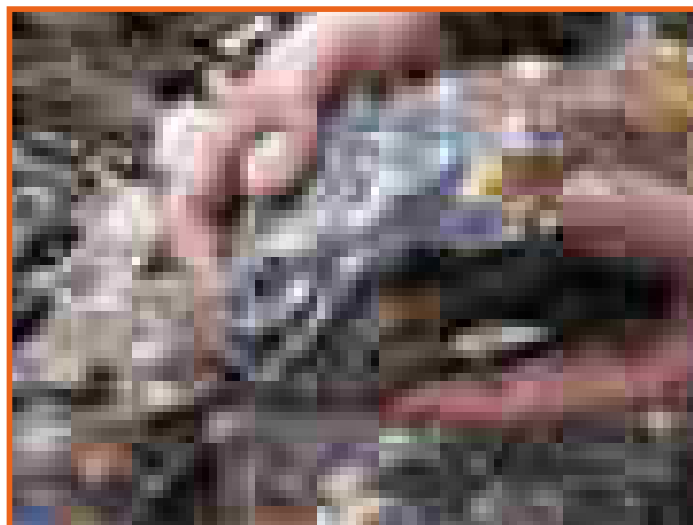
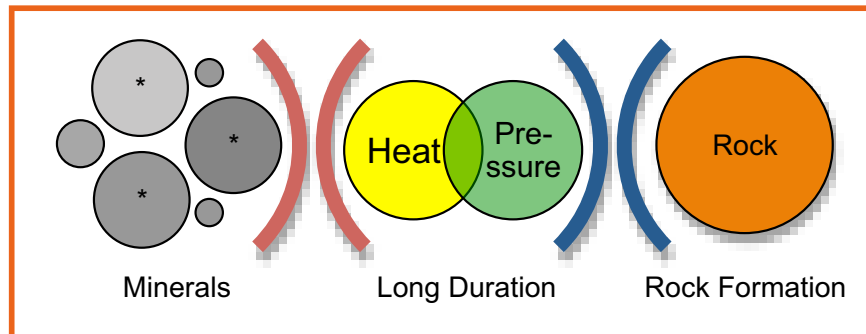


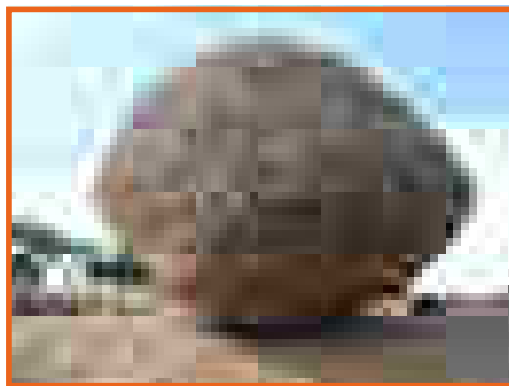
Fig. 1.1.2. Minerals

- **Rocks:** Compounds of minerals. The following shows the process of forming rocks.



*Fig. 1.2.2 Formation of rocks*

The following figure shows examples of rocks.



*Fig. 1.2.3 Example of Rock*

- **Ores:** Rocks containing minerals or metals which can be recovered and used as resources. The following shows the process of forming ores.

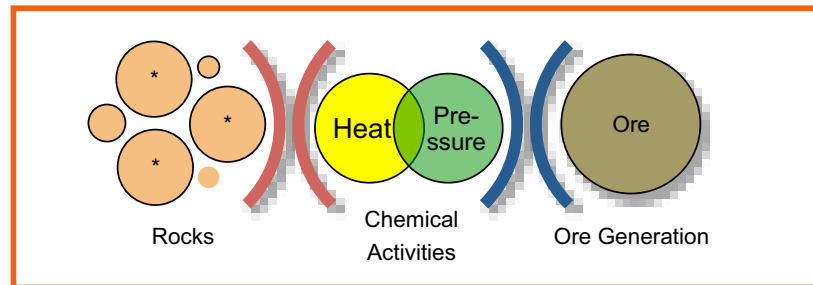


Fig. 1.2.4 Formation of ores

The following picture shows examples of ore.

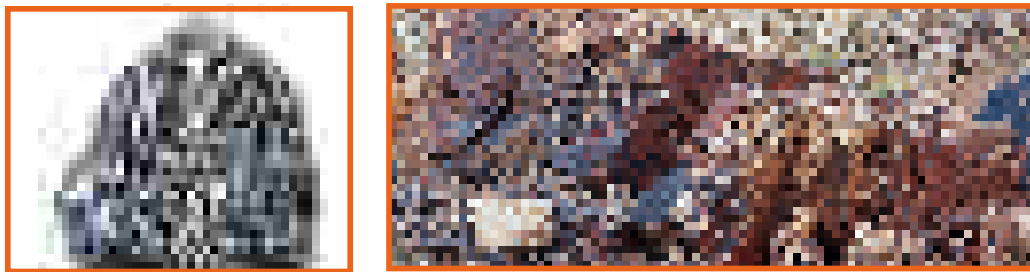
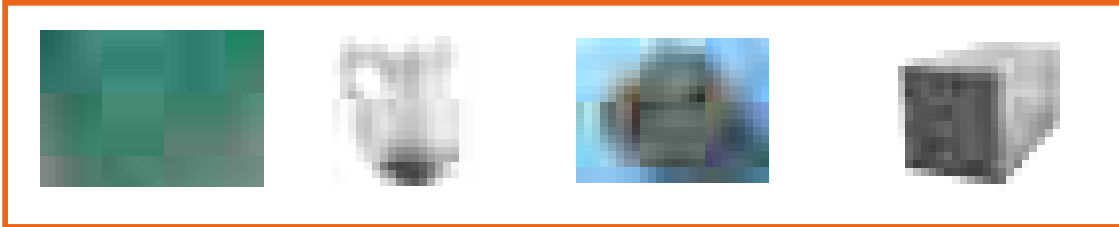


Fig. 1.2.5 Example of Ores

- **Artificial Minerals:** Created by people in industries. These are not technically minerals but are treated similarly during processing in factories. The following show some examples of artificial minerals.

Following figure show some examples of artificial minerals:



*Fig. 1.2.6 Example of artificial minerals*

## 1.2.2 Types of Mines

Mining operations can broadly fall under one of the below two categories:

- Surface Mining
- Underground Mining

### 1.2.2.1 Surface Mining

Surface mining is conducted on the surface of the ground. Surface mining can be of the following kinds:

#### **Open-Pit Mining**

Open-pit mining is a type of strip mining in which the ore deposit extends very deep in the ground. Here, the top layer of overburden is removed leaving a large pit to extract deposits such as coal. following picture shows an open-pit mine.



*Fig. 1.2.7 Open pit mine*

**Strip Mining**

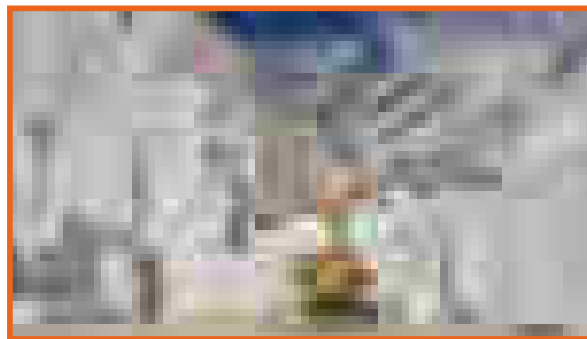
Here, the overburden is stripped and placed onto an area which has already been mined out. The following shows strip mining.



*Fig. 1.2.8 Strip mining*

**Quarrying/Cutting**

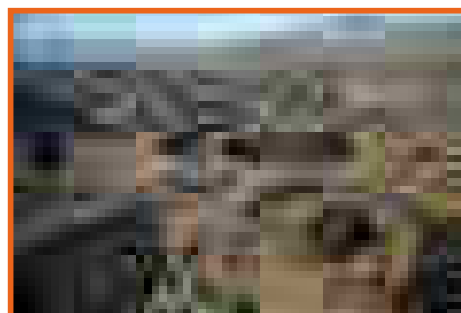
This is an open-pit mine to extract stones or rocks such as marble or granite. The following shows a quarry.



*Fig. 1.2.9 Quarry*

**Mountaintop Removal Mining**

This is the removing of overburden on a mountain-top to an adjacent valley. The following shows a mountaintop removal mining.



*Fig. 1.2.10 Mountain top removal mining*

**Placer Mining**

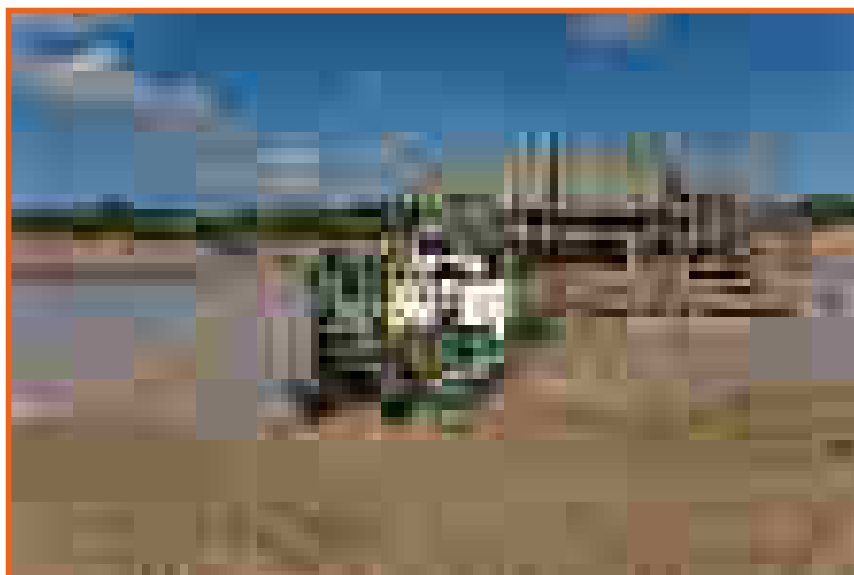
This is mining of river deposits for minerals. The following shows placer mining:



*Fig. 1.2.11 Placer mining*

**Dredging**

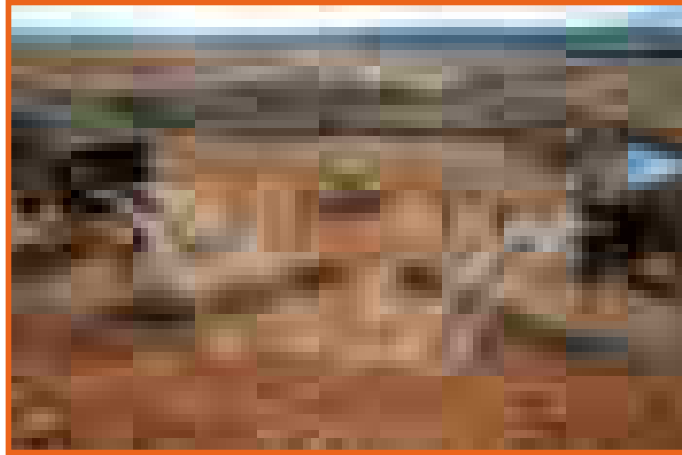
This is extracting minerals such as gold from sand, gravel, dirt using water and machines. The following shows dredging:



*Fig. 1.2.12 Dredging mining*

**Hydraulic Mining**

This is mining with high-pressure jets of water to remove rocks or sediment to mine minerals. The following shows hydraulic mining:



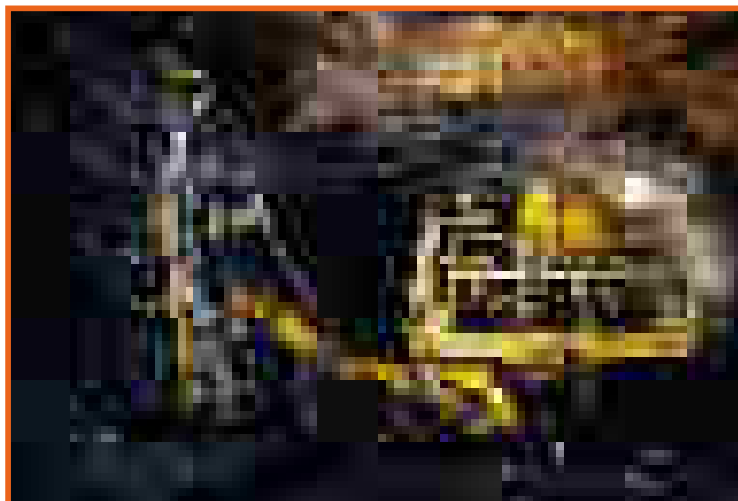
*Fig. 1.2.13 Hydraulic mining*

**1.2.2.2 Underground Mining**

This is mining for rocks under the ground. Underground mining can be of these types:

**Sub-Surface mining**

Here, mining is conducted underground. The following shows sub-surface mining:



*Fig. 1.2.14 Sub surface mining*

**Drift mining**

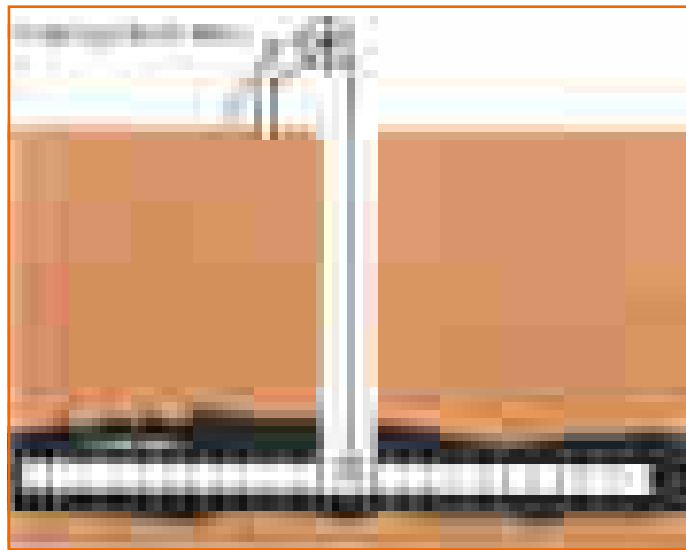
Here, mining is conducted horizontally underground. The following shows drift mining.



*Fig. 1.2.15 Drift mining*

**Shaft mining**

Here, mining is conducted vertically underground. The following picture shows shaft mining.



*Fig. 1.2.16 Shaft mining*

**Slope mining**

This is when shaft mining is done in a sloping way. The following picture shows slope mining.



*Fig. 1.2.17 Slope mining*



**Room and pillar**

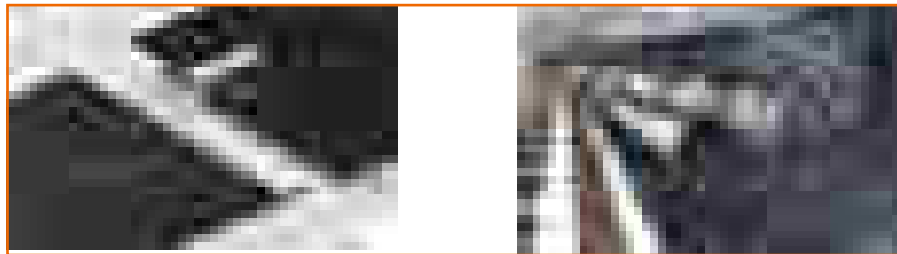
In this mining system, the mined material is extracted across a horizontal plane, creating horizontal sets of rooms supported by pillars. The following picture shows room and pillar mining.



*Fig. 1.2.18 Room and pillar mining*

**Longwall mining**

In this form of mining, a long wall of coal is mined in a single slice. The following Picture shows longwall mining.



*Fig. 1.2.19 Longwall mining*

### 1.2.3 Phases in Mining

A mining project is done in multiple phases, from locating an area with deposits that can be mined, to closing a mining area. The following shows the various phases in mining:

#### Exploration

- Determining volume of deposit
- Surveys
- Field studies
- Drilling test Boreholes
- Exploratory excavations

#### Development

- Construction of access road
- Site preparation and cleaning

#### Active Mining

- Open-pit mining
- Placer Mining
- Underground Mining
- Reworking of inactive or abandoned Mines

#### Disposal of Overburden and Waste Rock

- Removal of cover soil or rock for access to ores or deposits

#### Ore Extraction

- Use of Machinery
- Transportation of Ore

#### Beneficiation

- Grinding the ore and separating relevant metal from the other Material
- Milling Techniques
- Chemical Technique

#### Tailing Disposal

- Disposal of Waste or tailings
- Tailings pond
- Dry Tailing disposal
- Sub-marine trailing disposal

#### Site Reclamation

- Closing of mining facilities
- Restoration of pre-mining conditions

Fig. 1.2.20 Key phases in mining

### 1.2.3.1 Activities in Surface and Underground Mining



The following are the steps of mining operations in surface mining and underground mining:

#### **Surface mining-**

- 1- Site preparation
- 2- Mine Development
- 3- Ore Breakage / Overburden Removal
- 4- Drilling
- 5- Blasting
- 6- Excavating / Loading
- 7- Haulage
- 8- Beneficiation
- 9- Further Processing

#### **Underground Mining**

- 1- Site preparation
- 2- Mine Development
- 3- Room Pillar / Longwall technique for ore extraction
- 4- Ore Breakage (in Room Pillar) / Continue mining (Longwall)
- 5- Drilling
- 6- Blasting
- 7- Loading
- 8- Haulage
- 9- Beneficiation
- 10- Further Processing

### 1.2.4 Key Mining Terms and Definitions

You will frequently come across these words in the course of your training and also during your employment.

- **Abandoned mine:** A mining area that is sealed and deserted and where mining activities no longer take place
- **Air blast:** A strong rush of air in a mine, caused by an explosion. Can contain hazardous gases
- **Air shaft:** A vertical opening into a mine to let in air for ventilation
- **Airway:** Any passage in a mine through which air current can pass
- **Bedrock:** The hard rock found under river beds or alluvium deposits
- **Bench:** A horizontal section of coal seam separated by slate or formed during the process of cutting coal
- **Black damp:** Carbon dioxide gas which can be hazardous
- **Blasting:** The technique of breaking rock by making a hole in it, filling it with explosives and firing.
- **Bore hole:** A hole of small diameter drilled to explore the layer of rocks ahead
- **Brusher:** A mine worker who repairs the roofs, sides or floor of a passage in a mine
- **Cautionary Zone:** A zone in which the mineral deposit lies within a specific distance from any source of danger such as water
- **Chamber:** An underground excavation area from which coal or other deposit is mined
- **Choke damp:** Carbon monoxide and carbon dioxide, which can be hazardous gases
- **Colliery:** A coal mine
- **Crushing:** Operation on rocks post blasting to break the rocks
- **Cut:** A hole or groove excavated on the deposit to prepare for blasting
- **Detonator:** A device for initiating the explosive for blasting
- **Drilling:** Making holes in rocks
- **Face:** The exposed vertical part of rock
- **Loading:** Putting blasted material on trucks or conveyor belts for transportation to processing centre
- **Overburden:** The material above the mineral deposit that needs to be removed to reach the deposit
- **Rock faced:** The natural face of the rock
- **Rubble:** Irregular shaped stones
- **Shake:** A fracture that occurs across the surface of a rock and breaks it across the plane of cleavage
- **Vent:** A hole or gap which indicates a source of weakness in the stine
- **Water blast:** Explosion of water under pressure, which happens when trapped air expands as water level is lowered

### 1.2.4.1 Common Tools for Quarrying

Following are some common tools for quarrying :

- **Axe:** A tool with head of steel which is tapered on one or both ends, and fitted with a wooden handle
- **Boaster:** A broad-faced chisel for dressing a stone
- **Box trammel:** A tool for scribing parallel or circular lines
- **Bush hammer:** A tool with 4 to 10 thin blades of steel ground to an edge and bolted together on a handle
- **Chisel:** A steel tool with a plain shaft and a cutting edge
- **Circular saw:** A machine with a power-driven revolving steel disc for cutting stones
- **Dummy:** A mallet with a head made of lead or zinc to be used with wooden handled chisels
- **Fillet saw:** A small saw with adjustable handle
- **Pick:** A tool made of hard tempered steel tapered to a point at one or both ends, and fitted with a wooden handle
- **Splitter:** A hammer-headed tool 8 to 10 cm wide for cutting an edge
- **Tracer:** A large chisel for tracking a shallow groove along a series of holes for splitting a mass of rocks

## UNIT 1.3: Mining Equipments

### 1.3.1 Machine Used in Mines

Surface mining requires the use of a number of machines and tools. Following are some of the most important tools used.

#### 1.3.1.1 Diamond Wire Saw

A wire saw is a machine powered saw that uses diamond embedded beads on a metal wire to cut through stones. It uses continuous scratching or rubbing to cut hard stones into large blocks. The wire passes around a fly wheel and is carried on pulleys to the part of the quarry where the cutting is to be done.

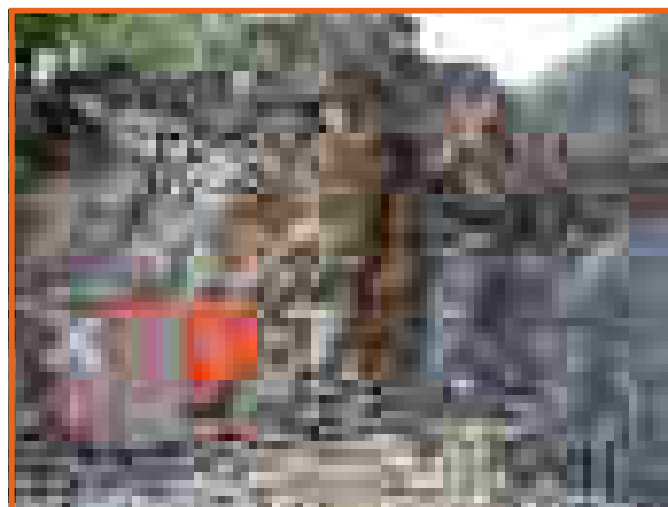


Fig. 1.3.1. A diamond wire saw

### 1.3.1.2 Air Compressor

In mines, air compressors are used as a source of electricity for powering drilling machines, conveyor belts or other machines. They are also used for supplying oxygen in underground mines. The following figure shows an air compressor.



Fig. 1.3.2. A Air Compressor

### 1.3.1.3 Jackhammer

This is an electrical tool that includes a hammer along with a chisel. With electricity the hammer strikes the chisel back and forth. Sometimes jackhammer also use compressed air supplied by an air compressor. The jackhammer is used for breaking rocks. The following figure shows a jackhammer.

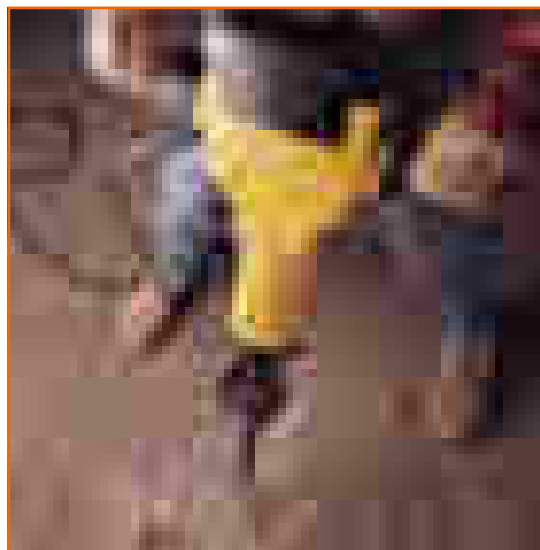


Fig. 1.3.3. A Jackhammer