

Lecture-1

Mine Development Operations, Methods and Procedure

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Content

What is mining

IMPORTANCE OF MINING

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What is mining

“Mining is the process of excavating minerals of economic values from the earth’s crust for benefit of mankind”.

There are various types of ore recovered by mining include metals, coal, limestone, bauxite etc.

Mining is the mother industry for other industries.



IMPORTANCE OF MINING

Mining is an important profession, because all most product used in modern homes require heavy minerals in some form or the other.

Mining is a money making business. Not only do mining companies prosper, but governments also make money from revenues. Workers also receive income and benefits.

Used For Metals and minerals

COAL BASED POWER GENERATION PLANT

Mine development

STAGES IN THE LIFE OF A MINE

1. Prospecting: 1-3 Years

Search for ore

a. Prospecting methods

Direct: Physical, geological

Indirect: Geophysical, geochemical

b. Locate favorable loci (maps, literature, old mines)

c. Air: Aerial photography, airborne geophysics, satellite
d. Surface: Ground geophysics, geology

e. Spot anomaly, analyze, evaluation



Mine development

STAGES IN THE LIFE OF A MINE

2. Exploration: 2-5 Years

Defining extent and value of ore (examination/evaluation)

- a.** Sample (drilling or excavation)
- b.** Estimate tonnage and grade
- c.** Valuate deposit: Present value = Income – Cost

Feasibility study: make decision to abandon or develop

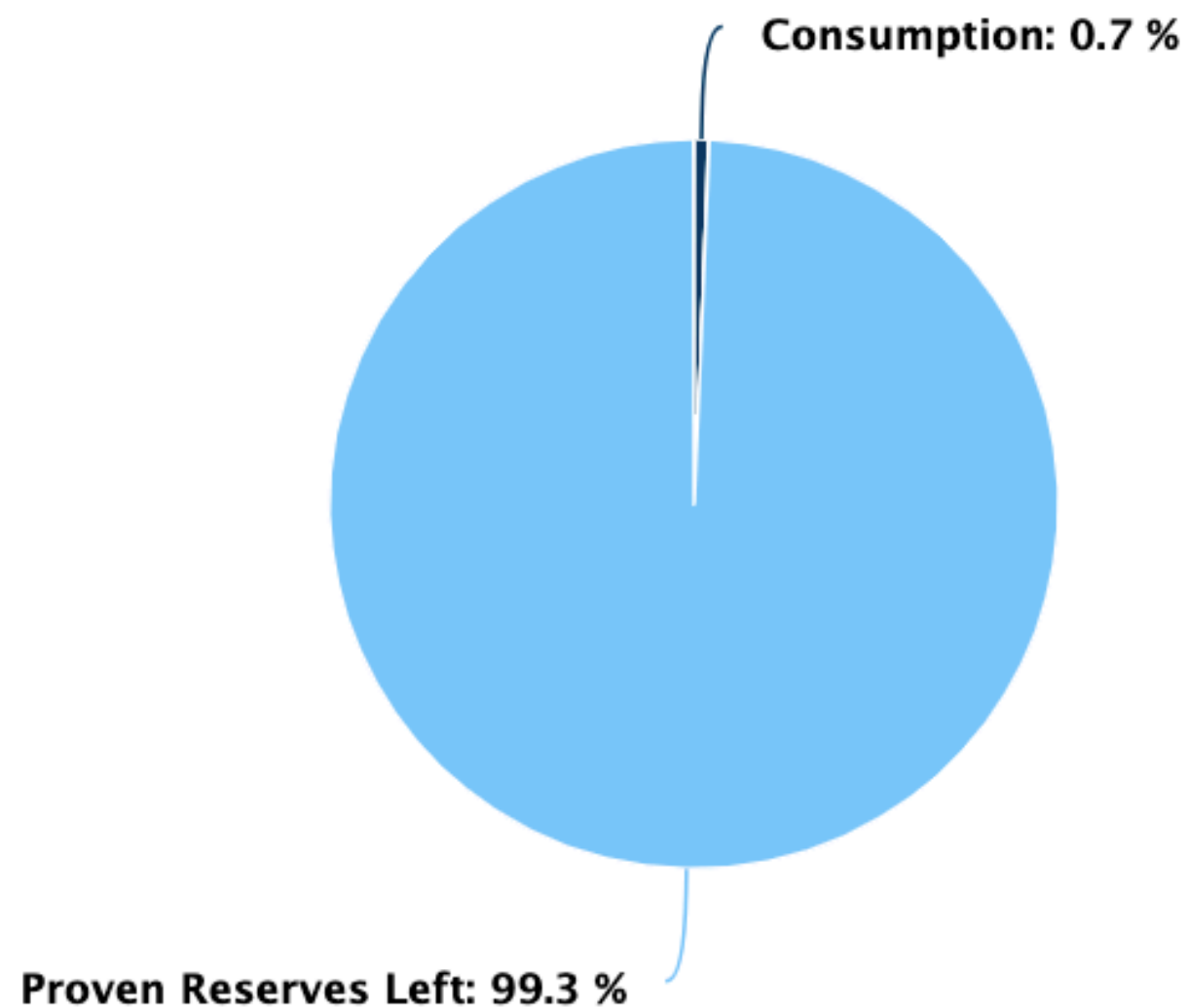


Bangladesh Coal Consumption and Production (tons)

Tons (short tons, "st")



Yearly Coal Production (Consumption + Net Exports) as share of Total Proven Reserves



Mine development

STAGES IN THE LIFE OF A MINE

3. Development: 2-5 Years

Opening up ore deposit for production

- a. Acquire mining rights (purchase or lease), if not done in stage 2
- b. File environmental impact statement, technology assessment, permit
- c. Construct access roads, transport system
- d. Locate surface plant, construct facilities
- e. Excavate deposit (strip or sink shaft).



Mine development

STAGES IN THE LIFE OF A MINE

4. Exploration: 10-30 Years

Large-scale production of ore

a. Factors to be considered: Geologic, geographic, economic, environmental, societal safety

b. Types of mining methods

Surface: Open pit, opencast etc.

Underground: Room and pillar, Cut & fill, Longwall, block caving

c. Monitor costs and economic payback



Mine development

STAGES IN THE LIFE OF A MINE

5. Reclamation: 1-10 Years

Restoration of site

- a. Removal of plant and buildings
- b. Reclamation of waste and tailings dumps
- c. Monitoring of discharges



Mine development

The process of constructing a **mining** facility and the infrastructure to support the facility is known as **mine development**. The term employed to designate the operations involved in preparing a mine for ore extraction.



Sinking- It's Actually *Shaft* sinking

Tunneling/Adit- Access to develop ways & infrastructures

Drifting & ramping- Connecting passage of one or more levels

Raising- A raise is a vertical or steeply-inclined opening, serve as a ladder way access to stopes, as an ore pass or as an airway in the mine's ventilation system.

Mine Operations

Mine operations is the process of managing many immediate and long-term activities in and around a mine site in order to facilitate the production of a mineral product.



A mine operation has five main activities:

1. Excavation of earth and rock
2. Processing and separate the ore from waste rock
3. Storage and maintenance of waste material
4. Environmental monitoring - air & water quality and noise levels
5. Operation of supporting services - repair shops, labs, living quarters, warehouses and offices

Mining Methods

Mining technique can be divided into two common excavation types-

❖ **Surface/Open-pit/Open-cast mining method**

Today, surface mining is much more common, and produces, for example, 85% of minerals (excluding petroleum and natural gas) in the United States, including 98% of metallic ores.

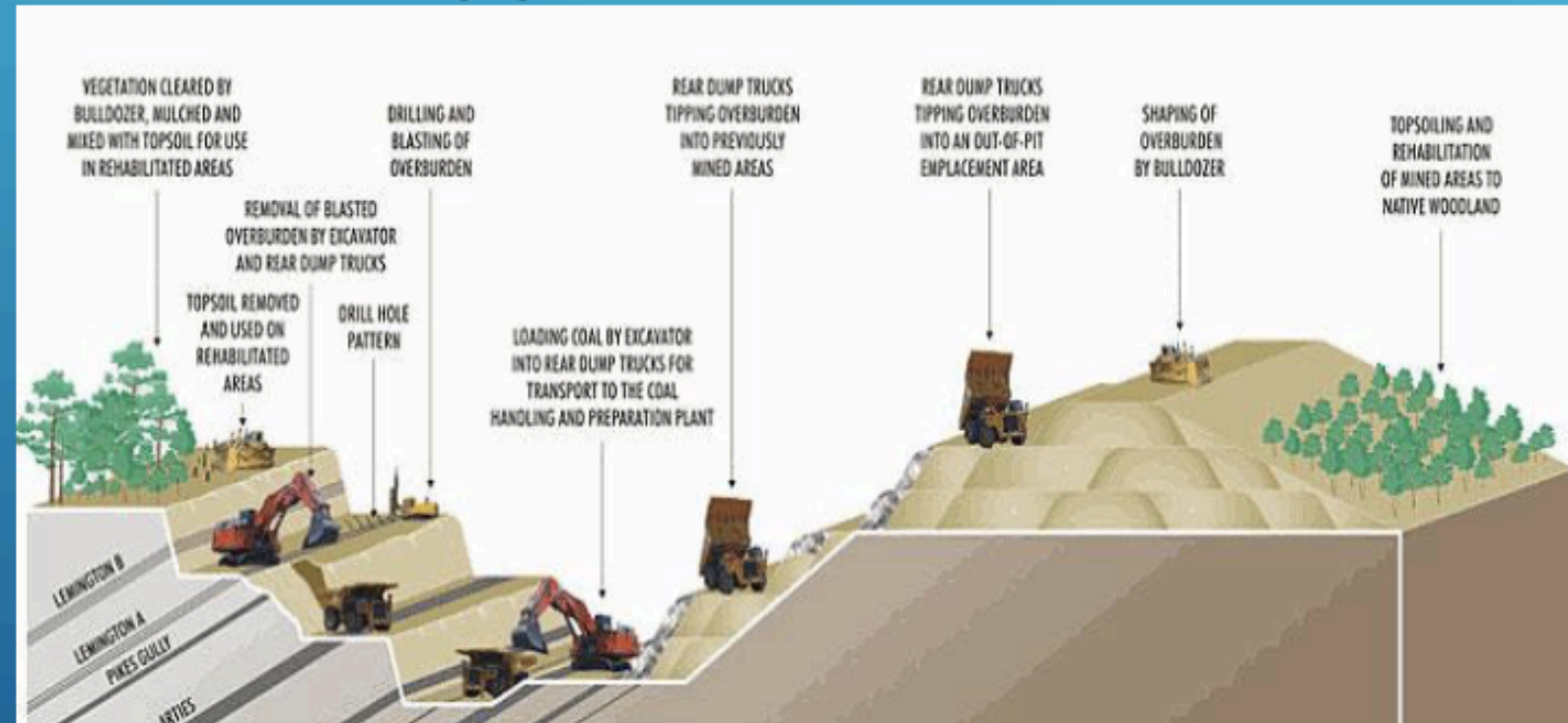
❖ **Sub-surface/Underground mining method**

But in Bangladesh we have only underground/sub-surface mine.



SURFACE MINING

A mine in which ore lies near surface and can be extracted by removing the covering layers of rock or soil. Almost all surface mining operations are exposed to the elements and require no roof support



SURFACE MINING METHODS

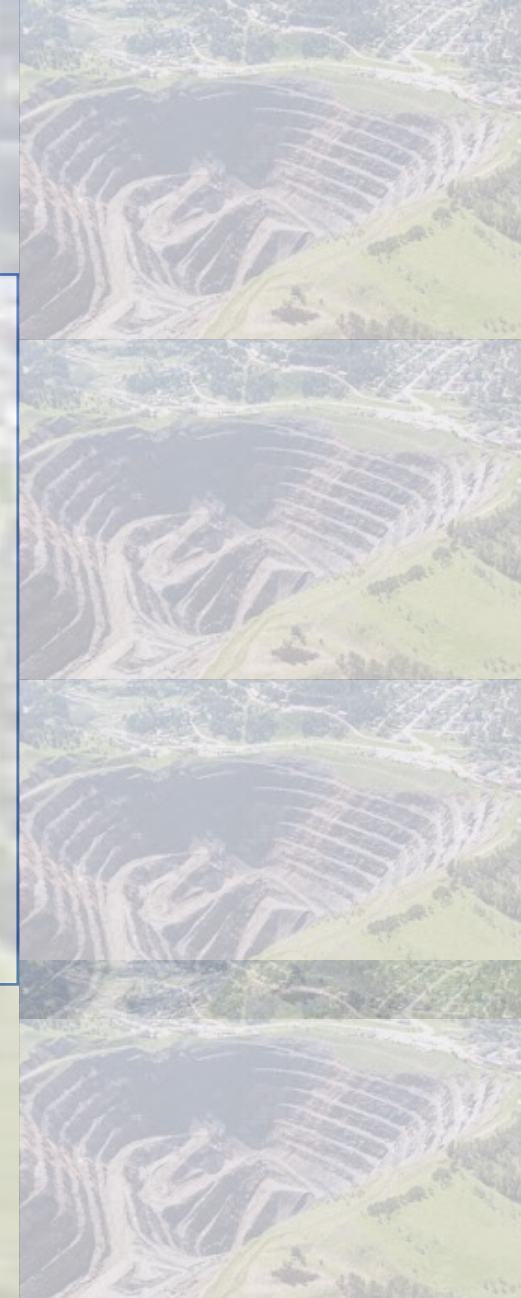
Some common surface mining methods are:

Open-pit : Reclamation after completion

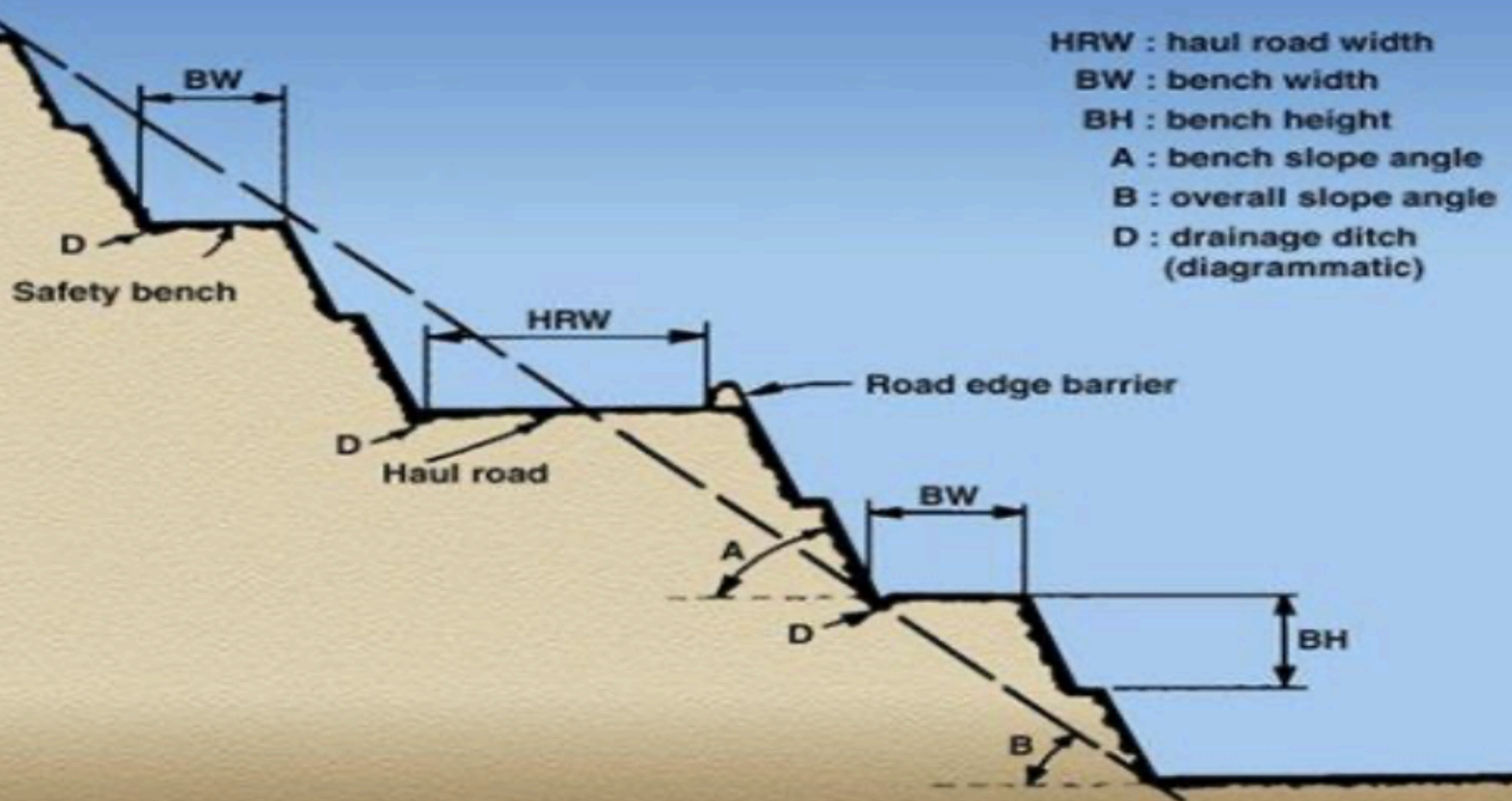
Open-cast : Reclamation during mining

Quarries : Stone, crushed rock, sand, gravel

Strip Mining : Removing surface (Overburden rock) in strips up to the resources



SURFACE MINING TERMINOLOGY



Outside Dump

**Typical Non-haul
Road bench**

**Typical
Bench Wall**

**Catch
Berm**

**Typical
Haul Road**

**Top of Main Ramp
Out of Open Pit**

**Drill rig Drilling Out
a New Pattern**

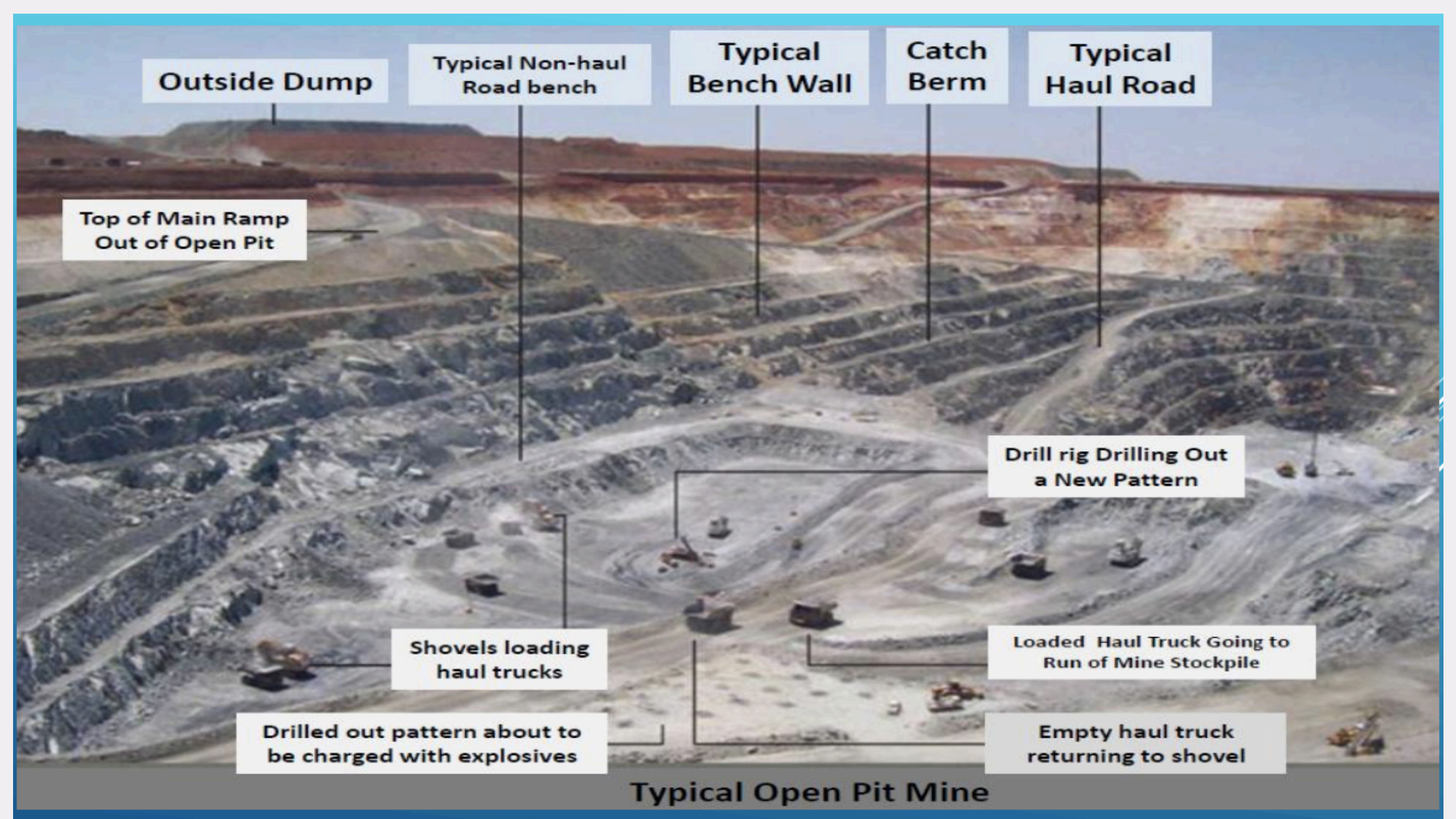
**Shovels loading
haul trucks**

**Loaded Haul Truck Going to
Run of Mine Stockpile**

**Drilled out pattern about to
be charged with explosives**

**Empty haul truck
returning to shovel**

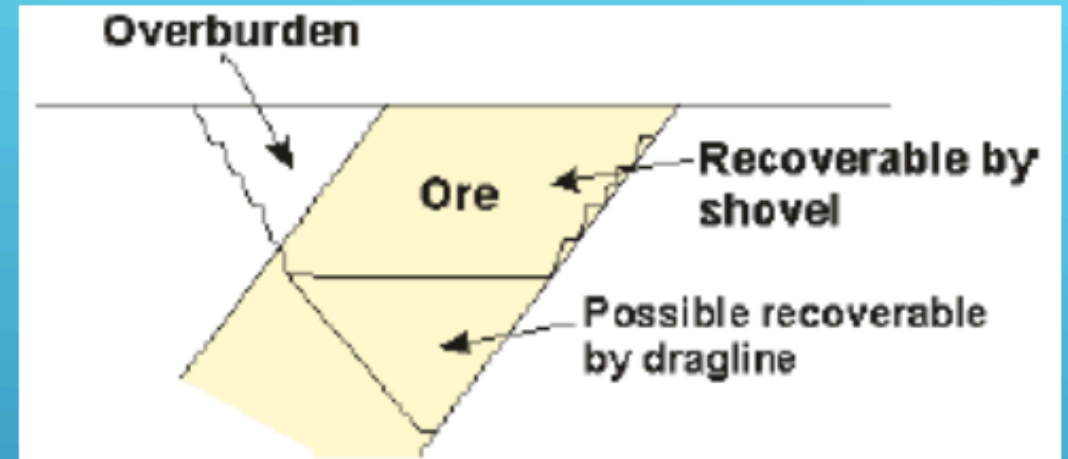
Typical Open Pit Mine



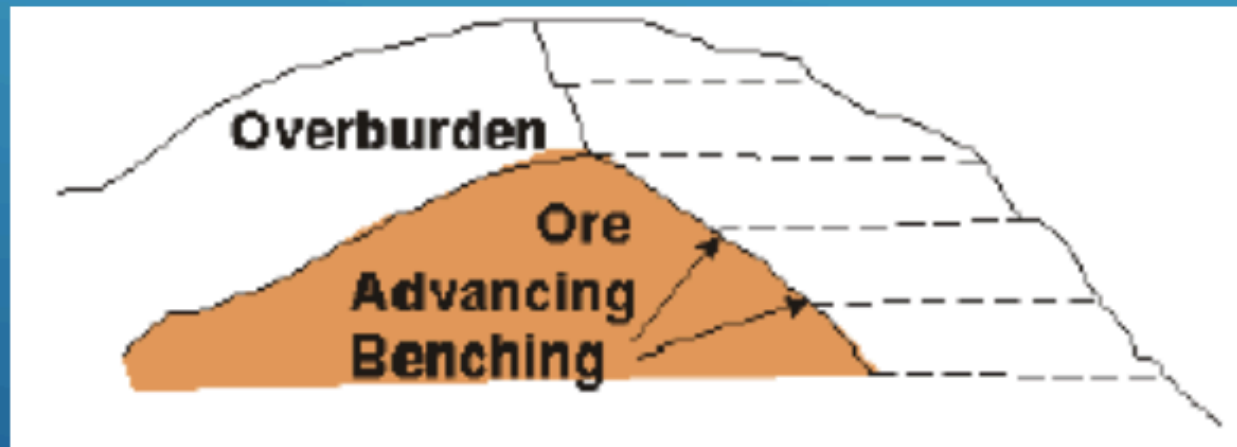
Various open-pit and orebody configuration:



Flat lying seam or bed, flat terrain



Dipping seam or bed, flat terrain



Thick bedded deposit, little overburden, flat terrain



Massive deposit, high relief

Methods for Underground Mining

Underground mining methods: There are different techniques/methods of underground mining methods and the choice is closely related to the Geology of the deposit and degree of ground support necessary to make the method productive and safe.

Methods based on extent of supports utilised

➤ Supported:



Methods based on extent of supports utilised

Unsupported



Methods based on extent of supports utilised

Caving



DIFFERENT TYPE OF UNDERGROUND MINING METHODS

Supported methods	Unsupported methods	Caving methods
1) Cut and fill stoping	1) Room-and-pillar mining	1) Longwall mining
2) Stull stoping	2) Stope-and-pillar mining	2) Sublevel caving
3) Square set stoping	3) Shrinkage stoping	3) Block Caving
	4) Sublevel stoping	

TABLE: METHODS FOR UNDERGROUND MINE

Underground methods	<i>Unsupported</i>				<i>Supported</i>		<i>Caving</i>		
Factor	<i>Room and Pillar</i>	<i>Stope and Pillar</i>	<i>Shrinkage Stoping</i>	<i>Sublevel Stoping</i>	<i>Cut and Fill Stoping</i>	<i>Square Set Stoping</i>	<i>Longwall Stoping</i>	<i>Sublevel Caving</i>	<i>Block Caving</i>
Ore strength	Weak / Moderate	Moderate/ Strong	Strong	Moderate/ Strong	Moderate/ Strong	Weak	Any	Moderate/ Strong	Weak/ Moderate
Rock strength	Moderate / Strong	Moderate/ Strong	Strong	Fairly Strong	Weak	Weak	Weak / Moderate	Weak	Weak / Moderate
Deposit shape	Tabular	Tabular / Lenticular	Tabular / Lenticular	Tabular / Lenticular	Tabular / Irregular	Any	Tabular	Tabular / Massive	Massive / Thick
Deposit dip	Low / Flat	Low / Moderate	Fairly Steep	Fairly Steep	Fairly Steep	Any	Low / Flat	Fairly Steep	Fairly Steep
Deposit size	Large / Thin	Any	Thin / Moderate.	Thick / Moderate	Thin / Moderate	Usually Small	Thin / Wide	Large Thick	Very Thick
Ore grade	Moderate	Low / Moderate	Fairly High	Moderate	Fairly high	High	Moderate	Moderate	Low
Ore uniformity	Uniform	Variable	Uniform	Uniform	Variable	Variable	Uniform	Moderate	Uniform
Depth	Shallow / Moderate	Shallow / Moderate	Shallow / Moderate	Moderate	Moderate / Deep	Deep	Moderate / Deep	Moderate	Moderate

METHODS AND PROCEDURE

Cut and Fill Stoping: This method is used in vertical stopes and in mining high-grade irregular ore bodies.

- The rock mass surrounding the ore deposit is usually weak
- Unable to support loads over an extended stoping height
- Successive cutting of the ore into horizontal slices is carried out starting from the bottom and progressing upwards towards the surface
- The ore is extracted in horizontal slices and replaced with backfill material
- The fill material varies, depending on the support required, and the material available

CUT AND FILL STOPING: (CONT.)

- ▶ It is one of the popular and expensive but selective mining method, with low ore loss and dilution
- ▶ Is done only in high grade minerals/resources (why)
- ▶ Ore is drilled, blasted and removed from stope
- ▶ The ore is mined in slices
- ▶ Voids are backfilled with a variety of fill type to support the walls ---rock waste, tailings, sand or other suitable materials

MINING PROCEDURE OF CUT AND FILL STOPING

- ❖ In cut and fill stoping, the orebody is retrieved in horizontal slices beginning at the very bottom and advancing upwards towards the surface.
- ❖ Ramps (inclined tunnels) are excavated to connect the surface to the underground ore body.
- ❖ Drifts are excavated to come in contact with the ore slices. The slices are drilled using a jumbo, blasted by charging the drill holes with explosives, and ore is removed by using dump trucks or Load Haul Dump (LHD) vehicles.
- ❖ The ore is dumped into an ore pass, an inclined tunnel where ore is transported to a lower elevation in the mine.

- ❖ The ore is picked up at the other end of the ore pass by a LHD to be transported out of the mine through a ramp (inclined tunnel).
- ❖ Once a slice is completely mined out, the empty space is partially backfilled hydraulically.
- ❖ The backfill material used can be a mixture of sand and rocks, waste rock with cement, or dewatered mill tailings (rejected low grade ore from processing, usually fine and sandy).
- ❖ The backfill underground serves to keep the mine walls stable and also as the floor for mining the next slice.
- ❖ Mining continues upwards towards the surface until the orebody is depleted.

BASIC DIFFERENTIATION OF MINING METHODS

Issues	Underground Mining	Open-pit Mining
Deposits	Relatively small, high grade or deep with sub-vertical ore zone	Relatively large, low grade or shallow, with sub-horizontal ore zone
Geology	Structurally controlled veins and breccias	Lithology controlled stockworks, disseminated zones
Resources/ Reserves	Generally difficult or not cost effective to prove up large resources/reserves	Generally cost effective to establish 10 to 15 year resource/reserve life
Productivity	500 to 8,000 tonnes per day	5,000 to 100,000 tonnes per day
Environmental	Generally easier to permit, limited footprint. Relatively cheap to reclaim	Large footprint from pit, waste dumps and tailings, relatively expensive to reclaim
Mine Life	To > 100 years	10 to 25 years, rarely longer

Thanks you very much

