CHAPTER-01

Development in Underground Metal Mine.

* Explain formation of blocks of mineral deposit. :-

In early stage an underground mine required carefully planned network of shaft drifts and rises etc. The formation of network of shaft drifts and rises is known as development of the mine.

At the time of developement following points should be kept in mind.

1) The deposit has to be ~~any horizon from~~ divided in separate blocks by driving drifts, levels, horizon from the shaft.
2) The haulage drive at any horizon from footwall should be staight and wide with much as possible.
3) The mineral are transported downwards in different section to the lower levels as far as possible. All ore carried which is located usually at lower levels.
4) Normal mining or stopping is carried out from boundary to the shaft in a retreating manner.
5) With steep deposit the miners enter the working from above.
6) Air current must goes to the lower levels and then rises to upper levels to ventilate the working district.

* Explain Level interval :-

The vertical distance between to two levels is known as level interval. Level driving is an narrow work involving more cost per m^3 than stoping each level requires timbering, haulage track, pipeline, loading machines and hauling machines. Some of these requirements have to be ~~main~~ minimised by concentrating life of the stopes above. The cost of the plats, crushers and ore chutes can be minimised by concentrating haulage on alternate or every 3rd level.

During lateral development in a metalliferous mine the interval between levels varies from 15m to 100m and depends upon the following considerations.

1) The deposit has not been proved adequately during exploration stage.
2) The deposit is irregular in dip, quality and extent.
3) Some of the orebody has been missed during initial Prospecting stage.

High grade ores or ores containing workable grade in pockets, require levels to be close together to avoid missing the ore. A retreating system where the stopes are started from the boundary of the mine lease hold may allow a larger level interval than an advancing system.

Whenever any work is being done in a mine the following points should be borne in mind as they are cardinal points for any mining activity, safety dominating all other considerations.

1) Safety and mining regulations.
2) Support of roof and sides and surface features.
3) Ventilation (4) Drainage. (5) Transport.

* Describe raising Methods in Metal mines.

1) Open raising Methods
2) Two Compartment method
3) Jora raise lift,
4) Long hole drilling Method.
5) Alimak raise Climber
6) Raise borer
7)

Shivshankar Yadav

(01) * 1) OPEN RAISING METHOD :-

This method is Conveniently adopted for raises of moderate length (upto 8M) and inclination of 40°–60° with the horizontal themselves if the strata and wall rock strong enough to support themselves so that artificial supports are not required.

Description :- ⓐ-This is simple and most common method adopted in majority of Metal mines.
ⓑ-The workers stand on a platform made of timber supported on iron bars into the footwall.
ⓒ-The dril hole is done by jackhammer and generally done by Wedge Pattern.
ⓓ- Holes are 32mm dia and 1.5M deep.
ⓔ-Before each round of blasting the platform is dismentaled.
ⓕ- During drilling exhaust from the compressed air drill provides Ventilation.

Disadvantage :- ◎- 1) Lack of Ventilation.
2) Damage to pipes and ladders etc. from the blasting.
3) Loss of efficiency when the raises go higher as the workers have to frequently go up and down the ladders.
4) Platform holes require careful alignment.

(02) * TWO COMPARTMENT METHOD :-

This method of raising is adopted for vertical or very steep raises. relatively large cross section. The working stage rests on two or three stulls 2 temporarily set into holes made in the walls of the raise. It consists of wooden planks laid over the stulls.

Description :- ◎ Depending upon requirement two or three Compartment are made.
◎ In two Compartment method one Compartment will be serves as ore pass and other Compartment will serve as man ways, Pipes, Cables etc.
◎ Initially the excavation 2m done from the lower level.
◎ Then the raise is divided into Compartment and the raise is driven Continuously.
◎ After getting Sufficent Progress, the Platform is extended. Generally after two or three blasting Compartment is required to be extended.

Advantages :- 1) Strong Platform Can be erected.
2) Pipes, Cables are Well exacted.
3) Since one Compartment is act as ore Pass, So loading is easier at Lower ends.
4) Person Can be protect in the Compartment When Climbing from flying rock or adjacent roof on Side fall.

Disadvantages :- 1) Ventilation is Sluggish.
2) Maximum Space occupied by Compartment

(03) * JORA RAISE LIFT :-

Raise driving by the Use of Jora raise Lift Was Probably the first approach towards mechanised raising upto 100 m long raise. for vertical raise. The Strata Should be Strong.

Description :- ◎- In this method a bore hole is drilled upper Level to meet lower Level.
◎- The bore is drilled Such that if represents the Center of raise drive.

◎- A small hoist pully is set in the upper levels from roof. The pully is set such that it is above the bore hole.
◎- The pully carries a steel wire rope on end of the rope is wound on hoisting drum set in the upper level. The other end of rope passed through this hole. The end of the rope will be in the lower level.
◎- Wedge cut holes are drilled in the roof of lower level around the rope. These holes are charged with blasting cable.
◎- The face is well dressed and blasting material shoveled and dropped in lower level for further transport.

Advantage :- 1) It is suitable for vertical and inclined drivage of raise.
2) Preparation is very quick and less time is lost in setting the platform.
3) The ladder way is not required as the workers are traveling in jora compartment.
4) The time wasted on softening is less.
5) Time is not wasted in loading as the blasted material on the platform is shoveled to lower level.
6) The working progress is high.

7) * LONG HOLE DRILLING METHOD (or Vertical Crater retreat (VCR) Method) :- ⇒ In the method of raising through longholing all the drilling, loading and blasting operations are performed from horizontal workings, and there is no need for the miners presence at the face. In order to put up a raise between horizontal working 1 and 2 long parallel blastholes 3 are drilled from the upper level within the cross-section bound of the future raise over its full length. The holes are then fired section or portionwise, either simultaneously or in succession. The length of the sections depends on the

Properties of the rocks, usually ranging from 1.5 to 6, or even 9 m. The bottom part of the blastholes is filled with plugs 4 from below and explosive charges 5 are lowered down into the holes on strings, the holes being then closed from top with stemming material 6.
The practical limit in adopting this method is holes of 15 – 150m at a maximum inclination of 35° off vertical as longer holes would result in deviation. 50m is considered the limit.

The method is used only in firm ground, mainly for excavating cut raises in stoping.

⑤ * Alimak raise-CLIMBER :-

The method of driving long raises with the help of a machine called Alimak raise climber was introduced in 1957. In India it was introduced for the first time at jaduguda Uranium mines in 1972.

The Alimak Raise Climber Consists of :-

1) A reel with air hose to provide compressed air to the twin air motors causing travel of the cage. The reel automatically winds upto the hose when the raise climber descends and feed its during ascent.
2) Compressed air hose as stated at 1.
3) The guide rail with rack and-pinion. The guide rail comes in length 1 or 2m. Some pieces are suitably curved for a smoth profile. The guide rail pieces are bolted ~~one~~ onto the rock bolts fitted into the sides of the raise.
4) The guide rails have recesses to carry 2 compressed air tubes, 1 water tube, and a telephone cable which also used for blasting.

5) The rock bolts are of expansion shell types, recoverable. Spacers are provided to cover up the length between the rock bolt and guide rail.

5) Compressed air drive unit with air motors for travel of the cage.

6) Protection Canopy.

The Alimak Raise Climber can be used only where the raise is driven at an angle of 40°(deg). or more with the horizontal since the rock blasted at the face of the raise has to come down by gravity.

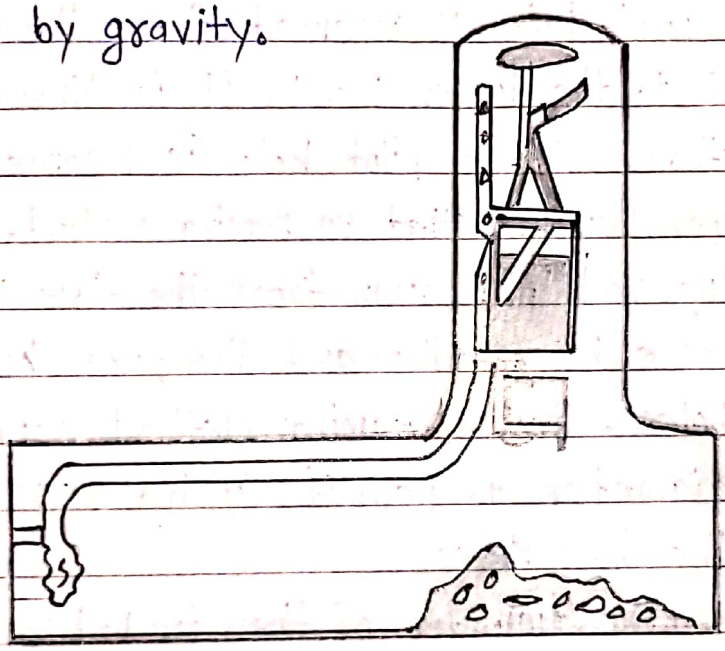


fig :- Alimak Raise Climber. (Dressing down roof and sides)

Advantages :-

1) The materials falls due to gravity in lower level.

2) Loading of material in lower level is quick.

3) Much of the time is saved by climber as workers are riding in

4) No ladder ways, pipes lines etc. are required.

5) Dressing is safe under canopy.

6) Platform is not damaged.

7) Cycle time is short.

8) It is quick method.

9) Suitable for vertical and inclined raise.

⑥ * RAISE BORER :-

Raise borer are first introduced in mines of Western Countries in 1962 and at Present 300 raise bores are in use throughout the Worlds.

1) The method of raise drilling of Pilot hole, 230 mm to 300 mm dia between two levels at the site, and in the direction of Proposed raise reaming the pilot hole by reaming bit to the size of the raise.

2) If the pilot hole is reamed from the face by gravity upper Level to the lower Level, It is known as down reaming method. If the pilot hole is reamed from lower level to upper Level, Called up reming method.

3) The Cutting rock fall down from the face by many mines using the face by gravity and the pilot hole does not need large dia holes. Down reaming method demands pilot hole of large diameter to permit Cutting rock between drill rod and the hole Sides.

4) Normally the diameter of the drilled raise varies from 1m to 3.7 m as the raise dril bit are available in these Sizes.

Driving rises has often Creates difficulty in many mines using Conventional method. Ventilation, transport, Safety of Person, Cost are the Problem in Conventional raise. Now hard rocks Can be Cut by Various type of rotary bit developed in recent years. This is possible by raise bore method ranging from 1m to 3.7 m dia

Advantages :-

1) They are usually drilled faster.

2) They are usuall less Cost in many Cases.

3) Personnel are not exposed to the hazards of raise

driving, blasting method.

4) The finished Section is often Smooth Which offers less resistance to flow Ventilation of air and drilled raise may not require Support.

5) The raising Cost per length becomes less as the raise length increases.

CHAPTER-02

* Give A COMPARATIVE Study between Coal and Metal Mining :-

The Differences between Coal and (Metalliferous) Metal Mining are as follows.

S.N	COAL MINE	METAL MINE
1.	Coal is a bedded deposit.	Non-bedded deposit.
2.	Geological disturbances i.e fold fault occurs.	Geological disturbance not effect.
3.	Research and Planning is very easy.	Research and Planning less easy.
4.	It is Softer than metal.	It is harder than Coal.
5.	Electricity is the main Power.	Compressed air is the main Power.
6.	Extraction is easy.	Extraction is difficult.
7.	Roof is Soft.	Roof is hard.
8.	It is Uniform in quality thickness and dip.	It is non-uniform in quality thinkness and dip.
9.	Regular in extent Shape thickness.	Irregular exist Shape thckness.
10.	They exits in Patche or Shoots.	They does not exit in.
11.	It is Less Varied.	It is more Varied.
12.	Underground mining is much Simpler	U/G mining is less Simplex.
13.	Geologist is not important in initial exploration.	Geologist is an essential Staff.
14.	It is amenable to large Scale Mechanism.	It is not amenable to large Scale Mechanism.

CHAPTER-03 STOPING METHODS

STOP :- It is a solid ore block or ore pillar which is under extraction is called stope.

STOPPING :-

It is the method of extraction of ore from a block or pillar formed during development. As a rule stopping is started on each ~~on~~ side of a raise winze connection.

STOPPING - METHODS :-

Stoping is the final extraction of an orebody that has already been developed. The main work consists of drilling and blasting of ore, removal of the broken ore from working place and supporting the ground so that the operations can be carried out safely. Various methods of stopping are adopted to exploit different ore deposits but the main objective in all cases is to mine the ore deposits in safest and most economical way without sacrificing the interest of conservation of minerals,

3.1 ⇒ * Classify stopping methods with application and factors affecting methods of stopping.

*** Classify Stopping Methods :-**

The basic classification of methods devised by the U.S Bureau of mines in 1936 is still valid and is being followed in many leading countries metalliferous mines. The classification is as follows :-

1) Stopes naturally Supported.
2) Stopes artificially Supported.
3) Caved Stopes
4) Combination of Supported and Caved Stopes.

1) Stopes naturally Supported :-

(a) open Stoping :

i) open Stopes in Small are bodies.
ii) Sublevel Stoping.
iii) Longhole Stoping.
b) Open Stopes With Pillar Supports :
i) Casual Pillars.
ii) Room (or Stope) and Pillar (regular arrangment)

2) Stopes - artificially Supported :-

(c) Shrinkage Stoping.

i) With Pillars. (ii) Without Pillars. (iii) With Subsequent Waste filling.
d) Cut and fill Stoping (e) Stulled Stopes in narrow vein
(F) Square - Set Stoping.

3) Caved Stopes :-

G) Caving.

i) Block Caving : including Caving to main level and caving to Chutes or branched raise (ii) Subelevel Caving.
(H) Top Slicing (Working under a mat, Which together With Caved overburden follows the mea mining downward in Successive Stages.)

4) Combination of Supported and Caved Stopes :-

(as Shrinkage Stoping With Pillar Caving Cut and fill Stoping and top Slicing of Pillars, etc.)

* Application of Underground metal Mining Methods :-

Type of orebody	Dip	Strength of ore	Strength of Walls	Possible Method of Mining.
Thin bodies	Flat	Strong	Strong	Room and lilar Casual lillar open Stopes.
		Weak or Strong	Weak	Top Slicing Longwall
THICK-Bodies	FLAT	Strong	Strong	Sub-level Stopping room and lillar Cut and fill.
		Weak or Strong	Weak	Sub Level Caving Top Slicing.
		Weak	Strong	Square Set Cut and fill Sub-Level Stoping.
Narrow Veins	Steep	Weak or Strong	Weak or Strong	Resuing in (a) open Stopes or (b) Stilled Stopes.
THICK VEINS	Steep	Strong	Strong	Open Stopes Sub-level Stoping Shrinkage Stope Cut and fill method.
	Steep	Strong	Weak	Cut and fill Stopes Square-Set Stope Top Slicing Sub-level Caving.
	Steep	Weak	Strong	Open Casual lillar Square-Set Stope Top Slicing block Caving Sub-level Caving.
	Steep	Weak	Weak	Square-Set Stopes Top-Slicing Sub-level Caving.
Massive		Strong	Strong	Shrinkage Stope Sub-level Stoping Cut and fill Stope.
		Weak	Weak or Strong	Square-Set Stope Top-Slicing Sub-level Cuing block Caving.

* FACTOR affecting methods of Stopping :

1) Thickness of ore body :- There are ore bodies with are thin, thick and extra ore bodies. Thin ore bodies are suitable to work with breast - Stopping Method.

2) Dip of the ore body :- The ore bodies with low inclination and not extending 35° inclination are suitable for breast stopping method.

3) Character of ore bodies :- Some of the ore bodies are strong and some of the ore bodies are weak.

4) Character of walls :- Some cases the hanging wall or footwall of ore bodies are strong and in some cases ~~of the~~ either the hanging wall or footwall or both may be weak

5) Cost of ore bodies :- Some of the ore bodies contain. Costly minerals and some of the ore bodies costly due to rich mineralization.

6) Nature of Mineralization & of ore body :- The are body contain low Percentage of Mineral can be worked by breast stopping Method.

7) Continuity of ore body :- Some of the are bodies are continuous and regular are bodies are worked by timer stopping method and shrinkage stopping method.

8) Cost of supports and availability :- In case of timber stope method and top slicing Method regular supply is supplied.

9) Depth of the ore body from surface :-
When ore bodies are at shallow depth the harrying bore method can be used.

10) The shape, size and regularity of the deposit.
11) Mineralogical character and value of ore and the distribution of values.
12) The dip, width and strength of the ore.
13) Nature of overburden.
14) Surface features : their support vis-a-vis caving.
15) Possibility of dilution of ore with waste.

* PREPARATORY Arrangement for Stoping. :-

Preparation for sublevel stoping is comparatively comprehensive, and costly which normally includes the following features.

1) Raises for access to and development of sublevels.
2) Driving of cross-cuts and of 2 or 3 sublevels nearly 20 m apart at the footwall side withine the orebody.
3) The sublevels may be at the ~~main~~ ter midheigh depending upon the length of blast-holes possible by the drill rig.
4) Haulage drift, situated at the main level below stope bottom.
5) Undercut at the bottom of the stope.

3.3 Q. Describe the following methods with layout including drilling blasting, transporation and supports.

a) OPEN Stoping. (b) OPEN Stoping With pillar support.
c) Shrinkage Stoping (d) Cut and fill Stoping.
e) Square Set Stoping (F) Block Caving.
G) Sub-level Caving. (H) Top Slicing.

A) OPEN STOPING :-

An open Stoping, by defination, is a Stope in which no filling or timber is used to support Walls and only simple forms of Scatered timbering is used as temporary Support. A typical Stop: block may have maximum dimensions 30M x 120M With the height Varying from 10M to 50M. In Softer rocks the Width should be less to avoid a large Span (Maximum 20M.). Steeply dipping orebodies are also extracted by open Stoping but upto a depth of about 450M.

Open Stopes in Small orebodies are further Classified as follows :

1) Overhand Stoping.
2) Underhand Stoping.
3) Breast Stoping.

1) Overhand-Stoping :-

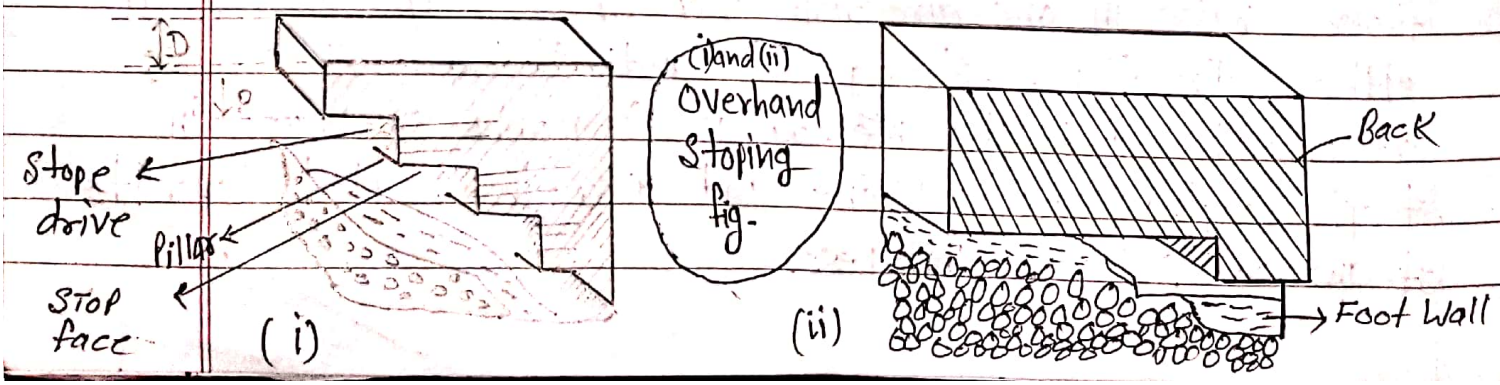
The TWo levels enclosing an ore block are Connected by raises at interval, 25m - 40m and Stoping Start from a raise in one direction only or it may extend in either direction. Strong ore and Stable Wall rocks are essential and the method is Commonly employed in Steeply dipping narrow Veins and also in bedded deposits of and of 2-3m thickness.

The Stope benches may be short or long along the Strike or may be obliquely inclined to it. A beanch is Pushed 2-4m thickness. Overhand Stoping is replaced by room and pillar method of Stoping. It is also known as breast Stoping. In thick orebody, Steeply dipping, the overhand Stoping is Usually Changed to Shrinkage Method or Sub-level method of Stoping.

Condition :- 1) The thickness is Selected is upto 4.5m
2) The ore body required Strong.
3) Both hangwall and footwall ~~Sto~~ Should be Strong.
4) The inclination of ore body is 40°-90°

Advantages :- 1) The full advantage of gravitational force is taken from face.
2) Blasting efficiency is high.
3) The broken ore fall away from face.
4) The danger is less.
5) The dust and Smokes Can be easily Cleared.
6) Ventilation is good.

Disadvantages :- 1) Setting of Plateform Cann't done easily.
2) Sometimes drilling Creates Problems.
3) No.- of benches blasted are 3-4 only.
4) Muck falls on body of Workers.
5) Selective Mining is not Possible.



2) Under-hand Stopping :-

This method is used in working thin steeply dipping veins enclosed in strong wall rocks. In an underhand stope the face is below the driller who is supported partly by the face and partly by the footwall. The stope is worked in a downward direction from upper main level to the lower main level commencing from a winze or connection between the two levels. A horizontal slice 2 to 2.5 m high is started on top of an oreblock.

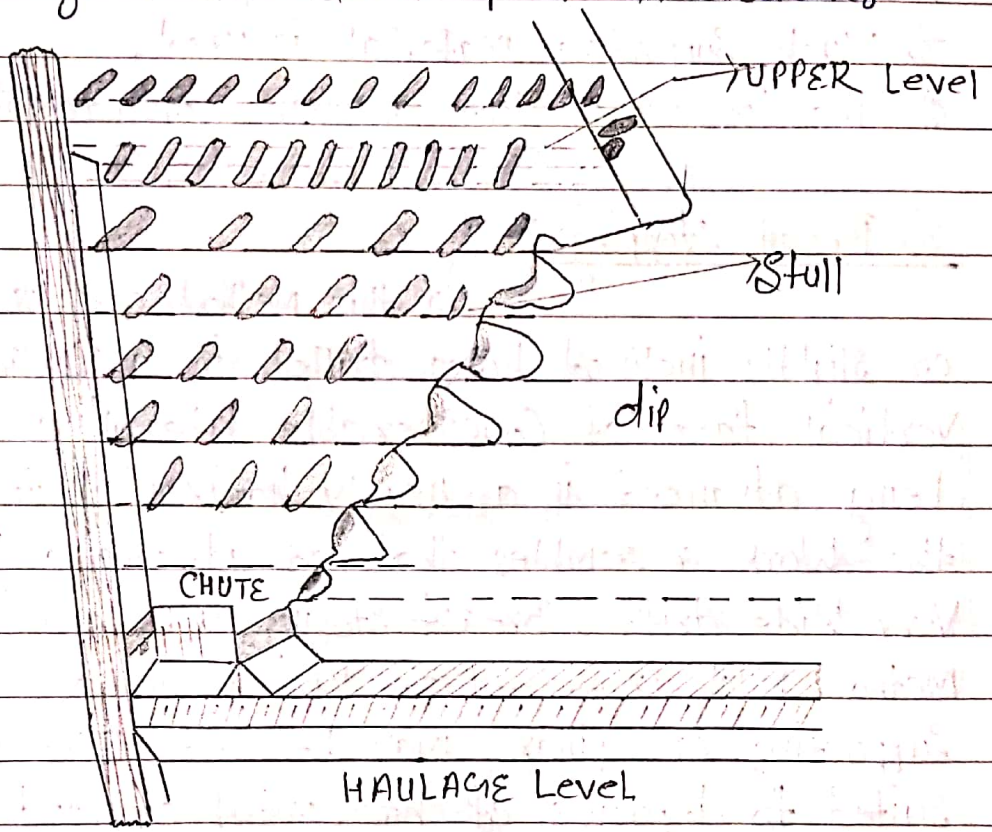


fig :- Underhand Stoping with Stull Support.

The ore is broken in Horizontal slice. It is a common ~~proj~~ practice to open new chutes as the stope is extended along the strike. Underhand Stoping is practised relatively rarely. The transport of ore is somewhat and blasting efficiency is poor as the blast has to lift the ore that is blasted. Ventilation is also not simple. Efficiency of miners in breaking the ore is, however, high.

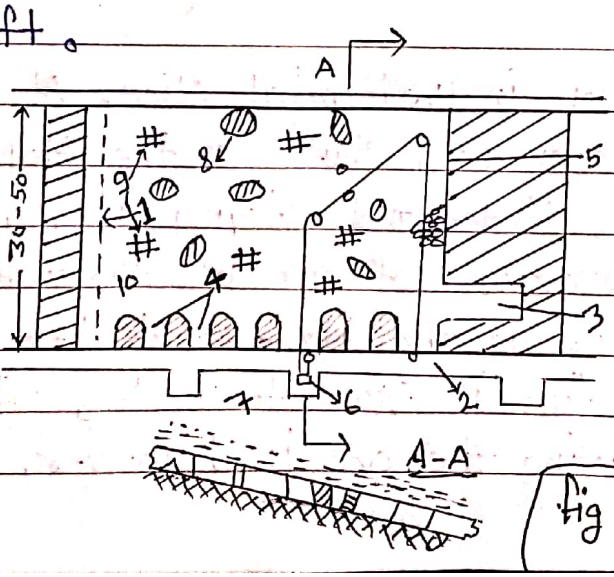
Advantages :- 1) It allows high blocks.
2) It makes a systematic sorting of the ore possible.
3) Broken ore falls clear of the face.
4) High wall and face can be conviently examined.

Disadvantages :- 1) The performance of the drillers is less.
2) With a dip exceeding 45° platform have to be erected in the stopes for the mines.
3) Much supporting material is used.
4) The losses of line ore are considerable.

3) Breast stopping :-

In this method ore is broken by flat or slightly inclined holes drilled in a vertical, or nearly vertical, face of considerable lateral area, which is being advanced in a nearly horizontal direction and the work resembles that of advancing the face of a very wide drift. Breast stoping is a low cost, simple method much preferred for low grade ore deposits where supporting ore pillars may be left. The method is best suited to deposits of horizontal or mild dip and of thickness of upto 5m. lying at moderate depths. Deposits upto 3 m thickness are normally mined in one face or lift.

fig)



1) Raise
2) Haulageway
3) Leading stope.
4) Short ore chute.
5) Blast Holes
6) Scraper hoist
7) recess.
8) Irregular pillars.
9) Timbmer Cribs
10) Stull.

fig - Breast Stoping

Advantage :~ 1) Simplicity and low prime Cost of ore.
2) Possibility of mechanisation of drilling and loading at the face
3) Selective mining is possible.
4) High intensity is possible.
5) More Safe than other methods.
6) It is simplest method.

Disadvantage :~ 1) Chances of high ore losses due to in Sit Pillars
2) High Stability are required.
3) the ~~ore~~ need for Keeping a Constant Watch of the Condition of the back.
4) Initial Cost is high.
5) Higher output is not possible.

*B) OPEN STOPING WITH PILLAR SUPPORT :~

The method of open Stoping With Casual Pillar is now a days not much Practised as the trend is for mechanisation in open Stopes.
This method is two types.
1) open Stoping With Casual Pillar.
2) Room and pillar method of mining.

1) open Stoping With Casual Pillar :~ In the Present day Practise it is more Convenient to drill and blast everything is the Stope to Keep Mining Costs to a reasonably minimum Level.

2) Room and Pillar Method of Mining :~ Room and Pillar method of Mining is Standard Method of development in Coal mines in India.

Where the development is followed by depillaring for Maximum extraction of Coal from the Standing Pillars supporting the roof over the Coal Seams.

Condition :- 1) When ore body is strong.
2) Hanging Wall and footWall are Strong.
3) the ore body thickness is not more than 4-5 mt.
4) Inclination of ore body is 0°- 30°

Description :- 1) In this method the ore is extracted in Wide rooms separated by Pillars Provided in regular manner for support of hanging Wall.
2) The dimension of room and Pillars depends on such factors like Stability of hanging Wall and ore ~~generally~~ thickness of deposits and rock Pressure.
3) Pillars are generally arranged in regular Pattern.
4) The ore left in the pillars may to some extent be recovered but generally to be required as lost.

Application :- (1) Ores ~~body~~ With horizontal or flat dip.
(2) Comparatively Stable hanging Wall and ore.
(3) Ore body upto 12m thickness.

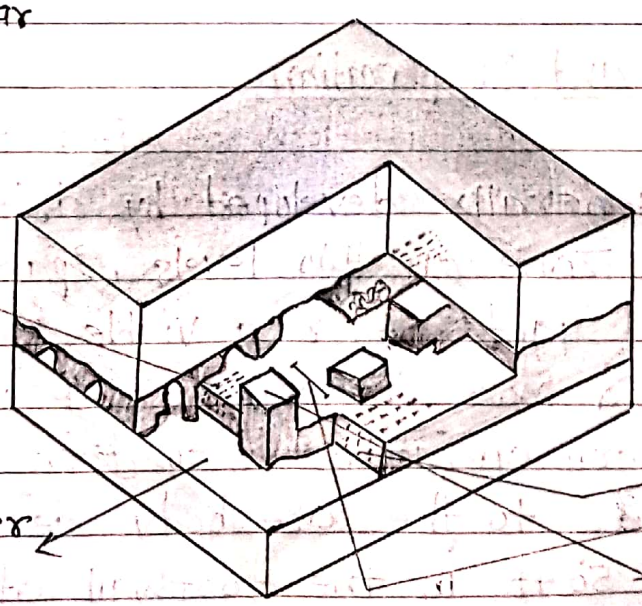
Preparation :-
In horizontal or nearly horizontal deposits the Preparation Work Consists only in the Preparation of roadways for ore, i.e. through the mined-out-areas. Inclined deposits are divided Vertically in levels on which haulage drills are established along the foot Wall.

Development :- 1) Ore body is approached through shaft and Cross-cut.
2) The Cross-cuts are located at regular interval of 100m-200m
3) When Cross-cuts touch the ore body the is devaloped by levels.
4) Here the Size of the Cross cut is 3-5m Wide and 2-3m height.
5) As Levels are developed at their horizons, they are interconnected by raises or Winzes at regular intervals of again 100-200m.

Advantages :- 1) The pressure on hanging Wall is distributed on barrier.
2) It is used for Comparatively More depth.
3) The Supervision of Work is more effective.
4) Work distribution is more.
5) Working Can be Well Ventilated.
6) More workers Can be employed.

Disadvantages :- 1) The loss of ore in barrier pillar more.
2) The percentage of extraction is Less.

fig) Room and pillar



(fig :- Room and Pillar)

c) Shrinkage Stoping :-

Shrinkage Stoping is a vertical, overhand mining method whereby most of the broken ore remains in the stope to form a working floor for the miners. Stopes are mined upward in horizontal slices.

Description and Conditions, application :-

Shrinkage Stoping can be used for orebodies with steep dips comparatively stable ore and sidewall characteristics, regular ore boundaries and ore unaffected by storage. Tis is a method underground mining where the ore deposit is deep and ore body is steep. It is a high costs method. We use exploitation method when minerals are vertical or sub-vertical and thickness little .1 to 10 m. It is designed for medium and small mining, The Inclination must be greater than 55° and the ore rock must be stable and competent. The mine ventilation, the working face is ventilated by injecting air from the transport gallery located in the base.

Development and Preparation :-

Sites for Shrinkage Stoping are generally developed by drifting in the vein or ore zone on two levels, spaced vertically 100 to 600 ft apart, After a viable are body has been established. A more common method of preparing stopes in modern operations is to drive an extraction drift parallel to the ore body development drift about 25 to 50 ft in the footwall of the ore body.

Advantages :- 1) It is more efficient and cheaper.
2) No scraping of ore is required.
3) It involves smaller capital outlay and less development work.
4) There are less preparation of stope.
5) Less timber support.
6) face ventilation is good.
7) No loss of firm ore.
8) Broken ore is clear at face.
9) Production can be boosted in short notice.
10) Faces can be additionally supported.

Disadvantages :- 1) If walls are flexible there is possibilty of diution of ore due to mixing of rock.
2) Chutes are to be closely placed.
3) Sorting of ore in the stope is not possible.
4) Selective mining is not possible.
5) Large amount of broken ore is locked in stope.
6) There is possibility of accident or fire.
7) Shorting is not visible.
8) Mechanization is not possible.
9) The chutes may jammed.
10) Man power requirement is high.

Fig)

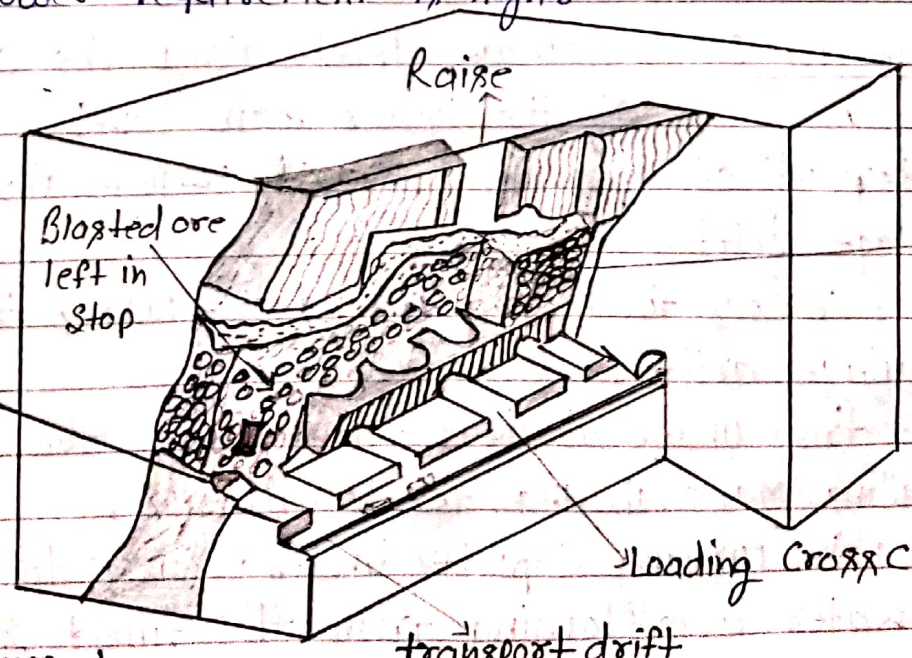


Fig - SHRINKAGE STOPING

* D) Cut and fill Stoping :-

It Cut-and fill mining the ore is excavated by drilling and blasting in horizontal slice, starting from the bottom of a stope and advancing upwards.

Description :-

A slice has a thickness more than 3m. The broken ore is loaded and Completly removed from the stope. When one slice of ore has been excavated, the Corresponding Volume is filled With Waste material upto within 2-3m of the back before the next slice is attacked. When the Water is drained off a Solid Consolidated fill With a Smooth surface is produced.

Application :-

Cut and fill mining Can be used With Steeply dipping as Well as large deposites With irregular outline Can be Worked. It is thus a Versatile Method. The filling operations are easier With steper deposite.

Preparation :-

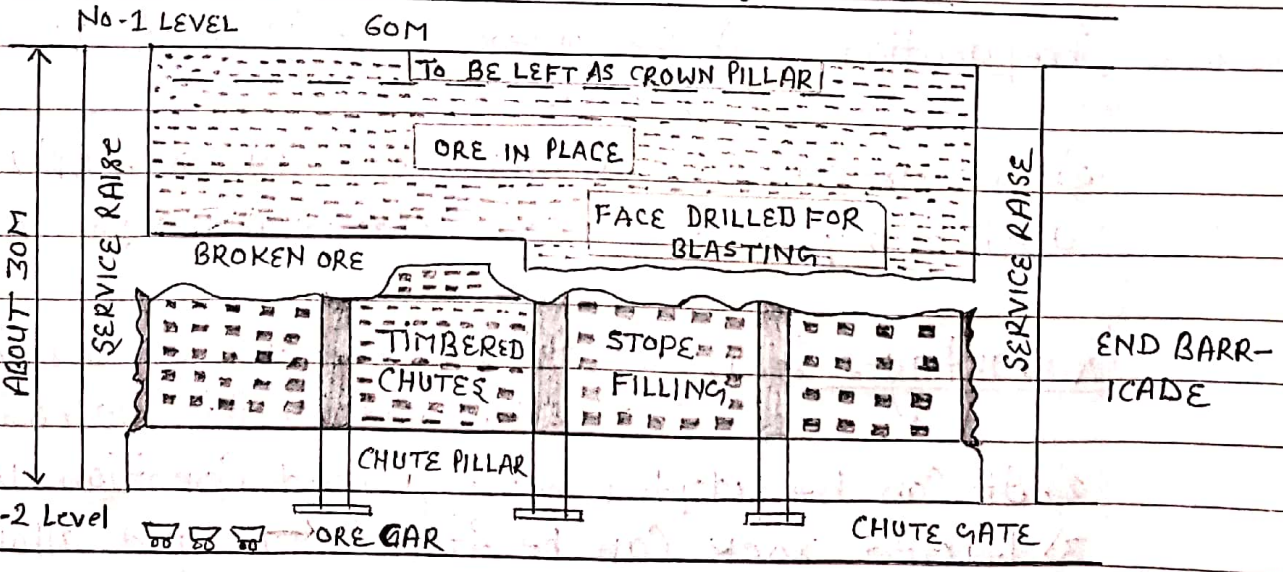
1) Haulage drift along the orebody at the lower main Level.
2) Undercut of the stope, Usually 5-10 m above the houlage drift.
3) Short raises for manways and ore passes from haulage drift to Undercut.
4) Raise from undercut to the level above for transport of filling material and for Ventilation.
5) Adegate Pumping Capicity Underground to Pump out Water overflowing from the filled stope.

Development :- The ore slices can be drilled in two different ways, with horizontal shot holes or with upward, vertical holes, for drilling light rocks simple wagons are often used. An advantage of up hole drilling method is that large section of the roof can be drilled without interruption and large round can be blasted.

Advantages :- 1) ore is removed immediately after blasting.
2) There are no fire hazards and no oxidation problem.
3) Preparatory arrangements or stopping are not heavy.
4) A large area is not exposed and the workers work in newly exposed area.
5) Stopes can be brought into production comparatively quickly.
6) Ventilation is comfortable because of small area of stope for air current.

Disadvantages :- 1) It is a cyclic method.
2) ~~For~~ Suitable filling material may not be availab
3) Production of ore is intermittent unless a few stopes are worked simultaneously.
4) Arrangements for procuring filling material and transport to the stope involves a sizable cut.

fig)



(Fig → Cut and fill Stoping – Longitudinal Section)

E) Square Set Stoping :-

Square Set stoping is the method of mining in which in which the walls and back of the stope are supported by regular frame work of timber called Set Square Sets. The frame work forms rectangular hollow prisms, in the space from which ore has been extracted. Mining large weak deposits by square setting usually requires a division of the orebody between any two levels, into stoping blocks of limited horizontal area. Size of blocks depends on strength of ground, so that work in any block is rapid enough to avoid excessive pressure.

Applications :- 1) Where the walls of the orebody and back of the stope are weak and do not stand without support even for a week.
2) For recovery of fractured remnants and pillars.
3) Can be used in almost any size of deposit regardless of its shape or depth.
4) Ore shaped be of high grade to pay for the mechanical of mining as square set stoping is costly and labour intensive method.

Preparation :- 1) The lower levels is used as main haulage level.
2) The arrangments of ventilation, power supply increased transport of ore and additional manpower is made.

Advantages :- 1) Irregular ore bodies of any shape can be worked by this method.
2) It can be adopted where ground condition is bad.
3) Wasted rock can be stored out and allowed to remain in the stope.

4) The grade of the ore can be controlled as each new face, can be sampled.

5) If the sets are filled with waste rocks as soon as possible after they are execed, only a small space is open at a time.

Disadvantages :- 1) Production of the one is slow and the oms is poor.

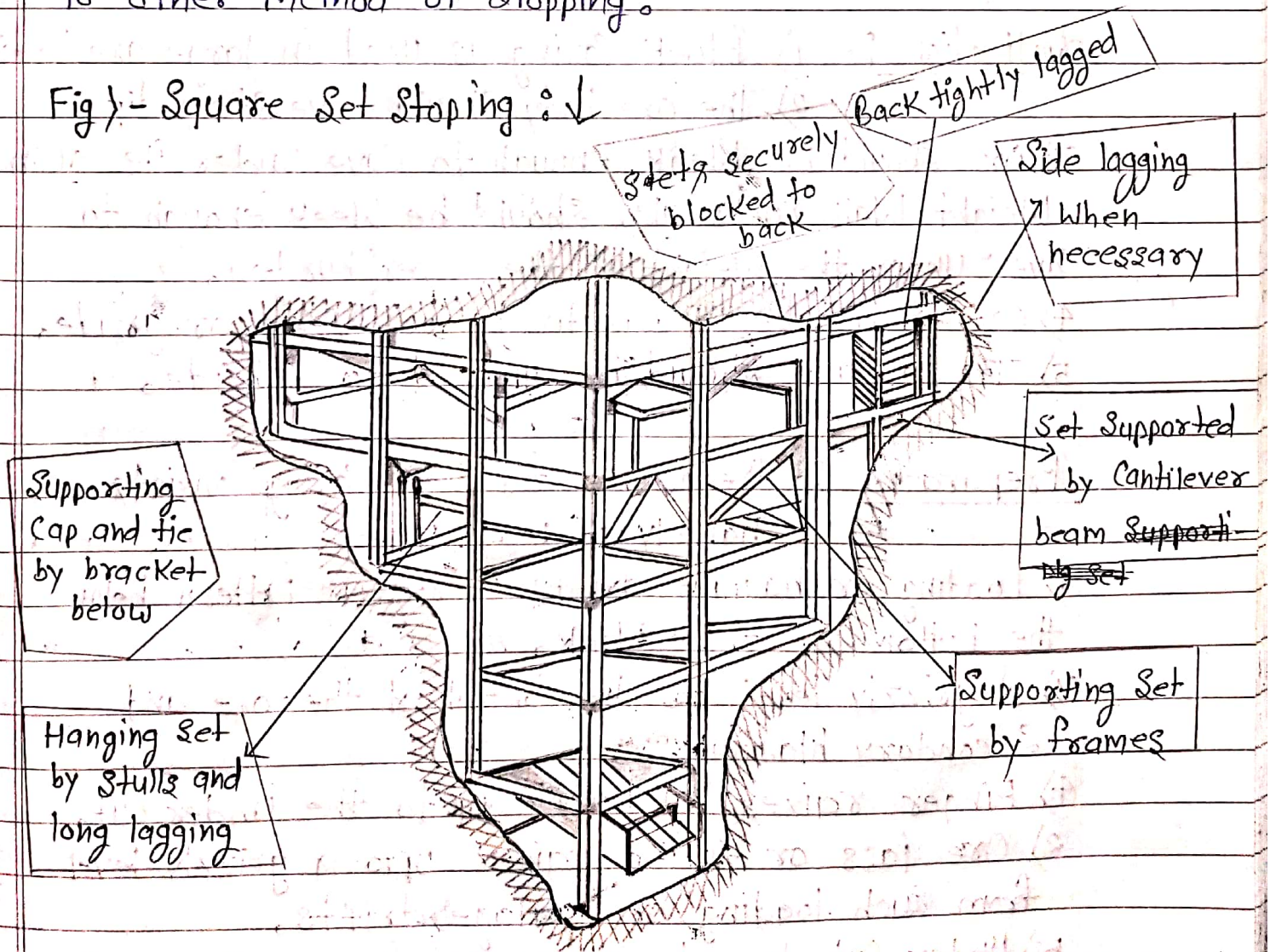
2) ~~Production of the ore is slow and the oms poor.~~

2) A large quantity of timber is required. It constitutes a fire hazard.

3) It is a labour intensive method with high cost of mining.

4) Square set stopping has a high accident rate compared to other method of stopping.

Fig) - Square Set Stoping :↓



(fig - Square Set Stoping)

* F) BLOCK-Caving :-

If an opening made during Stoping is large enough, it will eventually cave, even in the firmest and strongest rock, but a Caving System of mining like block caving, etc. require that the ore rock will cave over a small unsupported area. In block caving the ore is divided in large block with a horizontal Cross Section usually larger than 1000 m^2. The undercutting creates a series of fractures in the ore-body which gradually affects the whole block. The drilling and blasting is required only n the lower portion of ore-body. The upper portion caves down.

Application :- 1) Block Caving is used in large ore bodies.
2) The ore body should have steep dip.
3) Ore should be weak enough to cave under its own weight Wall rocks also should be week enough to cave under the weight of the over burden.
4) Ore should be comparatively low value or grade.
5) To. Surface should be allowed to subside.

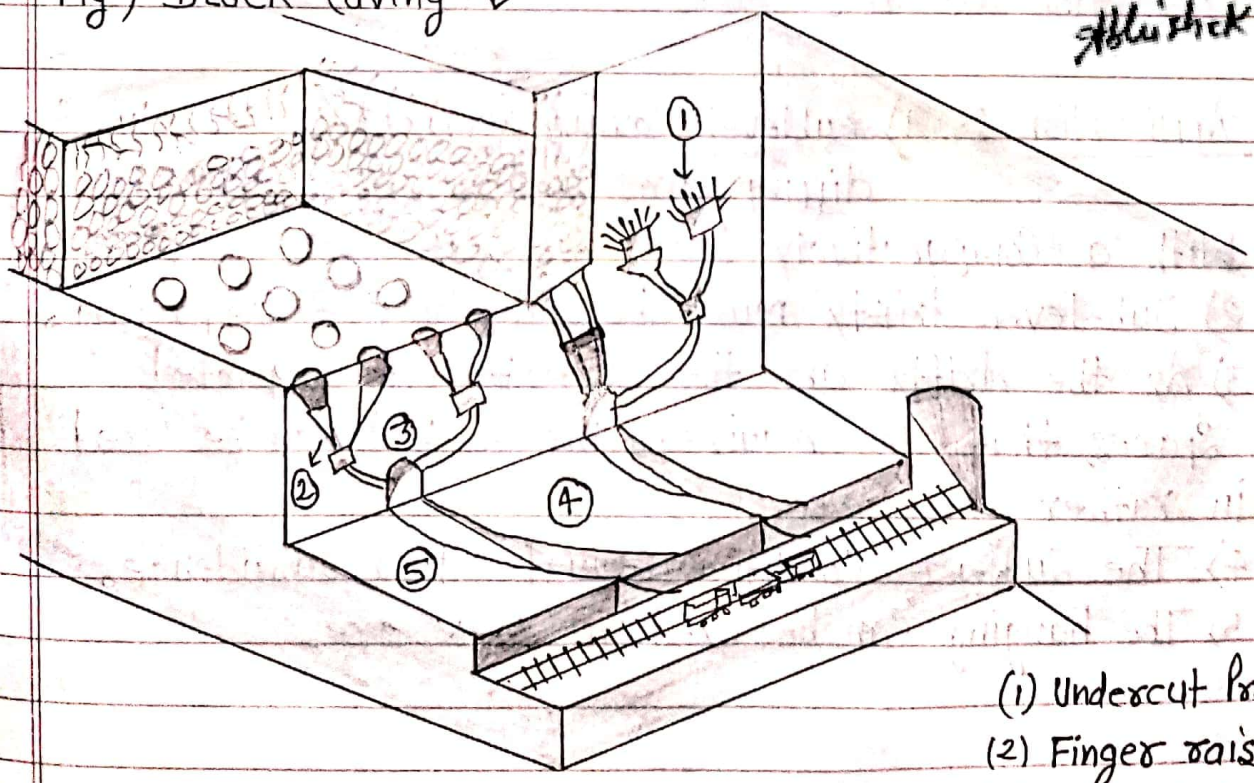
Preparation :- Preparation for block Caving Consists namely of :
1) Loading or haulage drifts in regular pattern below the bottom of those block.
3) A grizzly level for the Control of the ore and Secondary blasting.
4) Finger raises and come up to the under Cut.
2) Ore pass or finger raises upto a grizzly level from such loading or haulage drifts.
5) Under Cut due to Complicated Preparation and narrow Sections mechanized method ore often difficult to apply.

Advantages :- 1) Mining Cost is low and may be nearly as economical as in opencast method of mining.
2) The accident rate is fairly low.
3) ~~The~~ After the caving starts a high rate of production is possible.
4) Control of Ventilation is Less Compared to other methods of mining.

Disadvantages :- 1) Capital expense is Large.
2) Caving of a block is difficult to Control.
3) There is no change of Selective mining of high and Low grade ore.
4) There is ~~no chance~~ excessive dilution if caving is uncontrolled.
5) There must be Careful Supervision of ore drawing.
6) As in all method of caving, a Large flow of Surface Water or ground Water finds. At present block caving is not adopted at any of the mines in india.

Fig) Block Caving ↓

Abhishek Yadav



(1) Undercut Preparation
(2) Finger raise
(3) Grizzly Level
(4) Haulage tunnel + drift
(5) Main Level.

(fig - BLOCK CAVING)

*6) Sub-Level Caving :-

Sub-Level Caving is a development of top slicing method and resembles it in many ways. Sub-Level Caving is a caving method where the overburden and part of the ore is induced to cave in. The over-burden and the ore must be weak enough to cave readily. This method should not be confused with Sub-level Stoping in which all the ore is extracted by drilling and blasting and the ore as wel as the wall rocks have to be strong.

In Sublevel Caving the ore is divided by sub-levels with 8-10m vertical spacing. Each sub level consists of 2 or 3 slices and ore at each Sublevel. Several drifts and levels are worked simultaneously to kep a roughly even retreating front.

When a fan is blasted the ore caves into the drift, where it is loaded and transported to orepasses. The hanging wall caves continuously and follows the extraction of ore.

Application :- 1) Sublevel Caving is used in steeply dipping ores and in other deposits with a comparatively large vertical thickness.
2) Sub-level drifts must be largely self supporting.
3) As the drifts are the widest self supported spaces that are required, the method can be used in rather weak ore.
4) The surface conditions must allow subsidence.
5) The hanging can be used in weak ore.

Preparation :- 1) The main part preparation Consist of the very Comprehensive drifting on the Sublevels.
2) In additon to the drifts, ore passes and raises are required to Connect the Sublevels With the main Levels.
3) Initialy a 20% inclined service ramp is driven in the footwall rock.
4) In general, drifts in rock are 4.3m Wide by 3.7m high, While in ore they are 4.9m Wide by 3.7m high, a Wide drift improves recovery.

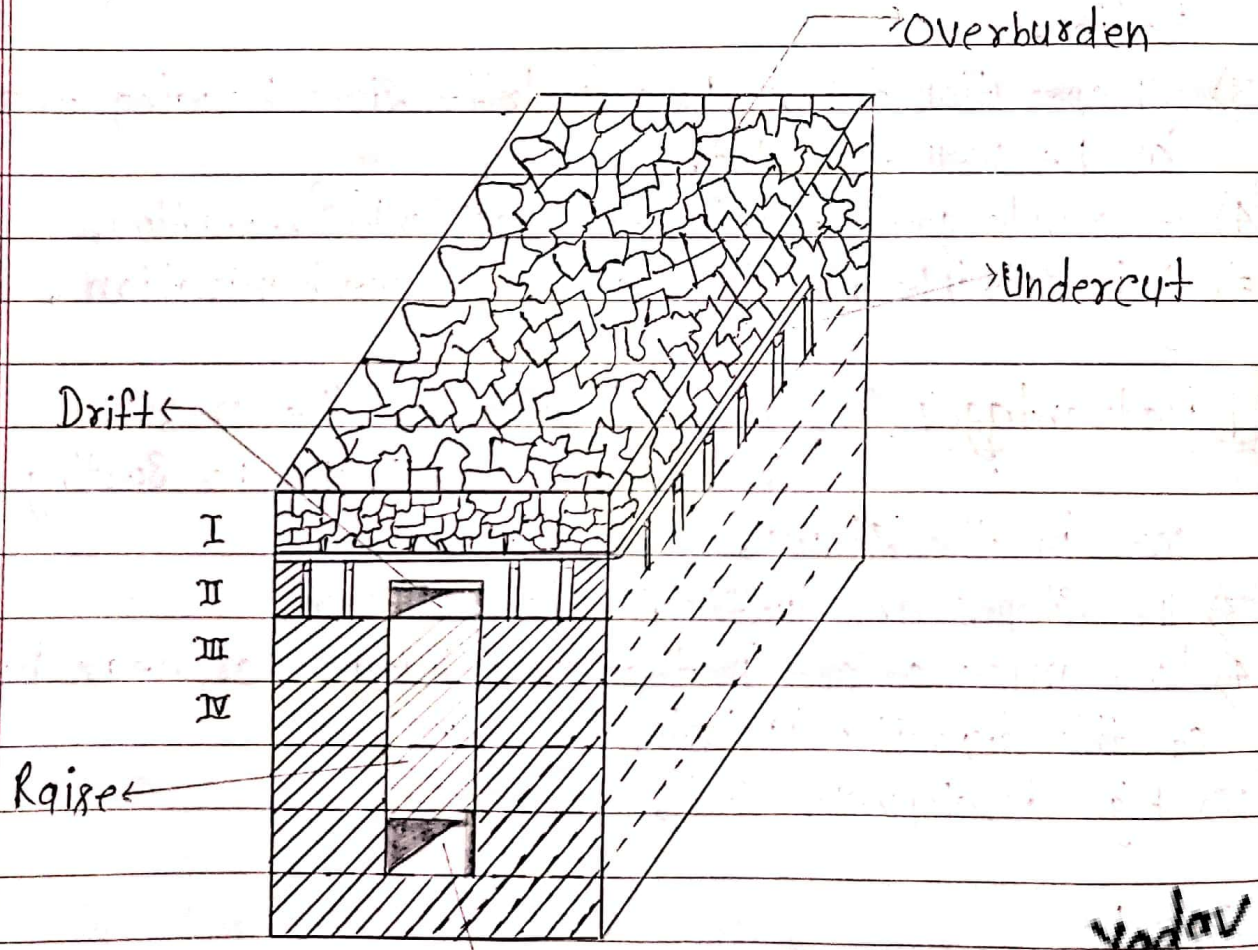
Advantages :- 1) It can be applied to both hard and moderately Weak ground.
2) It is flexible So that it Can be applied to irregular ore bodies.
3) All operation takes place in drift Size heading that Can be Well Supported.
4) It Provide good Condition for accident Prevention.
5) It is Suitable for high degree of mechanization.

Disadvantages :- 1) More dilution of the ore.
2) There is Practically no Sorting of ore in the Stopes.
3) The Stopes are difficult to Ventilate.
4) Low grade of ore in the over burden or near boundary of the deposits is Lost.
5) High development Cost.

Fig) ↓

* H) Top Slicing :-

In this method the ore is mined out in a series of horizontal slices by drilling and blasting beginning at the top of the orebody. Immediately beneath the overburden as the ore from first slice is being taken out timber supports are erected on the floor the slice. The next slice of the orebody is then extracted by drilling and blasting under the caved overburden resting on the timber mat, i.e. the workmen have to work below an artificial roof of timber mat. The slices, each about 2-3m thick, are then extracted in a descending manner. The timber mat consists of their wooden logs (about 125m dia) and thick wooden planks.



(fig- Top Slicing)

Abhishek Yadav

Application :- The method is applicable to.

1) Thick deposit of horizontal extent. The minimum thickness of ore body should be 2-3m.
2) Soft ore which is weak enough to stand without support only for a short period.
3) Weak walls and over burden which can easily cave in.
4) Ground surface which is not to be supported.
5) Areas with cheap and plentiful supply of timber as well as skilled timber man.
6) The timber should be tough and strong.

Preparation :-

The development for top slicing consists of driving a series of drifts and crosscuts at same distance below the top level and then raising to the top of the ore for mining. The ore is removed in slices 2-3m thick. A block is divided into horizontal slices. A haulage way is driven through the ore body and from it a two-compartment timber raise containing an ore chute and a manway is constructed throughout the entire height of the block upto the overburden.

Advantages of top slicing :-

1) It is safe method to use where overhand stoping cannot be employed.
2) It is suitable for intermittent operations.
3) The method permits of high recovery and dillution is little.
4) After the initial development is completed the method can be reasonably cheap provided the labour and timber are cheap.

5) It can be employed under sand or other loose material, and does not require as clean a mat as is required for sublevel caving.

Disadvantages of top slicing :-

1) The method causes surface subsidence.
2) Ventilation is somewhat difficult.
3) A considerable number of working place are needed for a large output and the rate is not flexible.
4) Period of development prior to production is fairly long.
5) Handling of timber and laying of mats is expensiv in labor and time consuming as in the case of square set mining.
6) Waste or low grade ore can not be easily left in place.

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CHAPTER-05

ROCK BURST

Ques :- Explain Causes and Prevention of rock burst.

* Rock burst :-

It is a sudden violent failure of rock and ground mine opening. In the rock burst the strain energy is released from the stressed rock mass violently with a magnitude of Sem Seismic events ranging from 1 to more than in a Richter Scale.

*Causes of rock burst :- 1) Presence of fault, dykes and geological disturbance. their Presence the occurrences of rock burst.

2) Rate of face advance : Lower the rate of face advances more be the chances of rock burst.

3) Extraction height and depth of Working : More the height of extraction and depth of Working more would be the occurrences of rock burst.

4) Decreage in abutment size will increage the occurrences of rock burst.

5) Increasing ~~in abutment size with~~ the span of face will increage the incidents of rock burst.

*Occurs of rock burst :-

1) It occurs in strong brittle rocks which contain few are and existing fracture.

2) Rocks are weak in tension and strong in compressive and hence large quantity of potential energy is stored in the rock under high compressive strength.

3) Rock bursts occurs frequently if the rate at which the energy is released is greater than the rate of which

The energy can be dissipated in a non violent fracture process than as the excavation enlarge.

4) Rock burst occurs frequently if the amount of energy released increases rapidly with the increase of stopping span, while energy can be dissipated non violently remains almost constant.

5) Some of the gravitational energy is increased as strain energy in stress concentration in rock and the remainder is released either non violently through crushing of rock and supports and violently through, which is generally know as rock burst.

*Prevention of rock burst :-

1) By reducing the energy release slowly by developing yielding pillars which yield gradually instead of accumulating high stress over the pillars.

2) Leaving no remnat pillars in the goaf since these pillars will be under the envelope of very high stress as the time passes on.

3) By fracturing the rock ahead of the face blasting which will reduce the level of stress in the rock.

4) By back filling the extracted out area and providing very high support density in the face.

5) By having limited no. of working face and mining the faces towards, each other must be avoided.

6) By Pre-distressing with blasting.

7) By Providing adequate supporting in the underground mine working.

8) By introducing special short firing technique.

* Factor - affecting the rock burst :-

◎- Both Severitly and fracture of rock burst increases With depth due to increases Strain in rocks but rock burst have been reported in Surface, mine as Well as Shallow mines due to lectoric Stress.

◎- The frequency and intensity of rock burst vary With the kind of rock burst are most Common in brittle rocks.

◎- Rock that Stand Well as long as excavation are Small may develop rock burst after.

* Mechanical Characteristics of rock burst :-

Rock Usually Connected With rock burst depending Upon that it is Strong of burst.

1) ROCK TYPE :- Plastically or Vasco elastically deformabe rocks fall Slowly and are Less likely to bursting.

2) PETROLOGY :- Petrology Igneous and metamorphic rocks are generally of no bursting zone that Sedimentary rock.

3) MINEROLOGICAL COMPOSITION :- More Si Siliceous rock quartz in those Containing hard members are belongings to burst Classes and Carbonates and other Sharp mineral are belonging to non burst Classes.

4) Geological FEATURES :- Measures geological features also Played a role on the Process of burst dyke may Cause Weakness in the mild Structure and ~~the increase~~ increases in burst Process in their rock Series.

CHAPTER - 06 ~~ROCK BURST~~

Que :- Describe Use of Jumbo drill With ~~leg~~ air Leg.

* Describe drill With air Leg :-

Where Compressed air is the motive for drills air legs may be advantageously Used to mount the Compressed air drills.

◎- An air leg is essentially a long Cylinder in Which a Piston is actuated by Compressed air Controlled Valve Which is also Used to release the air Pressure to Lower Piston.

◎- An air leg relives the operator of the fatigue involving in holding the drils and Keeping if, Pressed forward as the leg exerts an upward lift and a is forward feeding Pressure on the drill.

◎- The air leg does not increase the rate of Penetration of feed and is Used for drifts upto 2m height.

In Underground mine drilling rigs or jumbos have to be Used for high Speed drivage of large Size drifts.

◎- The term jumbo are after Used Synonymously but Jumbo is a Portable Carries for Under-ground Use.

◎- A Jumbo has a Crew 3-4 operator Who Performs Various operation of Setting a drill, drilling, dismantling etc.

Que :- Describe Various transportation machineries like L.H.D rocker shovel, Spiral Chutes and draw points, Scraper etc.

* Spiral Chutes :-

A narrow opening in mine working through which broken ore is loaded into mine car. The term also applied to a box like structure equipped with controlling gate fitted to such opening.

* Rocker Shovel :-

A Rocker Shovel is usually lowered by compressed air, or in some cases electricity. It is commonly mounted on steel wheels designed to run on narrow gauge rails, with some later models using metal or rubber-tyred road wheels. The operator, standing on a raised platform to one side of the machine operates the controls, one lever to drive the machine along the tracks and another to raise and lower the bucket.

* Draw Point :-

A draw point is a place located at the bottom of stopping area and from where ore can be loaded manually or by machines into tubs or mine cars. It has no controlling gate.

* Scraper :- 1) excavation cum transport equipment
2) Suitable for soft material
3) generally used for top soil removal
4) Diesel operated with pneumatic tyre wheels.
5) A bowl fitted with a cutting blade at the bottom.

* L.H.D (Load - Haul - Dump) :-

It is used to perform, Loading and dumping of bulk material.

Applicability :-
- Gradient 1 in 6.
- floor Condition required strong and good.
- Maximum Speed for empty L.H.D 8-30 mile per hour.

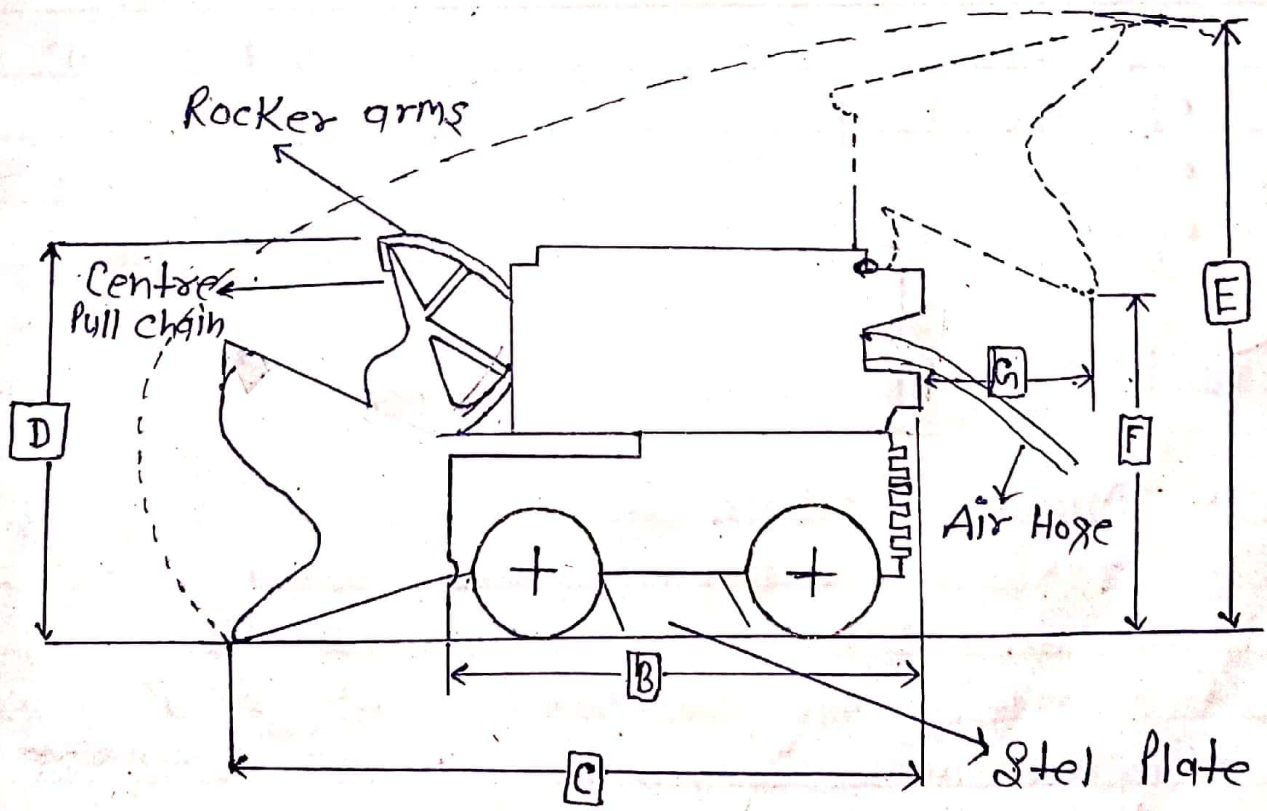
Advantages :-
1) Greater flexibility.
2) High Speed for transport (12 Kmph)
3) Maximum labour required.
4) Higher productivity.

Disadvantages :-
1) Difficult in heavy load movement.
2) High maintenance Cost.
3) Large Consumption of engine.

Ques- Rocker Shovel :-

A rocker shovel Consists of.

- A chassis futted with Crawler chain, Pneumatic tyres or Wheels for traction.
- A loader bucket Shovel at one end.
- Motor for lower and
- Necessary Controls for fitting ~~roadway~~ and for operation on the Shovel.
- When loaded, raises problems of braking and Control and a Crawler chain Shovel is to be Perfered.
- A rocker Shovel has a bucket or Shovel at its ~~from~~ Front end which may be used for dumping the Contents to one side.



(Diagram - Eimco 21 rocke Shovel.)

Some of Specifications of Eimco - Elecon Front end loader Shovel, Model 21, are as follows.

The model is used in many Metal Mines:

A) Overall operating width	1067 MM
B) Overall length (~~Bucet down~~)	1397 MM
C) overall length (Bucket down)	2210 - 2286 mm
D) overall height (bucket down)	1422 - 1549 mm
E) Headroom height	2235 - 2515 mm
F) Discharge height of bucket	1321 - 1727 mm
G) Discharge distance	457 - 711 mm
• Cleanup range	2286 - 2489 mm
• Range of track gauge	460 - 1220 mm
• Air pressure range	4.2 - 7.0 Kgf/cm^2
• Air hose Size	25 - 32 mm
• Bucket Capacity	0.21 - 0.28 m^3
• Weight, Completely assembled	3266 Kgf
• Motors (air)	2 Nos
• Air Consumption	8.5 m^3/mm

* Working :-

• Minimum Width	1.1 m
• Maximum Cleaning Width	3.5m
• Loading rate	84 m^3/h
• Operating air pressure	4.5 to 7.0 bar - min. 3,5 bar
• Maximum inclination	4°
Availability of Iloader	85%

Support

The coal pillars formed during drivage of galleries form the natural support. Where the roof is bad wide junctions should be avoided and level galleries on either side of a main dip should be staggered. Props should be avoided as far as practicable in roads having tub movements on gradients as they get dislodged by run-away or derailed tubs. In a thin seam a bar to support the roof in working places reduces the effective height and workers find it difficult to carry loaded baskets on head for tub loading. Roof bolting or roof stitching provides a good alternative for such situation.

Drainage

Drainage of water in the mine is effected by pumps which are designated as follows depending on the location of their installation.

1. Face pumps, 2. Stage pumps, 3. Main pumps.

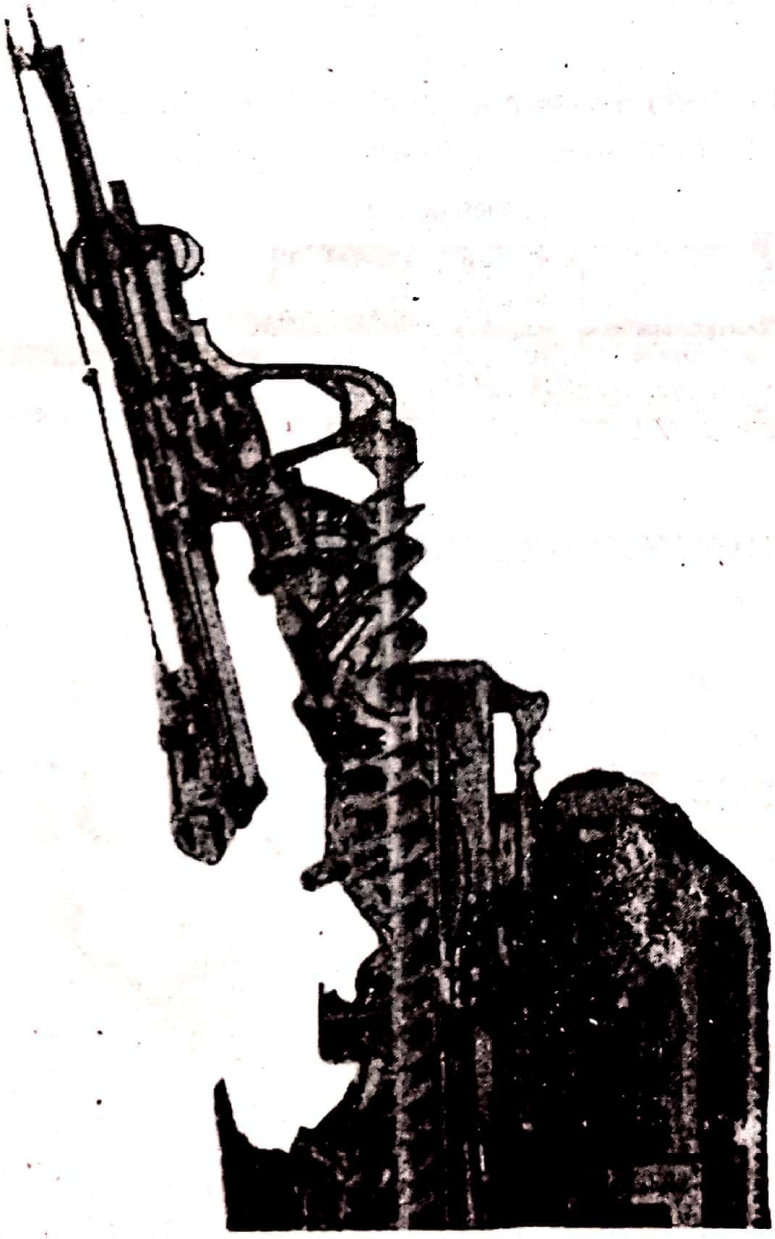


Fig. 7.5 and 7.6 show the general arrangement for dewatering the dip faces. As the face advances the pump at the face also has to advance. For this reason the pump is usually small, of 5 to 15 h. p., 50 mm suction and delivery pipes, with capacity of 250 to 450 mm capable of devloping only 15 to 30 m head, and is mounted on a also should preferably be mounted on the pump trolley. Centrifugal pumps are generally used but Roto pumps have greatly replaced them in recent years.

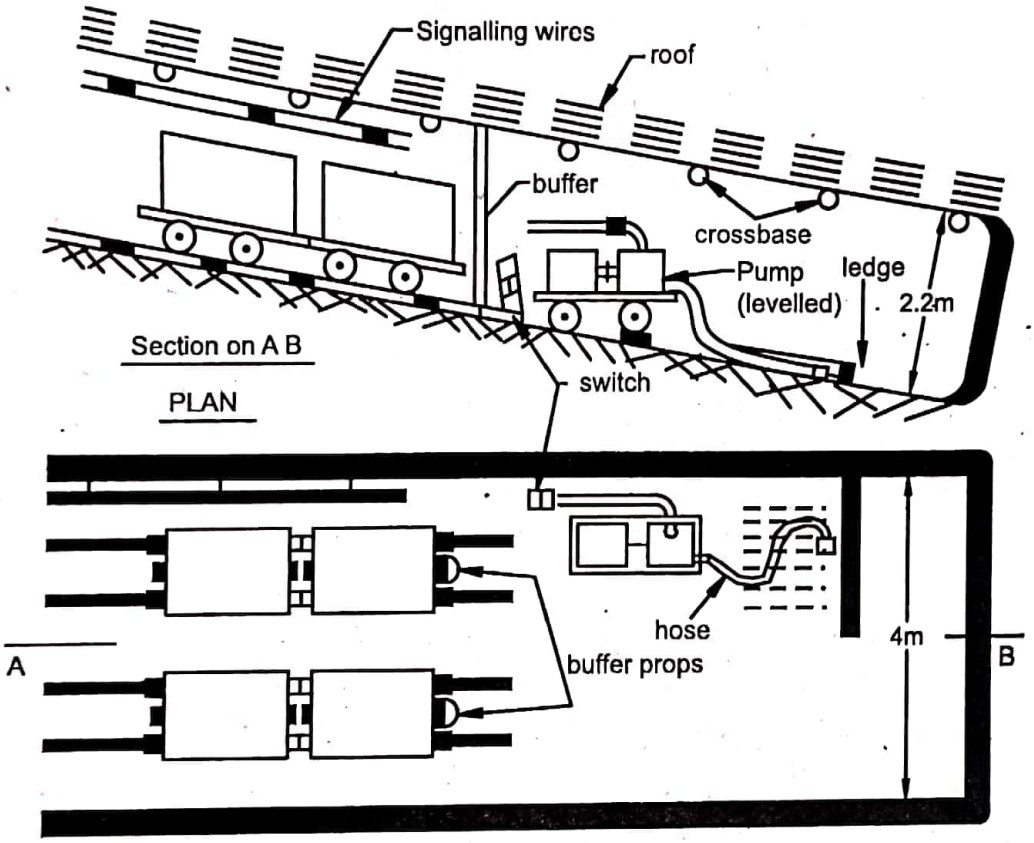


Fig. 7.5 Sectional elevation and plan of a dip face

The face sump is of a temporary nature and has a small capacity as the face has to progress daily. The sump serves one week where the face advances 9 m to 12 m per week. If the thickness of coal seam permits, the face sump may be formed by leaving in the floor a small ledge (called *adkha* in Hindi) 0.4 to 0.6 m high on one side of the gallery and 4.5 to 6 m outbye the face. Alternatively, in a thin seam the face sump may be formed by blasting the floor stone to give an excavation 2 m × 1.5 m × 1.3 m deep so as to have a capacity of 2500 to 3000 litres.

The pump discharges water into the sump of semipermanent pump on the outbye side, called the stage pump, which delivers water to the main pump. The sump of the stage of the pump may be formed by driving a short gallery S in a pillar if the latter is large. If the pillar is small a gallery driven to a length of about 5 m as shown in Fig. 7.6 may serve as a sump.

Small accumulations of water in a dip working at the face are bailed out by bailing majdoors with the help of buckets. The bailed out water is allowed to gravitate to the face pump of main dip or companion dip and from there it is pumped out. As a substitute for bailing majdoors small pumps operated by the coal drill are also available *e.g.* Rana Drill pump.

Drilling

For soft sandstone and shale the usual 1.25 H.P., hand held, 110 V. rotary coal drill can be used by (i) replacing the gear box to reduce the speed of drill rod from nearly 600 r.p.m. to approximately 240 r.p.m. (ii) use of turbine section drill rod instead of the diamond section drill rod used for coal drilling. The diamond section drill rod wears very fast. The drill bits used for coal can be used for the soft stone also, though the life naturally is much less. The improvised drill which normally has a rating of 20 of 25 minutes in coal, gets hot after use for 10 to 15 minutes and sufficient time should be allowed for its cooling down before re-use. Nearly 15 holes may be drilled in one shift of eight hours. The pull is only 1.2 to 1.5 m and with one hand held drill in conjunction with manual loading of muck into tubs, a weekly progress of nearly 5 m is possible in a drift of 4 m × 2 m cross section, 2-shift working.

For hard standstone or similar rock, the same arrangement with eccentric drill bit works well, but the drilling is slower. More progress and accurate direction of holes can be achieved by the use of power feed or mechanical feed arrangement.

Drilling in hard strata is generally carried out by compressed air operated drills, usually with mechanical feed. The rate of penetration varies from 0.2 to 0.3 m per minute in hard rocks. One jack hammer drill, mounted on air leg and adopted for wet drilling is used in a drift of 4 m × 2 m cross-section. An air leg relieves the operator of the fatigue involved in holding the drill and keeping it pressed forward as it exerts an upward lift and a forward feeding pressure on the drill. An air leg does not increase the rate of penetration or feed as it is used for drifts upto 2 m height (Fig. 7.8). Drilling rigs or jumbos have to be used for high speed and for large-sized drifts. The terms "jumbo" and "rig" are used synonymously. A jumbo is a portable carriage which has arms for mounting of 2 or more drills. The arms can be raised, lowered and slewed at any angle in position by hydraulic or air pressure and all the drill steels are placed in the carriage.

After the alignment and gradient are fixed, the drifting starts with drilling shot holes according to a specified form, called "drilling pattern", which consists of three or four groups of holes. The drilling patterns suitable for different types of rocks under different conditions of excavation in mining and the blasting methods are described in the chapter dealing with explosives and blasting. It may be mentioned as a broad guideline that burn-cut and wedge cut pattern are normally favoured for drifting in stone.

Blasting

All holes are charged and fired simultaneously with the use of milli-second delay detonators as the quantity of explosives is heavy. "Inverse initiation" is the general practice. "Sumpers" are connected to instantaneous detonators, "first eases" to delay detonators with delay *upto* 100 milli-seconds. The second easers and trimmers are similarly connected to delay detonators which give a suitable time gap of 100 milli-second or so, between successive rounds.

In a drift of 3.8 m × 3 m cross-section in sand stone the consumption of explosives per metre advance is 10 to 12 kg. It is less for shales. An average drift of 10 to 11 sq. metre cross-section in sandstones may require 30-40 shots with a total charge of 18 to 22 kg for a pull of 1.5 m.

Transport

The common mode of transport in majority of our mines is rope haulage, though scraper chain conveyors, belt conveyors and locomotives have been introduced in some mines. The transport used for an advancing heading should be capable of providing transport facilities near the advancing inbye faces. Direct haulage suits well in this respect for the advancing and the tail rope haulage for the rise headings. For level headings endless rope haulage is the common practice when the roadway is nearly 100 m or more in length, the shorter distances being covered by hand tramming before installation of haulage.

Two tracks, one for the load and the other for the empties, are always essential at the loading points at the face. The haulage tracks should be as near the face as possible for convenience of loaders and to avoid expenses on lead. When driving two or more headings a skid mounted machine has to pass in the space between the track and the pillars.

Scraper chain conveyors can be readily kept close to the face, within shovellable distance, by addition of pans. The scraper chain conveyor may deliver coal into tuvs or into a belt conveyor. A belt conveyor is not fully utilised if imployed for drivage of one heading or only one pair of headings due to insufficient coal and its extension is not as quick and simple as in the case of scraper chain.

Ventilation

Drifting is an unproductive and much costlier work than drivage of roads in coal. In any case, it is not immediately paying. It is therefore a standard practice to drive only one drift, and not parallel drifts at close interval. The ventilation is always provided by an auxiliary forcing or exhaust fan. A small drift, maximum length 300 m, can be ventilated by a single fan, either forcing or exhausting. To avoid recirculation of air by the fan it should be placed in the path of the main ventilating air current (from which a branch is taken to the drift) at least 5 m away from the nearest corner of the drift. In long drifts, however, a combination of exhaust and forcing fan is preferred for efficient ventilation and speedy removal of fumes after blasting. Such fumes are drawn direct into the exhaust tube and the drift-air is unpolluted for persons travelling and working in drift. The mouth of the exhaust tube should be within 2 m for the face and the forcing fan should be installed at least 10 m outbye the end of the exhaust tube to avoid recirculation of air (Fig. 7.12). The increasing use of diesel engines underground makes tremendous demand on ventilation system that have to clear out dangerous or irritating exhaust gases. 200 m^3/min of air is the accepted requirement of normal size drifts (say 4.2 m × 2 m) and where jumbos or drill rigs are used the standard requirement is estimated at 42 m^3/min per drill. Exhaust or compressed air operated machines largely help in ventilation. I.L.O. (Internation Labour Orgnisation) recommends a quantity of 0.175 m^3/s per m^2 of drift face area. In very hot faces upto 0.75 m^3/s have been used. DGMS circular no. 30 of 1973 requires the ventilation of drives exceeding 50 m in length to be such as to dilute the nitrous fumes produced by blating to 5 p.p.m. and CO to 50 p.p.m. within a period of 5 minutes. This is however a stringent requirement in case of long tunnels. It would be more desirable in such cases to increase the permissible time of dilution or use an overlapping system of ventilation.

MINE METHOD (U/G - METAL)

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(A)

SHORT TYPE QUESTION'S ONLY TWO NUMBER

Q- Define - raise.

Raising is a regular operation in the development of Metalliferous Mines. It is associated with danger of accidents due to fall of roof, rock, inadequate Ventilation resulting in poor visibility at the work site and uncomfortable working conditions. Frequent Climbing up and down the ladder, often with tools, between the working spot and lower level is quite tedious for the workers.

The Method practised for raising are :

(1) Open raising (2) Two Compartment raising
(3) Jara raise lift 4) long hole drilling Method.
5) Raise borer (6) Alimak raise Climber.

Q- Define Cross-Cut.

It is a horizontal drivage which leads the shaft and passes through the country rock in order to cut across the load at an angle to strike.

(OR)

When the development of mine is carried in any direction other than the dip and strike direction.

Q- Define STOPE. or (Define Stope and Stoping.)

STOPE:- It is a solid ore block or ore pillar which is under extraction is called Stope.

STOPPING:- It is the method of extraction of ore from a block or pillar formed during development. As a rule stopping is started on each side of a raise winze Connection.

Q- Define Spherical Charge.

- Meaning of 'Spherical Charge' is to keep an explosive column, not more than 6 times of diameter of hole.
- For Crater Blasting, normally, Spherical Charge' of Explosives are used.

Q- Define - level

Ans- • It is an horizontal roadway which is driven in the ore body on the direction of Strike is called level.
• A measurement of the difference of altitude of two point by means of a level.

Q- Define draw point.

Ans- A draw point is a place located at the bottom of stopping area and from where ore can be loaded manually or by machines into tubs or mine cars. It has no controlling gate.

Q- Define finger raises.

Ans- A finger raises is used for raise ore.
- The usual arrangement is as a system of several small cross-section shoot that branch together to the same delivery point.

Q- ~~Be~~ State the disadvantages of Block Caving Method of Stoping.

Ans 1) Capital expense is large.
2) There is no change of selective mining of high and low grade ore.
3) Caving of a block is difficult to control.
4) There is excessive dilution if caving is uncontrolled.

Q- State the applicability conditions of Sub-level Stoping :-

Ans- 1) Sublevel caving is used in steeply dipping ores and in other deposits with a comparatively large vertical thickness.
2) Sub-level drifts must be large vertical thickness.
3) The surface conditions must allow subsidence.
4) The hanging can be used in weak ore.

Q- State the applicability conditions for breast Stoping.

Ans- i) The deposite must be horizontal or mild up.
ii) laying at a moderate depth.
iii) ~~laying at a moderate depth.~~
iii) Country rock must be rock.
iv) Medium thickness of ore body upto 5m.

Q- What are the advantages of Top Slicing Method of Stoping.

Ans- 1) It is safe method to use where overhand Stoping Connot be employed.
2) It is suitable for intermittent operations.
3) The method permits of high recovery and dillution is little.
4) It can be employed under sand or other loose material, and does not require as clean a mat as is required for Sublevel Caving.

Q- State the applicability conditions for overhand Stoping.

Ans- [i] The thickness is selected is upto 4.5m
(ii) The ore body required strong
(iii) Both hangwall and footwall should be strong.
(iv) The inclination of ore body is 40°-90°.

Some of the terms which are typically used in metal mining practice are as follows :

Adit. If a deposits is at a higher level than the general ground surface, the access to it is by a level or a slightly rising roadway from the ground level. This type of nearly level roadway is known as adit.

Assay. To determine in the laboratory mineral content or metal content in an ore sample.

Alluvium. Alluvium is a loose or unconsolidated deposit resulting from the breaking up of the bed rock. The broken particles either remain in position or are moved by surface water and are redeposited elsewhere as a more or less loose deposit which may convert into unconsolidated rock.

Back :

(1) The term denotes the roof or hanging wall of an ore body if the dip is mild. Where the orebody is steeply inclined the term back is used for the lower or under surface of a block of ore. It is a surface usually horizontal from end to end, but may be inclined from side to side depending upon the dip of the vein.

(2) Back is the orebody between a level and the surface or between two levels. *Length of back* is the distance between levels on the plane of the orebody. Note that *level interval* is the *vertical* distance between two levels.

Beneficiation (also called ore dressing): The process of treating mined mineral matter in a plant so that the resulting product is richer or more concentrated with the useful mineral and nearly devoid of gangue/waste.

Breast. Vertical end surface of a working heading; the same as a face.

Cave-in. The partial or complete collapse of a mine working and extension of it upto the surface.

Chute. A narrow opening in mine workings through which broken ore is loaded into mine cars. The term is also applied to a box like structure equipped with controlling gate fitted to such openings.

Collar. The entrance-way from the surface, of a shaft or from a level, of a winze.

Compound lodes. Veins seldom occur alone. There are often a number of parallel deposits, of a series of intersecting veins. Such a system is called a compound lode and where veins intersect, the junction, sometimes referred to as a "pipe" or "chimaney" may carry high values.

Concentrate. The valuable powder produced from an ore after crushing, grinding and other processes in a concentrator plant or mill where the waste is separated to yield the mineral in a concentrated form in the powder. Metal is produced from the concentrate in a smaller.

Cone. A cone is a funnel shaped excavation located at the top of a raise and used to collect rock from the area above. It is also called a chute.

Country rock. The country rock of an orebody is that rock which is predominant in the area and which contains the ore body. The country rock forms the foot wall and the hanging wall.

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Crib-steel (also called **Chock or pigstie**). A system of timbering in which the members, about 1.5m long, are laid, one pair upon another, to form a rectangular opening in the centre and to build a solid timber support.

Cross-cut. A level tunnel or roadway which leads from the shaft or level and passes through the country rock in order to cut across, or touch, the lode at an angle to the strike.

Crown pillar. A pillar of insitu ore in mine to support the level above it. It may have a few essential openings for manway, ventilation, etc.

Cut-off Grade. The minimum percentage of metal in the ore for economic extraction of the ore from a mine and its subsequent smelting to extract the metal.

It represents the average grade of run-of-mine ore below which mining is no longer viable. It varies from time to time and depends upon market price of the metal as well as on costs involved in excavating ore from time to time.

Dip, Strike, The strike of a bed is a level line on the surface of the bed. In effect is a contour line in the plane of the bed. The line of true dip in a bed or surface is the steepest line in the inclined surface and is always at right angles to the strike.

Draw Point. A draw point is a place located at the bottom of stoping area and from where ore can be loaded manually or by machines into tubes or mine cars. It has no controlling gate.

Drive a Drift. A horizontal tunnel or roadway nearly parallel to the strike of the lode or vein but it can be located in the country rock either on the footwall side of the lode or on the hangwall side. It is called a footwall drive in the former case and a hangwall drive in the later case. The term **level** is some-times used for drive, but the distinction should be noted.

Dyke. It is longer parallel-sided vertical wall of igneous rock formed due to upward intrusion of molten magma generally through fissures of clacks existing in the previous rocks.

Exploration. The work involved in the search of mineral and in gaining knowledge of the size, shape, position and value of an orebody.

Fault. A fault is a fracture in rocks usually associated with lateral or vertical displacement of the fractured portions. Faults occur when the strength of the rocks is insufficient to withstand the stresses due to earth movement.

Fill. Waste material used to support the walls of a slope, and to provide a working platform for the miners, the underground area where such material has been packed is called backfill.

Finger raise. A finger raise is used for transferring ore. The usual arrangement is as a system of several small cross section raises of short length that branch together to the same delivery point. (Comparable with fingers branching off from the hand).

Foot Wall. The wall of rock on the under side of a vein. It is called floor in bedded deposits.

Grade. Amount of vertical size of fall in 100m of horizontal distance expressed in percent.

Grade. The proportion of metal contained in unit weight of ore, even though the metal is in the form of a mineral as is often the case. The metal may be in one or more of its mineral forms. The grade is usually expressed as a percentage by weight, e.g. a grade of 4% lead means a tonne of the lead or contains 40 kg of lead. The ores of precious metals contain minor amounts of the metal and are expressed as troy ounces per long ton or as grams per tonne. (1 ounce Troy = 31.1 gram).

Hanging Wall. The wall or rock on the upper side of an inclined vein. It is called roof in bedded deposit.

Heading. Any part of the underground mine where work of driving a roadway is in progress; usually confined to development working only.

Incline. An incline is a sloping tunnel driven from the surface to the deposit through the alluvium and the rocks overlying or underlying a mineral deposit. It is sometimes known as inclined shaft.

Level. Approach to underground mineral beds and orebodies at depth is first by vertical or inclined shafts and then from such shafts by horizontal passages (drifts and crosscuts) called *levels*.

These are commonly spaced at regular intervals, in depth, and are either numbered from the surface in regular sequence or designed by their actual distance below collar of the shaft, for example; 100 m L, 200 m level, etc. The term is often used in the same sense as "drift" or to cover all horizontal working on one horizon.

Lode. See "Vein"

Mill tailings. The crushed and ground reject material produced from one ore in a concentrating plant. It is often used as hydraulically placed fills in mines.

Ore. An ore is a rock containing mineral which can be use for economic extraction of metal after processing to separate the mineral from gangue. Ores usually occurs as veins or lodes.

Ore-Run-of-mine. See under "run-of-mine"

Straight ore. An one containing minerals of single metal.

Ore-body. The part of a vein that carries ore generally all parts of a vein are not ore.

Ore-pass. An ore pass is a vertical or inclined underground passageway for downward movement of ore by gravity.

Outcrop. Commonly considered as the surface exposure of a mineral deposit. The uppermost part of a mineral deposit may be covered with soil or other overburden however, and thus the out-crop may be hidden.

Over-burden. Valueless rock and earth covering a mineral deposit upto the ground surface.

Radio-activity. The emission of radiant energy; the property posessed by certain elements (chiefly radium, uranium, thorium, and their products), of spontaneously emitting alpha or beta rays and also gamma rays, by the disintegration of the nuclei of atoms. Such elements are called radioactive. These elements can be detected by radiation counters.

Raise. A connection between two levels in an ore body driven in an upward direction.

Reef drive. A reef drive is in the vein itself or partly in the reef and partly in the wall rock, usually the footwall.

Reserves.

1. Proved ore reserves, where the tonnages and grade of ore have been carefully outlined and assessed in 3 dimensions by excavation or drilling, but also include minor extensions where limiting geological factors are definitely known. These reserves are also described by some authorities as **measured ore.** 2. **Probable ore** (or **indicated ore**) applies to those parts of an orebody adjacent to proved or where the conditions cannot be so precisely defined, but indicate that ore will probably be found. 3. **Possible ore** (or **inferred ore**) where insufficient quantitative estimates are available, and limited to an assumed continuity based upon a broad knowledge of the geological character of the

Level : A level roadway in the ore body or be in which follows the strike. In metal mines a level is rarely in a straight line (unline in coal mines).

Cross-cut - A level tunnel or roadway which leads from the shaft or level and passes through the country rock in order to cut across the lode at an angle to the strike.

Drive or drift - A horizontal tunnel or roadway parallel to strike of the lode or vein but it can be located in the country rock either on the footwall side of the lode or on the hangwall side. It is called a footwall drive in the former case and hangwall drive in the latter case. The term *level* is sometimes used for drive, but the distinction should be noted.

Cross drift or Cross drive : It is horizontal underground roadway driven within the ore-body between the hanging wall and the footwall. It is usually at right angles to the drive or drift.

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A *reef drive* is in the vein itself or partly in the reef and partly in the wall rock, usually the footwall.

Level interval : The vertical distance between two adjacent main levels, main horizons or main drives.

Sub level or *intermediate level :* a level or drive situated between the main levels or main drives.

Raise : A connection between two levels in an orebody driven in an upward direction.

Raises intended for passing ore from an upper level to lower one under its own weight are called ore *chutes*. Short ore chutes intended for drawing broken ore from the blocks are called *Draw holes.*

Ore pass : An ore pass is a vertical or steeply inclined underground passageway for downward movement of ore by gravity. This term is not used in coal mining.

Draw point : A spot on the floor from where gravity fed ore of a higher level is loaded into tubs or minecars.

Winze : A dipping connection in the orebody joining two levels. A raise or winze is located mostly near the footwall of the orebody.

Plat or station : It is the excavation adjoining the shaft at each of the different levels where men and materials are removed or delivered.

Stope : An area from where ore (and in some cases, a little country rock in the hangwall and footwall) has been extracted and the hangwall allowed to cover or supported by filling of some material like sand, mill tailings, blocks of grainite, etc.

Stoping - Extraction of ore from block or pillar formed during development. As a rule stoping is started on is started on each side of a raise-winze connection.