Underground Mine Development

Lecture prepared for 2nd year mining Engineering, for the course – “Fundamentals of Mining Engineering” at Unity University

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Main reference used.

1. Nature of Underground Mining

Surface mining may be often preferred over underground mining for cost and productivity reasons but attraction of underground mining include;

- Variety of ore deposits that can be mined by the method
- Versatility of the method to meet production needs - that cannot be approached by surface mining
- Less environmental impact

Some analysts predict that the share of underground mining may increase and argue;

- Most of the near-surface deposits have already been mined
- Great expense of meeting all environmental requirement on surface

Other analysts for surface mining to continue to increase percentage and argue;

- Ever increasing productivity of surface mining equipment
- Ease with which surface mining equipment can be upsized and automated

Nevertheless it is safe to assume that underground mining will continue to play and important roll.

Main factors characteristics in planning for development

- Less affected by location factor, especially climate
- Less environmental consequences
- Most critical factors are ore and rock strength
- Presence of ground water
- Rock temperature
- More skilled labour is required
- Financing may be more difficult due to higher risk
- Subsidence may become the most important environmental concern

Limited excavation and relatively small opening may be required but these could be more costly on tonnage bases and more type of excavation could be required. Require ventilation. Possibility of double use of development works. Openings driven for exploration purpose may be used for development and vice versa
2. Type of underground openings

Underground development openings can be ranked in three categories in order of importance

1. **Primary**: Main openings, e.g., shafts, declines
2. **Secondary**: Level or zone openings, e.g., drift, entry
3. **Tertiary**: Lateral or panel opening, e.g., ramp, crosscut

Generally development work is done in this order but some variation exist with different mining methods.

3. Mine Development and Design

Mine development must proceed **considering** all aspects of mine **design**. Extreme care must be taken in decisions because of the **complexity** and **cost** involved and the most crucial matters include

a) Mining method selection

Once underground mining method is selected then selecting the **exploitation** method is the focus. Development should not proceed until;

- Production **plan** is adopted
- Select the **class** of underground **method**: unsupported, supported, or caving.
- Which depends on **natural** and **geological** conditions of the mineral deposit
- **Economical** and **environmental** factors

The **mining** method determines the **type** and **placement** of **primary** development opening. E.g., in **caving** methods the openings may need to be placed **outside** the fracture boundary. If the integrity of the ground overlaying the active mining area can be ensured primary openings can be located **centrally**

b) Production rate and Mine Life

A number of geologic and economic conditions determine the **optimum rate** of **production** including; **market** conditions, selling **price** of the commodity, mineral **grade**, development **time**, mining **cost**, means of **financing**, government **support**, taxation policies, etc.. Generally, the **higher** the production rate the **shorter** the mine life.
The recent trend is for higher production rate and shorter mine life due to higher borrowing cost, greater investment risk, higher labour cost, etc.

c) Main Access Opening

These concern the number, shape, and size of main openings.

Such decisions are made during the selection of primary material handing.

Factors influencing the decisions include depth, shape, size of the deposit, topography, natural geological conditions, mining method, and the production rate.

Changes should be avoided because they are disruptive and expensive especially in short-lived operations.

4. Type of opening

- Shafts that could be vertical or near vertical
- Declines
- Adits or drifts

Figure shows underground mine terms.
Shafts

Shaft - A primary vertical or non-vertical opening through mine strata that connects the surface with underground workings.

Vertical shaft are among the most common for deep mines. Near vertical are costly.

Application of near vertical shafts: in moderately inclined deposits, (30 - 70) degree

Application of vertical shafts: in vertical or steeply inclined, > 70 degree deposits

Shaft plant consists of the facilities installed for materials handling ore, coal and associated waste material and means of transport of miners.

They may include systems for ventilation, drainage, power supply, and communication.

A three dimensional model of an underground mine with shaft access – source wikipedia
Underground mine basic infrastructure

FIGURE 1.1 The underground mine—basic infrastructure
Decline or Slope

Declines can be a spiral tunnel which circles either the flank of the deposit or circles around the deposit. The decline begins with a box cut, which is the portal to the surface. Depending on the amount of overburden and quality of bedrock, a galvanized steel culvert may be required for safety purposes. They may also be started into the wall of an open cut mine.

Application: shallow or medium depth horizontal deposits, high production low life. Limited 12% to 14% inclination with truckss and about 16% for conveyors.

Adit or drift: for shallow outcrops, horizontal deposit or steeply inclined in high relief

5. Some important terminologies

Back - The roof or upper part in any underground mining cavity.

Bottom - Floor or underlying surface of an underground excavation

Angle of dip - The angle at which strata or mineral deposits are inclined to the horizontal plane

Floor - That part of any underground working upon which a person walks or upon which haulage equipment travels; simply the bottom or underlying surface of an underground excavation.

Pillar - An area of coal left to support the overlying strata in a mine; sometimes left permanently to support surface structures.

Rib - The side of a pillar or the wall of an entry. The solid coal on the side of any underground passage. Same as rib pillar.

Roof - The stratum of rock or other material above a coal seam; the overhead surface of a coal working place. Same as "back" or "top."
Strike - The direction of the line of intersection of a bed or vein with the horizontal plane. The strike of a bed is the direction of a straight line that connects two points of equal elevation on the bed.

Country rock – Waste material adjacent to a mineral deposit

Wall Rock – Country rock boundary adjacent to a deposit

Capping – waste material overlaying the mineral deposit

Shaft - A primary vertical or non-vertical opening through mine strata used for ventilation or drainage and/or for hoisting of personnel or materials; connects the surface with underground workings.

Ramp - A secondary or tertiary inclined opening, driven to connect levels, usually driven in a downward direction, and used for haulage.

Drift - A horizontal passage underground. A drift follows the vein, as distinguished from a crosscut that intersects it, or a level or gallery, which may do either.

Crosscut - A passageway driven between the entry and its parallel air course or air courses for ventilation purposes. Also, a tunnel driven from one seam to another through or across the intervening measures; sometimes called "crosscut tunnel", or "breakthrough". In vein mining, an entry perpendicular to the vein.

Main reference used.