Underground Mining of Metalliferous Deposits
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Lecture 39
Shrinkage Stoping – I

STOPING

Stoping is basically the extraction method of ores from the stope

A. Naturally supported
    1. Open stoping
        a) Open stopes in small ore bodies.
        b) Sublevel stoping.
    2. Open stopes with pillar support
        a) Casual pillars
        b) Room (or stopes) and pillar (regular arrangement).

B. Stopes with artificially supported.
    3. Shrinkage stopping.
        a) With pillars.
        b) Without pillars.
        c) With subsequent water filling.
    4. Cut-and-fill stopping.
    5. Stulled stopes in narrow veins.
    6. Square-set stoping.

C. Caved stopes.
    7. Caving (ore broken by induced caving).
        a) Block caving; including caving to main levels and caving to chuts or branched raises.
        b) Sublevel caving.
    8. Top slicing (mining under a mat which, together with caved caping, follows the mining downward in successive stages).

D.Combination of supported and caved stopes. (As shrinkage stopping with pillar caving, cut-and-fill stopping with top slicing of pillars, etc.)

E. Special methods of stoping.

1. Vertical crater retreat.
2. Hydraulicking
3. Extraction of narrow veins.
4. Resuing methods

1. SHRINKAGE STOPING

INTRODUCTION

- Shrinkage is meant for a temporary accumulation of the broken ore in the stope. Thus the method of working, in which the broken ore is stored is called shrinkage stoping method and in the stope, where the blasted ore is kept is called Shrinkage stope.
- Basically, shrinkage stoping is an overhand stoping, where the blasted ore is partially extracted and the rest is allowed to store in the stopes itself.
- As the most part of the blasted ore stays in the stope, the void volume in the stope is reduced or shrinked.
- The stored ore is also allowed to act as the platform for the operation of machineries and workers.
- No filling material is allowed in the stopes.
- The stored ore from the stope is extracted as per the demands/technical requirements.
- Swelling of blasted muck governs the partial extraction limit.

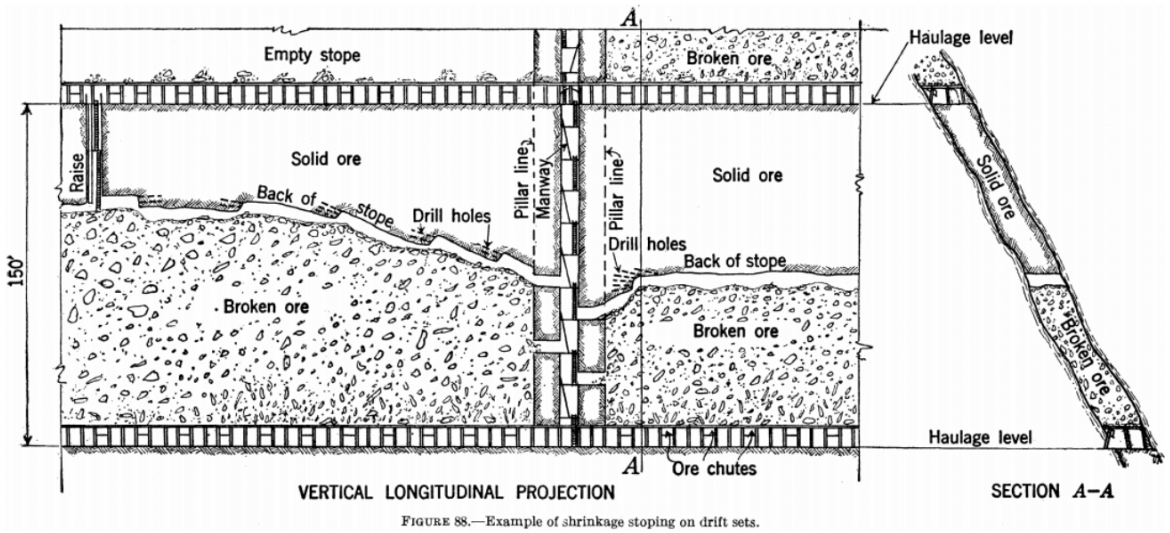

FIGURE 88.—Example of shrinkage stoping on drift sets.

Figure 1. Example of shrinkage stoping on drift side

Conditions of Applicability

Shrinkage stoping can be used in orebodies with:

- Ore body must be steeply dipping - the dip angle must exceed the angle of repose of the broken ore. Otherwise the stored ore from the stope will not gravited down through finger raise/ore-chute.
- Regularity/continuity of the ore body along the dip – As the stope need to follow the orebody there must be any serious obstruction to flow of ore.
- Ore mineral properties – As the broken ore act as platform, it must be strong. The ore mineral/associated or gang minerals should not be sticky to hamper the free flow through ore-chute/finger raise. Too much fine or clayey materials will hamper free flowing. Orebody must be continue and free from faults.

Shrinkage stoping can be used in orebodies with:

- No carbonaceous/sulfide material – As the blasted ore is stored for long duration, chances of spontaneous heating of carbonaceous/pyritic ores are to be considered. This problem may occur with sulfide ores which have a tendency to oxidise and decompose when exposed to air. Some sulfide ore may oxidise to such an extent that in the concentrator plant recovery may be much less. Ores, especially those containing uranium minerals which exude/discharge radon gas, increased radioactive emission. Inhalation of Radon results into severe health hazards.
- Strength of ore body and wall rocks– Generally competent ore body and wall rocks are preferred for shrinkage stoping. For weak ore body, degradation of ore size and quality may occurred as it act as a platform to the machines. In case of weak Hangwall/footwall rocks result into the spalling of the rocks on the orebody, which dilute the ore. Often 20 – 30% dilution may also occure.
- Cost of Mining - As the method does not need a lot of investment, it is economic mining. It is allowable for the low grade ore also.

Ground conditions

A. **Ore strength:** strong (other characteristics important – should not pack, oxidise or spontaneously combust)

B. **Host rock strength:** strong to fairly strong

C. **Deposit shape:** tabular or lenticular, defined boundaries

D. **Deposit dip:** steep (>50 degrees or angle of repose)

E. **Deposit size:** 1-30 m wide – fairly large extent

F. **Ore grade:** fairly high

Development work

The chronology of level operations:

A. Construction of x-cut/haulage roadway – First the access way or X cut needs to be excavated from the shaft to the nearest point of ore body.

B. Construction of Haulage drifts –On completion of X-cut, Haulage drifts are constructed.

C. Construction of X-cuts between drift and orebody–On completion of Haulage drifts, X-cuts between the drift and orebody are constructed.

D. Construction of Raise/winze–Raise/Winzes are constructed to connect the two levels.

E. Construction of Finger Raises–Finger raises are made at the sill. This will guide the ore towards the x-cut Alternatively often closely spaced ore chutes can also be used.