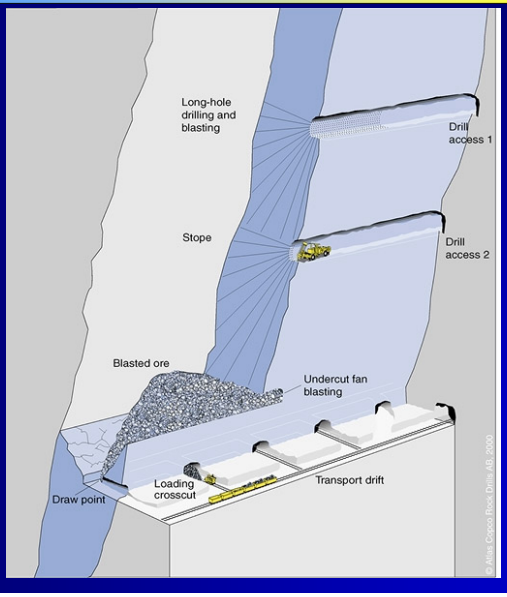
Sublevel Stoping



Sublevel Stoping

SUBLEVEL STOPING

Basic Facts

- Also called blasthole stoping or longhole stoping
- Vertical overhand mining method without support
- Stopes are mined in vertical slices
- Used in steep or massive deposits, for example in metal mining
- Large-scale mining method
- Three variations exist: ring drilling, parallel drilling and vertical crater reteat mining

Requirements

- Ore body should be fairly steep (preferably 60...90°) and fairly thick to moderately wide (6...30m)
- Ore body should have regular dip and boundaries
- Ore and surrounding rock should be rather strong
- Ore should not pack
- Ore grade can de moderate and should be uniformly distributed

Development (Ring Drilling)

- Fairly intensive development necessary
- Construction of main haulage levels (vertical distance between levels 45...120m)
- Construction of sublevel drifts in the ore body at a vertical distance of 10...55m
- Construction of an extraction drift parallel to the strike of the ore body in the footwall
- Construction of draw points and cross cuts connecting the stope and the extraction drift

Stoping Operations (Ring Drilling)

- Drilling:

Drilling of longholes from the sublevels

Drilling of fans using drill rigs

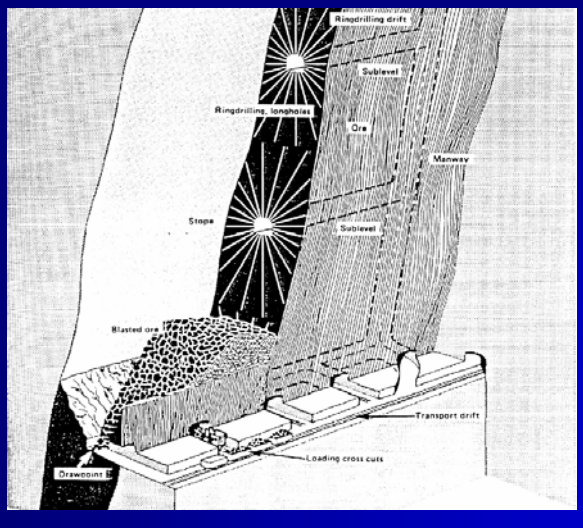
Relatively small hole diameter (50...75mm)

Hole deviation can be a serious problem!

New down-the-hole drill rigs can achieve less than 2 % deviation

Stoping Operations (Ring Drilling)

Typical sublevel stoping operation using ring drilling



Stoping Operations (Ring Drilling)

- Blasting:

Drill holes are charged with ANFO, gels or emulsions

Ore is blasted in vertical slices of 1.5...3m thickness

Good blasting is absolutely essential!

Stoping Operations (Ring Drilling)

- Ground Control:

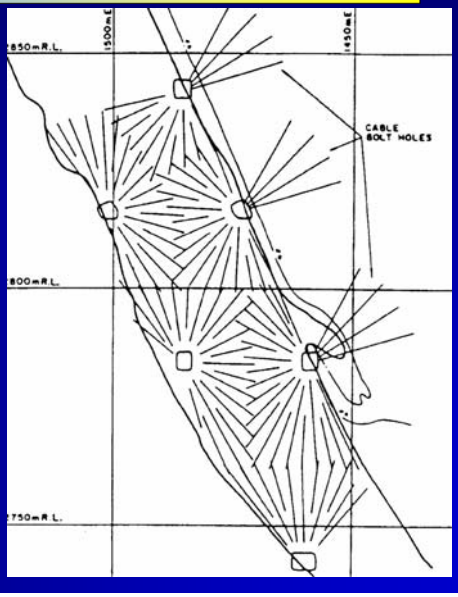
Usually only minimum ground support necessary

Support for sublevel drifts with rock bolts, wire mesh, cables or shotcrete if required

Full stope wall support can be provided by cable bolts

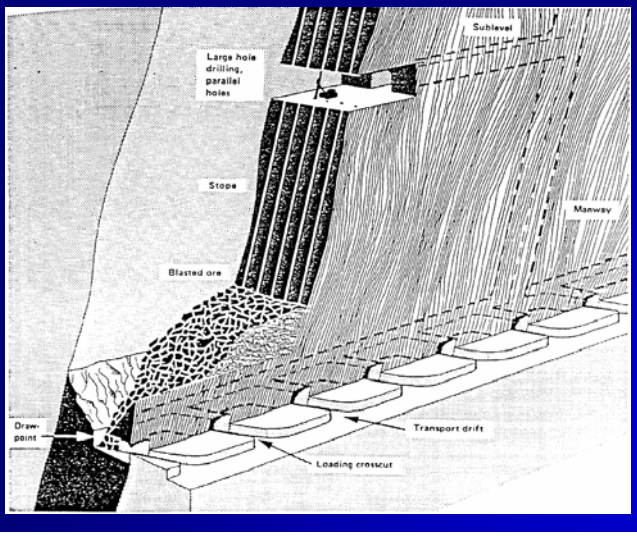
Stoping Operations (Ring Drilling)

Cable bolting in the Hanging Wall



Variation: Parallel Drilling

Typical sublevel stoping operation using parallel drilling



Variation: Parallel Drilling

Differences:

- Development:

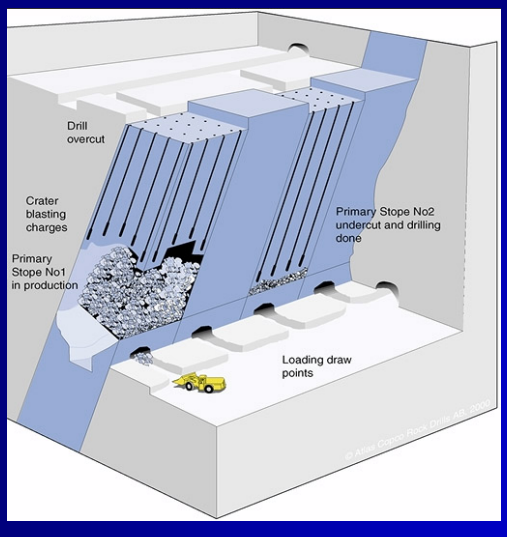
Sublevel drifts are widened to the width of the stope

- Drilling:

Large hole diameter (200mm), drilling with very little deviation (< 2 %) possible

Variation: Vertical Crater Retreat Mining

Typical sublevel stoping operation using VCR mining



Variation: Vertical Crater Retreat Mining

Differences:

- Development:

Sublevel drifts are widened to the width of the stope

- Drilling:

Large hole diameter (200mm), drilling with very little deviation (< 2 %) possible

Variation: Vertical Crater Retreat Mining

Differences:

- Blasting:

Blasting of horizontal slices of 4.5m thickness

Spherical placement of explosives for optimum fragmentation and powder consumption

Creation of an “inverted crater”

Stoping Operations

- Drawing of ore:

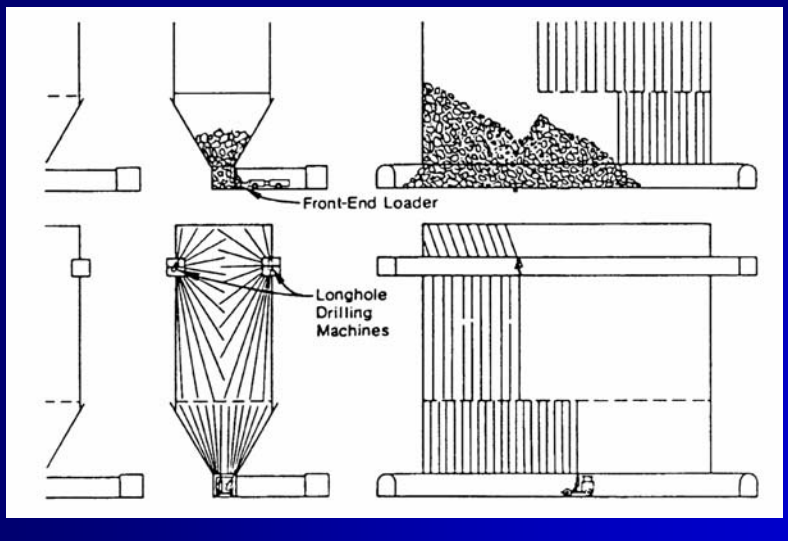
Ore freely flows to the draw points because of gravity

Ore is taken from the draw points using LHDs

Ore is hauled to the shaft using LHDs, trucks, trains or conveyor belts

Stoping Operations

LHD draw point system



Stoping Operations

- Backfilling:

Large openings need to be backfilled to avoid rock bursts and subsidence

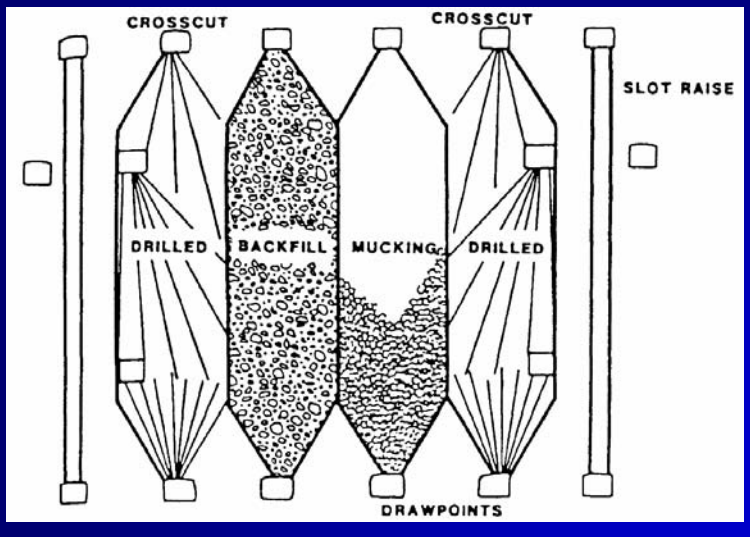
Rock fill, sand fill, cemented rock fill, cemented hydraulic tailings fill and high density tailings fill can be used

Backfilling allows pillar recovery and thus improves recovery

Cemented backfill can eliminate rib pillars

Stoping Operations

Cemented backfill as alternative to pillars



Equipment

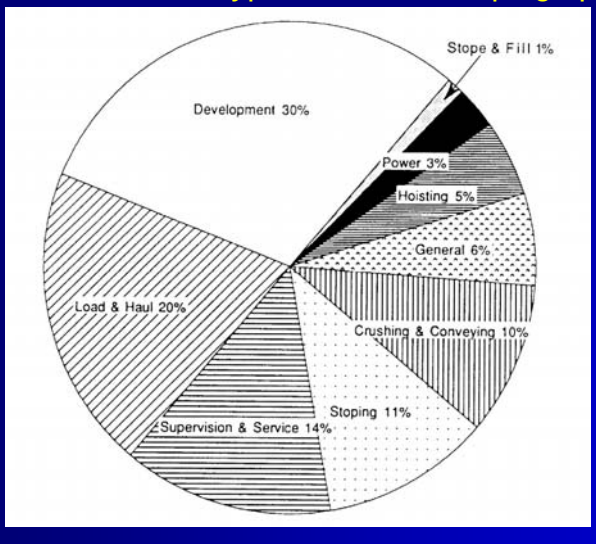
Production drill Tamrock

Equipment

LHD Caterpillar Elphinstone

Costs

Cost distribution for a typical sublevel stoping operation



Advantages

+ Moderate to high productivity (15...40 t (max. 375 t) per employee-shift)
+ Moderate to Low mining cost (relative cost 20 %)
+ Moderate to high production rate
+ Moderate to large-scale production
+ Not very labour intensive and easy to mechanise, simultaneous operation of units
+ Low breakage and handling costs
+ Good safety conditions and easy to ventilate
+ Fair recovery (75 %) and fair dilution (20 %)

Disadvantages

- Low selectivity and flexibility
- Complicated and expensive development
- Difficult longhole drilling
- Large blasts can cause problems (vibrations, air blasts, structural damage)

Example

Kidd Creek mine, Canada:

Massive sulphide deposit with copper, zinc and silver

Ore body 170m * 670m at the surface and extending to a depth of more than 2500m

Proven reserves of 19.2 Mt with 2.29 % Cu, 5.57 % Zn, 66 g/t Ag

Production 2.43 Mt/a of ore (1999)

Cash operating costs 1.2 $/t Cu

Example

Stopes are 18...24m wide, 30m long and 91m high

Sublevels are driven with a vertical distance of 30m

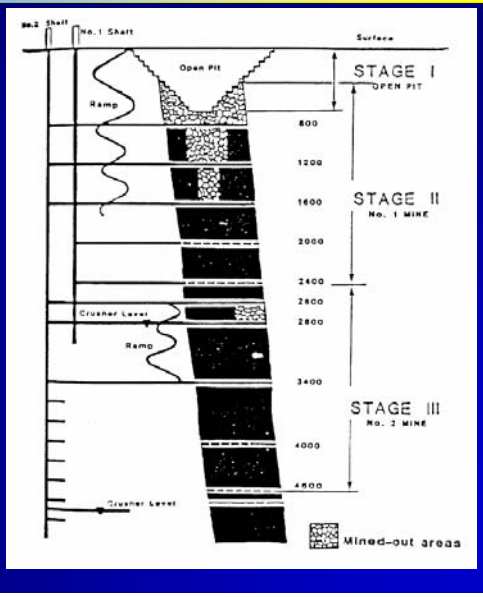
Rib pillars are 24m wide and sill pillars are 30m thick

Mined out stopes are backfilled using cemented rock fill

Equipment includes LHDs and drill rigs

Example

Ore body of the Kidd Creek mine:



Conclusion

Popular method, especially with parallel drilling

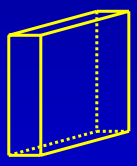
Assignment

The mining method for a deposit has to be chosen

• Data of the deposit:

Vertical ore body (10m wide, 250m high, 1000 m long)

Density of the material 4 g/cm^3



• Data of the existing treatment plant:

Feed 1 Mt/a (run off mine)

Recovery 90 %

Assignment

• Copper price:

Net smelter return 1.5 $/kg Cu

• Possible mining methods:

Shrinkage stoping (recovery 80 %, dilution 10 %)

Sublevel stoping (recovery 75 %, dilution 20 %)

Assumption: shrinkage stoping is 25 % more expensive per ton of material mined

Assignment

➔ Choose a mining method based on the given data!

Hint:

Calculate the annual production and the annual revenue of each of the two methods