**Underground Mining of Metalliferous Deposits**
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**Lecture 55**
**Sublevel Caving-1**

**SUBLEVEL CAVING** is a caving method where the overburden and part of the ore is induced to caved in.

"Sublevel " this method owes the first part of its name to the fact that work is carried out on many intermediate levels (i.e. sublevels) between the main levels.

- ❖ Ore is divided by sub-levels with 8-10m vertical spacing. Each sub-level consists of 2 or 3 slices and the ore at each sublevel is brought down by drilling and blasting.

The word "Caving" derives from the caving of the hanging wall and surface that takes place as ore is removed.

Should not be confused with Sublevel Stoping in which all the ores are extracted by drilling and blasting and the ore as well as the wall have to be strong.

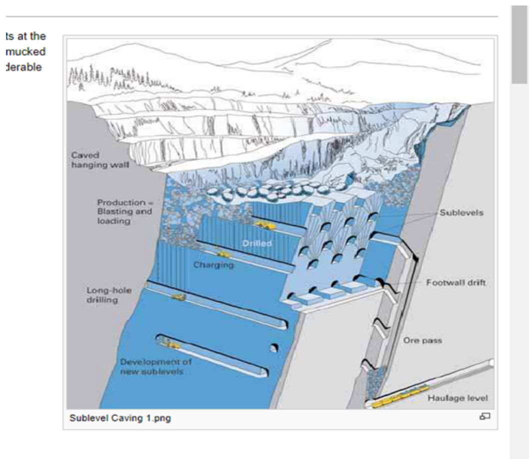


Figure 1. Sublevel caving in a massive orebody

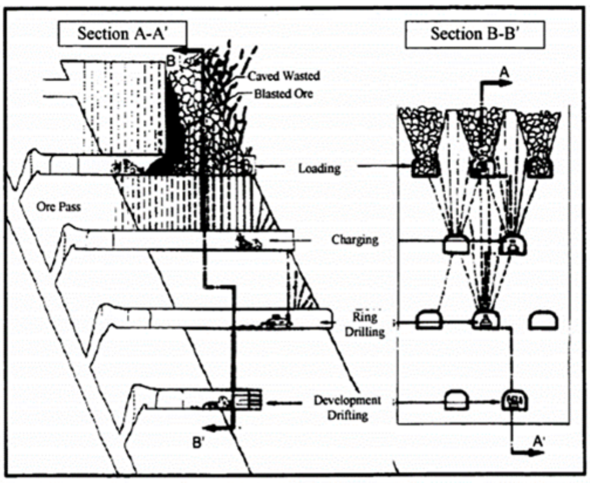


**Fig 2:** Sublevel Caving Overview: Development Drifting, Production Ring drilling, Charging, Loading.

In Sublevel Caving method, mining progresses downwards while the ore between sublevels is broken overhand with long hole uppers (fan-holes).

The overlying waste rock (hangingwall or capping) caves into the void created as the ore is drawn off.

Mining is conducted on sublevels from development drifts and crosscuts, connected to the main haulage level below by ramps, orepasses, and raises.

Every tonne of ore is drilled and blasted which results in improved cavability and fragmentation compared to Block Caving.

With care, recoveries in the order of 80% with dilution below 25% can be achieved.

**Table 1:** Comparison of Sublevel Stoping, Sublevel Caving and Block Caving.

| Method | Method Class | Suitable Ore strength | Suitable host rock strength | Deposit shape | Deposit dip | Deposit size | Ore grade and uniformity | Suitable depth |
|---|---|---|---|---|---|---|---|---|
| SUBLEVEL STOPING | Pillar supported | moderate to strong, | fairly strong to strong | tabular or lenticular, regular dip and boundaries helpful | Fairly steep (>45°, preferably 60 to 90°) | moderate to thick width (20 to 100 ft or 6 to 30 m), fairly large extent | Grade:Moderate<br>Uniformity: Fairly uniform | varies from fairly shallow to deep |
| SUBLEVEL CAVING | Unsupported | moderate to fairly strong | weak to fairly strong; | tabular or massive (if elongated along one axis, preferably vertical); may be moderately irregular | fairly steep (>60°) or vertical; can be fairly flat if the deposit is thick | large, extensive vertical or areal extent; thickness > 20 ft or 6 m | Grade:Moderate<br>Uniformity: moderate, no sorting possible (some dilution acceptable) | ( < 4000 ft or 1.2 km) |
| BLOCK CAVING | Unsupported | weak to moderate or fairly strong | weak to moderate | massive or thick tabular deposit, fairly regular | fairly steep ( > 60°) or vertical; can be fairly flat if sufficiently thick | very large areal extent; thickness > 100 ft (30 m) | Grade: Low<br>Uniformity: fairly uniform and homogeneous | >2000 ft (600 m) and <4000 ft (1200 m) |

**Applicability**

**Conditions suitable for Sublevel Caving:**

- Requires sufficient competence to stand without excessive support; less strength than for supported methods, but more than for block caving. Sub level drift must be largely self supporting.
- Should cave freely under own weight when undercut (requires induced caving).
- The surface must allow subsidence.

**Geotechnical parameters**:

- Ore strength: moderate to fairly strong
- Host rock strength: weak

**Geometry, disposition & orientation:**

1. Deposit shape: tabular or massive (if elongated along one axis, preferably vertical); may be moderately irregular.
2. Deposit dip: fairly steep (>60°) or vertical; can be fairly flat if the deposit is thick.
3. Deposit size: large, extensive vertical or areal extent; thickness > 20 ft or 6 m.
4. Deposit depth: less than 4000ft (1.2 km)
5. **Ore grade and uniformity**: moderate; no sorting possible (some dilution acceptable).

**STOPE DEVELOPMENT**

**Production Shaft:**

- Usually Located in the footwall
- Sized based off of the production rate

**Internal ramp:**

• Developed in the footwall
• Grade of around 15% with flattening at sublevel access drifts
• Follows the dip of the orebody
• Allows equipment to travel freely from level to level without the use of the shaft
• Designed to be approximately 5 ft wider and higher than the largest piece of equipment

**Sublevel extractions drifts:**

• Developed in footwall parallel to the strike of the orebody
• Designed to be approximately 5 ft wider and higher than the largest piece of

equipment
• Usually developed every 100 ft

**Production headings:**

**Heading Width:**
• Developed as wide as possible to get good draw coverage

**Heading Spacing:**
• Determined based on the ellipsoid extraction width usually around 60% to 65% of the ellipsoid draw height
• Should be wide enough to provide some interactive draw between headings
• Should be no less than twice the heading width to limit development costs

**Flat Back:**
• Results in a level zone of moving material
• An arched back will cause more ore to be drawn from the middle of the stope resulting in more dilution from the caved waste rock

**Heading Height:**
• As low as possible to allow more room for loading blasts but high enough to allow equipment to enter

**Orepasses:**
• Located every 100 ft to 200 ft in the sublevel extraction drift
• Used for transporting ore from the sublevels to the main haulage level
• Designed to have a dip of approximately 70° to 80°
• Sized based off of the production rate and orepass spacing
• Grizzlies and rock breakers should be installed at the top of each finger raise to prevent oversize from causing hang-ups

**Main Haulage Level(s):**
• Track drift developed in the footwall parallel to orebody strike
• Used to tram ore from the orepasses to the crushing station and loading pocket for skipping to surface
• Sized based off of the size of the tramming equipment which is based off of the production rate for the mine

**Mine Infrastructure:**
• Ventilation Raises – Sized based off of ventilation requirements( 100 CFM per brake horsepower)
• Equipment shops – Sized based off of equipment fleet
• Mine Dewatering system
• Pressurized air and water pipes
• Electrical System
• Refuge Stations

**Ventilation:**

Perimeter drifts are also used to provide access to the primary ventilation circuit and enable the installation of secondary fans to allow airflow to be delivered to the production working areas on the level.

**Ground supports:**

Standard ground support is used including rock bolts and screen. Shotcreting and cablebolting are used .

**GROUND SUPPORT:**

Almost all drifts have to be supported with a

Layer of shotcrete

Grouted rock bolts

Cable bolts

**Shotcreting** is carried out with one spraying unit. The shotcrete is transported underground by truck from the batching plant located in a nearby village. ( e.g., amount of wet-mix shotcrete applied annually exceeds 6000 m3).

**Rock bolting** is carried out with two Tamrock units that drill the holes and then install and grout the bolts with cement. A slick-line system for transporting the wet mix from the surface to the 1,230-m level is under construction. (e.g., 10,000 rock bolts installed annually).

**Cable bolts** are employed in the ore drifts to support the stopes. The cable bolts are installed in a 1.5- to 2-m grid with effective lengths of 5 to 10 m, depending on rock conditions and stope dimensions. (e.g., 30,000 m of cable bolt holes being drilled with two Tamrock cable bolting rigs).

**DESIGN OF SUBLEVEL CAVING:**

1. Transverse sublevel caving:

   For thick bodies.

   Perimeter drift is driven along (transverse layout) the strike of the ore body.

   Production drift is driven perpendicular to the strike of the ore body.

2. Longitudinal Sublevel Caving:

   For narrow bodies and sharp dip.

   Perimeter drift is driven perpendicular (longitudinal layout) to the strike of the ore body.

   Production drift is driven along the strike of the ore body.

For either layout type, the supporting development is similar with a perimeter drift containing either orepass tipping points or truck-loading stockpiles.