Capital Markets Day
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Mine cost drivers

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Two main types of mines

**Open pit mining**
- Roughly ten times lower in cost per ton compared to underground mining
- Slope stability decide waste/ore ratio
- With low grades a high production rate is needed
- Big equipment for high volume production

**Under ground mining**
- Under ground mines commonly have lower production rate
- Increased cost to infrastructure and ground support
- More up front development work
- Often smaller ore bodies but with higher grades
Mine design

- **Most important factors**
  - Knowledge of ore body and rock conditions
  - Efficient mine infrastructure
  - From basic design establish plans in long and short term for mining out the ore reserve

- **Mining method**
  - Method selection crucial
  - Many criteria for method selection
  - Shape of ore body and rock quality
  - Best suited scale of equipment and stopes
  - Amount of ground support needed
  - Control of ore recovery and waste dilution

- **Infrastructure**
  - Type of hauling and hoisting
  - Ventilation and water handling
  - Size and conditions of drifts and ramps
  - Possibility for automation
Under ground mining
Under ground mine infrastructure
Under ground mining methods – Room and pillar mining

- Common for flat ore bodies
- High production and low cost
- Good productivity
- Ore lost in pillars
Under ground mining methods
– Open stoping

- Common for steeply dipping ore bodies
- Can be deep
- Good production rate
- Moderate to high cost
- Higher dilution
- High capital cost
Under ground mining methods
– Block caving

- Common for massive ores
- Caveable rock
- Can be deep
- High production
- Low cost
- Very high capital cost
- No selectivity
- High dilution
- Surface subsidence
Under ground mining methods
– Cut and fill mining

- Common for steeply dipping irregular ore bodies
- Higher grades needed
- Moderate production
- Higher cost
- More ground support with depth
- Good recovery and controlled dilution
- Flexible method
Open pit mining
Open pit sequencing – push backs

Production flow

Economy cash flow

Solution push backs

Critical phase

Critical phase
The Aitik Mine 1968
– 2 million tonnes per year
The Aitik Mine early 70’s
– 6 million tonnes per year
The Aitik Mine 2000
– 18 million tonnes per year
The Aitik Mine 2010
– 36 million tonnes per year
Open pit mining cost distribution – industry average

- **Mining 50%**
  - Drilling 5%
  - Blasting 6%
  - Digging 9%
  - Hauling 30%

- **Milling 50%**
  - Grinding 30%
  - Flotation 10%
  - Dewatering 10%
Mill

Deposit Evaluation Feasibility Study → Ore Reserve → Drilling → Charging Blasting → Loading Haulage Hoisting → Rock Support → Ore → Waste Rock → Tailings → Concentrates → Smelters

Mine

Ore → Mill

Crushing → Grinding → Flotation Gravimetry → Leaching → Concentrates → Tailings → Metals

Leach/SX EW

Crushing → Heap Leaching Dump Leaching → SX EW
About the mill process

- Grinding is the major part in milling costs
- The choice of grinding technology is crucial, Boliden type of autogenous grinding (AG) has proved to be the most cost efficient
- Semi autogenous grinding (SAG) is by far the most used technology
- Flotation separation, based on surface chemistry, is the outmost important technology to separate base metal minerals from waste rock – products are called concentrates
- The flotation process is adopted to the specific ore type when it comes to equipment, circuit lay outs and reagent regime
- Since flotation is a wet process the concentrates must be dewatered, dewatering technology can vary depending on proprieties of the concentrate and customer demand
- Leaching process is used solely to recover the gold/silver content that not reports to concentrates
Mill (Ore Dressing Plant, Concentrator)

Crusher

Water addition

Mills

grinding

Flotation Circuit

separation

Thickeners

(dewatering)

Filters

dewatering
Fragmentation, crushing and grinding
Communition – industry average cost distribution

- Blasting 1%
- Coarse crushing 2%
- Fine crushing 20%
- Grinding 77%
Grinding mill
Flotation cells

Ore (pulp) → Chemicals → Air → Concentrate

Waste

ROM ORE → LIBERATION → SEPARATION

Comminution

waste "tailings"

concentrate
Dewatering - thickeners
Dewatering of Concentrates – pressure filter

- Fully automatic
- Capacity up to 250 t/h
Mill and leaching plant at Boliden Area Operations
Tailings and waste rock disposal
Stekenjokk – reclaimed minesite
Heap Leaching SX EW

- Deposit Evaluation
- Feasibility Study
- Ore Reserve
- Drilling
- Charging Blasting
- Loading Haulage Hoisting
- Rock Support
- Mine
- Ore
- Waste Rock
- Tailings
- Concentrates
- Metals
- Smelters
- Crushing
- Grinding
- Flotation Gravimetry
- Leaching
- Leach/SX EW
- Crushing
- Heap Leaching Dumps Leaching
- SX EW
Typical porphyry copper ore

Heap Leach SX EW Ore

Flotation Ore
Heap leaching SX EW

- The process is normally applicable to oxide minerals (the upper weathered zone of the ore bodies)

- Some 20% of copper production is coming from HL operations

- Some applications on zinc and nickel have recently started

- The heap leach process is now in many cases enhanced by use of bioleaching in order to recover primary minerals
Heap leach process – copper
Heap leach operation