Caving in the Fabian Orebody — from Mining Stope to Cave Crater in Malmberget

Jonny Sjöberg

Tomas Savilahti
Malmberget and the Fabian Orebody…
(year 2010)
Mining in Fabian

- Mining started in 1971 with slot caving
- Sublevel stoping started in 1978
- Large open void after completed stoping and slot caving
Mining and Caving 1971 – 2010

• Sublevel cave mining from 548 to 830 m level
• Continuous, slow caving process
• Reduction in cap rock thickness from 250 to 77 m
• Follow-up/monitoring using reflection seismics, probe drilling, laser scanning, etc.
• No ground deformations on surface above the stope
Stope dimensions (2010):
Width = 130-160 m
Length = 300 m
Height = 100 m
Distance to ground surface = 77 m
Prognosis 2010

• Compilation of existing material / data
• Scenario description (prognosis) as basis for action plan in case of collapse
• Three scenarios:
  – Stable cap rock / crown pillar => low likelihood
  – Gradual caving => high likelihood
  – Sudden collapse => low likelihood
• Action plan
  – Monitoring
  – Activity plan for different scenarios
Most likely scenario...

- Slow caving/expansion of void, toward the Kapten cave crater, gradual caving of cap rock
  - Likelihood: High
  - Consequences: Small vibrations and noise on ground surface
    - Small seismic events
    - Gradual expansion of Kapten cave crater
    - Some dusting in the area
    - No consequences outside the fence
Scenario description

Caving and expansion of Fabian stope

Current geometry:
- Stope
- Caved rock
- Orebody

Future scenario:
- Stope
- Caved rock

Fabian stope
Ground surface
Fence
Unmined ore
Fabian 1005 m
Fabian 830 m
Caved rock
Fence
1100 m
Scenario Description

Geological structure DZ023
What happened?

• Gradual caving during 2011–2012
  – May, 2011: 55 m cap rock
  – Jan, 2012: 41 m cap rock
    (no more scanning performed due to safety)
  – March 2012: Increase in seismic activity

• March 20, 2012:
  – Breakthrough to ground surface, new cave crater
  – Slow event, little dusting
  – Slight expansion the following days, stable thereafter
Structure DZ023

Fabian cave crater

Kapten cave crater

North
June 3, 2014

Structure DZ023
Surface crack
New sinkhole
Fabian cave crater
Kapten cave crater
North
Thickness of cap rock and caving rate in Fabian

- Cap rock thickness
- Caving rate
- Accumulated caving rate
Thicknness of cap rock and caving rate in Fabian

- **Cap rock thickness**
- **Caving rate**
- **Accumulated caving rate**

### Chart Details
- **Cap rock thickness**
  - Units: m
  - Data points from 1978 to 2012
- **Caving rate**
  - Units: m/year
  - Data points from 1978 to 2012
- **Accumulated caving rate**
  - Data points from 1978 to 2012

### Key Observations
- The cap rock thickness has steadily increased over the years, reaching a thickness of approximately 60 m in 2012.
- The caving rate has also increased significantly, reaching a peak of around 60 m/year in 2012.
- The accumulated caving rate shows a gradual increase until 2000, followed by a sharp increase in the late 2000s.

### Conclusion
The thickness of the cap rock and the caving rate in Fabian have both increased significantly over the years, with the caving rate peaking in 2012.
Conclusions & Further Work (I)

• Prognosis based on existing data, empirical relations and engineering judgement was found to be very **reliable**!

• Cave development, location and shape of new cave crater agreed well with prognosis

• Smooth caving process resulting in minimal disturbance to the municipality and the public.

• Numerical modeling could not replicate all aspects of the cave process
Conclusions & Further Work (II)

• Follow-up of ground deformations through systematic measurements
• Criterion for allowable mining-induced ground deformations proposed
• Knowledge increase required:
  – Caving process in cap rock / crown pillar / non-daylighting orebodies
  – Numerical modeling of caving / cave mining