Rock Mechanics investigations in connection with the introduction of a new pillar system in a deep magnesite mine

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Geometry of the Deposit

Deposit Length (dip direction): ≈ 2 km
Extension (strike direction): 150m - 500m
Thickness: 50m - 200m
Dipping: 25°
Depth: 0 m bis 1.000 m
Country rock: weak slate
Current mining method

- Post Pillar Mining Method
- The development of the mine is inside the deposit
- Average mining depth (500m) – small panel widths
- Height of the pillars up to 80m (backfilled)
- Signs of high stress in the development.
- Signs of high abutment stress at the boundary of the deposit
Problems with current mining method at depth

- Overstressing of small support pillars
- High exposure to rock fall hazard due to removal of hangingwall support after extraction of every of the up to 35 stope slices of 3.5 m height
- Delayed introduction of back fill support.
- Cost of support
- Low labour productivity
Aims of the Study

- The development of a safe and economic mining method for the lower parts of the deposit.
- Taking into account that:
  - Hydrogeology prevents caving methods
  - Depth approaches 1000m
  - Magnesite is not a high value mineral
  - Backfill is prescribed by the mining authority & necessary in this geotechnical environment.
“New Mining Method”

- Sublevel open stoping with backfill
  - Block wise
  - Local in retreat
  - Regional in advanced

- Width of the stope = 7m
- Height of the stope = 21m
- Width of the pillars = 6-7m
Key questions

- Strength of rock mass
- Strength of support pillars
- Stability of pillar system
- Effects of backfill on pillar behaviour
Strength of rock mass

- The following approaches were adopted:
  - Rock mass strength based on Hoek-Brown methodology
  - Back analysis of existing isolated development tunnels
  - Rock wall condition factor (RCF) developed for RSA gold mine tunnels
Geotechnical Situation in stoping area

- No signs of overloading at the sidewalls of isolated drifts!
- No signs of overstressed cores!
Rock mass strength based on back analysis

\[ c = 12.0 \text{ [MPa]} \quad \phi = 38^\circ \quad \sigma_{\text{min}} = 49.2 \text{ [MPa]} \]
Results of rock mass strength assessments

- Back analysis of isolated tunnels in stoping area result and RCF tunnel evaluation indicate rock mass strength values of > 50MPa.
- Hoek-Brown rock mass strength assessment method yields rock mass strength values of about 30 MPa which are lower than calculated rock stresses in vicinity of undamaged tunnel.
- Diederichs came to similar results, i.e. Hoek-Brown approach underestimates rock mass strength of hard brittle rock masses in higher stress environments.
Pillar behaviour

Behaviour of slender stope support pillars

- Stope system design is based on narrow mining panels separated by wide inter-panel pillars.
- Behaviour of long 7 m wide and 21 m high panel pillars supported by back fill is monitored using multiple extensometers and pressure gauges.
- Observations show stable pillar behaviour and stabilizing effect of back fill.
Monitoring of pillar behaviour
Conclusion and Outlook

- At present the mining method has proved suitable for deep mining conditions and is applied.
- The next step is to widen the existing mining panels
  - => increasing pillar load
  - => bigger stress
- 3 year research project (FFG)
FFG Research Project

- In cooperation with RHI (Breitenau) & Wolfram (Mittersill)
- Interaction rock mass & backfill
- In Situ & laboratory investigations
- Numerical simulations
- Stress measurement in the backfill
Thanks for your attention!

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