Improved stope design guidelines based on Stability Graph Method for Swedish underground mines (ISDG)

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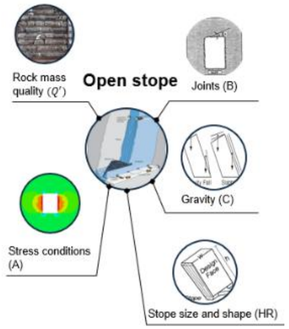
Project duration
Jan 2024 – Jul 2025

SWEDISH MINING INNOVATION

Med stöd från
VINNOVA Sveriges innovationsmyndighet
Energimyndigheten
FORMAS
Strategiska innovationsprogram

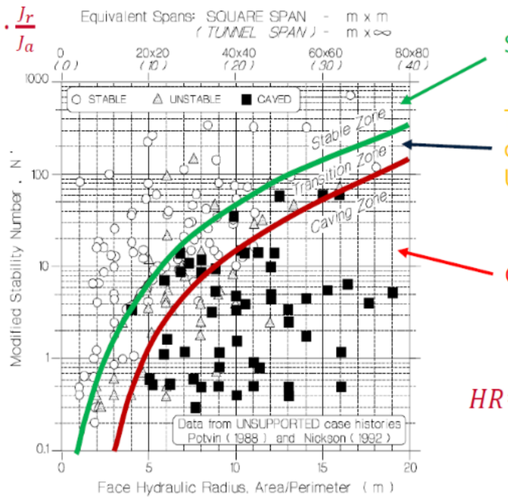
Background

- Stability graph method (SGM) is an empirical method for dimensioning open rooms/stopes and support design based on Q' and other three factors.
  - -An empirical method based on Q-system
  - -For initial dimensioning and support design for open stopes
  - -Developed in 1981 (Mathews et al., 1981)
  - -Modified in 1988 by Potvin and called Modified Stability Graph Method



$$Q' = \frac{RQD}{J_n} \cdot \frac{J_r}{J_a}$$

$$N' = Q' \cdot A \cdot B \cdot C$$



Stable zone

Transition zone or Unstable zone

Caving zone

$$HR = \frac{Stope\ surface\ area}{Stope\ surface\ perimeter}$$

Pre-study project (SGM): Evaluation of the limits of empirical stability graph method (SGM) for Swedish underground mines (Mar-Dec, 2023)

Future improvement …

2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

Problem identified by the mines and discussed with LTU (2017-2022)

Full scale project (ISDG) (Jan 2024 - Jul 2025)

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Goals of the project

- Improve the data collection approach for assessing stope stability with focuses on applying advanced scanning technology and selecting critical input parameters;
- Calibrate the three-dimensional numerical modelling methodology developed from previous pre-study project to reconcile observation;
- Examine the feasibility of using machine learning techniques to predict open stopes' stability using data from on-site cases and numerical models;
- Develop guidelines for qualitative and quantitative collection of input parameters used in stope design; and
- Develop new stope design tools/guidelines to reduce dilution and waste rock with the aid of numerical modelling and machine learning techniques based on on-site collection of cases and case histories from different rock masses in Swedish underground mines.

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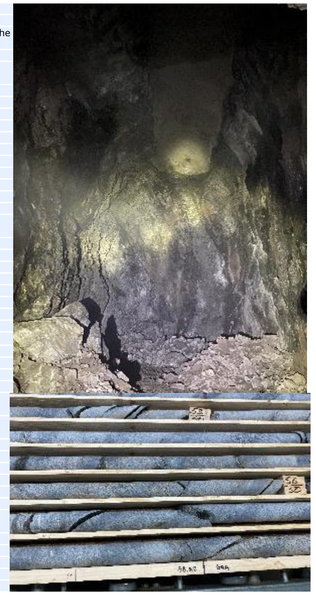
Results so far

Data collection (Zinkgruvan, Boliden Garpenberg)

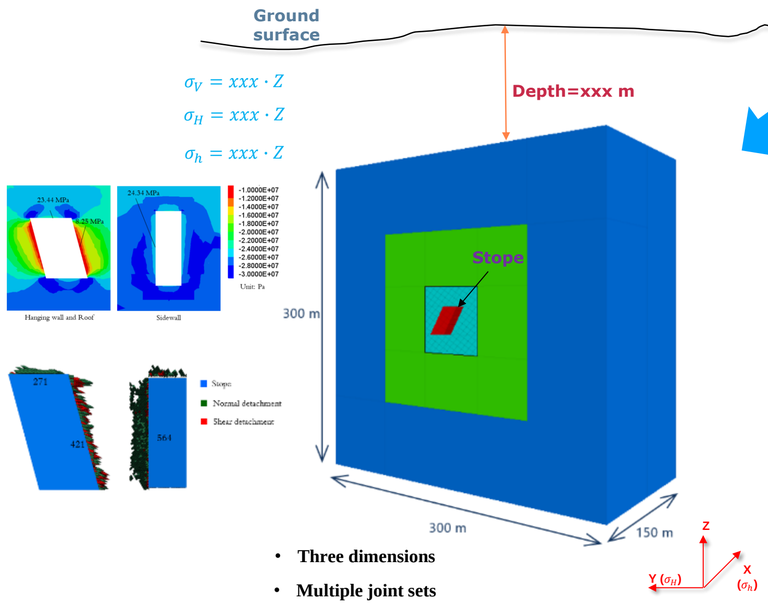
	Data collection on site	
Data speficied	Listed items	Parameters for the analysis
Geological information		
	Core logging	RQD
	Joint sets	Jn
	Joint orientation	
		Dip direction
		Dip angle
	Joint surface condition	
	1. Roughness	Jr
	2. Alternation	Ja
Rock types and properties		
	Rock types	
	Rock strength	UCS
Stope geometry		
	Stope dimension	
		Height
		Length
		Width
	Stope orientation	
		Dip direction
		Dip angle
Stress condition		
	Stress measurement data	
	Numerical modelling results	
Stope status		
		Stable
		Unstable
		Caving
Cavity scanning		
	Overbreak/underbreak	ELOS
Others		
	Mining method	
	Mining sequence	



Input

Calibration

Numerical simulation

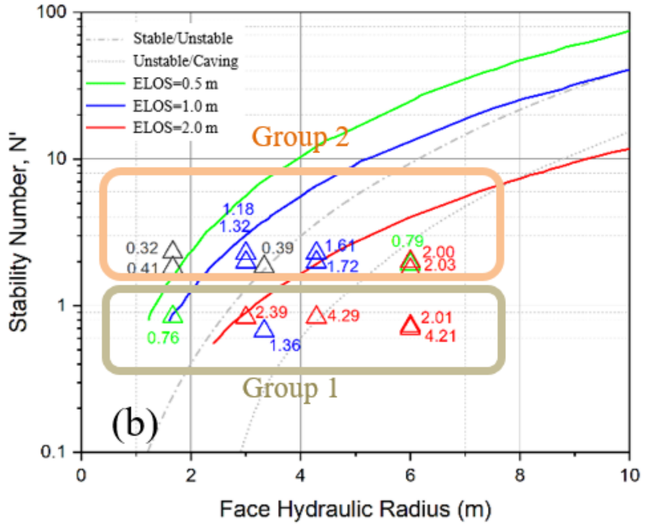


- **Three dimensions**
- **Multiple joint sets**

Input

Calibration

Newly modified SGM



Input

Modification

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Upcoming activities and next step

Numerical model calibration by using collected cases

- –Improvement of the current numerical model
- –Model calibration

Improvement of stope design by using multivariate statistical analysis and machine learning techniques

- –Machine learning and multivariate statistical analysis

Development of stope design tools/guidelines for Swedish underground mines

- –Results integration
- –Development of stope design tools/guidelines, report writing

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Mining innovation for a sustainable future

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