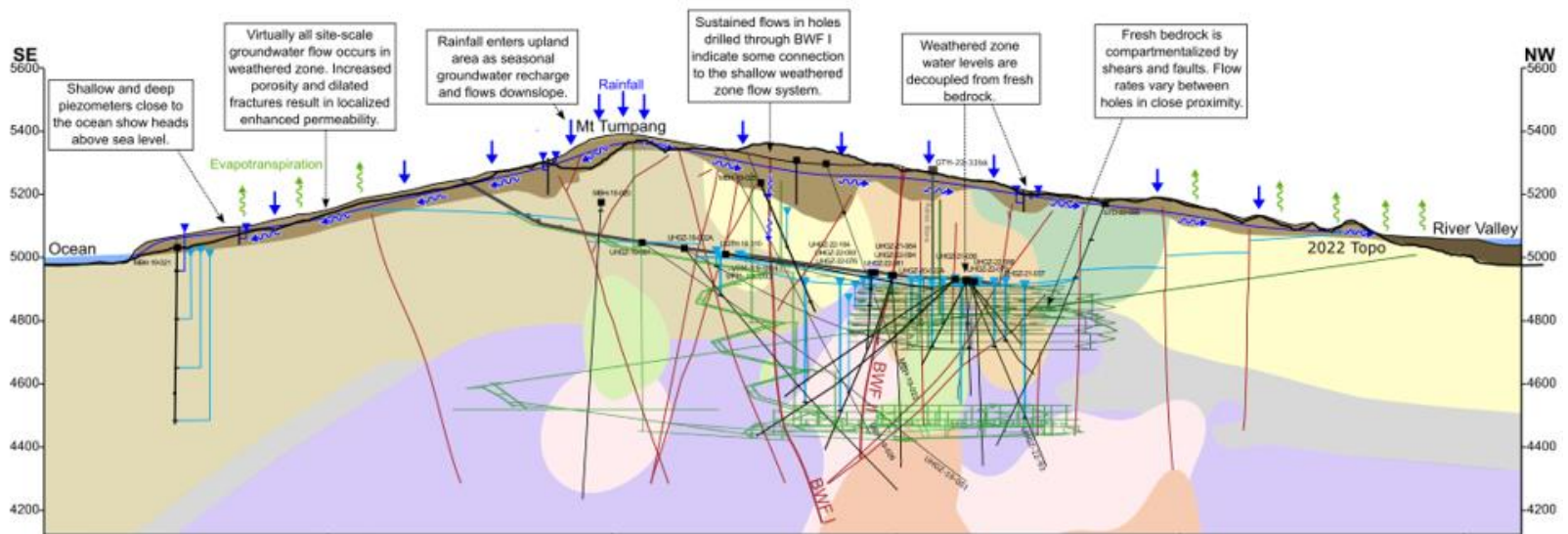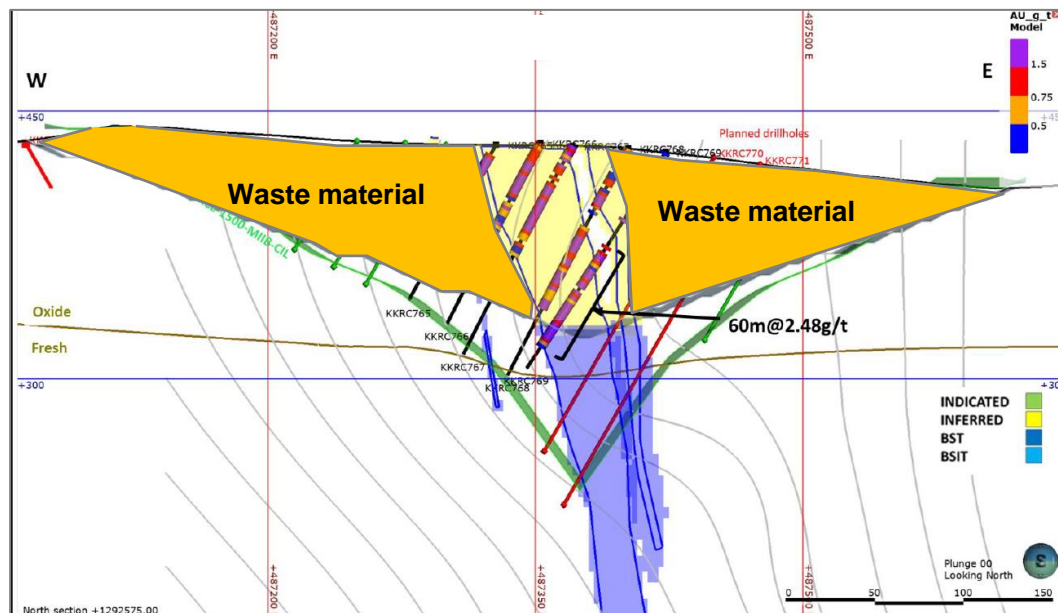# Hydraulic containment assessment of an underground project located in the vicinity of a shoreline
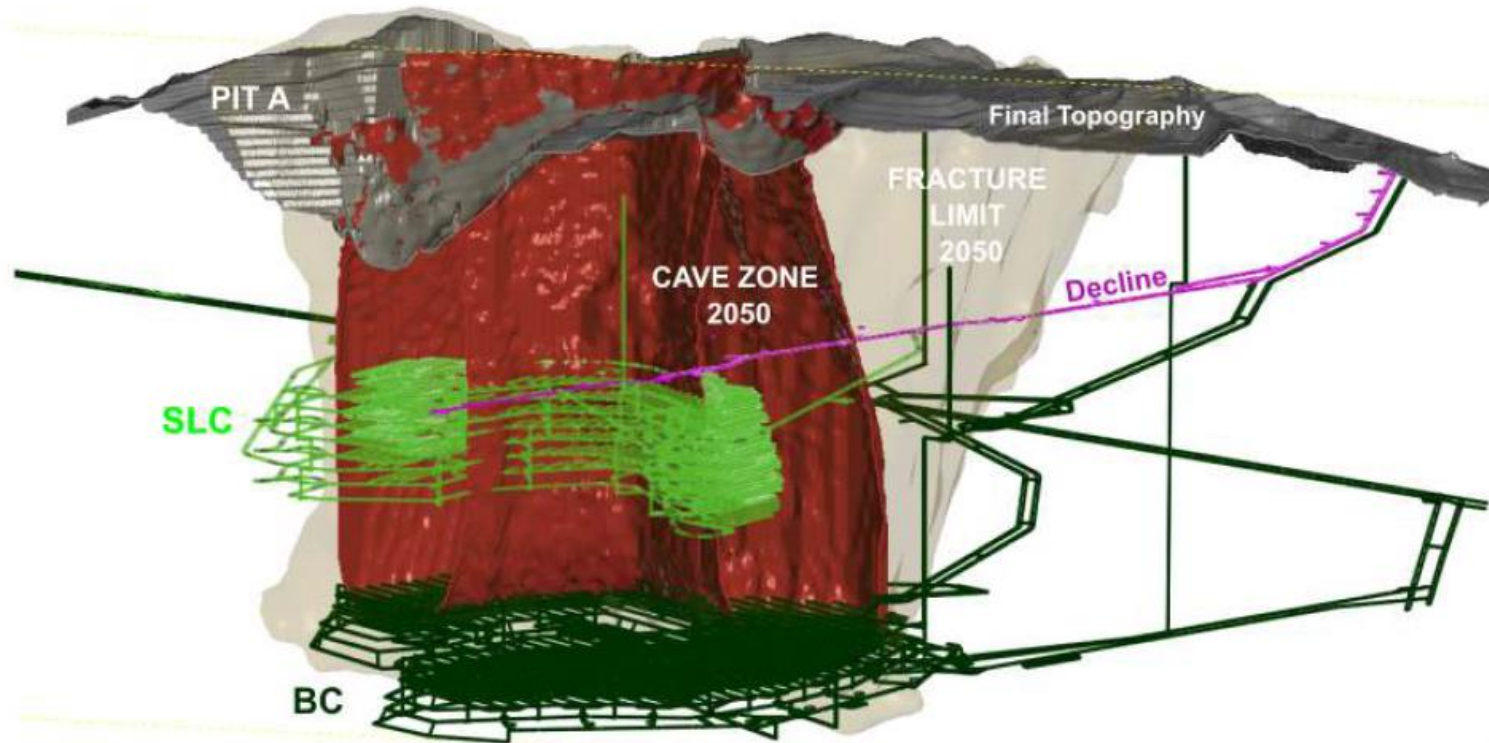

Florent Boddaert

June 2023

Mines today…
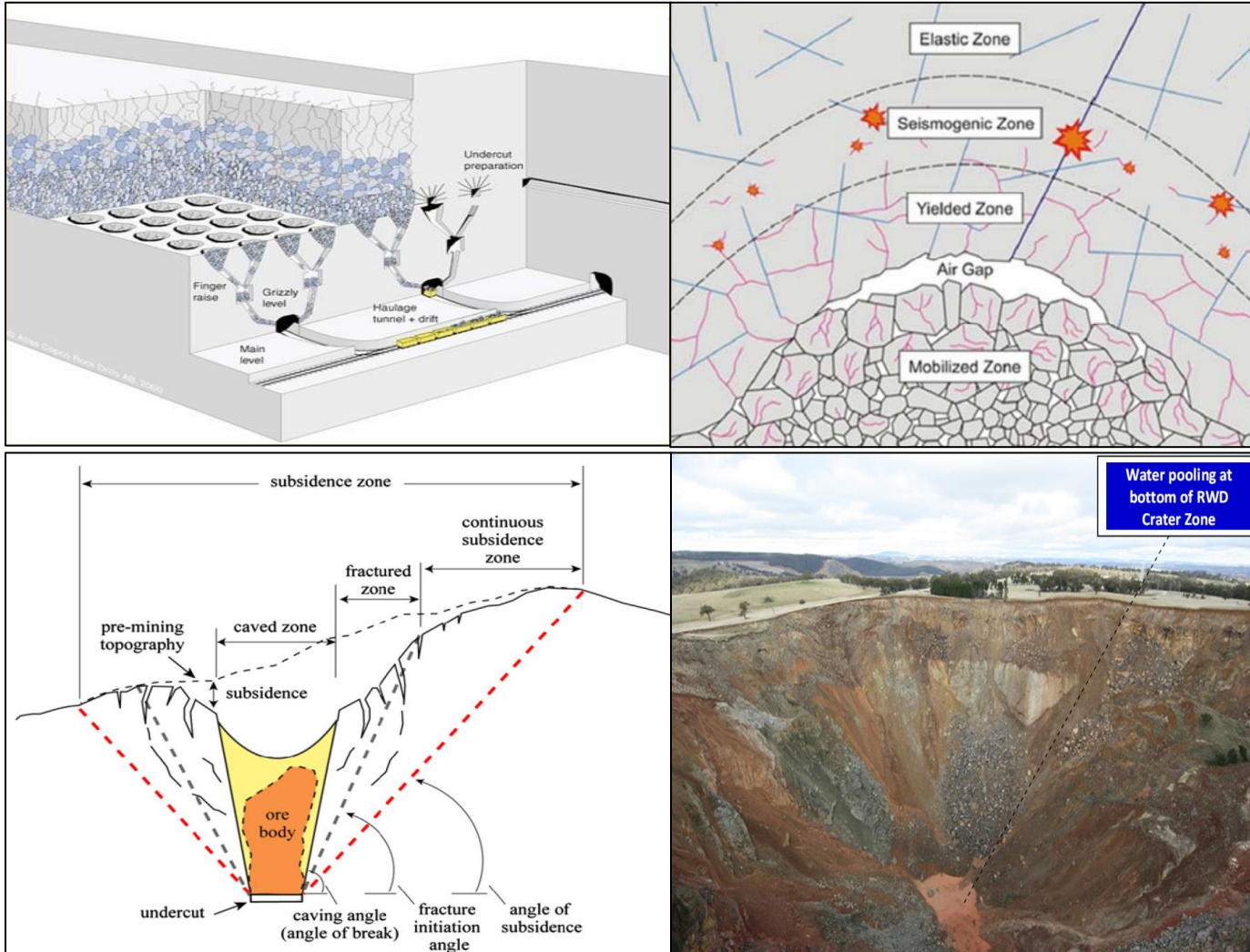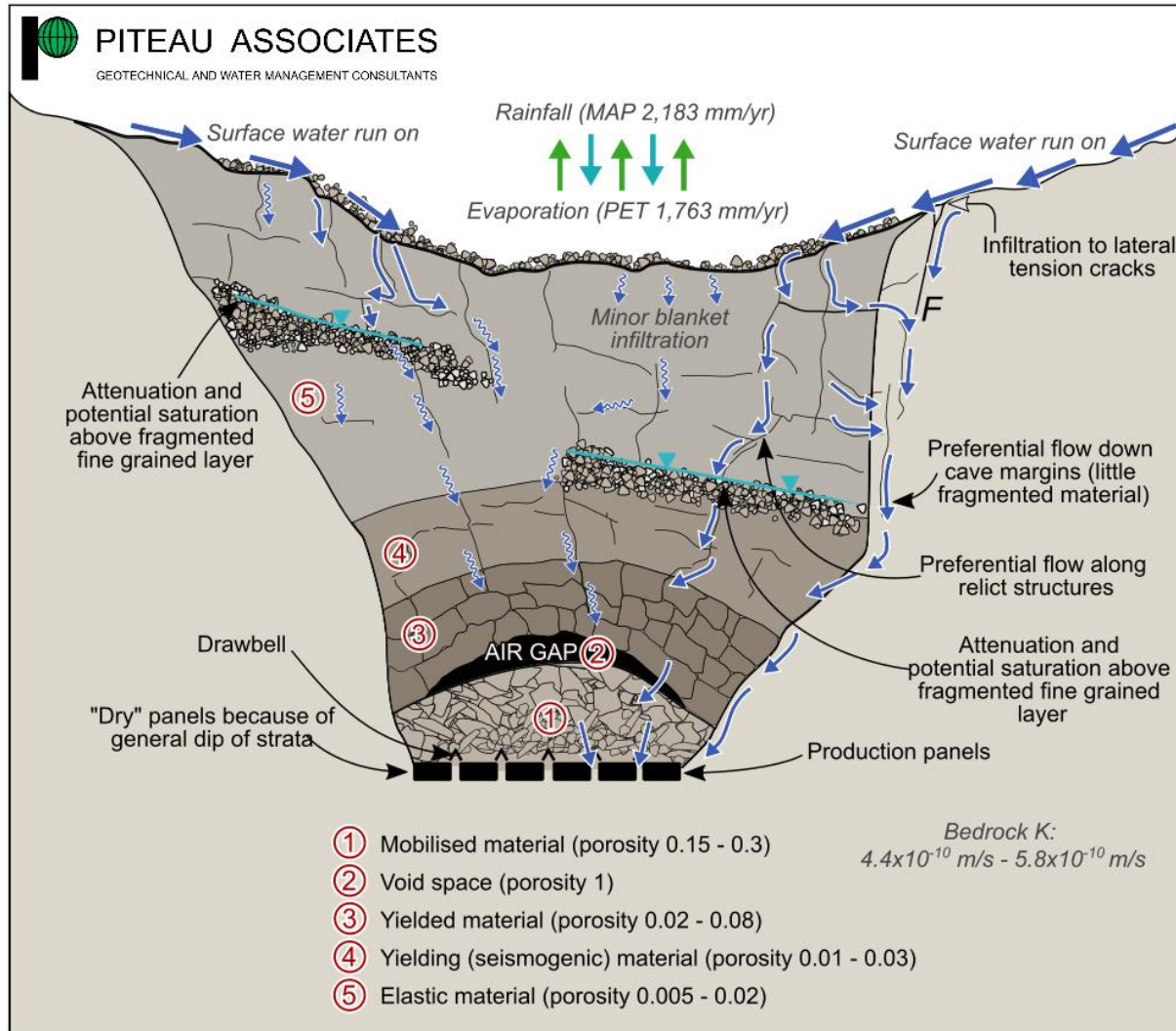
Mines of tomorrow?

Mines of tomorrow in the detail

Duplancic and Brady (1999)

4

Hydrogeologcial conceptual cross-section

What can we evaluate?

Legend:
- Aquifer Setting
- Muck Pile
- Fractures

- Precipitation
- Direct Inflow
- Cave Drawdown
- Groundwater Flow
- Inflows
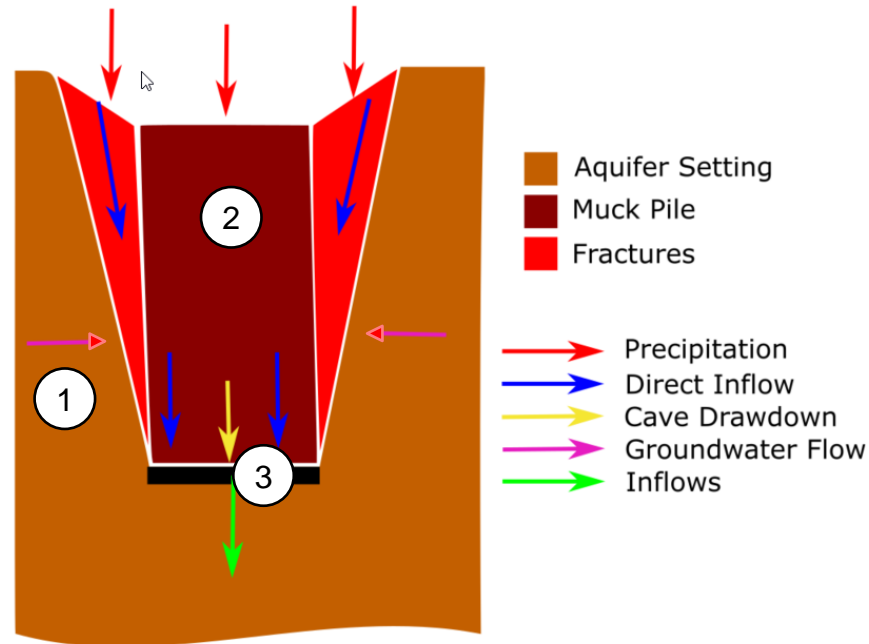
▶ **1. Groundwater inflows to underground infrastructures (including extraction levels, etc).**

▶ 2. Surface water inflows to underground infrastructures.

▶ 3. Development of increased saturation within the cave zone through mine life + mud rush risk based on moisture status and material types.

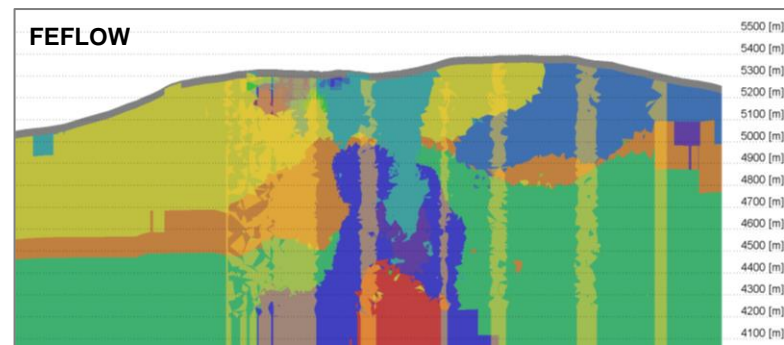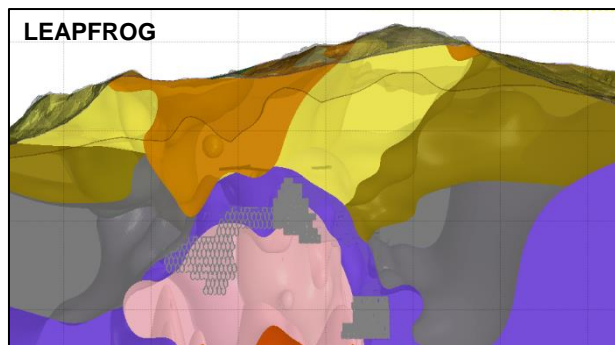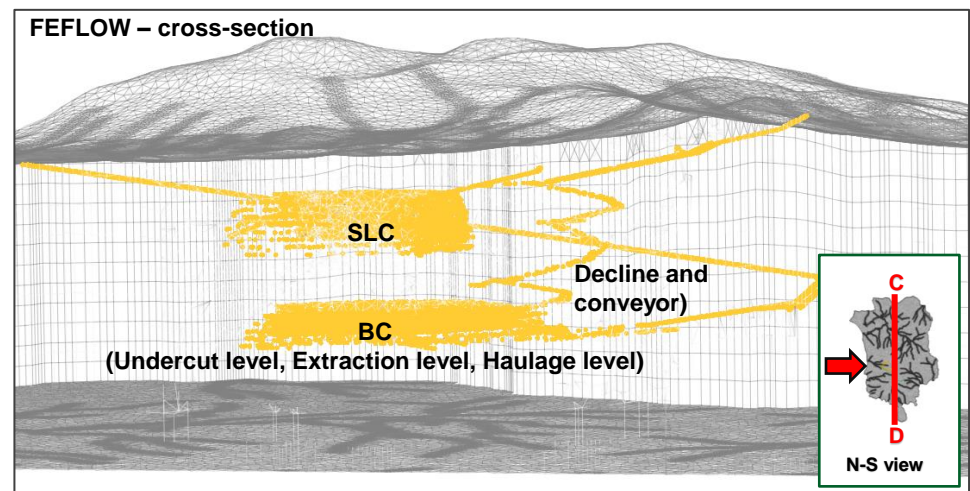# 3D GW model with FEFLOW
3D model and layering
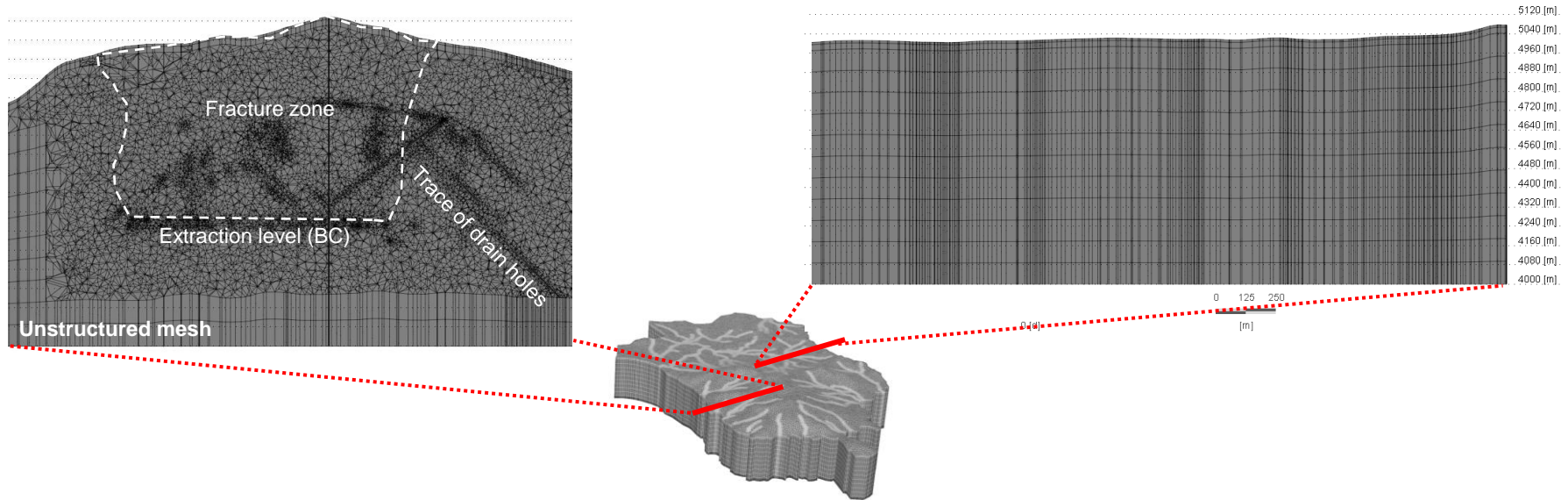
- ▶ Remeshing capabilities in FEFLOW with unstructured mesh (TetGen) enable to adapt the mesh to complex geometries.
- ▶ Nodes can coincide with drain hole trace, tunnels, UG levels.

3D GW model with FEFLOW
Complex geometries for UG infrastructures

Plan view

Transversal view with the exploration decline

FEFLOW

Plan view of SLC and BC

FEFLOW – cross-section

SLC

BC
(Undercut level, Extraction level, Haulage level)

Decline and conveyor)

C

D

N-S view
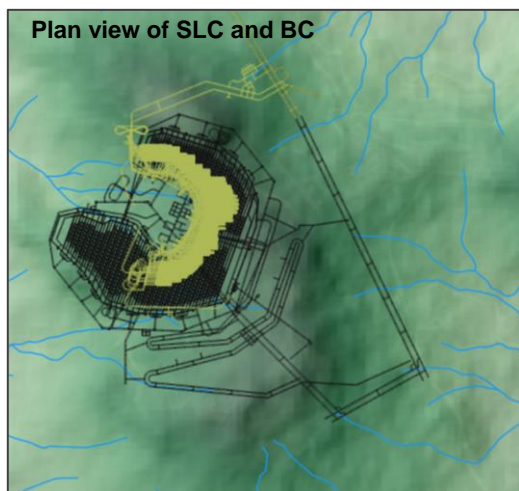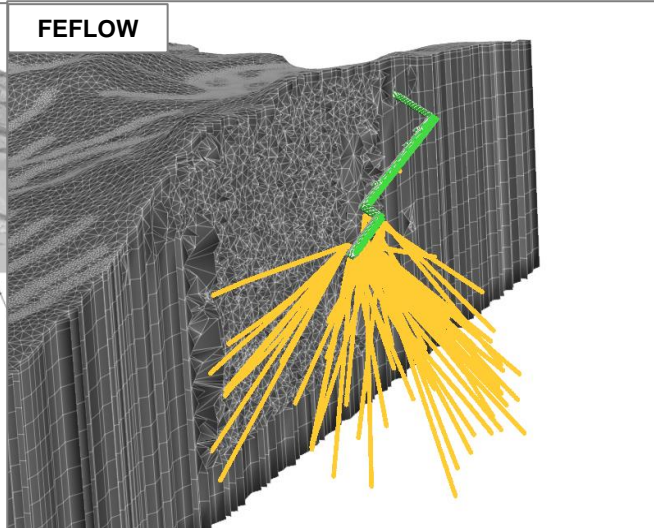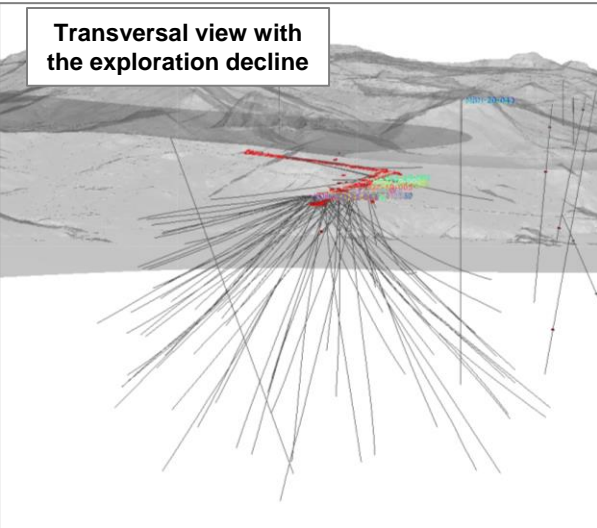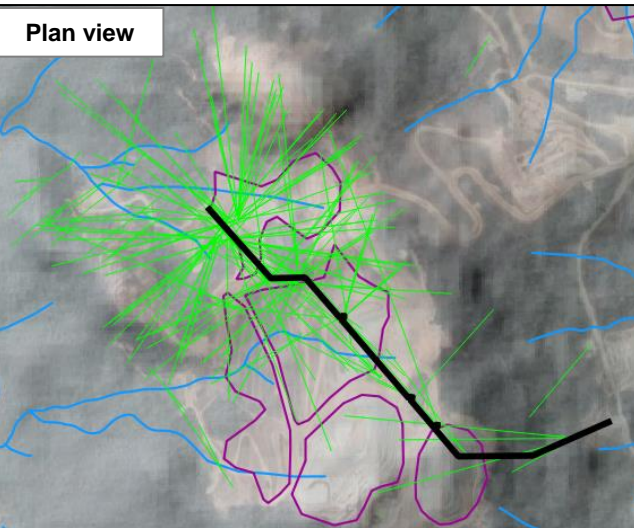
Model results – Effect of drain holes

Conceptual cross-section for 2023

Simulated hydraulic-head for 2023

▶ UHGZ holes drilled as part of the drilling program are actively participating to the dewatering of the cave area.

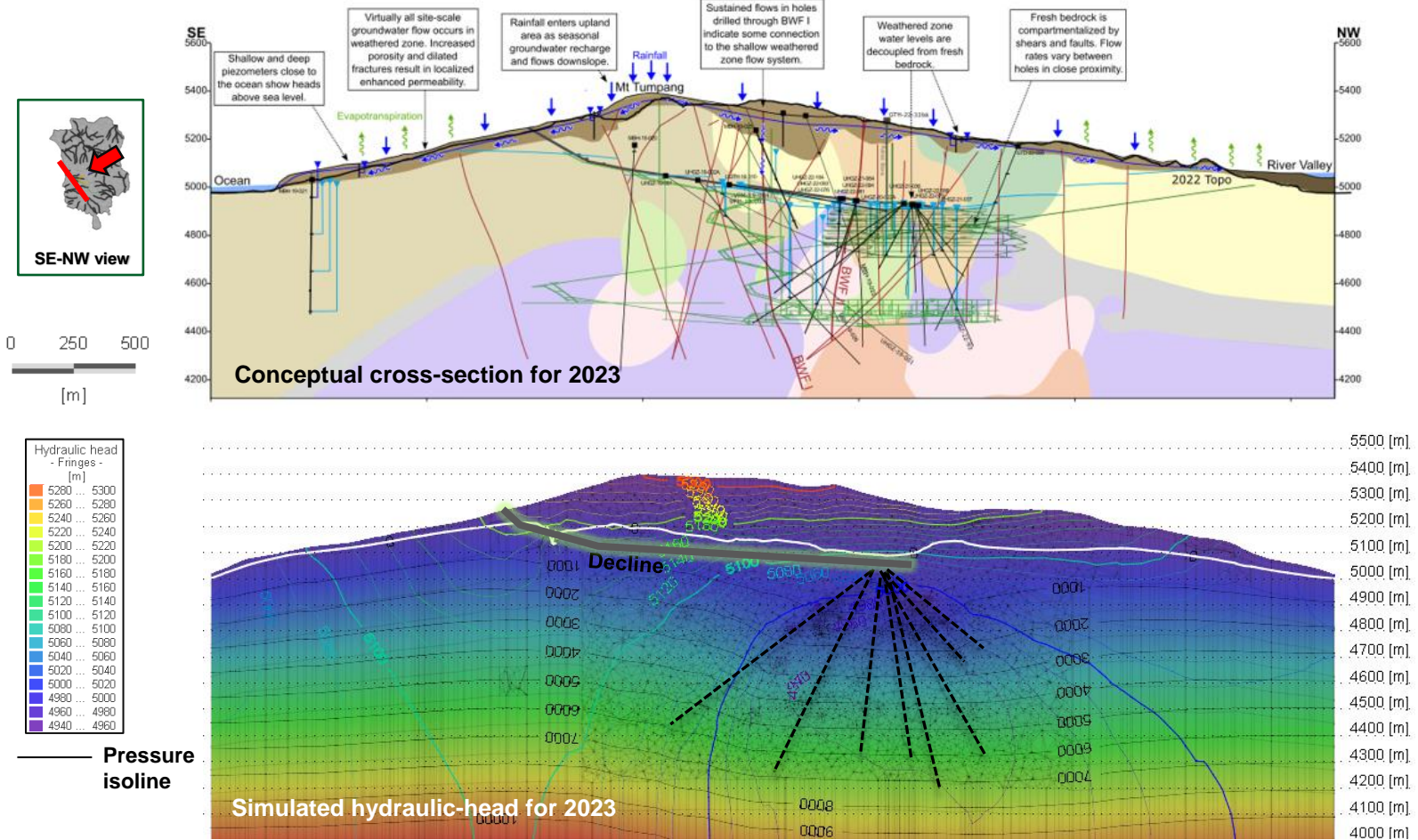▶ The depletion on the phreatic level at surface over the cave footprint is expected to be limited in the superficial units, but the UHGZ holes are effectively depressurize the zone receiving future infrastructures (extraction level, access tunnel, etc) in the deeper groundwater system taking place in the fresh bedrock.

Predictive scenario - Fracture zone propagation
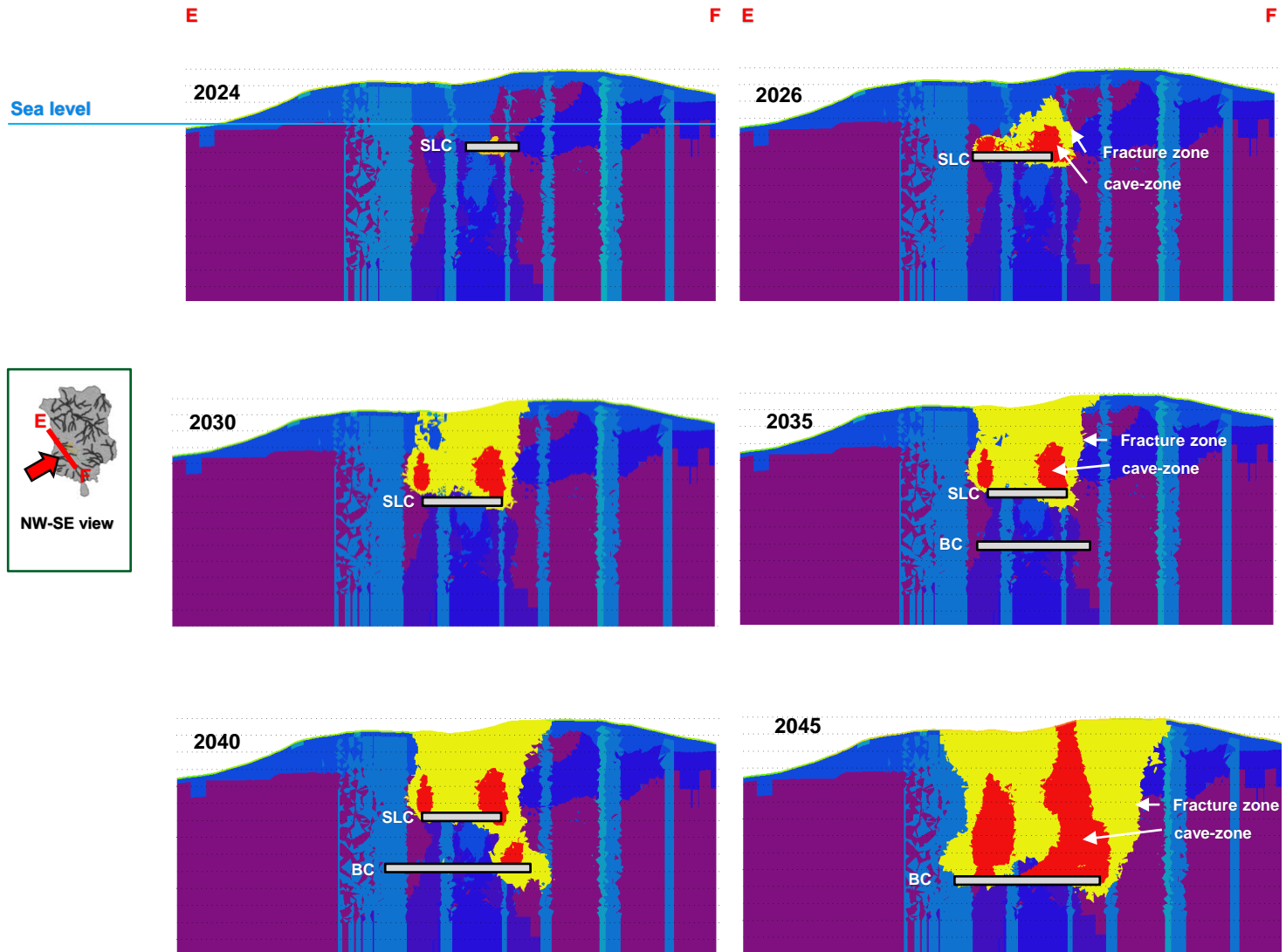
▶ Fracture and cave zone are inserted in the numerical model on a yearly basis.
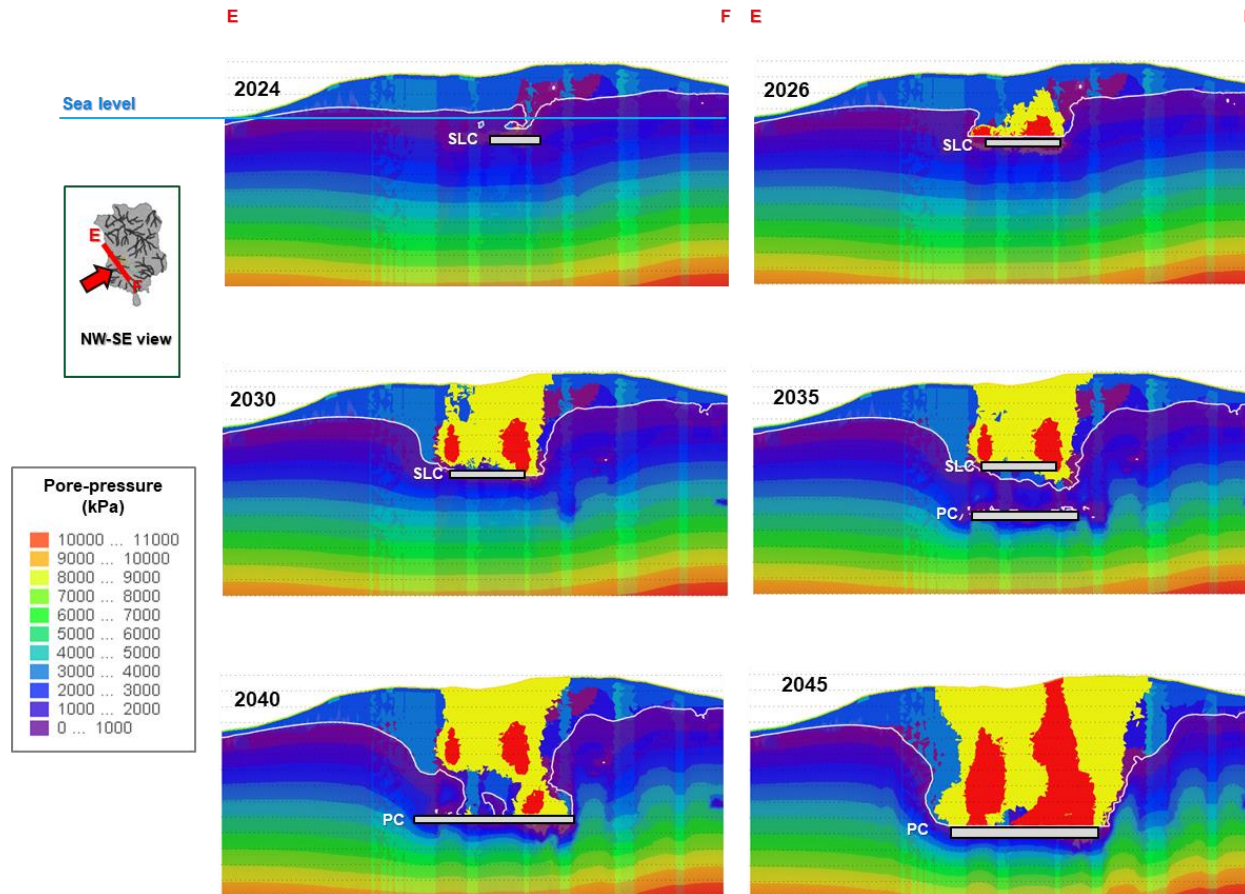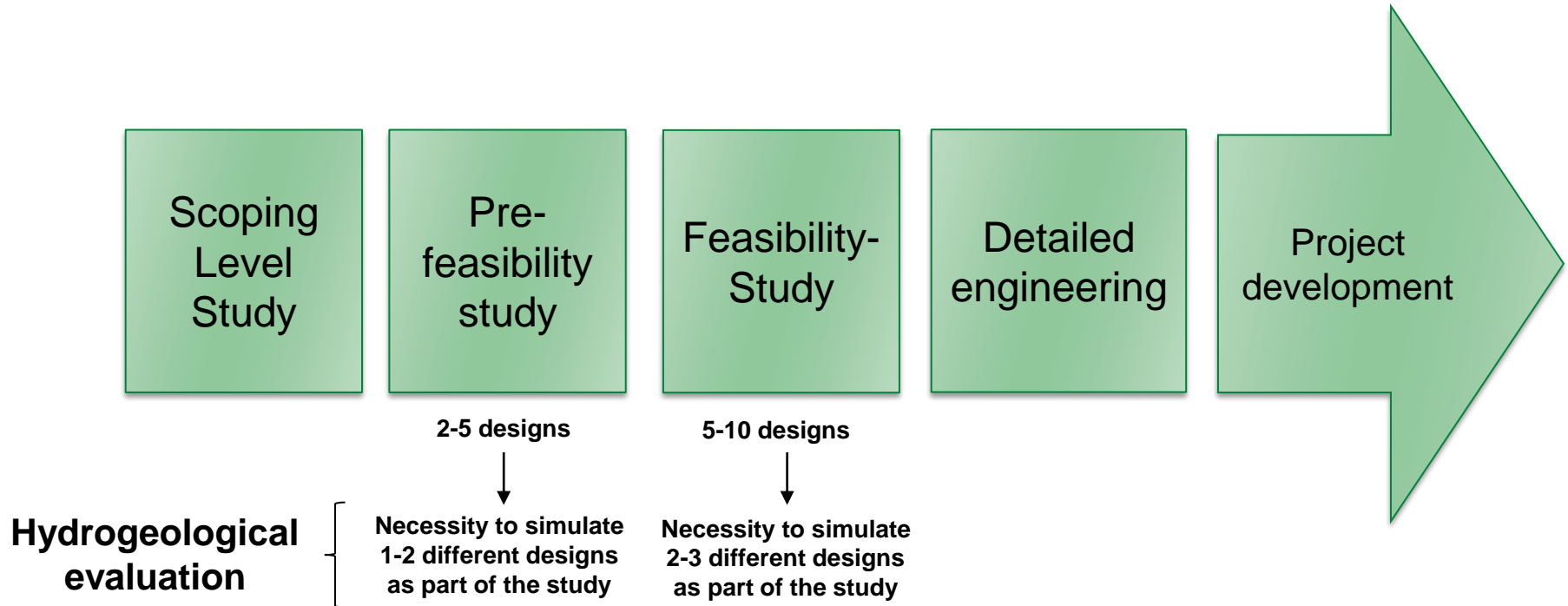
3D GW model with FEFLOW
Fracture zone propagation and groundwater levels

- ▶ Linear interpolation of material properties over selected periods.
- ▶ Groundwater lenvel variation induced by the fracture zone propagation.

Main stages in the development of a mining project

Scoping Level Study

Pre-feasibility study

Feasibility-Study

Detailed engineering

Project development

2-5 designs

5-10 designs

Hydrogeological evaluation

Necessity to simulate 1-2 different designs as part of the study

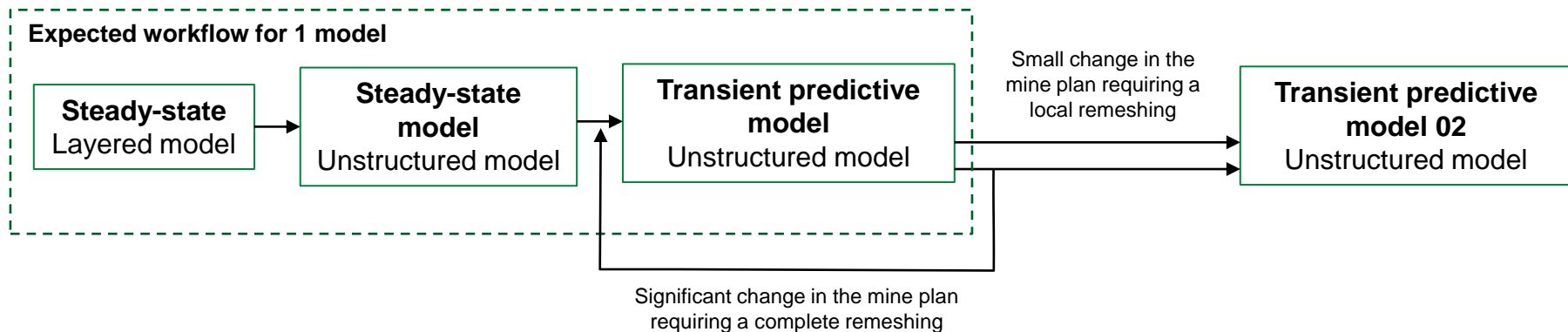**Necessity to simulate 2-3 different designs as part of the study**

Advantages of FEFLOW
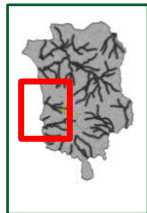
Tools available in Feflow

- ▶ **Unstructured mesh (TetGen):** Accommodating complex geometries of complex projects. Tool that can also easily accommodate <u>new</u> underground designs.

- ▶ **Time variant properties:** Easy to use option to simulate the cave and fracture zone propagation.

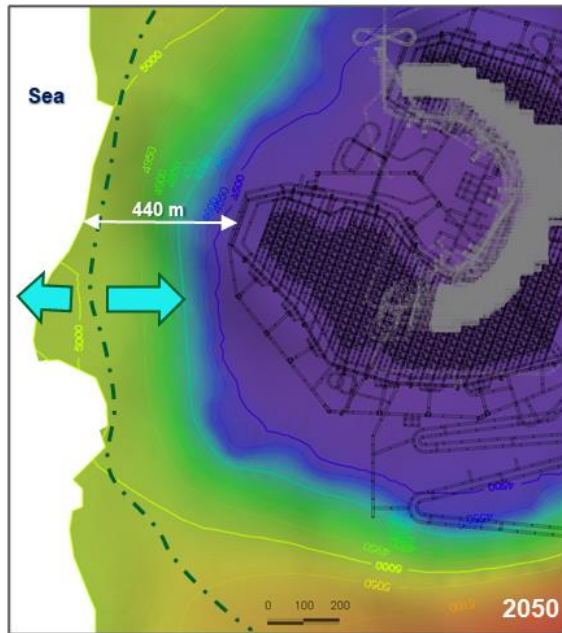- ▶ **Modulation functions**: Easy to use to simulate the progressive construction

Possibility to develop complex 3D groundwater models in a timeframe coherent with the overall project
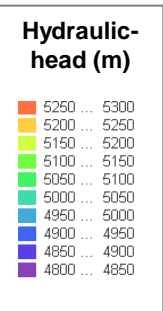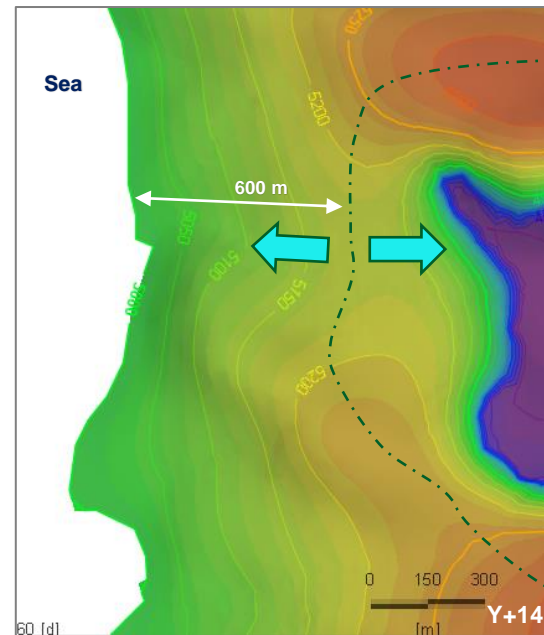
Expected workflow for 1 model

| **Steady-state** Layered model | → | **Steady-state model** Unstructured model | → | **Transient predictive model** Unstructured model | **Transient predictive model 02** Unstructured model |

Small change in the mine plan requiring a local remeshing

Significant change in the mine plan requiring a complete remeshing

Hydraulic-containment for different designs

Thank you for the opportunity