

# Groundwater Modeling as an Assessment Tool for Underground Mines Located in Fractured Massifs

Jordi Font-Capó<sup>(1)</sup> (jordi.font@amphos21.com) Albert Nardi<sup>(1)</sup>, Miguel Mendoza<sup>(2)</sup>, Eduardo Ruiz<sup>(2)</sup>  
Salvador Jordana<sup>(1)</sup>, Paolo Trinchero<sup>(1)</sup>, Jorge Molinero<sup>(1)</sup>

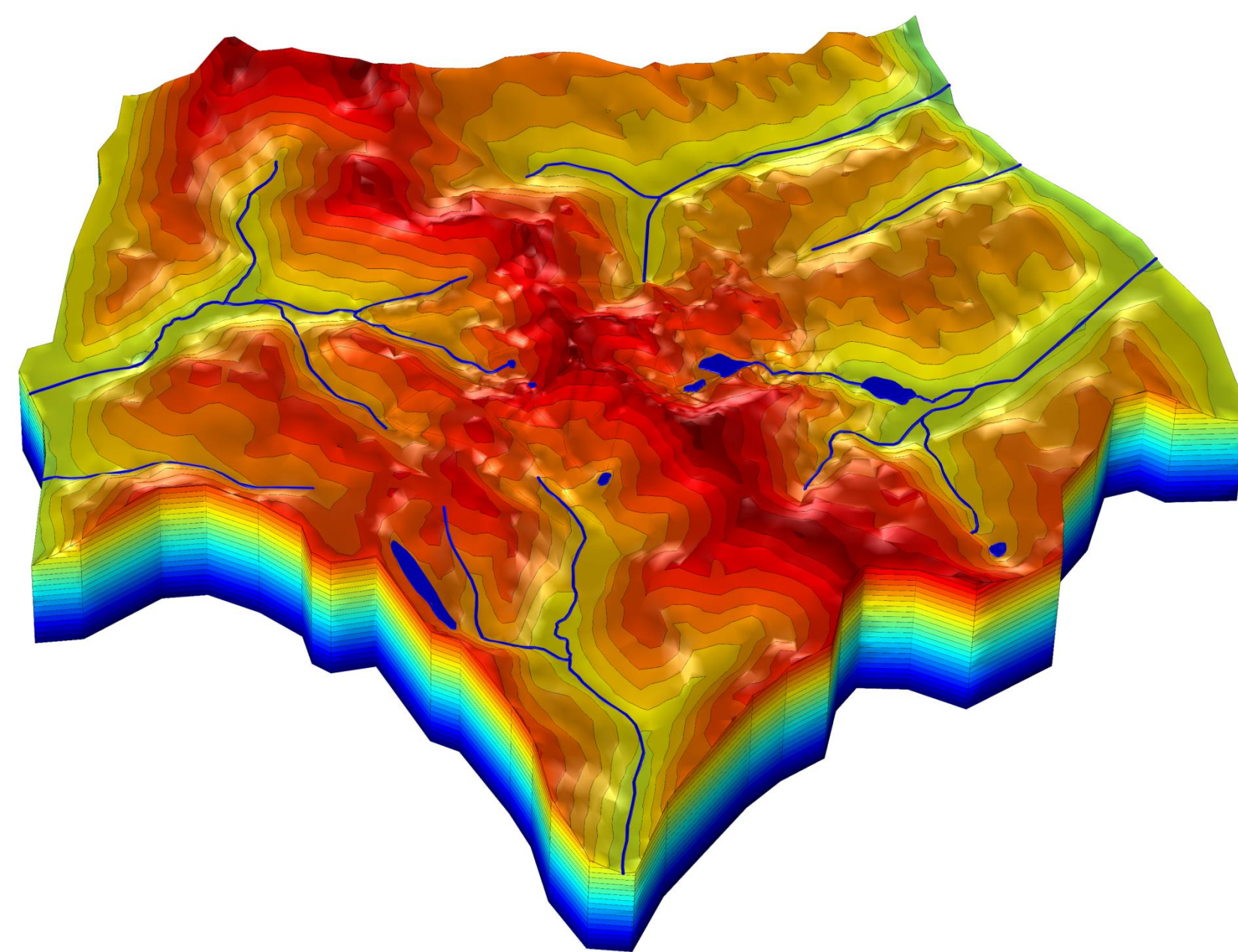
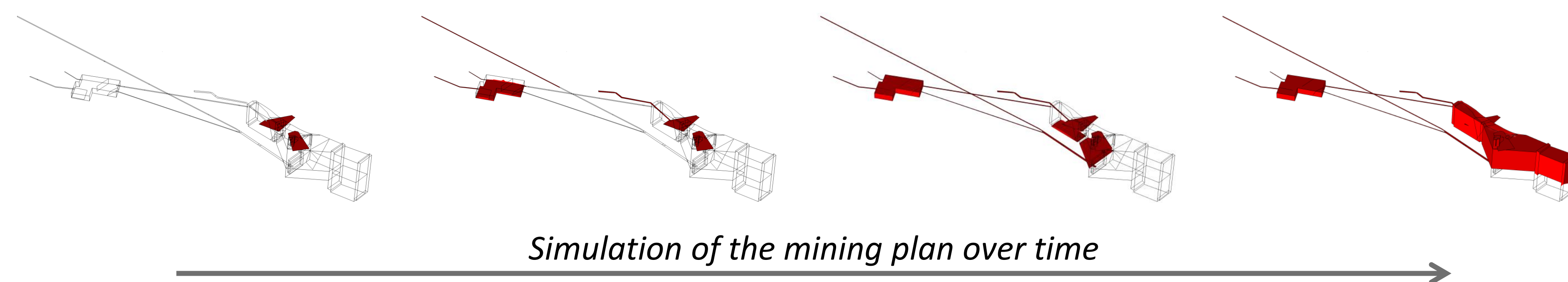
<sup>(1)</sup>Amphos 21 Consulting S.L <sup>(2)</sup>Amphos 21 Consulting Perú S.A.C.

## Introduction

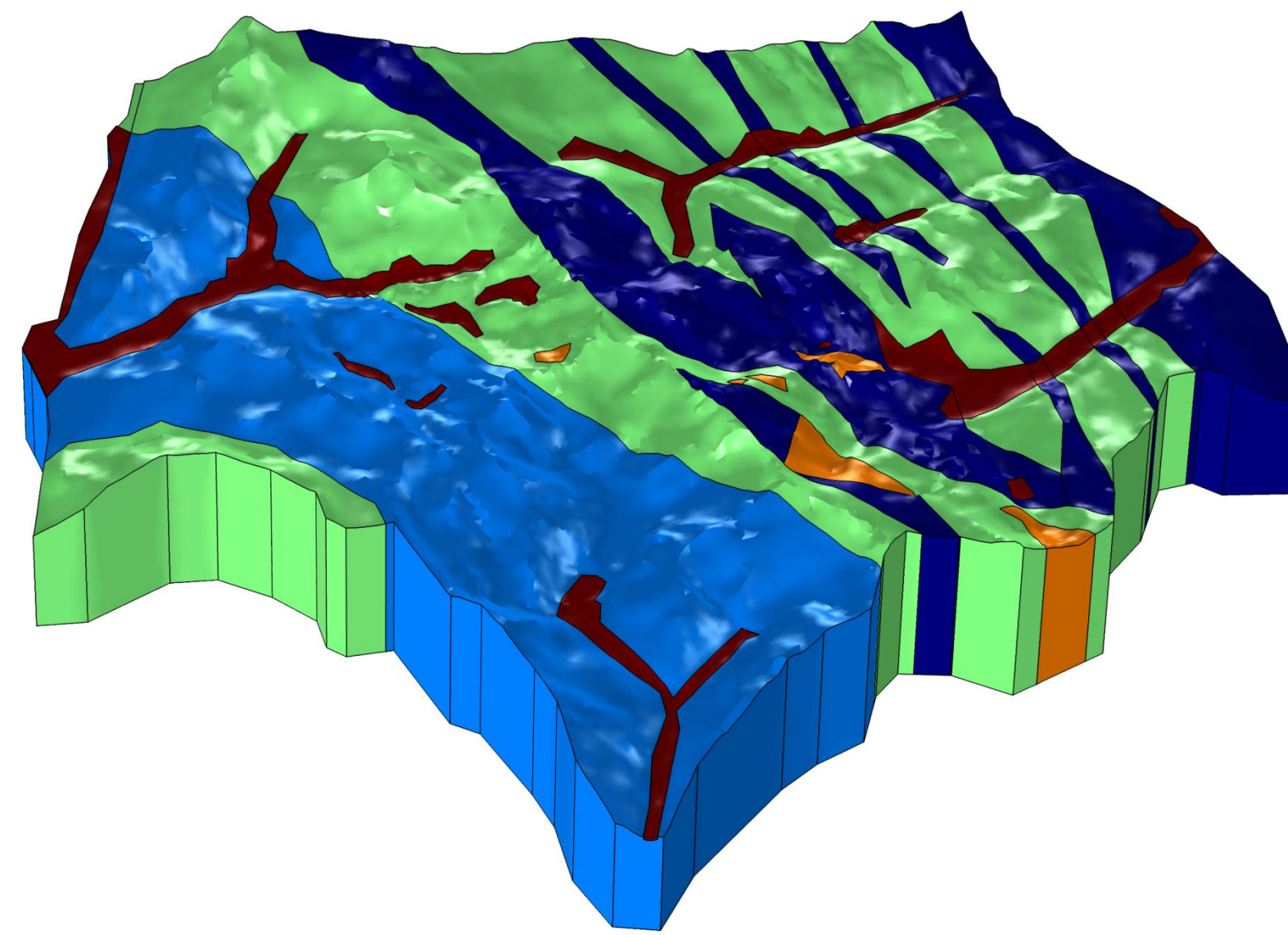
Some of the present metallic ores mines are located in areas formed by a heterogeneous fractured massif where groundwater flows preferentially through fractures.

Underground mining in these zones can cause impacts in streams, lakes and change the natural water balance of the watersheds, leading to conflicts between traditional uses of water and the mining activity. Quantification of these impacts is crucial for the sustainability of the operation time. In this work we develop a 3D integrated hydrogeological numerical model of a mining construction and operation in a fractured media.

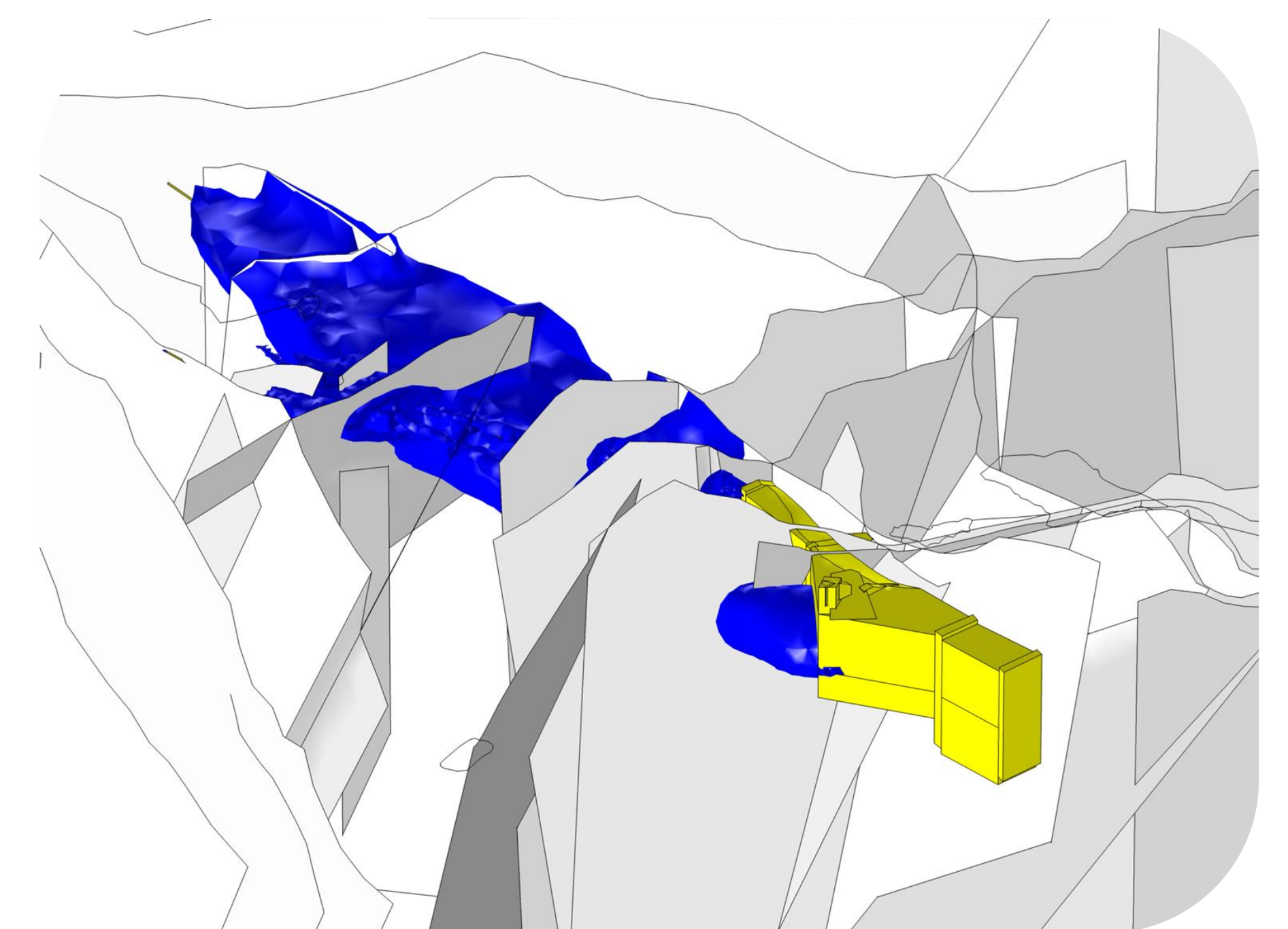
## Results



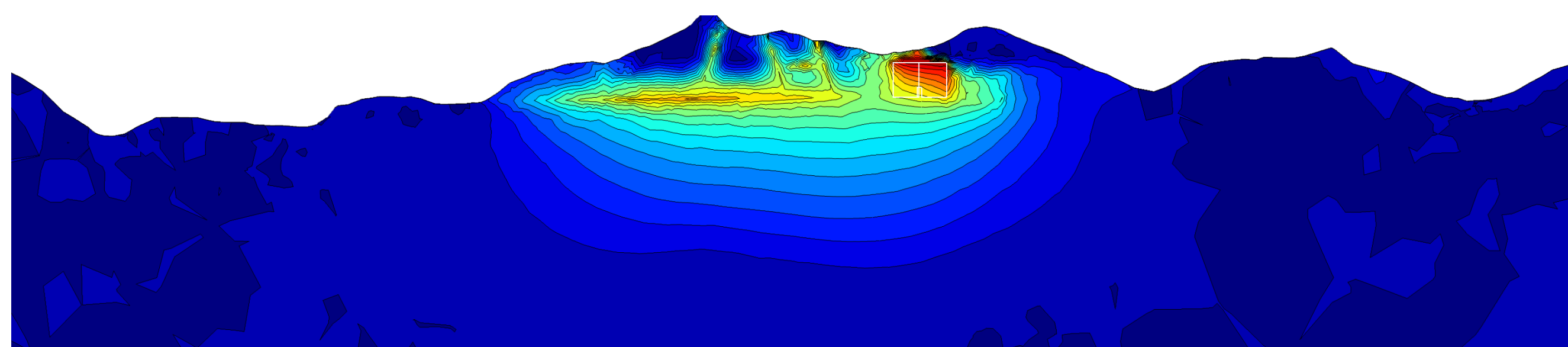
Topography, lakes and rivers



Hydrogeological formations



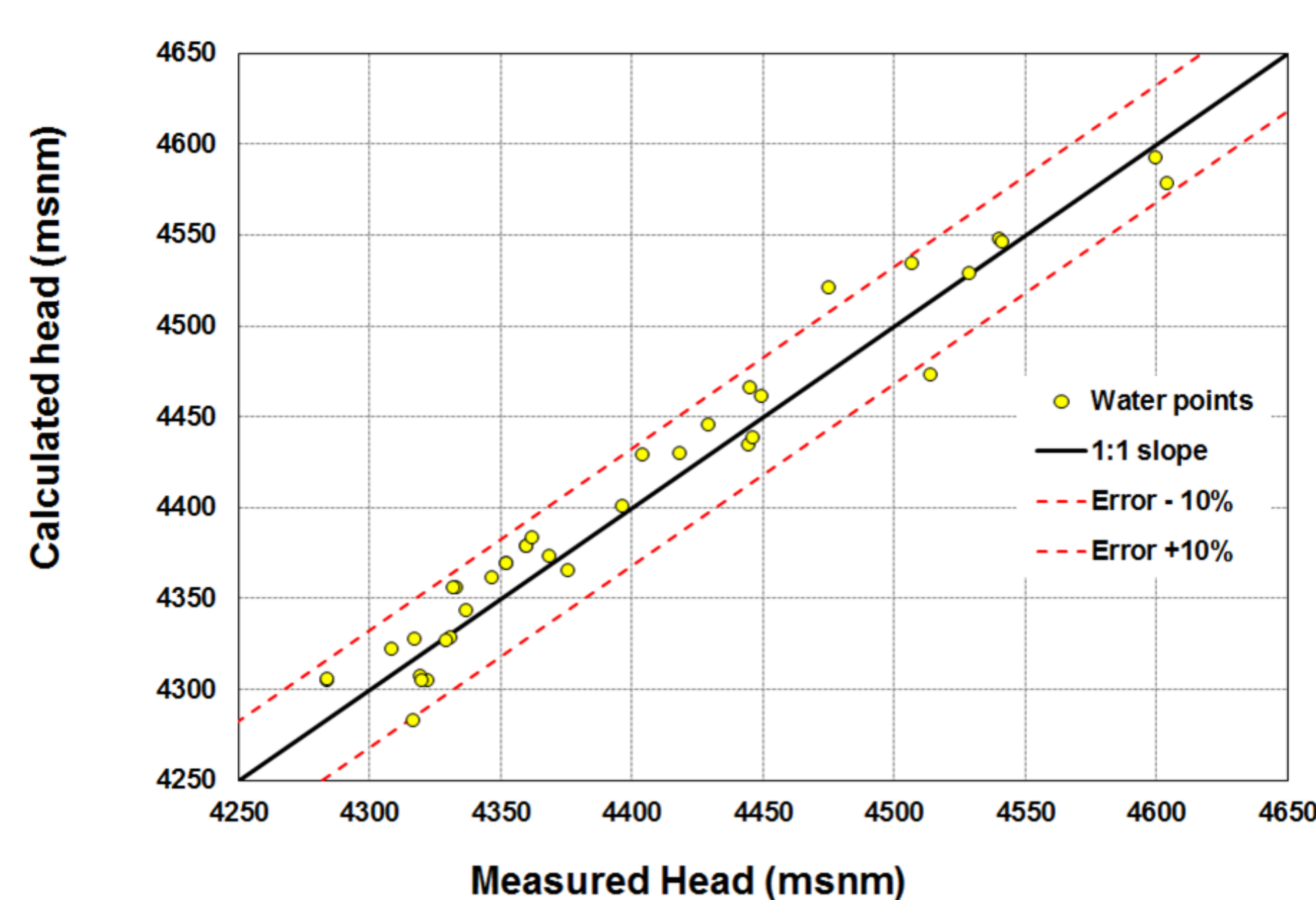
Discrete fractures (white and grey), drawdown calculated (blue) and mine galleries and tunnels (yellow).



Drawdowns produced by the tunneling in a vertical cut. Note the effect of the fractures.

## Model validation

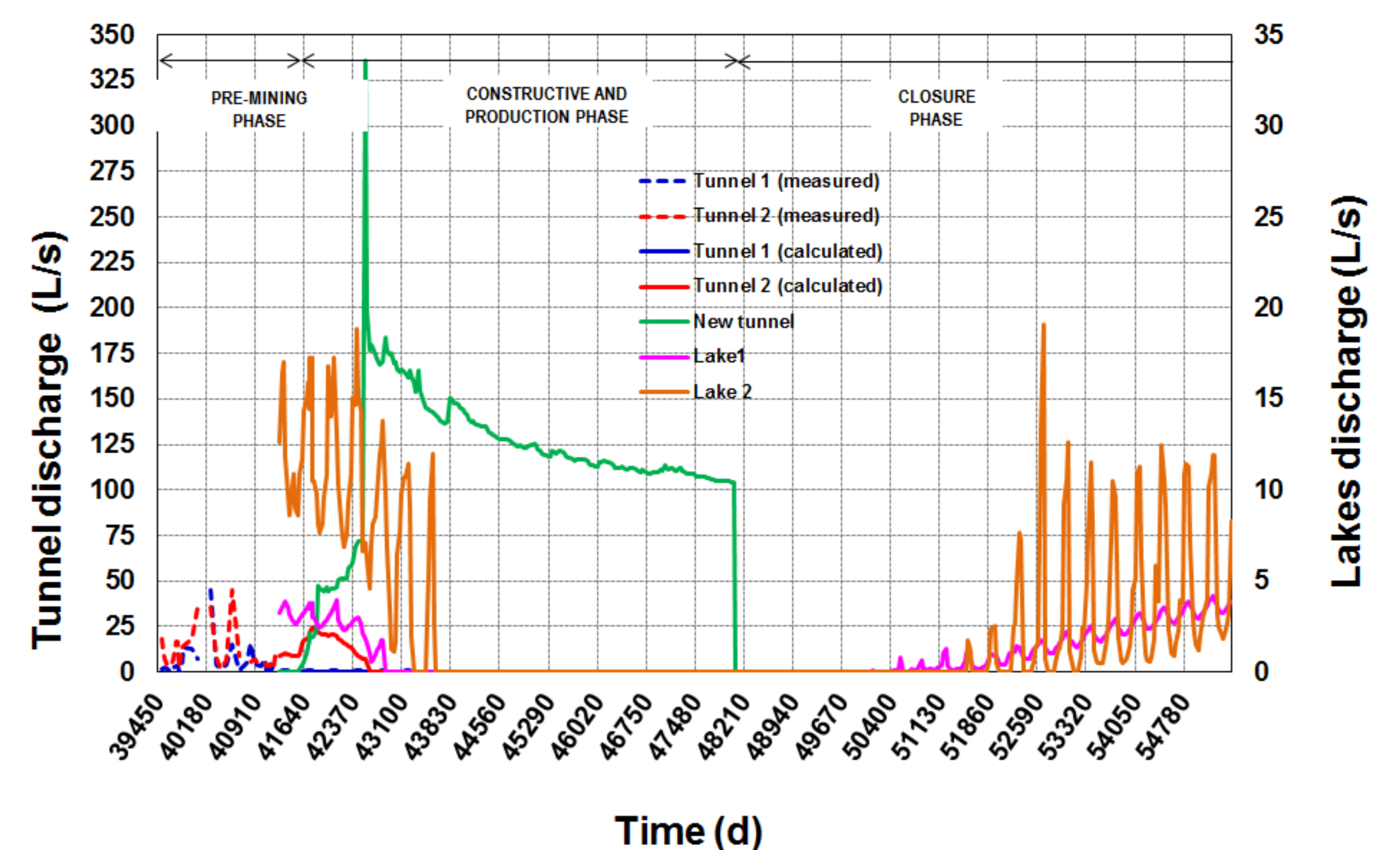
Model has been calibrated under steady state boundary conditions.



## Numerical model

- The abrupt topography is included through the Digital Elevation Model.
- Permeable discrete fractures known are incorporated as 2D planes.
- Hydrogeological properties of the media are defined using the previous geological information.
- Watersheds, rivers and lakes are taken into account by appropriate boundary conditions.
- Mine structures (tunnels, caverns) are introduced in their real position as planes and volumes.

The evolution of the tunneling has been simulated introducing time functions that activate the different structures as the mining plan progresses.



Predicted outflow in the lakes and inflow inside the tunnels

## Conclusions

- Tunnel inflow can be predicted and the flow variation due to the main fractures can be observed.
- Lake and surface outflow variations caused by the mining is also forecasted at any simulation time.