Modelling Large-Scale Mine Dewatering By Using Subsurface Flow Module in COMSOL Multiphysics

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Abstract

Groundwater is a key factor affecting mine operations worldwide. On one hand, both underground and open pit mines need to pump out groundwater in order to proceed with mineral extraction and increase the stability of rock slopes. On the other hand, groundwater abstractions can produce undesired environmental and social impacts, which should be anticipated in the environmental impact assessments and mine feasibility studies. However, simulating open pit dewatering activities is not trivial because usually involves large-scale domains (basin scale), complex geological settings, including fracture zones and faults and difficult geometrical constrains due to mine engineering. In this work, the Subsurface Flow Module of COMSOL Multiphysics was used to simulate the feasibility and hydrogeological impact of a future mine dewatering operation. Digital Elevation Model and geological settings were imported into COMSOL, as illustrated in Figure 1. The finite element mesh was generated for the whole hydrological basin, highly refined in the mine vicinities, in order to properly adapt the open pit geometry (Figure 2). The major fracture zones known by the geological and hydrogeological studies were considered as planar features by means of 2D elements, as illustrated in Figure 3. Figure 4 shows computed steady state groundwater heads affected by pumping according to planned mine dewatering. The hydrogeological impact produced by mine dewatering would be very limited to the near surroundings but in the north, where a higher propagation of the groundwater drawdown is predicted due to the influence of 2 major water-conducting fracture zones (Figure 4). Hydrogeological modeling with COMSOL Multiphysics is a powerful tool for mine dewatering optimization and prediction of possible environmental impacts. The methodology presented here allows integrating geomorphological, geological, hydrogeological and mine engineering information in an optimal way. A major advantage of COMSOL Multiphysics in comparison with most of the hydrogeological simulators is the possibility of using complex planar geometrical entities with 2D elements to represent major water-conducting fracture zones.

Figures used in the abstract

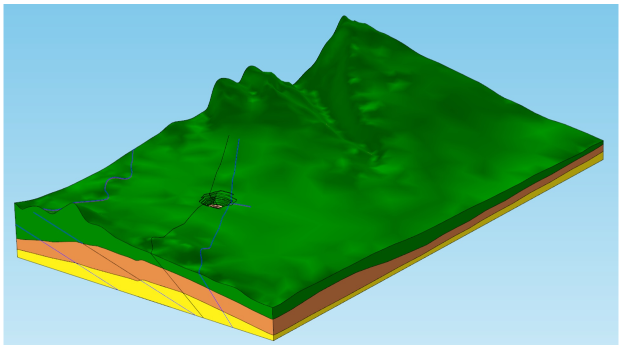

Figure 1: Digital elevation model of the hydrological basin, open pit geometry, geological settings and intersections with the major fracture zones reported in the area.

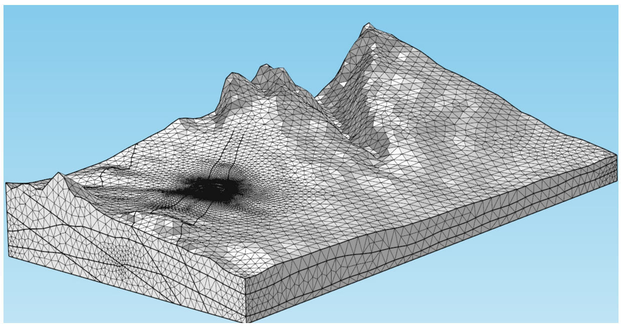

Figure 2: Finite element mesh for numerical simulations.

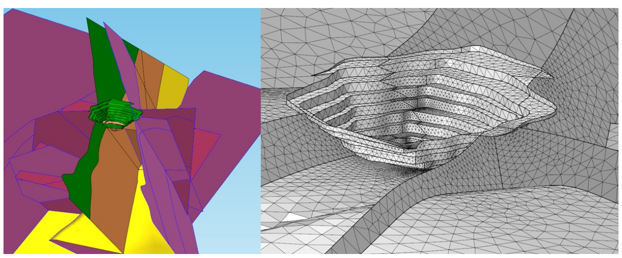

Figure 3: Discrete planar features representing major water-conducting fracture zones (left), and detail of the finite element mesh used for simulating fracture zone-open pit interaction.

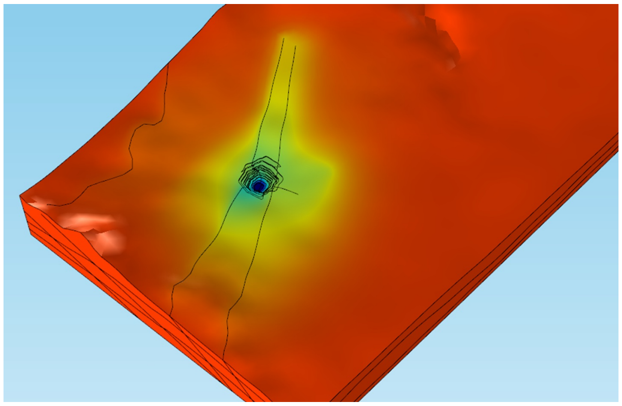

Figure 4: Computed steady-state groundwater heads and hydrogeological impact produced by mine dewatering.