Université de Neuchâtel
Centre d'hydrogéologie et géothermie

MSc in Hydrogeology and Geothermics
Thesis topic proposal 2024

Understanding the interplay between geomechanics and hydraulic properties of bedrock: a 3D geomechanical modeling of the Poschiavino catchment

Context and objectives

Understanding the intricate relationship between geomechanics and groundwater dynamics is fundamental to both critical zone science and alpine geomorphology. Within an alpine catchment, the properties and distribution of lithologies and bedrock fractures play a crucial role in regulating this interaction. However, the complex feedback mechanisms between stress distribution, hydraulic properties, and groundwater flow partitioning remain poorly understood at the catchment scale.

This master project aims to develop a comprehensive 3D geomechanical model of an alpine catchment observatory situated in the canton of Graubünden (Poschiavo). The student will play a key role in leading the experiment, which involves organizing field campaigns, acquiring multiple field data, and setting up a cutting-edge numerical experiment. The student will be trained in geological and geotechnical mapping, as well as advanced 3D geological and geomechanical modeling techniques. The primary goals of this project is to develop a robust 3D geological and geomechanical model of the site and assess the distribution of hydraulic properties. In the broader context, this model will serve to inform a groundwater flow and transport model being developed as part of a PhD project at UniNE.

Methodology

The methodology will involve a first compilation of existing geological and geotechnical data available at the site and conduct field investigations in designated areas of interest where high-resolution information is required. In addition to traditional geological mapping techniques, the student will receive training in conducting geophysical techniques to characterize subsurface heterogeneities, utilizing methods such as surface electrical and seismic surveys. Data from a dense network of boreholes will also be integrated into the analysis and the model. The student will then use the software Geomodeller to compile all geological information and construct an initial geological model. This geological model will serve as a basis for constraining a geomechanical model, to be developed using RocScience. The resulting stress and strain distributions will be qualitatively validated against geotechnical and geological structural observations, which will be obtained concurrently through a parallel MSc project. Specifically, the model outputs will be compared with fracture statistics, including orientation, length, density, and aperture and converted into hydraulic properties.

Supervision and collaboration

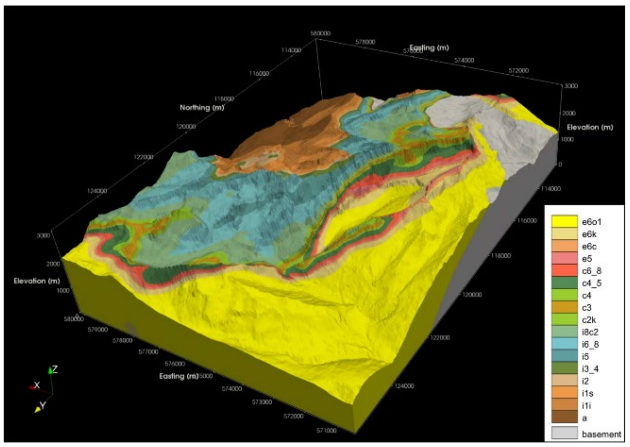

Figure 1: Example of a 3D geological model developed on the Vallon de Nants (Thornton et al. 2018)

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Collaborations with Dr. Nicolas Oestreicher (UniGe), Pr. Benoit Valley, Dr. Landon Halloran and Dr. Valentin Gishig (ETHZ).

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