Université de Neuchâtel
Centre d'hydrogéologie et géothermie

MSc in Hydrogeology and Geothermics
Thesis topic proposal 2024

INTEGRATING UAV IMAGERY AND IN-SITU INVESTIGATIONS FOR 3D FRACTURE NETWORK MODELLING

Context and objectives

Alpine catchments play a critical role in sustaining down-gradient streamflow. The hydrology of these catchments is highly dynamic, generally characterized by an annual cycle where groundwater storage and flow through the bedrock play a critical role. In settings underlain by crystalline rocks, groundwater dynamics is controlled by the 3D distribution of fractures. The lack of data regarding the connectivity and properties of the fractured network make the evaluation of relevant hydrogeological properties particularly challenging.

This master thesis will provide the student with the fundamental tools for the characterization of fracture networks, which is an essential aspect in fractured media flow and transport projects (e.g. geothermic, hydrogeology, energy and geotechnics). This project aims at providing quantification into the fracture-network statistics and its impact on groundwater flow. The research will be developed at an alpine catchment observatory located in the canton of Graubünden (Poschiavo). The student will participate in leading an experiment combining drone-based photogrammetry and borehole data. The goals of this project are to: a) image the geometry of the fracture network on representative outcrops throughout the catchment, b) identify zones with different types of fracturation, and, c) assessing the influence of the fracture network model on the hydraulic properties. In perspective, the model will be used to assess the impact of fracture network on groundwater flow.

Methodology

The student will compile available geological data that will be further completed by specific in-situ investigations including: 1) high resolution aerial pictures acquired with UAV instruments, 2) fracture characterization of borehole data (fracture mapping and optical televiewer), and, 3) fracture networks reconstruction using statistic theories. This will allow us to build a 3D fracture network model of the investigated area describing the distribution of mechanical and hydraulic properties. The 3D model will be further used as main constrains for the groundwater model to study the impact of fracture-network on flow and particle tracking. If the student is willing, scientific publications are feasible with the project.

Supervision and collaboration

Supervision by Dr. Clément Roques and Ronny Figueroa.

In collaboration with Pr. Benoît Valley and Dr. Landon Halloran.

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Figure 1: Picture of one of the main outcrops that will be investigated in this project.