

Rock Strength, Permeability, and Jointing Around Shallow Intrusions, Mt. Ruapehu

**Stanley Mordensky¹, Ben Kennedy¹, Marlene Villeneuve¹, Darren Gravley¹, Michael Heap², Jamie Farquharson²,
and Graham Leonard³**

¹University of Canterbury, New Zealand

²University of Strasbourg, France

³GNC Science, New Zealand

ABSTRACT

Summary

Magmatic intrusions affect the density of joints/fractures and alteration mineralogy of the host rock into which they intrude, which can influence host rock strength and permeability. At Mt. Ruapehu, New Zealand, we mapped joints/fractures and alteration mineralization in 3D space with respect to proximity of intrusions. Our aim is to compare these field analyses with laboratory measurements of strength and permeability.

Introduction

Mt. Ruapehu is an active andesitic stratovolcano with rockfall, landslide, and eruptive hazards. Our study focuses on the fossil hydrothermal system of Pinnacle Ridge in the Te Herenga formation (~170 ka), the oldest known formation of Mt. Ruapehu, exposed in a nearly vertical sequence by glaciation (~10 ka) (Hackett, 1985).

Methods

- Photogrammetry using Agisoft and UAV photography
- Scanline Fracture Mapping
- Field Schmidt Hammer and Field Permeability
- Rock Mass Classification
- Sample Core Porosity, Permeability, and Vp/Vs Tests
- Uniaxial and Triaxial Strength Tests

Results –Facies and Joint Regimes

Pinnacle Ridge is composed three distinct facies, variably altered coherent andesite lavas and sills, variably altered andesite breccias, and several generations of microdiorite dyke and stock intrusions. In all facies, cooling joints related to primary emplacement are overprinted by larger scale regional jointing and faulting related to regional extension and intrusion emplacement. Montmorillonite and illite alteration of intrusion margins is fracture controlled. Lava and breccia deposits close to intrusions are pervasively altered to clays and sulfides (Hackett, 1985).

Ground truthing and UAV orthomosaic photography provide a 3D perspective that reveals the discontinuity regimes in the rock mass. Jointing is predominantly sub-parallel to the NNE-SSW orientation of regional structures. Scanlines reveal polygonal, planar joint networks in the unaltered lavas and intrusions. In contrast, altered lavas and intrusions host a less regular fracture network with lower densities.

Conclusions

The effects of intrusive events on the host rock are highly heterogeneous proximal (<200 m) to the intrusions at Pinnacle Ridge. Our data suggest primary lithology controls rock properties more than the relative distance to the intrusion. Unaltered intrusions and lavas express a history of brittle failure and form the most vertical and unstable terrain, contrasting with the more altered facies that weather to gentler slopes. The clay content and joint characteristics of the altered breccias suggest a pervasive fossil hydrothermal system with time-variable permeability. The contrasting rock properties have implications for monitoring and understanding volcanic and geothermal systems. We suggest this type of detailed field study can provide important context to laboratory-based rock mechanical studies.