WETENSCHAPPEN &
BIO-INGENIEURSWETENSCHAPPEN

The Research Group

Physical Geography

has the honor to invite you to the public defense of the PhD thesis of

Sam POPPE

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Magma intrusion and related deformation of the Earth's upper crust in nature and analog experiments.

Promotors:

Prof. Dr. Matthieu Kervyn (promoter,VUB)
Prof. Dr. Eoghan Holohan (promoter, University College of Dublin, Ireland)

The defense will take place on

Friday November 8 2019 at 16h

in Auditorium D.2.01 at the Campus Humanities, Sciences and Engineering of the Vrije Universiteit Brussel, Pleinlaan 2 - 1050 Elsene

Followed by a reception.

Members of the jury:

Prof. Dr. Philippe Huybrechts (Chairman, VUB)
Prof. Dr. Steven Goderis (Secretary, VUB)
Dr. Gert Van Gompel (Radiologie, UZ-VUB)
Prof. Dr. Steffi Burchardt (University of Uppsala, Sweden)
Prof. Dr. Janine Kavanagh (University of Liverpool, UK)

Curriculum vitae

Sam Poppe completed his B.Sc. and M.Sc. in Geology at Ghent University. He studies volcano deformation processes, such as caldera collapse, gravitational deformation and magma intrusion, by combining analogue laboratory experiments, geochemical techniques and field work on active or eroded volcanoes. He published his work as (co-)author in several international peer-reviewed journals and a book chapter and has frequently presented his work at international conferences. As active science communicator, he received the 2018 KVAB Year Prize and often publicly comments on volcano news.

Abstract of the PhD research

Magma ascends through the Earth's crust towards its final subsurface position, or eventually towards eruption at the surface, by deforming the Earth's crust and by displacing its surface. Directly observing these subsurface processes is impossible in real time. Consequently, the interpretation of geophysical monitoring data – on which accurate volcanic eruption forecasts depend – is a challenge and must be guided by conceptual and physical models of magma emplacement.

This results in heavily-debated questions: What are the physical mechanisms that control magma-induced rock fracturing? How do magma intrusions grow to their final geometries? How can we interpret seismicity and surface displacement patterns? This Ph.D. research combines observations from exposed magma plumbing systems and active volcanic edifices with the development of an innovative analog laboratory modelling approach.

Observations on a small-scale outcrop in the Oslo Rift showed that the propagation of thin magmatic intrusions is controlled by pre-existing structural weaknesses in the host rock and thermo-chemical interactions with the magma. The propagating magma simultaneously induced opening-mode and shear-mode fracturing of the host rock.
In the laboratory, a set of detailed material tests showed that dry mixtures of silica sand and gypsum powder (plaster) are suitable as analogs for the Earth's upper crust, and display more complex mechanical behavior than hitherto appreciated.
Using those sand-plaster mixtures, a novel method was developed to analyze magma-induced displacement in laboratory models in 4D (3D + time) by using medical X-ray Computed Tomography. The modeling results show that analog intrusions propagate by mixed-mode deformation of their sand-plaster host material, similar to the findings in nature. The dominance of either opening- or shear-mode fracturing is largely controlled by the host rock rheology, among other physical parameters, and leads to a spectrum of intrusion geometries as observed in nature.
Comparison of the laboratory model results to surface displacement patterns at the active Piton de la Fournaise volcano, La Réunion, leads to improved interpretations of magma intrusion processes.