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AVHANDLINGENS TITTEL:	*Quantitative Laboratory Modelling of Host Rock Deformation due to the Intrusion of Magma*

Vulkanisme og magmatransport under jordoverflaten, er en av Jordas mest grunnleggende og fascinerende prosesser. Den kan forårsake katastrofale vulkanutbrudd, men bringer også naturressurser og termisk energi til overflaten. I avhandlingen er det utviklet og undersøkt modeller av magmatiske system og de resulterende deformasjonsmønstre. Ved å bruke materialer med lignende mekaniske deformasjonsegenskaper som steinen som omgir magma i naturen, indikerer Guldstrands resultater at modellene som for tiden brukes til å studere vulkansk overflateformasjon kanskje overforenkler prosessene som skjer i naturen.

Volcanism is a fundamental process on Earth. It is responsible for the formation of new crust, by adding hot magma to the surface where it solidifies. Ascending magma interacts with geological formations by adding heat, fluids, and other elements. This can result in the formation of ore deposits and, if in the vicinity of organic-rich deposits, may mature hydrocarbons and also release them to the atmosphere. In addition magma can induce ground motion, earthquakes, and sometimes, catastrophic eruptions. Current models of magma emplacement dominantly assume an elastic behaviour of the host rock. However, field observations indicate that substantial plastic deformation of the host rock is taking place during the intrusion of magma.

This PhD research work explores the effect of brittle rheology on the deformation associated with ascending magma through the shallow crust. Guldstrand applies laboratory models of magmatic systems comprised of injecting viscous fluids into cohesive silica flour, a fine-grained flour that fails similarly to natural rocks. Model monitoring required developing the use of photogrammetry and structure-from-motion software MicMac. Through taking pictures at set time intervals it was possible to compute digital elevation models, orthophotos and point clouds. This allows for the capture of dense spatial information and its evolution through time.

The data analysis of experimental intrusions show that it is possible to distinguish the subsurface intrusion geometry based on the characteristic surface deformation patterns. Notably, the deformation above experiment intrusions comprising vertical planar sheets, in nature commonly referred to as dykes, show uplift. Current models of dykes predict subsidence flanked by two bulges. A similar pattern can be seen in nature but almost exclusively in geologic extensional settings, such as rifts. Interestingly, current models commonly do not account for rifting, nor do they account for brittle rheology or the dynamic aspect of the problem. Furthermore, analysis of the experiments shows the close link of the eruption location and the highest point in the surface deformation and suggests that it may be possible to forecast the location of eruption.

A cutting-edge laboratory setup was developed that allow for monitoring of host deformation along with the inlet pressure. This reveals that the cohesive strength of the surrounding host controls the propagation and emplacement style of the intrusion and results in drastically different tip mechanisms and pressure readings. This PhD study shows that accounting for realistic rock rheology results in drastically different surface deformation and emplacement mechanics compared to established models. This PhD work was funded by the Norwegian Research Council grant Frinatek, which promotes basic research.