The emplacement processes and evolution of magma in the Earth’s crust are accompanied by crystallization, assimilation of rocks and replenishment of the magmatic reservoir by hotter and chemically less evolved material. These processes control the evolution of rheological and physical properties of magma residing in a chamber, and drive the magmatic system either to an eruption or to the generation of new crust. Petrology, thermal modeling and rheology were applied in this study to characterize the main factors controlling the fate of magma emplaced in sub-volcanic reservoirs.

We performed petrological experiments on a dacite starting material similar in composition to the Fish Canyon Tuff in cold seal, fast-quench pressure vessels, at 200 MPa confining pressure, to characterize accurately the variation of crystal content (X) with temperature (T) and water content. The data show a non-linear relationship between T, X and H2O. These results were combined with thermal modeling to monitor the temporal evolution of crystallinity in a magmatic reservoir in which hotter magma is injected and investigate the role of injection frequency in repeatedly replenished reservoirs. By quantifying the effect of H2O on phase relations and proportions we are able to explicitly take account of the effect of reheating partially degassed and solidified resident magma within the chamber. The rheology of material with the same characteristics (crystallinity, and crystal shapes) of the one synthesized experimentally, was measured using concentric cylinder viscometry. This study help constraining the conditions under which magma erupts or stall in the crust to generate intrusive bodies.