Pseudotachylytes in volcanic environments are formed by nonequilibrium melting of silicate rocks, which reach chemical equilibrium upon increase slip. Chemical mixing of silicate melts is controlled by diffusion and convection; a process, which is enhanced by, and in turn controls, frictional slip. The rheological properties of silicate melts are known to be strongly dependent on the chemical composition, temperature, the presence of crystals and bubbles, as well as strain rate. It results that the formation of pseudotachylyte associated with high-magnitude earthquakes lacks a rheological description.

Here, high-velocity friction experiments on andesitic and basaltic volcanic rocks are combined with rheological, geochemical and microstructural analyses to constrain the development of pseudotachylytes and their rheological control on fault properties. Frictional melting occurs at ca. 1000+/-50 °C and coincides with a peak in the coefficient of friction. As slip ensues, friction decreases and stabilises while temperature slowly rises. Post-experiments SEM image analysis show a gradation from the host rock, to a thin region of chemically heterogeneous protomelts, and an inner region of chemically homogeneous frictional melts in the slip zone. The initial protomelts chemically reflect the composition of the local crystal assemblage and as such, their rheology may vary significantly. The inner frictional melt, however, chemically reflects the bulk rock composition and remnants of crystal fragments as well as spherical bubbles. The viscosity of frictional melts is measured and modelled and we discuss the implication of our findings to the cases of tectonic faults, stability of volcanic edifices and evolution of lava dome eruptions.