Unravelling magma emplacement through palaeomagnetic backstripping of an intrusion-induced forced fold: A case study from the Sandfell Laccolith, SE Iceland

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Volcano eruption forecasting typically links ground deformation patterns to sub-surface magma movement. Injection and inflation of magmatic intrusions in the shallow crust is commonly accommodated by roof uplift, producing intrusion-induced forced folds that mimic the geometry of underlying igneous bodies. Whilst such forced folds have previously been described from field exposures, seismic reflection images, and modelled in scaled laboratory experiments, the dynamic interaction between progressive emplacement of hot magma, roof uplift, and any associated fracture/fault development remains poorly understood. For instance, analysis of ancient examples where magmatism has long-since ceased only provides information on final geometrical relationships, while, studies of active intrusions and forced folding only capture brief phases of the dynamic evolution of these structures. If we could unravel the spatial and temporal evolution of ancient forced folds, we could therefore acquire critical insights into magma emplacement processes and interpretation of ground deformation data at active volcanoes.

We put forth and aim to test a new hypothesis suggesting that thermoremanent magnetization (TRM) records progressive deflection of the host rock during incremental laccolith construction and that these measurements can be used to measure the rate of laccolith construction. Here, we integrate palaeomagnetic techniques with semi-automated, UAV-based photogrammetric structural mapping to test: (1) whether we can identify variations in Natural Remanent Magnetisation (NRM), TRM, and magnetic mineralogy across an intrusions structural aureole; and (2) whether measured magnetic variations can be related to deflection caused by incremental sheet emplacement. Our test site is located within the basaltic lava pile of the ~800 m wide structural aureole of the rhyolitic Sandfell Laccolith in SE Iceland, which intruded <1 Km below the palaeosurface at ~11.7 Ma. We discuss whether palaeomagnetic backstripping can be an effective resource to constrain the rate and magnitude of intrusion-induced forced fold evolution, and thus an effective tool in volcanic hazard assessment.

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