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The mechanics of sill emplacement in central volcanoes

Steffi Burchardt and Agust Gudmundsson

Department of Structural Geology and Geodynamics, Geoscience Centre, University of Göttingen, Goldschmidtstrasse 3, D-37077 Göttingen, Germany, sburcha@ gwdg.de

Sills are concordant bodies of magma and play an important role as proto-magma chambers in central volcanoes. The mechanics of sill emplacement is, thus, an important topic regarding the birth of shallow crustal magma chambers. The Njardvik Sill in the extinct Tertiary Dyrfjöll Volcano in Northeast Iceland offers uniquely clear insights in its mode of emplacement. It was fed from several inclined sheets that intruded along a contact between acid intrusive rocks and basaltic lava flows. After a constriction, each inclined sheet thickens considerably when it enters the sill. At least seven individual units within the sill demonstrate that the Njardvik Sill did not evolve into a homogeneous magma body or proto-magma chamber. During the time when the sill was still liquid it changed the stress field in its vicinity and created its own local stress field around it. As a result, subsequently injected inclined sheets were forced to contribute to the sill, and regional dykes were diverted to a trend parallel to it. The Njardvik Sill terminates after a lateral extend of 140 metres at a fault that cuts the sill. A numerical model based on the field observations of the Njardvik Sill offers new insights in the mechanics of sill emplacement and sill propagation. Analogous to dykes, sills are hydrofractures and driven by an internal magma pressure. Mechanical layering and weak or open contacts between layers abet sill emplacement. Sill propagation along contacts is favoured by high tensile stress concentrations. Once a sill is established it attracts the injection of new inclined sheets into it. However, the injection frequency controls if a sill develops into a homogeneous magma body and subsequently into a magma chamber.