



Emplacement of the Slaufudalur Pluton, southeast Iceland, deduced from field observations and its three-dimensional shape

S. BURCHARDT¹*, D. C. TANNER² AND M. KRUMBHOLZ¹

¹*Geoscience Center of the Georg-August University Göttingen, Goldschmidtstr. 1, 37077, Göttingen, Germany.*

²*Leibnitz Institute of Applied Geoscience, Stilleweg 2, 30655, Hannover, Germany.*

**e-mail: sburcha@gwdg.de*

Abstract: The margin of the excellently exposed, granitic Slaufudalur Pluton was mapped with high-resolution GPS. Based on the GPS data, we reconstructed its three-dimensional shape, which resembles an elongated rhomboid with subvertical walls and a flat roof at map-scale. At outcrop-scale, the roof contact is characterised by numerous steps and cusped indentations interpreted as signs of magmatic stopping. From this, we conclude that the main volume of the pluton was created by cauldron subsidence, whereas the roof was subsequently reshaped by magmatic stopping.

Keywords: pluton emplacement, cauldron subsidence, magmatic stopping, GPS mapping, three-dimensional modelling.

The emplacement mechanisms of plutons can be deduced from textures, field observations, and the three-dimensional shape of granitic plutons.

As a result of the exceptionally good exposure conditions caused by glacial erosion, detailed GPS mapping, field studies, and the reconstruction of the three-dimensional shape of the Slaufudalur Pluton, SE Iceland, allowed us to determine the dominant emplacement mechanisms. The results indicate that the main volume of the Slaufudalur Pluton was emplaced by cauldron subsidence. Subsequent magmatic stopping modified the roof contact, but was volumetrically less significant.

Geological setting

The Slaufudalur Pluton is a 2×7.5 km granitic intrusion surrounded by Tertiary flood basalts in SE

Iceland. It was emplaced at a depth of around 1 km below the surface of the Tertiary rift zone (cf. Walker, 1974). Three previous studies (Cargill *et al.*, 1928; Beswick, 1965; Carmody, 1991) proposed that the pluton was emplaced by cauldron subsidence. A compositional layering was interpreted as evidence for incremental subsidence of the country-rock that was replaced by successive magma injections (Cargill *et al.*, 1928; Beswick, 1965; Carmody, 1991). In addition, all three studies report “abrupt rises and falls” of the pluton roof.

GPS mapping, field observations, and three-dimensional reconstruction

We mapped the margin of the pluton with GPS and recorded its orientation and features. Then we combined GPS data and field measurements and observations into a new structural map focussed on the contact features.

The contact between pluton and host rock is knife-sharp. Along the roof contact, m- to tens-of-m-scaled steps and cusped indentations and in some places, xenoliths of the roof rocks occur. We interpret these observations as unambiguous signs of magmatic stopping.

From the GPS data and the Digital Elevation Model (DEM) of Iceland, we created a three-dimensional digital model of the pluton using Gocad 2.0.8 and 3DMove. The resulting three-dimensional shape of the Slaufudalur Pluton is a relatively smooth, elongated rhomboid characterised by subvertical walls and a flat roof.

Implications for the mechanisms of emplacement

The subvertical walls and the flat roof, the magmatic layering and the lack of host-rock distortion indicate that space was created by cauldron subsidence (Myers, 1975). The overall flat roof indicates that the pluton originally exploited the layering of the host rock basaltic lava flows.

The final emplacement mechanism that shaped the roof of the Slaufudalur Pluton was magmatic stopping, which produced the step-like pattern of the roof and xenolithic blocks of basalt. Our field observations allow a better understanding of the mechanism of magmatic stopping.

References

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Discussion and conclusions

Since the exposure of most plutons is limited to two dimensions, reconstruction of their three-dimensional shapes is generally difficult. So far, this has only been possible for tilted plutons or with forward modelling of gravity-inversion data. The approach to use GPS mapping as a basis for a three-dimensional reconstruction yielded extremely good results for the Slaufudalur Pluton. However, it generally requires extraordinarily good exposures along several accessible sections.

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