Geophysical Research Abstracts
Vol. 19, EGU2017-16465, 2017
EGU General Assembly 2017

Lateral intrusion and vertical inflation of sills in the Trachyte Mesa intrusion, Henry Mountains, Utah

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Deformation structures developed in the host rocks of shallow crustal igneous intrusions provide a record of how magma was emplaced and accommodated. Here we present field observations from sill and laccolith intrusions exposed in the Henry Mountains, Utah.
Trachyte Mesa is comprised of a series of stacked sheets. Deformation structures imply a two-stage growth mechanism for individual intrusive units, with radial growth of a thin sheet followed by vertical inflation. Syn-emplacement structures localised at the intrusion lateral margins consist of prolific deformation bands and dip-slip faults located at the tips of individual sheets due to strain localisation during vertical inflation. Magma tends to preferentially exploit these faults, initiating sill climbing. The order in which sheets are stacked impacts on the intrusion geometry and thus the associated build-up of deformation.
Host-rock lithology also plays an important role in intrusion tip-geometry and associated deformation. Various styles of sill tip termination are observed (bulbous, steep-faulted, sill-climbing). Sill sheets with bulbous terminations appear to develop preferentially in muddy red sandstone units, whereas sheets with faulted terminations, and those exhibiting sill-climbing, appear most common in sheets directly below massive (competent) sandstone units. Shales behave in a more ductile manner, inhibiting brittle fault development; while the more massive, competent sandstones are prone to the development of faults as sill sheets inflate. Extensional roof faulting and sill climbing are consistent with a two-stage growth history for the overall intrusion. Not only do the deformation structures record the strain evolution, and thus mode of emplacement of the intrusion, they also control the subsequent propagation of the intrusive body (e.g. sill climbing).

Much can be learnt about intrusion geometries and emplacement through the detailed analysis of syn-emplacement deformation structures. Significant observations include:
• deformation structures commonly parallel intrusion margins and, in some cases, magma flow directions;
• deformation styles vary according to local intrusion geometry;
• in stacked sill-sheet systems, insights into the order of stacking may be determined through the analysis of associated, emplacement-related, deformation structures;
• deformation structures can be used to establish the growth mechanism of sill sheets;
• magma tends to preferentially exploit reverse faults that develop at the periphery of sill sheets, initiating sill climbing; normal faults inhibit sill climbing;
• deformation structures and sill tip geometries vary depending on the host-rock lithology.
Consequently, even in areas where intrusion outcrop is not available, these observations can be applied to infer underlying intrusion geometries.