Magnetic characteristics of the Ság-hegy volcanic complex, little Hungarian Plain

N. Dworazik[1], A. Auer[1], U. Martin[1], K. Németh[2], H. de Wall[1], C. Rolf[3]
[1]Institut für Geologie, Julius-Maximilians-Universität Würzburg, Pleicherwall 1 97070, Germany
[2]Geological Institute of Hungary, 14 Stefania street, Budapest 1143, Hungary
[3]Leibniz Institute for Applied Geoscience, Stillweg 2, 30655 Hannover, Germany

The Ság-hegy volcanic complex is located in the little Hungarian plain volcanic field (LHPVF). An ^{39}Ar/ ^{40}Ar geochronolgy gave an isochron age of 5.42 ± 0.06 My for the Ság- hegy (Wijbrans et al. 2004). Evolution of the volcano included two clearly distinct events. At first, ascending magma entered meteoric water in a fluvio-lacustrine environment. Fuel-coolant interaction (FCI) of water (water saturated sediment) and magma led to the formation of a phreatomagmatic tuff ring. After water supply was used up the interior of the tephra ring was filled by a lava lake. Locally, the tuff ring wall collapsed and subsequently lava was able to flow out of the tuff ring. Due to intensive quarrying most of the effusive rocks have been removed, giving excellent insight to emplacement processes of feeder dykes, sills, and lava lake remnant (Martin and Németh 2004).

Pyroclastic rocks include massive and bedded units of lapilli stone, lapilli tuff/ tuff as well as pyroclastic breccias. Varying proportions of accidental lithic clasts indicate excavation of basement rocks during the eruption. Juvenile clasts comprise mainly of angular, blocky sideromelane glass sharts with nearly equent shapes and a minor proportion of tachylite. A high amount of water within the system is evidenced by soft sediment deformation and accretionary lapilli in the pyroclastic bedsets. Dune and antidune bedding, chute and pool structures grading, and sorting features suggest that the tuff ring was gradually built up by base surge and intercalated fallout deposits.

Subsequent to the phreatomagmatic stage the inner crater has been filled with a lava lake in which morphology was determined by the tephra deposits. At contacts to the pyroclastics a chilled margin of several centimeter thickness is developed which shows platty (onion shaped) jointing. A high number of dykes and sills were injected into adjacent bedsets. These shallow intrusive bodies can be found throughout the whole complex truncating and dissecting the pyroclastic units. In cases where pyroclastic units comprised a high amount of water this included even mingling with the wet tephra, leading to the formation of peperites. The uppermost units were represented by thick lava flows, which covered all underlying units. These rocks were quarried out except for a large strombolian spatter cone which is now exposed at the uppermost level of the quarry as a big sliced remnant including its large multiple feeder dyke. This setting offers a perfect opportunity to study the relationship between dyke and sill enplacement

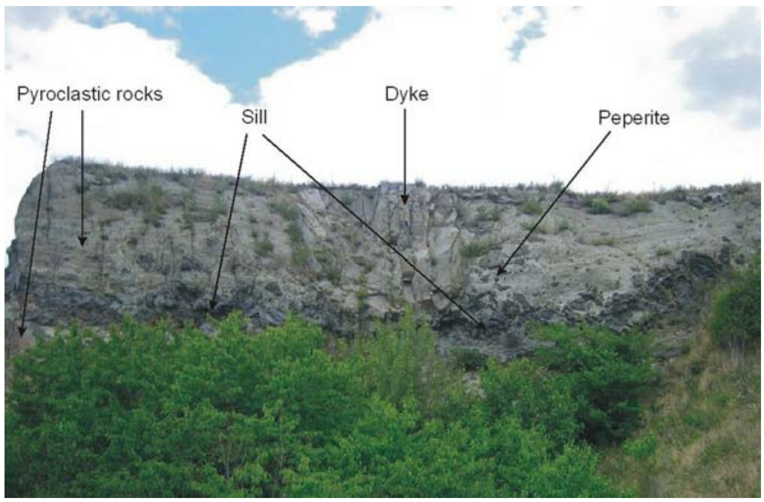

Fig. 1 A sill and dyke complex in the pyroclastic units of Ság-hegy. The sills are preferentially intruded along the unconformity of the tuff ring sequence

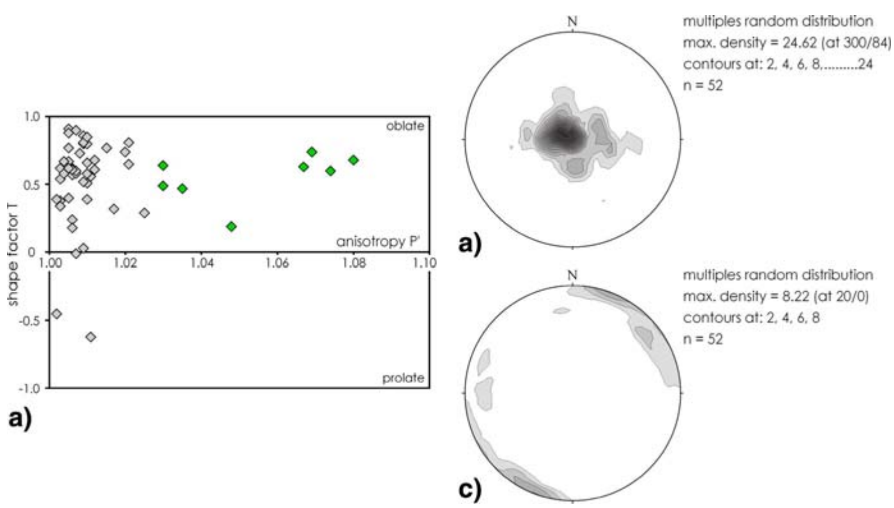

Fig. 2 **a** A Jelinek-diagram of the pyroclastic rocks, which are in the field of oblate fabric geometries, the tuff layer (*green*) display a higher anisotropy than the rest (*gray*). The orientation of the **b** magnetic foliation poles and **c** magnetic lineation of the pyroclastic units with a NE (020) directed material transport for the whole succession

with transitions from vertical to bedding-parallel geometries. Dimensions of the volcanic bodies range from centimeter thickness of small apophyses from the lava lake into the pyroclastic rocks up to dykes and sills of several meters.

We performed a detailed study on a section of pyroclastic rocks truncated by dykes and sills and have evaluated the magnetic characteristics. Preliminary results show that magnetic susceptibility of all the pyroclastic units is in the range of ferrimagnetic susceptibility and varies between 2 to 20×10^{-3} SI (Fig. 1, 2). Magnetic fabric anisotropy is generally low ($< 5\%$) and in the field of oblate fabric geometries, in bedded tuffs a significantly higher (5–10%) but also oblate anisotropy is realized. Magnetic lineations indicate a consistent NE (020) directed material transport for the whole succession. Remanence intensities are quite high with values of 1–15 A/m. In the pyroclastic units a stable magnetic remanence characterized by a single vector component has been measured, MDF values are in the range of 30–160 mT. The field vector has exclusively reversed polarity and steep inclination, which is in agreement with the paleofield direction and therefore is regarded as natural remanent magnetization acquired during deposition of the pyroclastic successions. In the dykes and sills, however, remanence direction scatter significantly and display geometries ranging from steep to flat orientations and also show strong variations in the declination. Coercitivity of magnetic carriers is significantly lower as indicated by the lower MDF values which are in the range of 8–30 mT in the dykes and 15–30 mT in sills. Beside a minor contribution of a viscose component the remanence vector in the dykes and sills is characterized by a stable single component. However, further investigations are needed to fully understand and interpret the results.

References

Martin U, Németh K (2004) Sag-hegy tuff ring. Geol Hung Ser Geol Tomus 26:159–163

Wijbrans J, Németh K, Martin U, Balogh K (2004) ^{39}Ar/ ^{40}Ar geochronology of a Mio/ Pliocene phreatomagmatic volcano field in the western Pannonian Basin. Earth Planat Sci Lett (in press)

Hydraulic inflation and buoyancy pumping in the large-scale mechanics of fracture-mediated felsic magma intrusion

G. J. Ablay[1], J. D. Clemens[1], J. Grocott[1], N. Petford[2]
[1]Centre for Earth and Environmental Science Research, Kingston University, Penrhyn Road, Kingston-upon-Thames, Surrey KT1 2EE
[2]Bournemouth University, Talbot Campus, Fern Barrow, Poole, Dorset BH12 5BB

A new fracture-mediated intrusion model resolves the sequence of events and nature of the magma and rock displacements. Giant intraplate systems are analyzed to neglect tectonism and focus on juvenile cracking by magma-intrinsic loads under idealized thermal and stress conditions. The anatectic magma source is wide and domical, formed by conductive heating and fluid-absent melting. It has a low aspect owing to heat focusing, forms in $\sim 10^6$ year, and has three potential zones; porous, permeable, and an anatectic core. The latter is unrealized owing to magma segregation. Of non-magmatic loads, thermal stresses are unimportant while vertical strain of curved crustal layers generates tensile stress during uplift by source dilation and lateral space upon relaxation. Dilative melting generates buoyancy and potential hydraulic contributions (ΔP_B and ΔP_v) to the magma pressure P_M. ΔP_V develops by elastic wall rock compression as the excess magma volume EMV arises too abruptly for full inelastic relaxation by uplift. Its instantaneous onset, fast augmentation, and high magnitude induce brittle source instability. Tensile rupture criteria are met by magma pore pressure and magma wedging by cracks. Cracks initiate in the porous zone as veins owing to source inflation and uplift. Preferred crack geometry reflects the initial stress field. For thermo-structural doming, radial vertical cracks form a central nexus that focuses space. A vertically extensive system, however, is hard to explain because ΔP_V tends to force dykes to reorient to sills. At a critical shallow depth, ΔP_B is enough for this. The solution is that ΔP_V reduces to incipient levels by volumetric crack growth (and possibly surface eruption) accommodating EMV^*. Once $EMV = 0$ magma transport is by buoyancy. For a simple melting function, two regimes are defined by this; $\Delta P_V \neq 0$ (hydraulic inflation) and $\Delta P_V = 0$ (buoyancy pumping). Loss of ΔP_V causes column stagnation, allowing ΔP_B to force shallow sill emplacement. Sill growth is by floor depression; ductile shear of lower crust and passive subsidence of upper crust. Effects are: (i) creation of sill volume, (ii) suppression of roof uplift, (iii) expelling source contents, (iv) processing protolith through the melting zone, and (v) reduction of σ_H in subsided crust, stabilizing conduits for pluton filling. Four hydraulic subregimes are identified: *disequilibrium-* and *equilibrium dilation*, and *disequilibrium-* and *equilibrium cracking*. The transitions are controlled by source relaxation, tensile rupture, and crack growth. The subsequent onset of buoyancy pumping requires crustal relaxation and a sill at or above the critical depth to allow decoupling.

Analog modeling of magmatic intrusion in a brittle crust with reference to thrusting

O. Galland[1,2], P. R. Cobbold[1], E. Hallot[1], J. de Bremond d'Ars[1], G. Delavaud[1]
[1]Géosciences Rennes, UMR 6118 Université de Rennes1-CNRS, 35042 Rennes Cedex, France
[2]PGP, Universitet i Oslo, Sem Selands vei 24, 0316 Oslo, Norway

Introduction

Magmatic activity concentrates at tectonic plate boundaries. According to their tectonic setting, intrusive bodies have different shapes. In non-deformed sedimentary basins, they tend to be axisymmetric saucer-shaped sills (Malthe-Sørenssen et al. 2004). In a context of regional extension, they are mainly steep dykes, perpendicular to the least principal stress. In compression, they are mainly horizontal sills (Hubbert and Willis 1957). In both extension and compression, intrusive bodies concentrate close to major faults. However, such relationships are not always clear (Paterson and Schmidt 1999).

To understand them better, we have developed new techniques of analog modeling.

Experimental method

The model crust consists of fine-grained crystalline silica powder (SI-crystal) and siliceous microspheres (SI-sphere). These materials fail according to a Mohr-Coulomb criterion. SI-crystal has some cohesion ($C \approx 300$ Pa), so that open fractures can form, whereas SI-sphere is almost cohesionless. By mixing them, we obtain a granular material with intermediate properties (SI-mix, $C \approx 60$ Pa). The model magma is a vegetable oil of low viscosity ($\eta \approx 2 \times 10^{-2}$ Pas). It is solid at room temperature and melts at ~ 31°C.

Our models are housed in a rectangular box (Fig. 1). The silica powder is compacted after deposition. Thin layers of SI-sphere, alternating with thick layers of SI-crystal, represent sedimentary strata. A moving piston is able to deform the model in either extension or compression. An attached mobile plate localizes the deformation at its leading edge. During the experiments, oil is injected at a steady rate. The rates of injection and deformation are independent parameters. At the end of each experiment, the oil having solidified, the model can be cut into longitudinal cross sections.

Magnetic characteristics of the Ság-hegy volcanic complex, little Hungarian Plain

Dvorazik, Nina

2006-01-01