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Exploring Mechanisms and Conditions for the Generation of Self-propagating Dykes

Herbert Wallner and Harro Schmeling
Goethe University Frankfurt, Institut für Geowissenschaften, Geophysics, Germany (wallner@geophysik.uni-frankfurt.de)

Within the scope of our project “Modelling melt ascent through the asthenosphere-lithosphere-continental crust system: Linking melt-matrix-two-phase flow with dyke propagation” it is necessary to implement mechanisms with appropriate conditions to generate dykes which are propagating independently.

Conditions for self-propagating depend on the density contrast of melt and rock and the geometry of the fracture. Certain limits for the fluid-filled volume and dyke width must be reached. The height must be longer than the Bouguer length. To satisfy these conditions enough melt under overpressure must be available in the source region to supply the growing dyke.

A known and accepted mechanism for dyke generation is a tension fracture whichs opening space immediately is filled by fluid melt. The normal stress due to expansion of the magma on the wallrock causes tension therein parallel to the melt front. In brittle material the yield stress for extension is very low and the confining cold rock easily cracks.

With depth pressure, temperature and ductility of crustal rock and consequently the yield stress for the tensile cracking increases. Furthermore, the background permeability or connectivity, and finally the height of fluid columns decrease and the fluid overpressure is not high enough to exert matrix extension. Another dyke initiation mechnism must be found for the deeper parts of the crust.

A not smooth melt front - and pillows are often seen on top of magma chambers – provides shear stresses and stress concentrations. Above a certain yield stress for shear failure shear bands start to evolve. In such a network of fracture zones permeability should increase. Melt may intrude, coalesce bands and develop a growing dyke. Such a local scenario will be modelled and results presented. A further aim is the parametrisation of these mechanisms.