Numerical model of magmatic mingling: an example from the Bayankol massif (Sangilen Plateau, South Siberia)

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The interaction of mafic and felsic magmas usually include mechanical mingling and chemical interdiffusion (mixing) of contrasting melts, resulting in the formation of enclave-bearing or hybrid rocks (composite 'net-veined' complex), such as Burgasy quartz-syenite massif, western Transbaikalia [Burmakina, Tsygankov 2013] or Erzin gabbro-monzodiorite massif, Sangilen [Polyansky et al., 2017; Semenov, Polyansky, 2017, in press]. For understanding of formation mechanism of such intrusions, the construction of coupled thermo-convective models is required, taking into account contrasting physical and chemical properties of mafic and felsic liquids.

We developed a numerical model of convective flow in multiphase medium which takes into account a temperature dependence of melts rheological properties. We performed calculations to determine the critical proportion of felsic material in the initial mixture, capable of moving up more dense mafic enclaves. For this purpose, numerical experiments were carried out with different ratios of mafic/felsic component in the initial composite melt from 30/70 to 90/10%. As expected, the upwelling of mafic enclaves becomes less effective with a decrease of felsic material in the mixture. As follows from numerical experiments, the uplifting of high temperature, low viscosity magma occurs in the form of composite dykes to higher levels in the pluton. As follows from the experiments, the dyke is able to propogate at a high velocity of 1000 m per 0.36 years (2.7 km/yr). The simulations showed that density difference is the main parameter which determines the mode of convection: for small density difference ($\leq$ 30-40 kg/m^3) magma mixing and hybridization occurs in a small contact zone, while for large density difference ($\geq$100 kg/m^3) mingling predominates. The difference in viscosity determines whether the interpenetration of melts or their fragmentation into drops, spheres, etc. occurs. The limiting value of felsic magma viscosity, when the magmatic mingling in magma chamber "freezes", is 10^8 Pa·s.

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