Geophysical Research Abstracts
Vol. 13, EGU2011-10760-2, 2011
EGU General Assembly 2011

Basaltic magma as trigger for felsic intrusions

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Plutons grow by melt transfer from a deep source to a higher emplacement level. However, in the case of felsic magmas, the buoyancy in a lower crustal level alone is usually not sufficient to drive further ascent. Evidence for sublithospheric material in crustal magma bodies indicates the transfer of mantle derived magma on a larger scale through the lithosphere. For example, recently published data (Quick et al [2009]) indicate that intrusion of mantle-derived mafic melt into lower crust and crustal scale silicic volcanism is closely related in space and time in the Ivrea zone, northern Italy.

Following up on such observed correlations between mantle and crustal material we used numerical modeling to identify potential physical mechanisms for triggering the ascent of granitic magma by intruding mantle melts. The code I2ELVIS (Gerya and Yuen [2007]) has been used to study the emplacement of granitic intrusions into the upper crust in a self-consistent way including strong mechanical interaction between the ascending melt and the crustal rocks. It includes a visco-elasto-plastic rheology of the crustal rocks and it is possible to handle strong contrasts in the material properties between magma and crustal material. In the initial setup for the models we assume a region of high temperature in the lower crust where partial molten felsic magma is generated and a lower mantle reservoir of mafic melt. This reservoir is connected to the bottom of the lower crust via a magmatic channel.

In our numerical experiments we could show that the influx of mafic magma from a mantle source into a partial molten region in the lower crust can cause overpressure that initiates the ascent of granitic material from the lower crust to a higher emplacement level. Furthermore, our study indicates, which parameters are governing the timescales of ascent and emplacement processes and of possible shapes of granitic intrusions.

References:

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