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Mafic magma as trigger for felsic intrusion processes

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Plutons grow by melt transfer from a deep source to a higher emplacement level. However, the mechanisms leading to felsic magma transport through the crust is still a point of discussion [1]. Geochronological data of exposed rocks in the Ivrea Zone, northern Italy, indicate a close spatially and temporally relation between intrusions of mantle derived mafic magma into the lower crust and crustal scale silicic volcanism [2].

Following up such observations on the correlation of mafic and felsic magma we used numerical modeling to identify potential physical mechanisms for the initiation of felsic magma ascent by injection of mafic material. The code I2ELVIS [3] 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. As initial setup we assume a region of high temperature in the lower crust where partially molten felsic magma is present and a mantle reservoir of mafic melt at a depth of 100km. This reservoir is connected to the bottom of the lower crust via a magmatic channel. We do not apply an initial stress field in the crust in order to get results independent from predefined stresses.

With our numerical experiments we show that the influx of mafic magma from a mantle source into a partially molten region in the lower crust is able to trigger the ascent of felsic material from the lower crust to a higher emplacement level. Furthermore, our study indicates which parameters determine timescale and final shape of upper crustal felsic intrusions and how they influence the development of the ascent and emplacement process.

References

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