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The control of melt:rock ratio on magma transport: insights from reactive melt flow modelling

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A key missing point in our understanding of the genesis and evolution/differentiation of the continental crust is the magma transport processes occurring in the upper-most mantle to lower-middle crust. While structural, petrological and metamorphic studies of exposed deep hot crust sections allow to draw out the first order chemical, pressure and temperature conditions of magmatic and crustal differentiation, the role of the melt/rock ratio (which governs the chemical reactivity between ascending melt and host-rock) have received very little attention.
However, available experimental studies have shown that the melt/rock ratio have a critical control on both melt and stable-phases composition. Although the melt/rock ratio can be easily controlled in laboratory experiments, scaling its role up during lower crust magmatic differentiation remains problematic. Indeed, the mechanisms by which magma differentiation occur in the deep crustal hot zone are characterized by complex physical, chemical and thermal conditions in a multiphase medium that can vary in both space and time.
Here we use a newly coupled 2-dimensional thermal, two-phase and petrological modelling approach to investigate the role of melt/rock ratio in controlling chemical differentiation during magma ascent in deep crustal hot zone. We find that the melt:rock has a dominant control on the compositional evolution of both segregated magmatic products and host-rock. Moreover, our results best reproduce available composition of exposed magmatic section (Talkeetna & Sierra Valle Fértil) for melt:ratio > 1:1.