Magma Ascent through Heat Propagation Buoyancy and Thermal Loss in the Lithosphere

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We introduce a rather simple model for the ascent of the magma through the lithosphere, based on a mix of conduction, rock partial melting, and buoyancy, where we take into account the heat dissipation due to the melting process. Under suitable assumptions, a hyperbolic linear partial differential equation describing the process is derived from a general thermodynamical model whose constitutive equations are compatible with the second principle of thermodynamics. Then, we derive numerically a solution to a physically meaningful initial/boundary condition that can explain many of the experimental observations. More precisely, we suggest a mechanism for the magma emplacement able to explain the different depths of emplacement depending on one of the model parameters. Moreover, this parameter can be tuned to obtain the disappearance of the emplacement, which justifies the occurrence of hot spots (volcanoes forming a plume of molten rocks that rises from deep within the Earth's lithosphere).