Geophysical Research Abstracts, Vol. 9, 02920, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02920

Magma ascent and effusion from a tensile fracture propagating to the Earth's surface

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We consider a vertical tensile fracture originating from a magma chamber. The fracture is filled with a low-viscosity magma. We assume that the magma pressure in the fracture increases slowly with time, due to an overpressure in the magma chamber, and study the quasi-static fracture propagation through the Earth's crust. Under the assumption that the fracture is horizontally very long, the problem is two-dimensional and is solved by an expansion of the stress release into Chebyshev polynomials. When the fracture reaches the Earth's surface, magma pours out from the vent, driven by the pressure gradient in the fracture. Under the assumption of laminar flow, we evaluate the effusion rate as a function of the relevant model parameters and establish a relationship between the flow rate in the fracture and the thickness of the ensuing lava flow, in the case of effusion on a steep slope.