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Transport of volatiles and trace elements in solitary porosity waves using a two-phase flow approach including disequilibrium melting

Janik Dohmen and Harro Schmeling
Institute of Geosciences, Goethe University, Frankfurt, Germany (dohmen@geophysik.uni-frankfurt.de)

Magmatic phenomena such as volcanic eruptions on the earth's surface show, among others, that melt is able to ascend from partially molten regions in the earth's mantle. Thereby it firstly flows through the partially molten source region and then through the unmolten lithosphere until it eventually reaches the surface. The governing processes in this source region are poorly understood.
Since McKenzie (1984) introduced his equations for two-phase flow, which include a fluid phase (melt) and a porous deformable matrix, the physics of this region are of broad interest. One of the features which were studied is the emergence of solitary porosity-waves.
Using these two-phase flow equations the transport of volatiles and trace elements in ascending magmas is investigated. To do this two additional mass equations for the concentration of a volatile or trace element in the solid and the fluid are solved. The equations we use apply to disequilibrium fractional melting and are based on the equations by Spielgelman (1996). They assume surface equilibrium instead of complete equilibrium between mineral grains and melt, and neglect chemical diffusion within the grain. Furthermore we neglect the effect of freezing on the concentrations in solid and fluid.
The models show that solitary waves are able to transport volatiles while ascending upwards and in the course of this build up small columns with a higher amount of incompatible elements.
Further steps on this study are the implementation of freezing and to investigate the effect of build up and collapse of solitary waves on the redistribution of volatiles and trace elements on a certain area.

McKenzie, D. (1984). The generation and compaction of partially molten rock. Journal of Petrology, 25(3), 713-765.

Spiegelman, M. (1996). Geochemical consequences of melt transport in 2-D: The sensitivity of trace elements to mantle dynamics. Earth and Planetary Science Letters, 139(1-2), 115-132.