Geophysical Research Abstracts, Vol. 9, 03387, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03387

Focused flow and basalt-peridotite interactions beneath mid-ocean ridges: an experimental study

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The compositions of primitive mid-ocean ridge basalts (MORBs) are not only controlled by partial melting processes at depth, but also by magma-rock interactions en route to the surface (as well as shallow-level fractional crystallization). During their ascent, basalts dissolve pyroxenes in the surrounding peridotites, ultimately leading to the formation of high-porosity dunitic channels. Focused flow in dunitic channels may play a major role in the dynamics of magma transport beneath mid-ocean ridges (Kelemen PB & al., 1995, *Nature*, 375: 747-753).

We performed a series of experiments in a piston-cylinder apparatus to determine the effects of focused magma transport on the composition of the ascending basalt and on the formation of dunitic channels. We assumed that the system follows an adiabatic decompression path and that magma focusing occurs instantaneously at 1.25 GPa: at this pressure, the total mass of liquid in the system is multiplied by a factor Ω, referred to as the focusing factor. We first determined the equilibrium melt composition of fertile mantle MBK at 1.25 GPa-1310˚C; this composition was then synthesized as a gel and added in different proportions to peridotite MBK to simulate focusing factors equal to 3 and 6. Peridotite MBK and the two basalt-enriched compositions were equilibrated at 1 GPa-1290˚C, 0.75 GPa-1270˚C, and 0.5 GPa-1250˚C.

Our main result is that, at 0.5 GPa-1250˚C and Ω=6, the liquid composition is very close to primitive MORB compositions and is in equilibrium with olivine only. Therefore, this strengthens the hypothesis that magma transport by focused flow can explain both the formation of dunite channels beneath mid-ocean ridges and the fact that MORBs are not in equilibrium with a harzburgitic residue at low pressure.