Fast assimilation of serpentinized mantle by basaltic magma

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Findings of oceanic volcanics and mafic cumulates originated from melts depleted in incompatible elements and enriched in silica and radiogenic Sr isotopes were attributed to an interaction between the mantle-derived melt(s) and the overlying hydrated lithosphere [1], but the proofs of the model yet remain elusive. Here we report results of experiments constraining mechanisms and rates of reactions between serpentinite and tholeiitic basalt at 0.5 - 1.0 GPa and 1200 - 1300°C. Our data show that the reaction proceeds *via* a multi-stage mechanism involving (i) transformation of serpentinite to harzburgite (with Fo_{92-95}) containing pore fluid, (ii) partial melting and dissolution of the harzburgite with formation of interstitial hydrous melts (up to 62 wt% SiO_2), and (iii) final assimilation of the harzburgite and formation of a hybrid basaltic melt with elevated 12 – 13 wt% MgO, ~500 ppm Cr and ~200 ppm Ni contents. Hybrid magmas produced by the assimilation of the serpentinized lithospheric mantle may be recognized by high Mg-numbers, Cr and Ni contents in minerals, an excess of SiO_2 and H_2O in the melts, and unusual Sr, O and He isotope compositions. Our experimental work provides convincing evidence that depleted MORB and orthopyroxene-rich cumulates depleted in incompatible elements can be routinely produced from “normal” mid-ocean ridge basaltic melts modified by reaction with hydrated lithospheric peridotite. The assimilation rate of serpentinized peridotite is controlled by silica diffusion in the reacting hydrous basaltic melt. Our study challenges traditional interpretation of the variations in chemical and isotopic composition of MORB and OIB in terms of deep mantle plume source heterogeneity and/or degree of partial melting.

[1] Benoit M. et al., 1999. *Nature* **402**, 514-518.