

Crustal contamination of mantle-derived magmas within the edifice of Piton de la Fournaise Volcano

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We present a study of the ²²⁶Ra-²³⁰Th-²³⁸U disequilibria, Sr, Nd, and Hf isotope ratios, and selected incompatible trace-element abundances of historical lavas from Piton de la Fournaise, a frequently active ocean-island volcano. The temporal fluctuations in lava chemistry at this volcano from 1950-1998 do not display any simple trends, although some geochemical parameters vary systematically over a period of years (Fig. 1). Based on the chemistry of lavas erupted between 1998-2002, Vlastélic *et al.* [1] proposed that parental magmas at Piton de la Fournaise undergo two stages of crustal contamination: deep assimilation of the oceanic crust and shallow assimilation of the volcanic edifice. We evaluate these possibilities and find that assimilation of the oceanic lithosphere (crust or mantle) requires excessive amounts of contamination (>20%). Instead, we suggest that the chemistry of the lavas can be explained by a single stage of shallow crustal contamination of compositionally heterogeneous magmas derived from the upwelling mantle. Mass-balance modeling shows that the trace-element abundances of the contaminated lavas can be matched (within 1%) by incorporation of small amounts (<6%) of low degree (<1%) melts of gabbro and/or wehrlite cumulates.

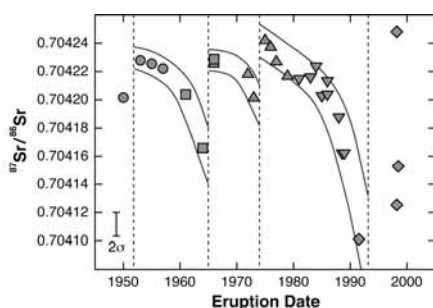


Figure 1: Temporal variations of Sr isotope ratios.

[1] Vlastélic *et al.* (2005) *J. Petrol.* **46**, 79-107.

Can alkaline basalts form by high degrees of melting of metasomatic veins?

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If recycled oceanic crust is a significant component of the sources of ocean island tholeiites (e.g., Hawaii, [1]), it is difficult to envision how it can also be an important component in the sources of strongly silica-understaturated OIBs. Alternatively, as suggested by [2], veined/metamorphosed oceanic or continental lithosphere could be an important recycled component in the sources of alkaline OIBs. Piston-cylinder experiments on natural amphibole-rich veins and on their dehydrated equivalents demonstrate that high degrees of melting of metasomatic veins can reproduce key features of the major and trace element compositions of many basanites from both oceanic and continental settings.

Metasomatic veins are generally interpreted as cumulates produced during ascent and differentiation of liquid generated by low-degrees of melting of volatile-bearing peridotite [3]. We have constructed a forward trace-element (TE) model to test whether the TE contents of the veins (~ equal to the TE contents in alkaline OIBs) can be produced by accumulation from low-degree melts of peridotite. To account for the effect of uncertainties in the large number of variables in the model, we used a Monte Carlo simulation. The inferred polybaric crystallization sequence of the partial melt of peridotite was constrained by experiments and the mineral compositions and modes in metasomatic veins. The TE contents in our model cumulates are similar to those observed in metasomatic veins from oceanic and continental lithosphere and to those in alkaline basalts; furthermore the TE pattern of cumulates shifts from HIMU to EM "signature" type as function of the increase of trapped melt in the cumulate veins (confirming the model proposed by [4]). We suggest that melting of metasomatized lithosphere is a viable alternative to the hypothesis of recycled oceanic crust for the formation of alkaline OIBs and that the recycled components in the sources of islands characterized by tholeiitic magmas (e.g., Hawaii or Iceland) differ from those where *ne*-normative compositions are dominant (e.g., Polynesia, island in the Atlantic Ocean, etc.) are distinct.

[1] Sobolev *et al.* (2007) *Science* **316**, 412-417. [2] Niu & O'Hara (2003) *J. Geophys. Res.* **108**, 2209. [3] Harte *et al.* (1993) *Philos. Trans. R. Soc. Lond. Ser. A*, **342**, 1-21. [4] Pilet *et al.* (2005) *EPSL* **236**, 148-166.