



Origin of alkaline OIBs: constraints from experimental petrology and melting behavior

S. Pilet (1, 2), M.B. Baker (2) and E.M. Stolper (2)

(1) Institute of Mineralogy and Geochemistry, University of Lausanne, Switzerland,

(2) Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, USA (sebastien.pilet@unil.ch)

The interpretation of melting anomalies beneath oceanic islands (thermal or compositional) is directly linked to the nature of the source material that melts. Trace-element and isotopic characteristics of basaltic magmas from ocean islands suggest the presence of “enriched” components in their sources. These components have been interpreted as being derived from recycled oceanic crust \pm sediment. An alternative is that the enriched components are metasomatic veins present within the lithosphere or metasomatized lithosphere that has been incorporated into the convecting mantle. These two interpretations (oceanic crust vs. metasomatic veins/lithosphere) are generally considerate as being antagonistic. However, the large petrological and chemical variability observed in OIBs (from *ne*-normative to *hy*- and *qtz*-normative magmas), suggests that both components may be important, e.g., oceanic crust may be important in the generation of tholeiitic magmas from large oceanic islands and continental lava flows [1]. The fact that partial melts of oceanic crust are silica oversaturated makes it difficult to envision a significant role for them in the generation of alkaline (i.e., *ne*-normative) magmas.

Partial melting experiments at 1.5 and 2.5 GPa on natural amphibole-rich veins and on their dehydrated equivalents demonstrate that key features of the major and trace element compositions of alkaline basalts from both oceanic and continental settings can be explained by moderate to high degrees of melting of metasomatic veins “in situ” or after having been recycled within the convecting mantle. However, this interpretation

of the origin of alkaline basalt is not unique and the melting of silica-deficient garnet pyroxenite (formed by the extraction of silica-rich fluids during subduction from initial silica-oversaturated oceanic crust) could also explain, in some respects, the formation of *ne*-normative basalts [2, 3].

A critical aspect of partial melting in the context of upwelling mantle is the melting behavior of the different lithologies within the upwelling mantle (i.e., metasomatic veins /recycled oceanic crust + enclosing peridotite). If low-solidus vein material melts during adiabatic decompression but is chemically isolated from but in thermal equilibrium with the adjacent peridotite, the degree of melting of the veins will be enhanced relative to the amount of melting that only vein material would undergo, meanwhile the enclosing peridotite will be “refrigerated” by the melting of the veins, and thus will melt at lower pressure and to lower degrees than if the veins were not present. Thus, low-solidus vein material in upwelling mantle should melt to much high degrees relative to the accompanying peridotite [4]. Stracke et al. [5] indicate that the degree of melting of subducted oceanic crust would have to be very low ($\leq 1\%$) in order to explain the high trace-element contents of alkaline OIBs. Given that oceanic crust has a lower melting temperature than peridotite [6], such low degrees of melting is inconsistent with the above analysis [see 4]. Our experiments on the other hand show that metasomatic veins can melt to a large degree and still satisfy the trace element contents of alkaline basalts. We conclude that melting of amphibole-bearing lithospheric veins (or their dehydrated equivalents after recycling within the convecting mantle) plays a role in the petrogenesis of alkaline lavas and we suggest that recycled components in the sources of islands characterized by tholeiitic magmas (i.e., Hawaii or Iceland) and in the sources of islands where *ne*-normative compositions are dominant (i.e., Polynesia, island in the Atlantic Ocean, etc.) are distinct.

[1] Sobolev et al. (2007) *Science* 316, 412-417.

[2] Hirschmann et al. (2003) *Geology*, 31, 6, 481-484.

[3] Dasgupta et al. (2006) *J. Petrol.*, 47, 4, 647-671.

[4] Stolper and Asimow (2007) *Am. J. Sci.*, 307, 1051-1139.

[5] Stracke et al. (2003) *G3*, doi:10.1029/2001GC000223.

[6] Kogiso et al. (2004) *J. Petrol.*, 45, 12, 2407-2422.