Experimental constraints on the origin of alkaline basalt: Evidence for a metasomatized lithospheric source

S. Pilet, M.B. Baker and E.M. Stolper

California Institute of Technology, Pasadena, USA
(pilet@gps.caltech.edu; mikeb@gps.caltech.edu;
ems@gps.caltech.edu)

Due to the difficulty of explaining the high trace element and isotopic compositions of alkaline magmas from oceanic islands and alkaline massifs by simple peridotite melting, a recycled oceanic crust component is often assumed to be present in the source of these rocks. Alternatively, this component may be recycled oceanic or continental lithosphere that contains metasomatic veins. Coupled major and trace element models for the formation of alkaline lavas can provide important constraints on this debate. At present, no experimental studies have successfully reproduced the range of alkaline basalts found in ocean islands or continental massifs.

We present the results of melting experiments on natural clinopyroxene hornblendite and hornblendite lithologies from the French Pyrenees conducted at 1.5 GPa and 1150-1350°C, and explore the alternative hypothesis that OIBs result from partial melting of recycled metasomatized lithosphere. The compositions of low-degree melts in experiments on both amphibole-bearing lithologies are controlled by kaersutite breakdown and are strongly ne-normative and silica-poor. K_2O/Na_2O, Al_2O_3/TiO_2 and CaO/Al_2O_3 ratios in the experimental partial melts are similar to silica-poor basanites found in oceanic islands and continental alkaline massifs. Moreover, the incompatible trace element patterns of the glasses overlap those of silica-poor lavas in both tectonic settings. A second set of experiments was done using a layer of hornblendite sandwiched between layers of moderately depleted peridotite (DMM1) at 1.5 GPa and 1225-1325°C, and demonstrates that the reaction of partial melts of amphibole-rich veins with surrounding peridotite can explain the observed compositional transition between basanite and alkali basalt. The higher SiO_2 content (4-5 wt%) observed in melts from the sandwich experiments relative to those containing just the amphibole lithologies reflects the dissolution of orthopyroxene in the peridotite layers in the sandwich runs.

Our results support the hypothesis that partial melting of metasomatized lithosphere (i.e., peridotite+amphibole-bearing veins) generates alkaline basalts in continental settings [1] and that recycling and partial melting of such veined lithosphere can also contribute to the compositional characteristics of oceanic alkaline lavas. Further, the isotopic characteristics of both HIMU and EM-type OIBs are consistent with plausible models of amphibole-bearing vein formation and the resulting element fractionations [2]. Thus, recycling of metasomatized lithosphere should be considered as a viable, testable alternative to widely accepted models of OIB formation that invoke recycling of oceanic crust ± sediments.

[1] Pilet S. *et al.* (2004), *Geology* **32**, 113-116;
[2] Pilet S. *et al.* (2005), *EPSL* **236**, 148-166.

AFM observations of dissolution and growth on anhydrite (100), (010) and (001) cleavage faces

C.M. Pina and L. Fernández-Díaz

Dpto. Cristalografía y Mineralogía. Universidad Complutense.
28040 Madrid. Spain. (cmpina@geo.ucm.es;
lfdiaz@geo.ucm.es)

Anhydrite is a common calcium sulphate mineral which can coexist with gypsum in evaporitic and diagenetic rocks. Textural relationships between both minerals often indicate that gypsum crystals form after previously crystallised anhydrite, through a process that involves the coupling between dissolution and crystal growth reactions. In this work, we present *in situ* Atomic Force Microscopy observations of the interaction of anhydrite (100), (010), (001) cleavage surfaces with deionised water and $CaSO_4$ aqueous solutions. In water, anhydrite faces dissolve at different rates and exhibit specific nanotopographic features (e.g. etch pit shapes, retreating and stabilisation of certain step directions, etc.) that can be justified on the basis of the Hartman-Perdok Theory. In contact with $CaSO_4$ solutions, the growth of metastable monolayers (~3.5Å in height) is promoted on both anhydrite (010) and (100) faces (the growth on anhydrite (001) faces was not observed). The monolayer develops jagged edges that form defined angles with the original steps on anhydrite surfaces. Moreover, as occurs in the case of dissolution, the growth of monolayers over anhydrite (010) and (100) surfaces is highly anisotropic, revealing a strong crystallographic control. The nature of such monolayer is discussed on the basis of both crystallographic and thermodynamic arguments.