ABSTRACT FINAL ID: T44D-02;

TITLE: Evidence for metasomatic enrichment in the oceanic lithosphere and implication for the generation of intraplate basalts

SESSION TYPE: Oral

SESSION TITLE: T44D. The Origin of Intraplate Volcanism: Hotspots, Nonhotspots, and Large Igneous Provinces II

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ABSTRACT BODY: Petrological studies play a significant role in the debate regarding the origin of intraplate magmas by providing unequivocal constraints about the source(s) composition and melting processes related to basalt formation. Two major hypotheses are currently in debate: first, intraplate magmas are produced at depth (i.e. within the asthenosphere) by low-degrees melting of an enriched peridotitic source in the presence of CO2 [1]; second, alkaline magmas are produced by the melting of metasomatic hydrous veins present within the lithospheric mantle [2]. If the existence of metasomatic veins in the continental lithospheric mantle is well documented, their existence and the mechanism of their formation in an oceanic setting are still mostly unconstrained. Here we report new petrological data demonstrating that metasomatic veins can be produced within the oceanic lithosphere by percolation and differentiation of low-degree melts initially located in the low velocity zone [3].

The existence of metasomatic veins in the oceanic lithosphere is documented by cpx xenocrysts in accreted basaltic sills from northern Costa Rica. New field observations, 40Ar-39Ar radiometric dating, biostratigraphic ages and geochemical analyses indicate that the sills represent a possible, ancient analogue of petit-spot volcanoes produced off Japan by oceanic plate flexure [4]. The cpx xenocrysts are interpreted as a relic of metasomatic veins based on their composition, which is similar to that of cpx from metasomatic veins observed in mantle outcrops and xenoliths. The major and trace element contents of the studied cpx xenocrysts indicate that they crystallized at high pressure in a differentiated liquid. This liquid represents the last stage of a fractional crystallization process that produced early anhydrous cumulates followed by later hydrous cumulates, a mechanism similar to that proposed by Harte et al. [5] for the formation of metasomatic veins in the continental lithosphere. Monte Carlo simulation of this process indicates that the differentiation of low degree melts can produce metasomatic cumulates with a mineralogical and chemical composition suitable to be a source for alkaline rocks observed in an oceanic setting [6].
The presence of low degree melts at the base of the lithosphere has been recently suggested to explain the occurrence of the ubiquitous low seismic velocity zone at the base of the oceanic lithosphere [3]. We propose that tectonic processes such as plate flexure [4] or/and small scale mantle convection [7]

can allow these melts to percolate and differentiate across the lithosphere to form metasomatic cumulates (i.e. veins). Such cumulates are likely to represent a potential source of alkaline rocks observed in intraplate ocean volcanoes, especially those produced by low volumes of magma.
[1] Dasgupta et al. (2007) J. of Petrol. 48, 2093;
[2] Pilet et al. (2008) Science 320, 916;
[3] Kawakatsu et al. (2009) Science 324, 499;
[4] Hirano et al. (2006) Science 313, 1426 ;
[5] Harte et al. (1993) Phil. Trans. Royal Soc. of London, Series A 342, 1;
[6] Pilet et al. (2011) J. of Petrol. doi:10.1093/petrology/egr007;
[7] Ballmer et al. (2009) G3 doi:10.1029/2009GC002386.

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Additional Details

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