

Oceanic basalts geochemical heterogeneities distribution in four large scale domains supporting a first order two large cells whole mantle convective structure

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The analysis of compositional heterogeneities displayed at a large scale by the oceanic basalts, using combined isotopic and incompatible trace element ratio diagrams, and in particular the $^{208}\text{Pb}/^{204}\text{Pb}$ vs $^{206}\text{Pb}/^{204}\text{Pb}$, and Nb/La vs Th/La representations, leads to identification of four large scale domains. The mentioned representations display interesting properties for evidencing and quantifying intra mantle magmatic differentiation processes, as for estimating the residual characteristics of mantle sources according to the continental-mantle differentiation process. Two domains are identified within the Atlantic-Pacific realm, (specified as the Atlantic-East Pacific (AEP) and the South Central Pacific (SCP) domains), while the other two are on the opposite side of the globe within the Indian Ocean - South Atlantic realm (specified as the Indian Ocean (IO), and Kerguelen - South Atlantic Islands (KSA) domains). In each opposed hemispheric realm, one of the domains includes both the MORB's and the OIB's plotting on the same compositional trend, interpreted itself as relying materials differentiated through intra-mantle magmatic differentiation processes. The other domain in each hemisphere contains only OIB and oceanic plateau basalts that exhibit more enriched characteristics (according to CC-mantle differentiation) than basalts from the other domain. Within the Pacific area, the enriched-type domain is related to the super-plume rising below the Pacific. A similar super-plume origin, but located below Africa, is proposed for the enriched-type domain in the Indian Ocean - South Atlantic area. A relationship can be drawn, in a more general way, between the geographical repartition of these domains and long wavelength geophysical features as seismic and gravity anomalies. The good relationship shown between large scale geophysical and geochemical features, as the geochemical compositions of these large scale domains, lend support to a simple first order convective structure of the whole mantle in two large convective cells, in which the SCP and KSA domains correspond to upwelling zones, issued from the base of the mantle, and located inside the respective AEP and IO domains. Such a structure looks consistent with convective structures issued from numerical modeling results as with earth mantle flow models which take into account numerous geophysical and physical parameters and which lead to a close two large cells mantle structure (e.g. Forte *et al.*, 2002). The advanced structure bears constraints on plumes as on plateau basalts origin.

Reference

Forte A., J.K. Mitrovica, and A. Espeset, (2002) *Phil. Trans. R. Soc. Lond. A.*, **360**, 2521-2543.

MC-ICP-MS measurements with d-DIHEN direct injection nebulization

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Compared to the classical spray chamber nebulization, direct injection nebulization offers to increase the analyte transport efficiency and thus the sensitivity, to reduce the sample amount needed for one analysis and the memory effects, rendering bracketing isotopic measurements much more suitable and precise for elements such as boron.

The recently developed d-DIHEN (demountable Direct Injection High Efficiency Nebuliser, Westphal *et al.*, 2004) has been tested for isotopic measurements on a Neptune (Thermo) MC-ICP-MS.

The spray is optimized by varying the capillary-nebuliser tip distance and observing the water meniscus formed at the end of the nebuliser tip, before the d-DIHEN is positioned into the torch (4mm before the intermediate tube tip) and the plasma lit up (1200W). Best sensitivities are obtained for sample gas flow between 0.15 and 0.20 l/min, and auxiliary gas flow around 1.5 l/min. A peristaltic pump allows uptake rates of 10 to 100 $\mu\text{l}/\text{min}$. Best performances were obtained for 20 to 50 $\mu\text{l}/\text{min}$.

The sensitivities with d-DIHEN are similar to those with APEX for elements such as Mg, Sr, Nd, and Pb (approx. 11, 12, 4.5 and 10 V on larger isotope for 100 ppb solutions at 25 $\mu\text{l}/\text{min}$), and are respectively 7, 2.5, 2 and 2 times higher than double Scott spray chamber ones. Sensitivity gains for B and Li are 4 and 6.

Signal stability is typically 0.07% (RSD for 5 minutes on B). Oxids and doubly charged are more abundant than with the previous introduction systems: typically $\text{NdO}/\text{Nd} = 25\%$, $\text{Ba}^{2+}/\text{Ba} = 2\%$.

Boron isotope measurements with d-DIHEN led to an external reproducibility of 0.4‰ (2 σ) on purified 100 ppb B seawater samples. Internal reproducibility was 0.1‰. 200 seconds of wash were sufficient to reach 1‰ of the sample signal (2V). Measurement accuracy was successfully tested with enriched standards for $\delta^{11}\text{B}$ between -50‰ and +40‰.

Neodymium isotope measurements gave internal reproducibility similar to those obtained with a double Scott spray chamber for comparable signal intensity (2 ppm on $^{143}\text{Nd}/^{144}\text{Nd}$).

References

Westphal C.S., Kahen K., Rutkowski W.F., Acon B.W. and Montaser A. (2004) *Spectrochim. Acta* **59** 353-368.