Genesis of EPR lower crust: Petrographical and chemical evidence for mixing between MORB type and OIB type melts

*Sayantani Chatterjee[1], Marie Python[1], Marguerite Godard[2], Norikatsu Akizawa[3]

1. Hokkaido University Department of Natural History Science Division of Earth and Planetary Systems Sciences, 2. University of Montpellier, 3. Kyoto university

IODP Expedition 345 aimed to drill lower crust gabbros at Hess deep rift (East Pacific Rise, 2˚14’ N-101˚ 30’ W), which is located at the junction between EPR and the Cocos, Nazca and Ridge. Lower oceanic gabbros were sampled on a about ~200 m wide bench located on the intrarift's southern slope between 4675 and 4850 m below sea level, and total of 11 holes (A to P) were drilled among which two reached a depth over 100 m below seafloor (Holes 1415J and 1415P) (IODP Expedition 345 Scientific Report, 2013). Primitive troctolites and olivine-rich gabbros were the main lithologies recovered from these two holes. Shipboard data showed a high Mg# whole rock chemistry in concordance with their primitive nature.

We studied about 70 samples from Holes J and P for their petrography and mineral chemistry. The olivine gabbros show an overall cumulate texture with ophitic to subophitic domain consisting of large clinopyroxenes enclosing plagioclase chadacrysts. Non-ophitic clinopyroxenes are in association with orthopyroxene in an interfingered relationship. Olivine is subhedral to subrounded and plagiolse appear as subhedral laths. Overall texture points to a crystallisation order starting with olivine and plagioclase, and finishing with clinopyroxene in association with more or less orthopyroxene as expected for a crystallising MORB. Mineral chemistry show primtive characteristics with olivine forsterite content above 85% and clinopyroxene Mg# higher than 86% for all samples. Mg# in Cpx and the forsterite content in olivine show relatively narrow downhole variation ranges (from 86 to 89% for Cpx and 85 to 90% for olivine) together with a large scatter in minor elements (Ti, Al, Cr, Ni, Mn), suggesting that, at a global scale, only a moderate degree of differentiation occurred during the gabbro formation process. Chemical zoning observed in the ophitic cliopyroxenes show that the crystallisation process may be locally dominated by small scale differentiation.

Minor and trace elements contents in olivine, Cpx and plagioclase show a great variability scattered over the MORB chemical range. Calculated compositions for liquids in equilibrium with all minerals using both minor and trace elements are consitently between the EPR MORB and the Galapagos basalts chemical domains. This demonstrates that magmatic contamination from the Galapagos hotspot is significant in the Hess Deep lower crust. Interestingly, a weak degree of contamination from the Hawaii hot spot was detected in EPR basaltic glasses (Niu et al.,1999) but Hess Deep basalts seems to be of purely MORB nature (Batiza et al, 1992) without any chemical evidence of Galapagos influence . This shows that either lower gabbros, and especially Cpx in these rocks as this mineral represent the main incompatible element reservoir, may act as a chemical filter by preventing contamining primitive melts from the Galapagos hot spot to be expelled out of lower levels magmatic mushed.

References:
Batiza, R., & Niu, Y. Petrology and magma chamber processes at the East Pacific Rise~ 9 30′ N. *J. geophys. Res, 97(6), 779-776, (1992).*
Gillis, K. M. et al., primitive lower gabbros from fast-spreading lower oceanic crust. *Nature. 268, 154-156 (2013).*

Gillis, K. M., Snow, J. E., et al., Exploring the plutonic crust at fast-spreading ridge: new drilling at Hess Deep, *Priliminary Report Expedition 345, (2013)*.
Niu, Y., & Collerson, K. D. Origin of enriched-type mid ocean ridge basalt at ridges far from mantle plumes: The east Pasific Rise at $11^{0}22'$ N. *J. geophys. Res, 104,7067-7087, (1999)*.

Keywords: Hess Deep, IODP Expedition 345, Gabbros, Magma Mixing, MORB, OIB

