Crustal contamination and hybridization of an embryonic oceanic crust during the Red Sea rifting: An example from the Tihama Asir igneous complex, Saudi Arabia

Valentin Basch1, Alessio Sanfilippo1,2, Luigi Vigliotti3, Antonio Langone2, Najeeb Rasul4, Salem AlNomani4, Ali AlTharawi4, Adel Jerais4, and Marco Ligi3

1Department of Earth and Environmental Sciences, University of Pavia, Pavia, Italy (valentin.basch@gmail.com)
2Istituto Geoscienze e Georisorse (IGG), CNR, Pavia, Italy
3Istituto di Scienze Marine (ISMAR), CNR, Bologna, Italy
4Saudi Geological Survey, Jeddah, Kingdom of Saudi Arabia

The Red Sea rift system represents the best case study of the rift-to-drift history, i.e., the transition from a continental to an oceanic rift and the formation of passive margins. Although the onset of seafloor spreading has been constrained by geophysical observations to 5 Ma in the southern Red Sea, recent studies have suggested that MORB-type melts were intruded within the extended continental crust already during the early stages of rifting. We present here a petro-geochemical investigation of gabbroic bodies and associated basaltic intrusions from the Tihama Asir igneous complex, which formed as part of the intense magmatism that occurred during early Red Sea continental rifting. The most primitive olivine gabbros present modal, bulk and mineral compositions consistent with formation from MORB-type parental melts, but more evolved gabbros and oxide gabbros show saturation of phlogopite and define a geochemical evolution that progressively diverges from that of lower oceanic crust at mid-ocean ridges. Indeed, the Tihama Asir evolved gabbros are characterized by enrichments in LREE and highly incompatible elements (Rb, Ba, U, Th, Nb, Sr, K), suggesting hybridization of a MORB-type parental melt through a process of progressive assimilation of continental crust during the emplacement of gabbroic bodies. Additionally, the gabbros are associated with basaltic dike swarms intruded into the extending continental crust. The basalts show enrichments in LREE and highly incompatible elements similar to the gabbros, suggesting that they formed from melts extracted from the hybridized gabbroic crystal mush. This indicates that the Red Sea oceanization started before the onset of seafloor spreading, and that the cold continental crust was partially assimilated and replaced by hot gabbroic bodies since the early stages of continental rifting.