A sharp continent-ocean transition in the area of the Canary Islands: Evidence from upper mantle and lower crustal xenoliths

Else-Ragnhild Neumann[a], Riccardo Vannucci[b,c], Massimo Tiepolo[c], William L. Griffin[d], Norman J. Pearson[d] & Suzanne Y. O'Reilly[d]

[a] Physics of Geological Processes, University of Oslo, PO Box 1048-Blindern, N-0316 Oslo, Norway
[b] Dipartimento di Scienze della Terra, Università di Pavia, via Ferrata 1, 27100 Pavia, Italy
[c] CNR - Istituto di Geoscienze e Georsisorse, sezione di Pavia, Via Ferrata 1, 27100 Pavia, Italy
[d] Department of Earth Sciences, Macquarie University, Sydney, NSW 2119, Australia

Our present information on passive margins rests almost exclusively on seismic and density data. An important exception is the west Iberia margin where petrological and geochemical information on crustal and mantle rocks have been made available through drilling experiments. In order to increase our information about, and understanding of, passive margins and their mode of formation, more information on crustal and mantle rocks along different types of passive margins are needed. In the area of the Canary Islands such information has been obtained through the study of mantle and deep crustal xenoliths brought to the surface by basaltic magmas. In-situ laser ablation (LA) ICP-MS mineral analyses have enabled us to "see through" the effects of the Canary Islands event and obtain robust information about the original (pre-Canarian) chemical character of the crust and upper mantle on which these islands are built.

Our studies show that the lithosphere beneath the Canary Islands originated as highly refractory N-MORB type oceanic mantle overlain by highly refractory N-MORB crust. Both the lithospheric mantle and lower crust have been metasomatized to different degrees by a variety of fluid and melts. The enriched material is commonly concentrated along grain boundaries and cracks through mineral grains, suggesting that the metasomatism is relatively recent, and is thus associated with the Canary Islands magmatism. The original, strongly depleted trace element patterns and the low $^{87}Sr/^{86}Sr$ isotopic ratios typical of the oceanic lithosphere are preserved in the minerals in the least metasomatized rocks (e.g. $La_N/Lu_N<0.1$ in orthopyroxene and $^{87}Sr/^{86}Sr=0.7027$-0.7029 in clinopyroxene in mantle xenoliths). The compositions of the most depleted gabbro samples from the different islands are closely similar, implying that there was no significant change in chemistry during the early stages of formation of the Atlantic oceanic crust in this area. Strongly depleted gabbros similar to those collected in Fuerteventura have also been retrieved in the MARK area along the central Mid-Atlantic Ridge. Furthermore, we have found no evidence of continental material that might reflect attenuated continental lithosphere in this area. The easternmost Canary Islands, Fuerteventura and Lanzarote, appear to overlap the lower part of the continental slope of Africa. The presence of normal oceanic lithosphere beneath these islands implies that the continent-ocean transition in the Canary Islands area must be relatively sharp, in contrast to the passive non-volcanic margin further north along the coast of Morocco, along the Iberia peninsula, and in many other areas. Our data also contradict the hypothesis that a mantle plume was present in this area during the opening of the Atlantic Ocean.