Trace element and Sr-Nd-Pb-Os evidence for a lithospheric mantle source for the European CAMP basalts

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Continental tholeiitic basalts from the Central Atlantic magmatic province (CAMP) in South and North America, in Africa and Europe were emplaced at ca. 199 Ma, before disruption of Pangea. In southwestern Europe, remnants of the CAMP are represented by dykes (including the 550 km-long Messejana dyke), sills (in the Pyrenean region), and lava flows (in southern Portugal). These basalts yield the typical composition of low-Ti (~1 wt. %) CAMP tholeiites, with relatively high SiO_2 (> 51 wt %), K_2O (~ 0.6 wt %), LILE/LREE (Ba_{PM}/Ce_{PM} 1.7-1.8), LREE/HREE (Ce_{Ch}/Yb_{Ch} 2.1-2.9), low Nb/Th (~4.3), Sr and Nd isotopic compositions close to chondritic ($^{87}Sr/^{86}Sr_{200Ma}$ = 0.7053-0.7065, εNd_{200Ma} = 0.1 to -2.48) and Pb isotopic ratios (e.g., $^{206}Pb/^{204}Pb_{200Ma}$ = 18.15-18.48) above the NHRL. $^{187}Os/^{188}Os$ vs $^{187}Re/^{188}Os$ compositions of analyzed basalts are correlated and yield an apparent age of 184 ± 8 Ma (MSWD = 19), slightly younger than the $^{40}Ar/^{39}Ar$ magmatic age (197-199 Ma). This minor discrepancy might be explained by the random addition of small amounts of Re during post-magmatic alteration, consistent with the presence of traces of secondary chalcopyrite. Such a process would have almost no effect on the initial $^{187}Os/^{188}Os$ ratio of the correlation (0.130 ± 0.007), which is typical of mantle-derived magmas.

Combined trace element and Sr-Nd-Pb-Os isotopic ratios of the analyzed basalts permit only minor amounts of assimilation (less than 5-7 wt. % for the most evolved basalts) of old metamorphic silicic crust. Therefore, the enriched incompatible element and Sr-Nd-Pb isotopic signature and the non-radiogenic Os isotopic composition reflect mantle-source characteristics. Such compositions do not correspond to those of plume-related OIBs, notably those of nearby Atlantic islands, but instead support a significant contribution of the local sub-continental lithospheric mantle (SCLM). Consistent with this hypothesis, some samples of the southern European SCLM, which underwent several cycles of subduction-related fluid/melt metasomatism since the Neo-Proterozoic, share similar trace element ratios and isotopic compositions with the analyzed CAMP basalts. Magma generation within the shallow SCLM is also compatible with melting modeling, which suggest that the CAMP basalts were generated by about 10% melting of a spinel peridotite.