The genesis of CAMP basalts (Morocco) from enriched lithosphere to late asthenosphere mantle sources

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The Central Atlantic magmatic province (CAMP) basalts were erupted at the Triassic-Jurassic boundary, before disruption of Pangea over a surface of > 10 million km^2 in regions adjacent to the main rift zones (e.g., Morocco, eastern North America), yet also far inland (e.g., Mali, Bolivia). Sr-Nd isotopic and incompatible trace element ratios of most basalts display a slightly enriched signature which may reflect either generation from an enriched mantle and/or crustal contamination en route to the surface. In Morocco, several lava flow sequences show a systematic evolution from early to late erupted basaltic units. The lower three units were erupted at ca. 199 Ma as five short-lived magma pulses. They display a progressive depletion of incompatible element contents from the volumetrically dominant lower to the few upper unit basalts (e.g., TiO_2 from average 1.3 to 1.0 wt %, Nb from 12-13 to 4-5 ppm, chondrite-normalized La/Yb from 5 to 2.5), coupled with moderate variation of Sr-Nd isotopic compositions (e.g., average epsilon Nd from +0.3 for lower to -1.0 for upper basalts). A similar time-related progressive transition from enriched to depleted compositions has been observed for the CAMP lava piles of North America and for dyke swarms of Mali and seems to be typical of the CAMP. This geochemical shift can only in part be attributed to low-pressure fractional crystallization +/- crustal assimilation, but requires also changing mantle source compositions. The observed geochemical variations are best modeled by melting of a garnet-spinel peridotite, with progressive exhaustion of the most fertile and enriched source components within the lithospheric mantle. A dominantly signature origin is consistent also with recent studies of CAMP basalts from Europe and South America. By contrast, a contribution of a plume-related mantle is not evident for the CAMP.

In Morocco, a few late lava flows were erupted at ca. 197 Ma shortly before continental disruption and display a flat REE pattern, high TiO_2 (ca. 1.5 wt%), and depleted isotopic compositions compared to older basalts (e.g., epsilon Nd = + 1.3), witnessing the increased influence of the depleted asthenospheric mantle during the advanced stages of continental rifting. Consistently, similar late basalts with dominant asthneospheric signature were erupted also in eastern North America, yet are lacking in regions far from the continental margins in Europe, Africa and South America.