Geochemistry and age of the European CAMP basalts

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The Central Atlantic Magmatic Province (CAMP) is Earth's largest Phanerozoic continental igneous province, with tholeiitic basalts cropping out over about 7 million km^2, around the Central Atlantic Ocean. The CAMP event occurred at about 200 Ma and preceded the break-up of Pangea. The northernmost CAMP is represented by basaltic lava flows, dykes and sills occurring in Portugal, Spain and France.

$^{40}Ar/^{39}Ar$ step-heating ages on plagioclase separates from the European CAMP lava flows have been obtained (age of neutron-fluence monitor Fish Canyon sanidine = 28.02 Ma) for lava flows of southern Portugal. The plateau ages range from 195.6 ± 1.2 Ma to 198.6 ± 0.6 Ma (2σ errors) and are undistinguishable from the age of peak magmatic activity throughout CAMP. Therefore, this brief and simultaneous igneous event includes the European occurrences.

Major and trace elements composition of European basalts and basaltic andesites are similar to those of low-Ti basalts (TiO_2 < 2.0 wt.%) from the entire CAMP. They are moderately evolved (MgO 10-5 wt.%) tholeiites characterized by moderately enriched light REE and LIL elements relative to heavy REE (mantle-normalized La/Yb = 1.8-3.5; Ba/La = 9.2-25.5), with negative Ti, P and Nb, and positive Pb anomalies. Initial Sr, Pb and Nd isotopic compositions define a relatively limited compositional field ($^{87}Sr/^{86}Sr$ = 0.70528-0.70652; $^{206}Pb/^{204}Pb$ = 18.19-18.77; $^{207}Pb/^{204}Pb$ = 15.59-15.75; ε_{Nd} = 0.24 to -2.88) particularly when compared to CAMP basalts from Africa, South and North America. In general, relatively homogeneous isotopic and trace element ratios suggest a common signature for the European CAMP basalts, despite the large sampling area and despite locally different crustal and tectonic settings, suggesting that these basalts issued from an enriched mantle source.

Nonetheless, local effects are observed, such as relatively low $^{207}Pb/^{206}Pb$ and ε_{Nd} displayed by lava flows from southern Portugal and moderate correlations of isotopic and major and trace element compositions for basalts from the 550 km long Messejana dike. These characteristics suggest that geographically defined basaltic suites evolved from slightly heterogeneous mantle sources, and locally assimilated moderate amounts of distinct lower (trend towards low ε_{Nd}) or upper crustal rocks (trend towards high $^{87}Sr/^{86}Sr$), as is consistent also with preliminary $^{187}Os/^{188}Os$ analyses (measured $^{187}Os/^{188}Os$ = 0.159-0.392).

A genetic relationship between Archean TTG granitoids and eclogitic and peridotitic xenoliths from the subcratonic mantle? experimental evidence at 2-4 GPa

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Models for the origin and growth of the continental crust and the chemical evolution of the subcratonic lithosphere in the Archean require a general understanding of the genetic relationship between Na-rich TTG (tonalite-trondhjemite) granitoids comprising the earliest continental masses and their deep roots or "keels" in the underlying mantle. Partial melting of hydrous basalt in the laboratory at pressures of 1-4 GPa produces liquids that, in terms of major-element composition, closely resemble early-mid Archean TTGs. These melts are in equilibrium with eclogitic residual assemblages. Reaction between TTG melts and mantle peridotite produces hybridised granitoid melts compositionally comparable to late-Archean sanukitoids, in equilibrium with garnet websteritic reaction residues (Rapp et al., 1999). We have used the ion microprobe to geochemically fingerprint, in terms of an array of trace elements (Ba, Rb,Th, U, Nb, Sr, Zr, Y, Cr, REEs), coexisting granitoid liquids, and crystalline residues of melting (eclogite) or melt-rock reaction (peridotite) in these experiments, generating mineral-melt partition coefficients relevant to partial melting and melt-rock reaction in the process. Because the measured data are at natural abundance levels, we can make direct geochemical comparisons with (1) Archean TTG granitoids (e.g., trace element abundance patterns of liquids at 2-4 GPa match nearly perfectly those of TTG granitoids from the Kaapvaal craton), (2) eclogite xenoliths interpreted as residues from partial melting and TTG magmatism in the Archean (e.g., Barth et al., 2001), and (3) cratonic peridotites showing evidence for metasomatism by Si-rich (i.e., TTG) melts.

References

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Rapp, R.P., Shimizu, N., Norman, M.D. and Applegate, G.S. (1999). *Chem. Geology* **160**, 335-356.