Archean to Proterozoic depletion in Cape Verde lithospheric mantle

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Two groups of protogranular spinel-lherzolite and harzburgite xenoliths occur in Late Tertiary necks on Sal Island, Cape Verde Archipelago. Large protogranular clinopyroxenes from lherzolites (cpx 8–17 vol%) have high Cr_2O_3 and low CaO contents, and upward-convex rare earth element (REE) patterns (LaN = 3.6–5.3; SmN = 8.3–12.8; YbN = 2.4–4.8). Orthopyroxenes show very high Cr_2O_3 contents and flat HREE distributions, with YbN ranging from 0.7 to 0.9. Small secondary clinopyroxenes in harzburgites (cpx 1–3 vol%) are characterized by strong enrichment of LREE and MREE (LaN = 7.9–64.1; SmN = 36.6–95.4) with positively fractionated HREE patterns (YbN = 4.9–13.1).

Orthopyroxenes in harzburgites reflect high degrees of partial melting, with low Al_2O_3 contents (<2.5 wt%), and negatively fractionated HREE patterns (YbN = 0.7–0.9; SmN = 0.07–0.13). Whole-rock and mineral chemistry strongly support two different origins for the two lithotypes, which cannot be ascribed to a simple progressive depletion process. The Cape Verde harzburgites were produced by high-degree partial melting (>25%) of a spinel-bearing protolith, whereas the lherzolites reflect low-degree partial melting of a garnet-bearing lherzolite that re-equilibrated in the spinel stability field.

Both lithotypes have been metasomatised by kimberlite-like melts, leaving veins of K-rich glass + K-feldspar. In situ Re–Os analyses of intergranular sulfides from lherzolites yield values of 187Os/188Os varying from 0.1037 + 0.0020 to 0.1256 + 0.0022. TRD model ages define three groups: 3320 + 150 Ma, 2060 + 140 Ma and 996 + 73 Ma (1 s).

The age patterns in the Re–Os data, the juxtaposition of strongly depleted harzburgites and (originally) garnet lherzolites, and evidence of kimberlite-like metasomatism suggest that part of the ancient African subcontinental lithospheric mantle was incorporated into the newly formed oceanic lithosphere during the opening of the Atlantic ocean.