Spinel-lherzolite xenoliths from the Hoggar swell: Evidence for intracratonic asthenosphere upwelling and lithosphere rejuvenation

L. BECCALUVA[1], A. AZZOUNI-SEKKAL[2], A. BENHALLOU[3], G. BIANCHINI[1], R.M. ELLAM[4], M. MARZOLA[1], F. SIENA[1] AND F.M. STUART[4]

[1]Dip. Scienze della Terra, Università di Ferrara, Italia
[2]Faculté des Sciences de la Terre, Géographie et Aménagement du Territoire, Université des Sciences et Technologie Houari Boumédienne, Alger, Algérie
[3]Centre de Recherche en Astronomie, Astrophysique et Géophysique (CRAAG), Alger, Algérie
[4]Isotope Geoscience Unit, Scottish Universities Environmental Research Centre, East Kilbride, UK

The mantle xenoliths included in Quaternary alkaline volcanics from the Manzaz-district (Central Hoggar) are proto-granular, anhydrous spinel lherzolites. Major and trace element analyses on bulk rocks and constituent mineral phases show that the primary compositions are widely overprinted by metasomatic processes, which however are not reflected by pyrometamorphic textures. Trace element modelling of the metasomatized clinopyroxenes allows the inference that the metasomatic agents that enriched the lithospheric mantle were highly alkaline carbonate-rich melts such as nephelinites/melilitites (or as extreme silico-carbonatites). These metasomatic agents were characterized by a clear HIMU Sr-Nd-Pb isotopic signature, whereas there is no evidence of EM1 components recorded by the Hoggar Oligocene tholeiitic basalts. This can be interpreted as being due to replacement of the older cratonic lithospheric mantle, from which tholeiites generated, by asthenospheric upwelling dominated by the presence of a HIMU signature. Accordingly, this rejuvenated lithosphere (accreted asthenosphere without any EM influence), may represent an appropriate mantle section from which deep alkaline basic melts could have been generated and shallower mantle xenoliths sampled, respectively. The available data on lherzolite xenoliths and alkaline lavas (including He isotopes, Ra < 9) indicate that there is no requirement for a deep plume anchored in the lower mantle, and that sources in the upper mantle may satisfactorily account for all the geochemical/petrological/geophysical evidence that characterizes the Hoggar swell. Therefore the Hoggar volcanism, as well as other volcanic occurrences in the Saharan belt, are likely to be related to passive asthenospheric mantle uprising and decompression melting linked to tensional stresses in the lithosphere during Cenozoic reactivation and rifting of the Pan-African basement. This can be considered a far-field foreland reaction of the Africa-Europe collisional system since the Eocene.

Lithosphere/asthenosphere interaction in a plume region: Evidence from Ethiopian mantle xenoliths

L. BECCALUVA[1], G. BIANCHINI[1], R.M. ELLAM[2], C. NATALI[1], F. SIENA[1] AND F.M. STUART[2]

[1]Dipartimento di Scienze della Terra, Università di Ferrara, Italy (bcc@unife.it)
[2]Isotope Geoscience Unit, Scottish Universities Environmental Research Centre, East Kilbride, UK

Mantle xenoliths entrained in alkaline lavas from Injibara (Gojam) and Nekemte (Wollega) at the western border of the Ethiopia-Yemen basaltic plateau provide information on the lithospheric mantle evolution in an area where the existence of a deep mantle plume is widely accepted (Afar plume; Courtillot *et al*., 2003).

The studied xenoliths include prevalent spinel lherzolites and subordinate harzburgites (sometimes containing metasomatic amphibole) and olivin-websterites characterized by generally flat chondrite-normalized bulk-rock REE patterns, with only few enriched samples (La_N/Yb_N up to 5). Clinopyroxene (cpx) REE patterns are generally flat or LREE depleted (La_N/Yb_N down to 0.6). In a few samples a pristine equilibration in the garnet peridotite facies is suggested by peculiar cpx upper convex REE patterns quite similar to those observed in garnet peridotite clinopyroxenes.

Sr-Nd isotopes on separated cpx mainly show compositions ($^{87}Sr/^{86}Sr < 0.7030$; $^{143}Nd/^{144}Nd > 0.5132$) approaching the Depleted Mantle end-member, or displaced ($^{87}Sr/^{86}Sr$ 0.7033-7034; $^{143}Nd/^{144}Nd$ 0.5129-0.5128) toward the Enriched Mantle components which also characterize the Ethiopian Oligocene plateau basalts.

These characteristics indicate that most xenoliths were variably affected by metasomatic processes, whose agents may be envisaged as mafic subalkaline melts that infiltrated and reacted at high melt/peridotite matrix ratio.

The compositional evolution of the studied samples seems to reflect complex asthenospere/lithosphere interactions occurring in a plume region where lithospheric bulging and thinning by the uprising asthenosphere is accompanied by pervasive refertilization due to reactive percolation of sublithospheric subalkaline melts. Therefore the studied mantle xenoliths may represent asthenosphere-derived mantle material entrained by the buoyancy flux of the Afar plume which equilibrated to shallower levels and accreted to the lithosphere.

References

Courtillot *et al*., 2003. *Earth Planet. Sci. Lett*. **205**, 295-308.