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Mantle refertilization during subcontinental lithosphere-asthenosphere interaction: evidence from the layered pyroxenite-peridotite in the Ronda peridotite massif

C.J. Garrido (1), J.-L. Bodinier (2), I. Chanefo (2) and O. Bruguier (2)

(1) Dep. Mineralogía y Petrología, Fac. Ciencias, Universidad de Granada, 18002 Granada, Spain, (2) Laboratoire de Tectonophysique, Université de Montpellier II, CNRS, Place E. Batillon, 34095 Montpellier, France (carlosg@ugr.es)

The Ronda peridotite (S Spain) contains a variety of pyroxenites ranging from high-pressure garnet pyroxenites to low-pressure plagioclase-olivine websterites (Garrido & Bodinier, 1999). The high-pressure garnet pyroxenites occur in the preserved 'sub-continental lithospheric' part of the massif ('spinel tectonite' domain). The 'astheno-spherized' part of Ronda massif (the 'granular' and 'plagioclase tectonite' domains) (Lenoir et al., 2001; Vauchez & Garrido, 2001) contains abundant spinel websterite layers without noteworthy deformation and metamorphic imprint. They occur as swarms of layers and lenses hosted by harzburgites and dunites, showing gradual transitions from peridotites containing thin pyroxenite layers ($<$1 cm) to thick websterites lenses ($>$ 1 m) containing olivine seams.

Field and petrographic observations suggest that layered spinel websterites in the asthenospherized Ronda domain were formed by pyroxene-forming, melt-rock reaction leading to replacement of refractory mantle peridotites. Numerical modelling shows that the overall decreasing Mg# (=Mg/Mg+Fe cationic ratio) with increasing pyroxene proportion in pyroxenites can be accounted for by melt-consuming reactions resulting in the formation of mildly evolved, relatively low-Mg# melts (down to Mg# $\sim$0.65). However, the melt fraction during reaction and the time-integrated melt/rock ratio had to be high enough ($>$0.1 & $>$1, respectively) to balance Mg-Fe buffering by peridotite minerals. The whole-rock and clinopyroxene chondrite-normalized REE patterns of spinel websterites are convex-upward. This REE distribution is consistent with pyroxene-forming, melt-consuming reaction, provided that the melt was substantially more depleted in LREE than expected from the composition of partial melting residues in the Ronda “recrystallization front”. Such LREE depletion might be the consequence of an olivine + melt forming reaction roughly coeval with pyroxenite formation and responsible for the spatially associated harzburgites and dunites.

The strong melt localization responsible for the origin of layered pyroxenites may explained by melt channelling in high-porosity layers developed by compaction processes near the partial melting front developed after the thinned subcontinental lithospheric domain in Ronda (Lenoir et al., 2000). Although strongly heterogeneous on centimetre to tens of meters scale, the Ronda mantle domain where pyroxenite- and dunite/harzburgite-forming reactions occurred is significantly more fertile than the residual, ‘coarse-granular subdomain’ that results from the melting of the subcontinental lithosphere. Our observation therefore indicates that heterogeneous (‘veined’) refertilization would trace the moving boundaries of receding (conductively cooling) partial melting domains during thermal erosion of subcontinental mantle leading locally to pervasive refertilization of residual mantle.

References:

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