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Melt percolation and impregnation in peridotites from a fossile rifted margin: evidence from the Mt. Nero peridotite (External Ligurides, Northern Apennine, Italy)

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Present knowledge on the External Ligurides (EL) ophiolitic peridotites indicate that they derived from the subcontinental mantle lithosphere, to be successively exposed to the sea-floor of the slow spreading Jurassic Ligurian Tethys. During exhumation, they underwent significant melt percolation and impregnation forming plagioclase peridotites (Piccardo et al., 2004).

Plagioclase peridotites from Mt. Nero (EL) show relict tectonite foliation and deformed spinel-facies assemblage: they experienced the interstitial crystallization of unstrained plagioclase (plg) and pyroxenes (px), sometimes concentrated in mm-size gabbroic pods, as a consequence of impregnation by melts percolating the spinel tectonites via pervasive porous flow. Locally, tectonite fabrics were almost completely recovered during melt impregnation and coarse-granular textures were developed.

Plagioclase peridotites have commonly high plg contents (up to 15% by volume). Spinels are remarkably Al-depleted, Ti-enriched, and cpx are Al-Na-depleted with respect to minerals of the pristine lithospheric spinel lherzolites. Cpx also show significant enrichment in transition trace elements (i.e. REE, Ti, Sc, V, Zr, Y), having convex-upward REE patterns (MREE up to 30xC1).

In places, plagioclase peridotites are strongly deformed with formation of decameter-scale plg-rich tectonite-mylonite shear zones, which frequently present decimeter- to meter-wide bands of coarse-granular, plg-free spinel harzburgites, parallel to the main foliation. Spinel harzburgites are reactive in origin, being characterized by reaction microtextures (namely pyroxene dissolution / olivine precipitation) and coarsening of the olivine crystals. They are the product of the complete consumption of plg and most of cpx and the recovering of the previous deformation textures by focused reactive migration of melt along the shear zones.

The reactive spinel harzburgites have relict cpx grains with significantly low contents of some trace elements (i.e. Actinides and HFSE), but high Sr and Na contents. Cpx have convex-upward REE patterns ($La_N/Sm_N = 0.40$; $Gd_N/Yb_N = 1.56$) with a maximum at Eu_N (9.14), which defines an appreciable positive anomaly. Such chemical signatures witness the role played by plagioclase dissolution in the evolution of the migrating melt.

This work describes the composite evolution of a sector of subcontinental mantle lithosphere during exhumation at an ocean-continent transition zone. Pristine spinel lherzolites: i) were deformed under spinel-facies conditions during exhumation; ii) underwent diffuse porous flow percolation and refertilization (formation of plagioclase peridotites) by upwelling pyroxene-saturated asthenospheric melts. Later on, plagioclase peridotites: i) were strongly deformed along extensional shear zones with formation of plagioclase-bearing tectonites-mylonites, ii) underwent the reactive focused migration along shear zones of pyroxene-undersaturated melts forming coarse-granular spinel harzburgite channels.

Abundance of plagioclase peridotites among the EL mantle rocks indicates that the ocean-continent transition zone of the Jurassic Ligurian Tethys was not a-magmatic sensu stricto but that early asthenospheric melts were stored in the mantle lithosphere.

Piccardo G.B., Muentener O., Zanetti A., Pettke T. (2004) – Ophiolitic peridotites of the Alpine-Apennine system: mantle processes and geodynamic relevance. International Geology Review, 46, 1119-1159.