EXHUMATION HISTORY OF SUBCONTINENTAL GARNET PYROXENITE-BEARING MANTLE FROM THE EXTERNAL LIGURIDE OPHIOLITES (NORTHERN APENNINE, ITALY): IMPLICATIONS FOR RIFTING AND MANTLE EXHUMATION PROCESSES AT OCEAN-CONTINENT TRANSITION

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ABSTRACT

The External Liguride Jurassic ophiolites derive from an ocean-continent transition similar to the West Iberian margin. The mantle sequence consists of spinel and spinel-plagioclase lherzolites recording a lithospheric thinning history culminated into mantle exhumation at the ocean-floor. They represent unroofed subcontinental lithosphere of the former Adria-Europe system largely affected by thermochemical erosion, heating and refertilization by asthenospheric melts during the Ligurian Tethys formation (Rampone et al., 1995; Piccardo et al., 2004). Peridotite bodies which escaped melt contamination and intrusion preserve relics of a deep-seated lithospheric origin, i.e. occurrence of graphite-bearing garnet clinopyroxenite and websterite layers. The garnet pyroxenite-bearing mantle from the External Liguride ophiolites therefore represents a unique tectonic sampling of deep levels of subcontinental lithosphere exhumed in an oceanic setting.

Garnet clinopyroxenites are mafic rocks with a primary assemblage of pyrope-rich garnet + sodic Al-augite (Na2O ~2.5 wt%, Al2O3 ~12.5 wt%), with minor amounts of orthopyroxene, graphite, Fe-Ni sulphides and rutile. Decompression yielded Na-rich plagioclase (An50-45) exsolutions in clinopyroxene porphyroclasts and extensive development of symplectites composed of secondary orthopyroxene + plagioclase (An50-70) + Al-spinel ± clinopyroxene ± ilmenite at the interface between garnet and primary clinopyroxene. Further decomposition is recorded by the development of an olivine+ plagioclase-bearing assemblage, locally under synkinematic conditions, at the expenses of two-pyroxene + Al-spinel. Mg-rich garnet has been also found in websterite layers, which are commonly characterised by the occurrence of symplectites made of orthopyroxene + Al-spinel ± clinopyroxene. The enclosing peridotites are Ti-amphibole-bearing lherzolites with a fertile geochemical signature and a widespread plagioclase-facies mylonitic foliation, which preserve in places a spinel tectonite fabric.

Lu-Hf and Sm-Nd mineral isochrons (220 ± 13 Ma and 186 ± 1.8 Ma, respectively) have been obtained from a garnet clinopyroxenite layer and interpreted as cooling ages. Geothermobarometric estimates for the high-pressure equilibration have yielded T = 1150-1200 °C and P = 2.6-3.0 GPa.

The early decompression was associated with significant cooling, corresponding to T = 900-1050°C, and development of the spinel tectonite fabric in the lherzolites. Further decompression associated with plagioclase-olivine growth in both peridotites and pyroxenites was nearly isothermal. The shallow evolution was characterized by a widespread polyphase brittle deformation under decreasing temperature conditions, coupled with hydration. In particular, the brittle evolution includes an early amphibolite-facies veining stage, followed by low-temperature hydrothermal alteration and serpentinisation associated with polyphase cataclasis.

The exhumation was likely accomplished as a two-step process starting during Late Palaeozoic continental extension. The low-pressure portion of the exhumation path, possibly including also the plagioclase mylonitic shear zones, was related to the Mesozoic (Triassic to Jurassic) rifting that led to continental break-up. In Jurassic times, the studied mantle sequence was involved into an extensional detachment structure up to sea-floor exhumation, which was associated with development of serpentinisation-related hydrothermal activity. Integrated values of cooling and uplift rates for the Jurassic rifting evolution are ~35°C/Ma and 0.6-1.4 mm yr\(^{-1}\).

REFERENCES

