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Mantle-Crust relations in embryonic slow-spreading ocean basins: insights from the Ligurian and Corsica ophiolites

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It is well known that the structure, composition and evolution of the oceanic lithosphere can vary significantly in different oceanic settings, i.e. passive margins, ultraslow- vs. slow- vs. fast- spreading ridges. Remarkable differences are i) the origin and processes recorded by mantle peridotites, 2) the abundance of crustal rocks, 3) the mantle-crust relations, i.e. the existence of a genetic link between residual peridotites and associated crust, as it would be expected in mature oceanic lithosphere. Insights on this latter topic have resulted from last decade isotope studies on the Ligurian (Northern Apennines and Erro-Tobbio, Ligurian Alps) ophiolites, which are remnants of the Jurassic lithosphere of the Ligurian Tethys embryonic ocean. These studies have pointed to the peculiarity of these ophiolites, which are mostly characterized by the association of old subcontinental lithospheric mantle and younger oceanic crustal rocks. This feature is increasingly documented as representative of the atypical oceanic lithosphere from passive-rifted margins, and embryonic oceans developed through passive lithosphere extension and slow-spreading oceanization. In this paper we present a comprehensive review of available Sm/Nd isotopes on the crustal and mantle section of the Ligurian ophiolites, integrated with new Sm/Nd isotope data on the Erro-Tobbio gabbroic intrusions and on the Mt.Maggiore (Corsica, France) gabbro-peridotite association. A major aim is to provide evidence about three main features which characterize the lithosphere of this embryonic ocean: i) the large exposure at the sea-floor of older tectonically exhumed subcontinental lithospheric mantle, sporadically intruded by younger (Jurassic) MORB-type discrete gabbroic bodies, ii) the predominant lack of a direct mantle-crust cogenetic relationship, iii) the

magmatic crystallization ages recorded by the gabbroic rocks (180-160 Ma), which presumably reflect sporadic magma production and intrusion in a rather large time interval, since early rifting to slow-spreading oceanization. Mantle peridotites from the External Liguride (EL, Northern Apennines) and Erro-Tobbio (ET, Ligurian Alps) ophiolitic units both represent old (pre-Jurassic) subcontinental mantle. They record a long and multi-stage exhumation-related evolution, characterized by subsolidus decompression (recrystallization from spinel- to plagioclase- to amphibole-bearing assemblages), diffuse melt migration and melt-rock interaction, and multiple episodes of ultramafic-mafic intrusions. Sr and Nd isotopes have indicated that the EL lherzolites were accreted to the subcontinental lithosphere since Proterozoic. Sm/Nd dating on the plagioclase-facies recrystallization stage in the ET peridotites have yielded Permian ages, thus indicating an early emplacement of these mantle sectors at shallow lithospheric levels. Gabbroic rocks intruded in both the EL and ET mantle peridotites record the oldest ages available for the gabbroic crust of the Ligurian Tethys (EL: 179 $\pm$ 9 Ma, Tribuzio et al., 2004; ET: 180 $\pm$ 14, this study). In the EL and ET mantle peridotites and associated gabbroic rocks, no genetic link can be envisaged, because the peridotites represent subcontinental lithospheric mantle whose tectonic exhumation was even completely unrelated to mantle melting and melt production. Sm/Nd isotope studies on the depleted mantle peridotites from the Internal Liguride (IL, Northern Apennine) ophiolitic units provided a Permian (275 Ma) DM model age of depletion. Associated gabbroic rocks have been dated at 165 $\pm$ 14 Ma. Thus, even in the IL ophiolitic sequences, residual mantle and associated crustal rocks are not cogenetic and coeval. Sm/Nd isotope data on the depleted ophiolitic peridotites from Mt.Maggiore (Corsica) have furnished a Jurassic (165 Ma) DM model age of depletion. Associated gabbroic rocks have been dated at 162 $\pm$ 10 Ma. Thus, Sm/Nd isotope data on the Mt.Maggiore gabbro-peridotite association provide evidence of the existence of isotopic equilibrium between depleted peridotites and associated magmatic rocks, and suggest that this could be a key feature recording the attainment of a mature oceanic stage.

Tribuzio et al. (2004) – J.Petrology 45 (6), 1109-1124.