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Inversion of back-arc basins : example of the Ligurian Basin, Western Mediterranean

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The Mediterranean back-arc basins, once opened, are often rapidly submitted to inversion along the complex Eurasian-African convergent border. Along their continental margins, these small basins consist of heterogeneous systems that juxtapose lithospheres with different nature, mechanical behavior and structural inheritance. In this study, we focus on the northern Ligurian margin to examine how such complex systems might deform when they are submitted to compressive stress. The northern Ligurian margin, of Oligo-Miocene age, has been undergoing contraction over at least the last $\sim$6 Ma. Below the margin, active thrust faults responsible for the regional uplift of the continental edge have been proposed in previous works, but have never been imaged. Seaward of the margin, no recent or active crustal compressional structure has been identified so far in the oceanic domain, although seismicity extends as far as midway through the basin.

We use seismic reflection data, including 72- and 12-channel high-resolution acquisitions (MALISAR, 2006 and FABLES, 2012) and 96-channel deep-penetrating ones (MALIS, 1995), to image the Ligurian margin and the adjacent oceanic domain. In the seismic lines, the Messinian event, well dated over the Mediterranean (5.96-5.32 Ma) and well identified in the seismic stratigraphy, allows us to quantify the vertical deformation over the last 5.3 Ma. The seismic reflection data set is interpreted together with 3D-velocity-depth models deduced from wide-angle seismic data (GROSMARIN, 2008).

Below the margin, the contraction is characterized by folds, south verging thrusts, tilted crustal blocks, and by a global margin uplift that exceeds 1500m. Within the adjacent oceanic domain, noticeable deformation is restricted to large, SW-NE elongated salt walls located 10 to 40 km from the margin toe, over a 70 km length. We interpret them as resulting from combined deep-seated crustal and thin-skinned deformations. However, although the salt walls are well expressed in the seafloor morphology, their seismic images do not reveal any significant vertical throw across their trace, and the amount of deformation gradually disappears toward the structure ends. This suggests that the post-Messinian deformation taken along these features is moderate, compared to the margin. The synchronicity of the crustal deformation in the oceanic and the continental domains supports the idea that the lower deformation amounts observed within the deep basin are related to different mechanical behaviours within the continental margin and the adjacent oceanic domain, rather than the result of a recent basinward propagation of the deformation.

Thermo-mechanical models suggest that mainly two factors could control the focused deformation along the margin: (1) the locus of highest topographic gradient of the main crustal interfaces, (2) the thermal contrast between the subsiding cooling oceanic domain and the uplifting warming margin. According to these models, the continental versus oceanic nature of the lithospheres would be of second order in the localization of the deformation.