Kinematics and rifting processes of the Liguro-Provençal Basin, Western Mediterranean

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The Liguro-Provençal Basin, situated at the junction of the Northern Apennines and the Western Alps, formed due to the rollback subduction of the Adriatic-African plate underneath Europe and the subsequent upper plate extension in the Oligocene to early Miocene times. The opening of the basin was accompanied by the counter-clockwise rotation of the Corsica-Sardinia block relative to Europe until 16 Ma, with the basin widening towards the southwest. It remains controversial if the extension ever reached seafloor spreading with the production of oceanic crust, or whether it led to anomalously thin continental crust and/or to mantle exhumation. Although considered as tectonically inactive today, the Liguro-Provençal Basin shows active seismicity, indicating compression and possible basin inversion (Thorwart et al. 2021). Thus it is crucial to better understand the opening of the basin and the tectonic inheritance due to rifting in order to interpret the present-day seismicity.

To this end, we compiled existing geological and geophysical data, including recent data from the 4DMB project ("Mountain Building Processes in Four Dimensions"), to constrain the crustal and sedimentary thicknesses throughout the basin. We focus specifically on two profiles in the NE (Corsica-Provence) and SW (Sardinia-Gulf of Lion) parts of the basin, along the opening direction of the basin. For each selected profile we calculated the average velocity using the kinematic reconstructions of Le Breton et al. (2021) and the amount of extension using an aerial balancing approach. We then compared these profiles and amounts of extension with results of coupled thermo-mechanical of asymmetric rifting and surface processes modelling using Aspect and Fastscape codes from Neuharth et al. (2022).

The results of the thermo-mechanical modelling fit very well the present-day geometry of the rifted continental crust, with a wider hyper-extended rifted margin on the European and a narrower rifted margin on the Corsica-Sardinia side. Rifting migrated southeastward through time and seems to not have reached oceanic spreading nor mantle exhumation in the northeast part of the basin, as observed in the most recent seismic profile A401A-SMPL obtained within the 4DMB SPP project. Towards the southwest, the model confirms the presence of exhumed mantle, as proposed in previous study (Jolivet et al. 2015). The synthesis of geophysical data and thermomechanical modelling also fits very well in the existing kinematic reconstructions from 35 to 0 Ma of the Western Mediterranean, allowing us to infer the lateral extent of oceanic crust and exhumed mantle domains within the basin. Finally, present-day compressional seismicity seems to reactivate rift-related structures.

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