Basin inversion: reactivated rift structures in the central Ligurian Sea revealed using ocean bottom seismometers

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The Alpine orogen and the Apennine system are part of the complex tectonic setting in the Mediterranean Sea caused by the convergence between Africa and Eurasia. Between 30 Ma and 15 Ma, the Apennines-Calabrian-Maghrebides subduction retreated in a southeast direction pulling Corsica and Sardinia away from the Eurasian landmass, opening the Ligurian Sea. In this extensional setting, the Ligurian Sea was formed as a back-arc basin. The northern margin of the Ligurian Basin shows notable seismicity at the Alpine front, including frequent magnitude 4 events. Seismicity decreases offshore towards the basin center and Corsica, revealing a diffuse distribution of low-magnitude earthquakes.

Within the framework of the AlpArray research initiative, a long-term amphibious seismological experiment was conducted in the Ligurian Sea to investigate the lithospheric structure and the seismicity in the Ligurian Basin. The passive seismic network consisted of 29 broad-band ocean bottom stations from Germany and France next to permanent and temporary broad-band land stations. The ocean bottom stations were in operation between June 2017 and February 2018.

Two clusters consisting of 18 earthquakes occurred between ~ 10 km to ~ 16 km depth below the sea surface, within the lower crust and uppermost mantle, in the centre of the basin. Thrust faulting focal mechanisms indicate compression and tectonic inversion of the Ligurian Basin, which is an abandoned Oligocene–Miocene rift basin. The basin inversion is suggested to be related to the Africa–Europe plate convergence. The locations and focal mechanisms of seismicity suggest reactivation of pre-existing rifting-related structures. Slightly different striking directions of presumed rifting-related faults in the basin center compared to faults further east and hence away from the rift basin may reflect the counter-clockwise rotation of the Corsica–Sardinia block.

Mantle refractions Pn and Sn have apparent velocities of 8.2 km/s and 4.7 km/s. The low Vp-Vs-ratio of 1.72 indicates a more brittle behavior of the mantle material. This supports the hypothesis of strengthening of crust and uppermost mantle during the Oligocene–Miocene rifting-related extension and thinning of continental crust.

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