Generation and Destruction of Lithosphere in the Ligurian Sea

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The overall theme of this project is to resolve the lithospheric structure of the Ligurian Sea with broadband OBS data and adjacent land stations. Therefore, our project focusses on the offshore component of the AlpArray seismic network. 29 French and German ocean bottom seismometers (OBS) were deployed by RV Purquois Pas? in June 2017 and recovered by RV Maria S. Merian in February 2018. The OBS network (LOBSTER) fills a gap in data availability southwest of the Alpine region in the Mediterranean Sea. 23 OBS recorded eight months of continuous data on seismometer components and the hydrophone. The data are used to invert surface wave group velocity maps of the southwestern Alpine region imaging the subsurface structure. The velocity maps will hold an image of the present-day crustal and lithospheric architecture of the Ligurian Sea and will e.g. help answering which type of crust dominates the Ligurian Basin (research theme 3), locate the Alpine front prolongation into the Mediterranean Sea and might contribute imaging the Alpine's complex subduction structure (research theme 1).

Compared to land stations, OBS data have additional noise sources imposed from the water column (e.g. infragravity waves, compliance, instrument tilt), thus making ambient noise studies using OBS data less straightforward compared to land stations. To enhance the signal propagating through the solid earth we remove tilt and compliance signals to better isolate the surface wave travelling along the seafloor. Cross-correlation functions (CCF) from dayfiles reveal signals travelling with the speed of Rayleigh waves as well as a weaker signal propagating with 1 km/s often dominating short periods. We calculated dispersion functions using the multiple filter technique (MFT) introduced by Dziewonski, Bloch and Landisman (1969)[1]. The resulting dispersion functions from ambient noise are reliable for periods ranging from 4 s to 12-20 s (depending on data quality).
We repeated this procedure for short time windows with signals from strong regional and teleseismic events. Doing so we only used station pairs with azimuths coinciding the earthquake-station azimuth to estimate dispersion functions up to 50-75 s - longer periods than from ambient noise alone. This will contribute to resolving the velocity structure of greater depths.
To study not only the OBS network area but the Ligurian Basin as well as the adjacent Alpine region we incorporated land-station data and compute dispersion curves using OBS and land station data pairs. Next step of this ongoing work is to estimate surface wave group velocity maps from dispersion curves for different periods. Those will contain information about different depths. We will use an algorithm by Nicholas Rawlinson (University of Cambridge) called FMST (fast marching surface tomography package). Finally, we target to convert group velocity maps to a three-dimensional spatial velocity model considering the bathymetry and topography. This will improve the understanding of the 3D geometry of the Ligurian Sea's complex lithospheric system.

The OBS network is also used to investigate the local seismicity of the Ligurian Sea. The network was complemented with stations in Provence, Corsica (France), Liguria and Piedmont (Italy).OBS records show a high noise level on the hydrophone component and in general poor P onsets on the seismometer. Onset of S-waves and P-S converted waves – about 1-5s after P onsets - can be well identified on the horizontal components. Up to now 700 P-onsets and 1,400 S-onsets of about 200 events were picked in the OBS records. The events were located together with arrival times from the land stations.

[1] A Technique for the Analysis of Transient Seismic Signals, Dziewonski, Bloch and Landisman, 1969, BSSA

We find several active areas in the Ligurian Sea (Fig. 1). The most active area is close to the intersection of the alpine range and the coastline. There are several small events close to Toulon (France). A cluster consisting of minimum 14 events occurred about 150 km west of Corsica at (42.2°N/7.1°E). This cluster was active in June, August, September and November 2017. The high coherent waveforms indicate a similar focal mechanism for all events in the cluster and therefore a repeated activation of a fault. The direction of the first motion of the P-wave is negative on land stations close to the French coast but positive at the closest OBS just above the cluster indicating a thrust-faulting regime.
Thrust faulting is also observed at 3 earthquakes located 40 km east of cluster in 2011 and 2012.

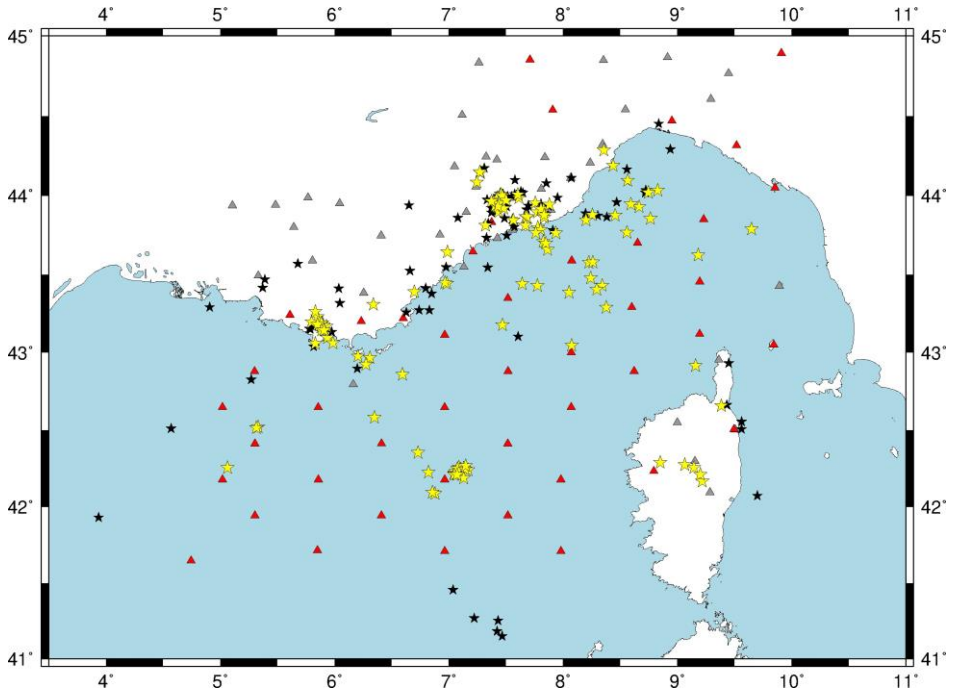

Figure 1: *Local earthquakes (stars) in the Ligurian Sea. Triangles indicate seismic stations, red triangles indicate OBS stations.*

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