Title: LOBSTER - „**L**igurian **O**cean **B**ottom **S**eismology and **Te**ctonics **R**esearch“
PIs: Heidrun Kopp, Dietrich Lange, Ingo Grevemeyer
Postdoc: Anke Dannowski
PhDs: -

Goals:
The LOBSTER project comprises the offshore component of the AlpArray seismic network using ocean bottom seismometers (OBS) to record teleseismic and local events in order to define subsurface structures at the transition from the Western Alps to the Apennines and to improve our understanding of the 3D-geometry of the system and its kinematics. The LOBSTER network consists of 23 OBS that recorded continuously over a period of 8 month (June 2017 – February 2018). Additionally, two seismic refraction profiles were shot to provide the velocity distribution within the Ligurian Basin lithosphere (Fig. 1) with the aim to image the offshore ocean-continent boundary. Profile P01 extends from the Central Corsican margin across the Ligurian Basin to the Ligurian Provencal margins. A total of 35 stations were deployed along the 147 nm long E-W profile, which was extended on Corsica with 3 land stations recording the 2418 air gun signals. The NE-SW trending profile P02 covers the central Ligurian Basin with a length of 73.5 nm. A total of 15 stations recorded 1033 shots. The data quality of both refraction seismic profiles is good and instruments show clear PmP Moho reflections and Pn mantle phases.

New results and interpretations:
At the long-term network, the data quality of the seismometer components is good and the instruments recorded local as well as teleseismic events. The instruments are working autonomously at the seafloor. Therefore the clock is not permanently synchronised via GPS as would be the case for land stations. Clocks are synchronised before and after the deployment. A drift of up to 4.5 s was observed and the data were corrected for the time difference assuming a linear drift. The correct timing was verified by the active shots recorded at the end of the deployment. All recorded data were corrected for timing errors. Once the instruments are deployed from the vessel they fall independently through the water column down to the seafloor. During the free fall they can drift in the water column and turn around their own axis resulting in an unknown instrument location on the seafloor and unknown directions of the horizontal components, while the Z-component will be oriented vertical. The vertical alignment of the Z-component was assessed every 30 days by a tiltmeter. The trillium seismometer that was used is also equipped with a magnetic compass. Due to magnetic material on the flotation frame and the steel anchor of the instrument it is difficult to calculate the absolute directions of the horizontal components based on compass measurements. However, we could prove for all instruments that the horizontal components did not change their orientation during deployment time. The same is true for the vertical alignment of the Z-component. To provide absolute values of the direction of the horizontal seismometer components (H1 and H2) we used the active shots of the wide-angle profile P01, recorded at the end of the deployment period. Shots were recorded on all stations at the seafloor during this time, except OBS A412A. Seismic shot sections for P01 were generated. The data were high pass filtered to remove the refraction phases, leaving the direct arrivals and their multiples (Fig. 2a). The data were subsequently plotted in a hodogram and orientation angles were calculated based on the shot azimuth (Fig. 2b). For all 22 OBS the rotation angles could be calculated with an accuracy of 5 to 10 degrees (Fig. 1). In Figure 2b (left panel) two data examples of the rotated horizontal components are displayed in the shot sections of the active seismic profile P01.

A first velocity profile has been developed along wide-angle refraction profile P02 by means of travel time tomography. The velocities have been converted to densities and the gravity Free Air Anomaly response was calculated and compared to measured gravity field from satellite data. The crust-mantle boundary in the centre of the Ligurian Basin is determined at ~9.5 km depth below the seafloor. The acoustic basement is difficult to map seismically. Seismic phases indicate the transition to the crystalline crust in the southern part of the profile at a depth of ~6.5 km below the seafloor. The nature

of crust in the central part of the Ligurian Sea is still under discussion. The absolute seismic velocities can be interpreted as hyper-extended continental crust or serpentinised oceanic mantle. The crustal portion interpreted from the seismic velocities thickens toward the north. Seismic results and the converted densities are in good agreement with the measured gravity field.

Relevance for the AlpArray Experiment and 4D-MB:
LOBSTER provides the offshore component of AlpArray and the SPP 2017 ‚Mountain Building Processes in 4D' and hence extends the AlpArray core seismic network into the Ligurian Sea, making an amphibious approach possible. The project is the core of Activity Field B of the SPP: AF-B: Ligurian Ocean Bottom Seismology and Tectonics Research (LOBSTER). It is the offshore component of the SPP and hence closely associated to AF-A DSEBRA. As such, it is intimately linked to Research Themes 1, 3 and 4 of the SPP.

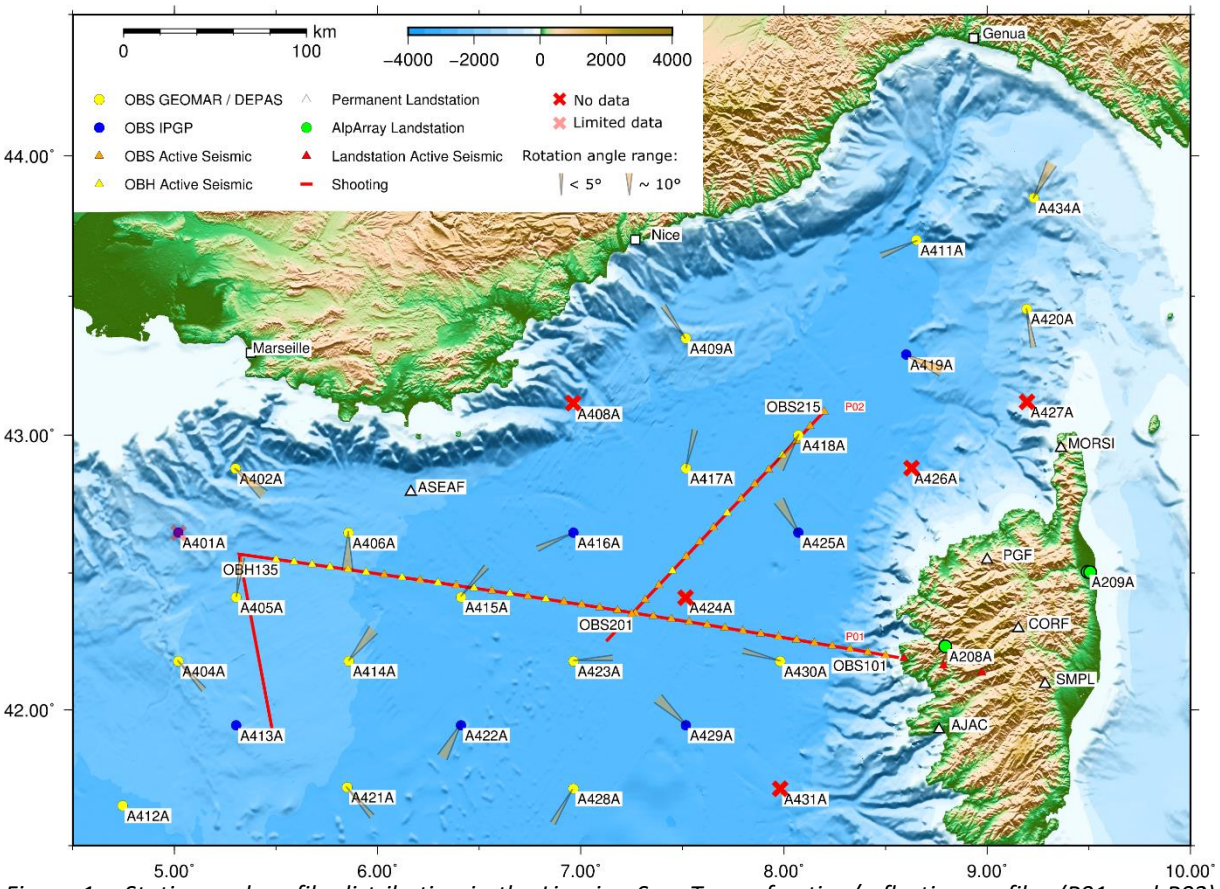

Figure 1 – Station and profile distribution in the Ligurian Sea. Two refraction/reflection profiles (P01 and P02) were acquired with 35 and 15 stations, respectively. In addition, shooting along profile P01 was extended to the SE in order for the long-term AlpArray OBS to record the shots. The yellow shades display the angle of the horizontal component H1 of the seismometer at each instrument.

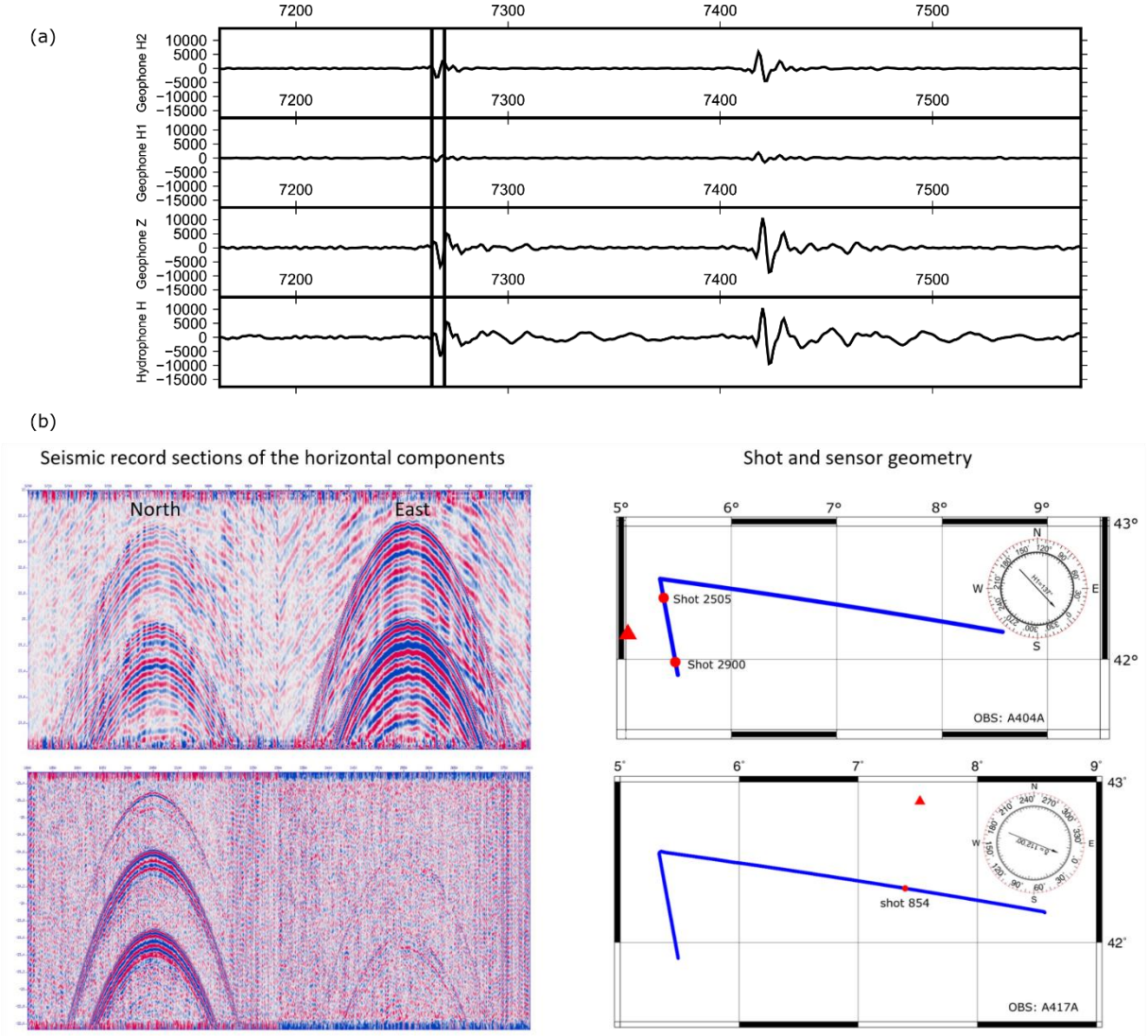

Figure 2 – (a) The three seismometer components and the hydrophone component for shot 2900 at OBS404 are displayed after a high pass filter of 10 Hz to minimise refracted phases and impose the direct arrival through the water. (b) Left panel shows a seismic shot section of the two horizontal components H1 (east) and H2 (north) after rotation. Right panel displays the geometry of single shots (red circle) and OBS (red triangle). The blue line represents all active source shots.

Publications:

Dannowski, A., Wolf, F. N., Kopp, H., Grevemeyer, I., Lange, D., Thorwart, M., Crawford, W., Caielli, G., de Franco, R., Paul, A., Petersen, F. and Schramm, B. and MSM71 cruise participants, AlpArray Working Group (2019). Investigations of the Ligurian Basin using refraction seismic data and the ambient noise technique, EGU General Assembly 2019, 08.-13.04.2019, Vienna, Austria.

Dannowski, A., Kopp, H., Grevemeyer, I., Lange, D., Thorwart, M., Crawford, W., Caielli, G., de Franco, R., Paul, A., Petersen, F., Wolf, F. N. and Schramm, B. and MSM71 cruise participants, AlpArray Working Group (2019). Seismic investigations of the Ligurian Basin, 79. Jahrestagung der Deutschen Geophysikalischen Gesellschaft (DGG), 5.3. - 8.3.2019, Braunschweig, Germany.

Kopp, H., Crawford, W., Paul, A., Lange, D., Dannowski, A., Wolf, F., Caielli, G., Thorwart, M., de Franco, R., AlpArray offshore: Preliminary results of the Ligurian Sea OBS network and refraction lines, EGU General Assembly 2018, 8.-13.04.2018, Vienna, Austria.