Generation and Destruction of Lithosphere in the Ligurian Sea

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1.) Tectonic and geodynamic overview of the Ligurian Basin and surrounding

The Ligurian sea is a key location and termed the "Ligurian knot" (Laubscher et al., 1992) due to its complex geodynamic setting characterized by pronounced variations in crustal nature. The deep structure is characterized by the transition from the western Alpine orogen to the Apennine system and change in subduction polarity (e.g. Jolivet and Faccenna, 2000; Handy et al., 2010) **(Alp Array Research Theme 1)**. Beneath the Ligurian Sea the Alpine front subducts to the East while beneath the Apennine eastward subduction and subduction rollback advancing to the NW occurs (Jolivet and Faccenna, 2000). Topographic gradients in the area are the largest for the entire Alpine-Mediterranean domain, rising from -2500 m in the Ligurian basin to >3000 m in the Alpine-Apennine orogen over a distance of less then 100 km corresponding to strong heterogeneities at depth at crustal and lithospheric scales (Béthoux et al., 2008).

Two refraction seismic profiles (Makris et al., 1999, Gailler et al., 2009) imaged the MOHO depth in the Ligurian sea. **However, the precise Moho geometry and deeper structure of the basin as well as the transition from oceanic to continental domains are still poorly established due to a lack of modern broadband OBS data resolving the structure on lithospheric scales.** In particular for larger depths (>20 km) no seismological imaging using OBS data was carried out and the knowledge of the deep structure in the Ligurian sea is inferred from land data observations. Velocity profiles have been interpreted as an oceanic-type crust (Contrucci et al., 2001), although it could contain exhumed serpentinized mantle rather than being a typical oceanic crust (Rollet et al., 2002) or underplated material (Makris et al., 1999). The available data available in the Ligurian basin does not allow to discriminate between these hypotheses.

The kinematic boundaries around the Ligurian Basin are poorly resolved, in particular the transition from the oceanic domain to the continental domain at its north-northeastern termination, where the nature of the offshore prolongation of the Alpine front remains unknown (Rollet et al., 2002; Nocquet, 2012). Specifically, in the Alps-Apennines transition zone, geophysical imaging of the deep structure is clearly insufficient in the sense that based on existing data it remains unclear if the change in subduction polarity between the two orogens is a lateral one that existed since at least 50 Ma ago (e.g. Faccenna et al., 2001). Improved imaging of the lithospheric structure of the junction between the Alpine and the Apennine system in the Ligurian Basin is hence mandatory to address open issues on regional kinematics, strain distribution and surface response.

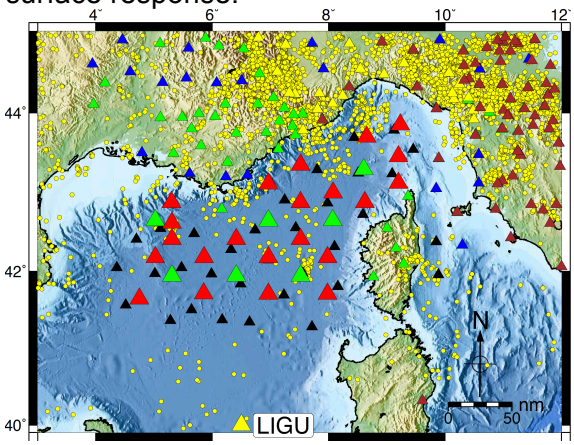

Figure 1: *AlpArray station distribution. The LOBSTER OBS stations are shown with red triangles. The LOBSTER OBS network consists of total of 29 offshore stations with an average distance of 41 km and will record for up to 8 months. The French OBS instruments are broadband Trillium 240 s OBS and the German DEPAS instruments are wideband Güralp CMG-40T 60 s OBS. Recovery is foreseen with RV Merian in February 2018. Blue and green triangles indicate temporary and permanent AlpArray stations, respectively. Stations from IGN (Seismic network IV, http://cnt.rm.ingv.it/en/instruments/network/IV) are shown with brown triangles and stations from the regional seismic network of northwestern Italy (*http://www.distav.unige.it/rsni/ITA/*) with yellow triangles. Seismicity (2005 until 2015) from the ISC event catalogue is shown with yellow circles.*

The OBS data of the LOBSTER deployment is the offshore component of the AlpArray and forms the base for the proposed project (Figure 1). Deployment of the OBS was conducted from RV Porquais Pais? in June 2017. In February 2018 RV Merian will recover all OBS stations. The LOBSTER involves deployment of 29 broadband stations from France/Germany in the Ligurian Sea: Institute de Physique du Globe de Paris (IPGP, PI: W. Crawford) has a total of nine broadband OBS, all of which will be dedicated to LOBSTER. 22 broadband OBS were provided by the DEPAS pool.

2.) Objectives

2.1.) Resolving the deep (lithospheric) structure from ambient noise correlation techniques using OBS data and from shear velocities from Rayleigh wave group dispersion

Although the routine of estimating the cross correlation functions (CF) for landstations is fairly routine using landdata the processing for OBS stations is more complex, since additional complexity such as the timing correction and the instrument orientations is added for processing OBS data.

After stacking the daily records for the stations, the frequency-dependent group velocity of the Rayleigh waves will be calculated using frequency-time analysis. In the first phase of the project we focus only on the vertical component (the horizontal components of the OBS data will not be available since they need to be rotated) but will incooperate horizontal components at a later stage of the project, although we expect best CFs on the Z and P channels of the instruments since horizontal components of OBS stations do normally not contain usable noise for ambient noise studies.

Recent works show that ambient noise techniques using OBS work significantly better when the vertical OBS component is corrected for the seafloor compliance signal because in shallow water compliance noise swamps the microseism band (Crawford and Webb, 2000). Within AlpArray the project from Kopp et al. (Activity field B, LOBSTER) will provide the corrected vertical channels for the OBS array. The correction reduces the amplitude of vertical noise sources by 1–2 orders of magnitude Recent works applied the compliance correction for OBS data reducing the Power spectral density for long periods (>10 s) resulting in high quality empirical Green functions between the receivers.

2.2.) Observing current crustal deformation in the Ligurian Sea determined by microseismicity

In order to obtain the best hypocentral coordinates for the local events in the Ligurian basin we process the OBS stations jointly with the landstations on the adjacent mainland of Corsica, France and Italy (see Fig. 1 for the station distribution). Locations of seismicity will be compared with bathymetry, known fault distribution and other available data in order to relate the seismicity to the active structures and to better understand the current deformation of the Ligurian basin. Fault plane solutions of stronger events obtained by moment tensor inversion could support the understanding by revealing the orientation of the active faults and the stress field.

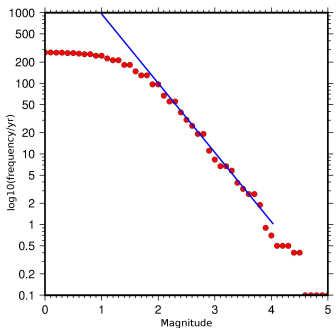

Figure 2: *B-value plot using the ISC Online Bulletin (2005-2015) for marine events in the Ligurian Sea and the onshore region approximately 30 km further onshore. The event frequency (on the y-axis) is normalized in order to represent the occurrence of events during one year suggesting approximately 200 events with magnitude units of 2 or larger.*

3 International cooperation partners

- Wayne Crawford, IPGP Paris.
- Anne Paul, ISTerre, Grenoble.
- Roberto de Franco, IDPA, Milano.
- Jean-Xavier Dessa, GeoAzur, Nice .