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Seismic monitoring of the Galicia Margin, NW of Iberia, in relation with the sinking of the 'Prestige' oil-tanker

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The sinking of the 'Prestige' oil-tanker in November 2002, at about 250 km from the NW coast of Iberia, motivated the Spanish research agency to launch a series of special actions to investigate the environmental hazards in relation with the oil spill. One of them has been the evaluation of the geological hazard of the sinking area, which included a specific seismic study of the local activity and of the regional seismicity in the Galicia Margin. Published global catalogues show that a diffuse but significant seismicity can be associated with the Northern flank of the Galicia Bank with a roughly E-W distribution, including about ten events with $M > 4$ during the last 30 years. However, event locations in this area are poorly constrained due to the inappropriate geometry of regional seismic networks.

In this project we collected and analyzed data from two seismic experiments, one involving a dense deployment on OBS around the sinking place and the other including installation of a network of land stations at the NW corner of Iberia. On land, 12 seismic stations were deployed in 2003 for a 7 months period, covering a 200x300 km^2 area in the NW corner of Iberia. Stations operated in continuous mode and provided up to 124 events identified and located, 30% of them not reported by the permanent array of Spanish IGN. Magnitude of the events ranged from 4.5 to 1.5, most of them located on land, although up to 4 events with magnitudes greater than 3.5 have been located in a radius of 150 km from the sinking site, confirming the existence of a moderate seismicity in this area.

Offshore, 10 OBSs from IRD-Géosciences Azur were deployed for 1 month of in

a 0.3ºx0.3º area surrounding the 'Prestige' wreckage. In a first stage, 6 multichannel seismic profiles were recorded both by the 2400m long streamer of the BIO-Hespérides vessel and by the OBSs array. In a second phase, the OBSs where operated as a passive seismic network, recording a wide variety of seismic signals. The sedimentary sequence and the basement topography are well imaged in the vertical reflection stacks, with clear evidences of lateral variations, in particular the presence of tilted blocks of basement, reflecting the complex geodynamic history of the area. The wide-angle profiles recorded by the OBSs will provide detailed models of the P-wave velocity distribution in the upper crust.

Data from the OBS network has allowed the location of three earthquakes of magnitudes $\leq$2.5 at the vicinity of the sinking site. Three more events have been identified, but the poorer data quality has just permitted a rough determination of their epicenters, based on the polarization of the P-wave arrivals.

Besides these earthquakes, a careful analysis of the OBS data sets evidenced the occurrence of numerous seismic events of different types. First of all, a huge amount of short duration events have been identified, some of them with high amplitudes, although recorded only at individual sites. They are similar to the Long Period Events described in areas of volcanic or hydrothermal activity, and at each OBS have been classified into families or clusters according to their waveform and frequency properties. They can be interpreted as the effect of the resonance of fluid-filled cracks induced by impulsive pressure transients.

Secondly, we identified intense monochromatic signals lasting for up to 4 hours that can be described as harmonic tremors. They show a time periodicity that can be related to the tidal variations of the oceanic load. As for the case of the short events, these harmonic tremors are not correlated between the different recording sites and therefore must have a very local origin. Moreover, they are not recorded at the hydrophone channel, which seems to discard an origin related to marine currents or other acoustic phenomena.

Finally, the dataset includes also a group of very short and regularly spaced pulses that can be explained as acoustic calls generated by finback whales. The trajectories of the individuals could be resolved by applying seismic location methods to those pulses. These results show that the deployment of semi-permanent passive seafloor arrays can be a valuable instrument not only for seismological purposes, but also to track and monitor the movements of marine mammals.