First European Conference on Earthquake Engineering and Seismology
(a joint event of the 13th ECEE & 30th General Assembly of the ESC)
Geneva, Switzerland, 3-8 September 2006
Paper Number: 546

INSTALLATION AND FIRST RESULTS OF A PERMANENT OCEAN BOTTOM SEISMOMETER OFFSHORE TARRAGONA (NE SPAIN)

Tànit FRONTERA[1], J. Antonio JARA[2], Xavier GOULA[1], Arantza UGALDE[3] and Carme OLIVERA[1]

SUMMARY

The Institut Cartogràfic de Catalunya (ICC) and the Observatori de l'Ebre, in collaboration with the Spanish oil company Repsol Investigaciones Petrolíferas, are carrying out a project with the aim of improving the knowledge of the seismicity and seismic risk in the Tarragona region (northeastern Spain). Within this framework, on August 2005 a permanent ocean bottom seismometer (OBS) was installed inside the security perimeter of the Casablanca oil platform, which is located 40 km offshore Tarragona. The OBS station has a three component broad band sensor and a differential pressure gauge (DPG). They were submerged at about 400 m to the SW of the oil platform and were deposited at about 150 m depth. Data are digitized on-site and are transmitted through a submarine cable to the platform, where they are recorded. A continuous mode and almost real time VSAT satellite data transmission from the platform to the data center at the ICC is expected for 2006. This step will imply the total integration of the OBS station into the ICC seismic network. Since the OBS is operative, some local as well as distant seismic events have been recorded. A seismic noise study from the OBS and the DPG recordings is being performed, as well as a low frequency noise correction.

1. INTRODUCTION

On August 12th 2005 a permanent Ocean Bottom Seismometer (OBS) and a differential pressure sensor (DPG) were installed near the Casablanca oil platform, at about 40 km from the coast of Tarragona (figure 1). The project has the goal of improving the area's seismicity understanding, which is densely populated and industrially very active. The CASABLANCA project is being carried out by the *Institut Cartogràfic de Catalunya (ICC)* and the *Observatori de l'Ebre* with the collaboration of *Repsol Investigaciones Petrolíferas S.A.* and it is being financed by the *Ministerio de Educación y Ciencia* (CASABLANCA REN2003-06577), FEDER funding and the *ICC*.

This project, which is pioneer in Spain, has several precedents in Europe: the Norwegian OSG seismic station was placed near an oil platform in the North Sea between 1988 and 1996 (Atakan and Havskov, 1996). The ANTARES project in the Ligurian Sea includes a similar OBS and DPG instrumentation as in our project (Deschamps et al, 2005). Offshore east Sicily there is the SN-1 observatory, which has a three component broad-band seismic sensor, a gravimeter and a hydrophone, among other instruments (Beranzoli et al., 2003, Favali et al., 2003, Stephen et al., 2005). The ESONET (European Sea Floor Observatory Network) project is at the moment still being evaluated. It counts on the participation of more than twenty institutions and purposes the European structuring of the sea-floor observation.

[1] Institut Cartogràfic de Catalunya, Parc de Montjuïc s/n. 08038, Barcelona (Spain) www.icc.es/sismes E-mail: tfrontera@icc.es
[2] RSE S.A. Aplicaciones Territoriales, Barcelona (Spain)
[3] Observatori de l'Ebre, Horta Alta, 38. 43529 Roquetes, Tarragona (Spain) http://www.obsebre.es/

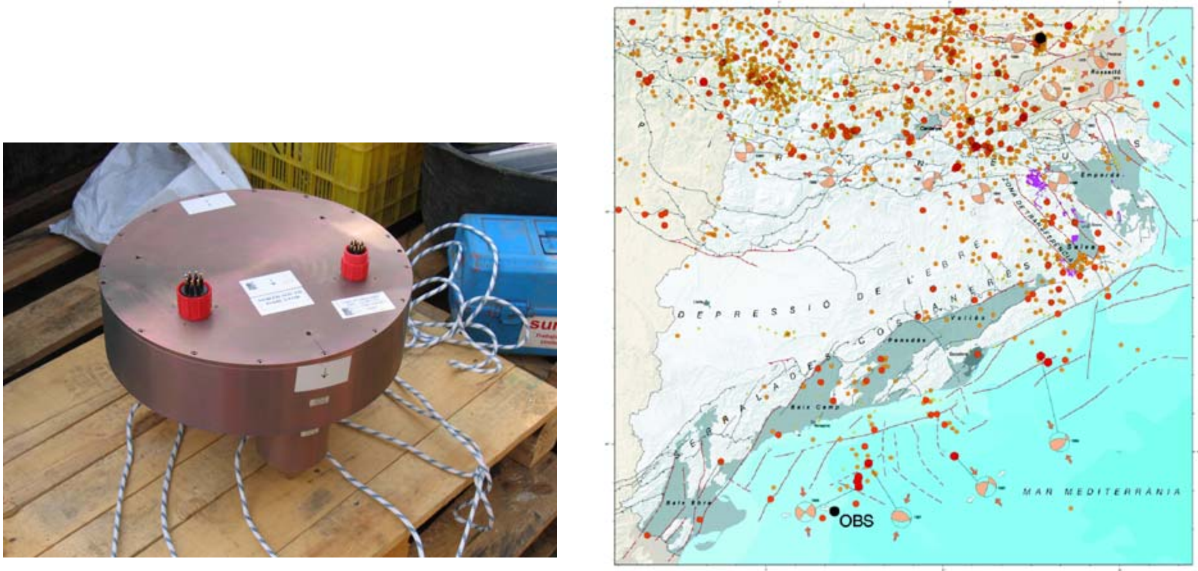

Figure 1: Left: OBS before its installation. Right: OBS location on the *Mapa de Sismicitat de Catalunya 1977-1997* (ICC, 1999).

2. INSTRUMENTAL SPECIFICATIONS

- CMG-3T (Güralp Systems): flat instrument velocity response from 50 Hz to 120 sec.
- DMA24 digitizer in the cylinder top.
- The horizontal sensor has the capability of levelling in between ±10 degrees.
- The casing of the sensor is manufactured with titanium (grade 5) with double "O" rings.
- Differential pressure sensor (DPG).

3. INSTALLATION PROCESS

The installation operations began on August 9th at the commercial harbour of Sant Carles de la Ràpita, where the material preparation started on board of the ship Boluda Abrego, from which were done the maneuvers.

The OBS was loaded onto the ship, which sailed to the immersion point, where was submerged and deposited on the seabed (figure 2). In order to control the process, a submarine robot sent images that were watched from the ship. Additionally, an uninterrupted signal analysis was made. The OBS was installed at about 400 m SW from the platform, in the security area of the Casablanca field, and at a depth of about 150 m (figure 2).

Figure 2: Left: OBS' immersion. Right: Submarine robot image from the OBS and the pressure sensor deposited on the seabed.

Once the sensor was installed, the ship sailed to the platform, launching the cables with adequate ballasts, so that they stay buried in the sea bottom (figure 3).

At the platform the connections to the equipment to store the seismic data were made. The nearest part of the submarine cables to the platform was fixed to its structure in order to reduce the signal noise.

Figure 3: Cables' launching, once jointed with ballasts.

4. FIRST RESULTS

As an example, some seismic events recorded on the vertical component are showed:

Japan earthquake on 16th August 2005. Mw=7.2 (figure 4).

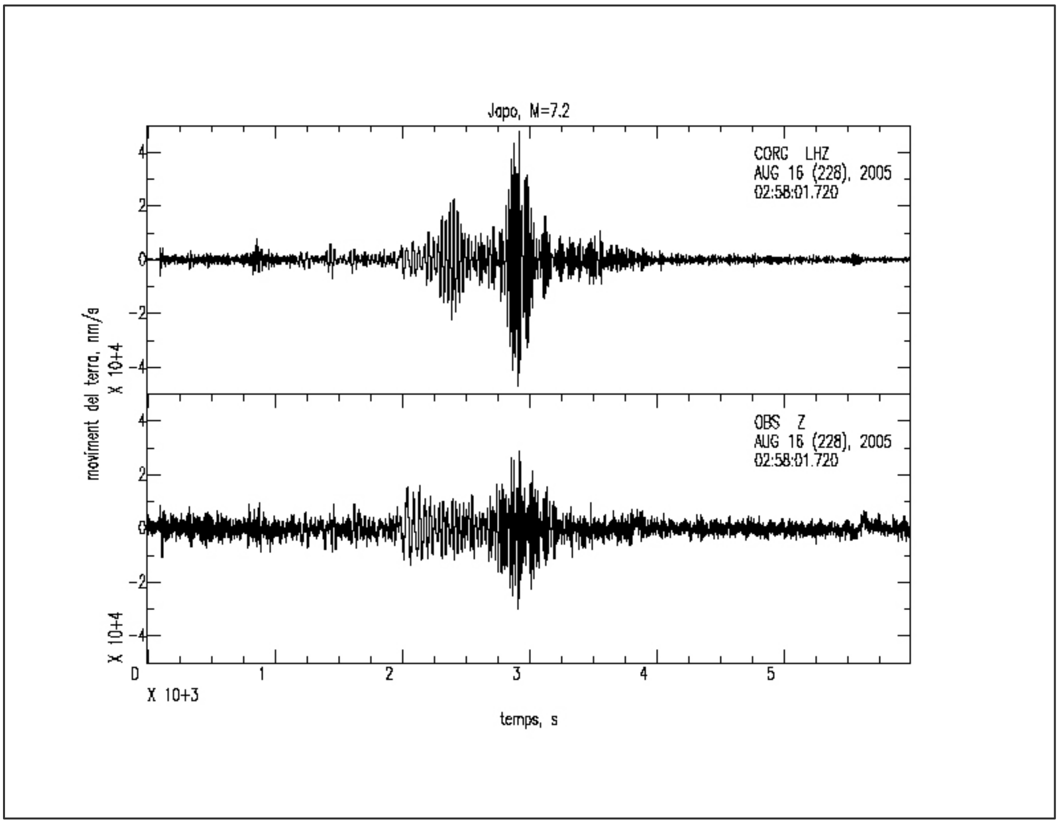

Figure 4: Non-filtered vertical records from the OBS (bottom) and CORG terrestrial station (top). One hour and forty minutes at one sample/second are represented.

Local event offshore Tarragona on August 22nd 2005. M=1.4 (figure 5).

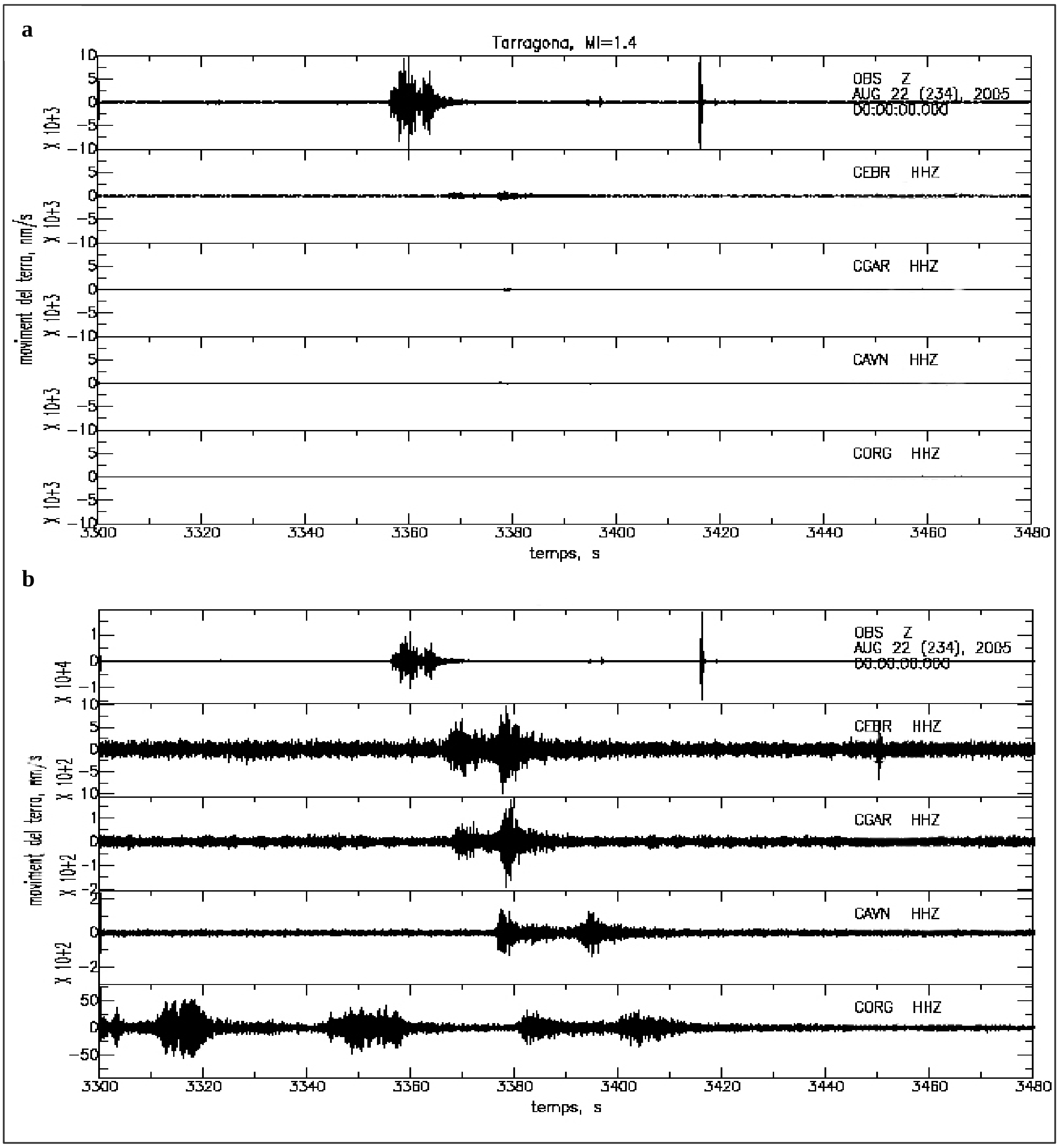

Figure 5: High pass (1Hz) filtered vertical records from the OBS (top) and some terrestrial stations. Three minutes at 100 samples/second are represented. a: All records are plotted at the same scale. b: Records are scaled at its own maximum amplitude.

5. PRELIMINARY NOISE ANALYSES

The acceleration power spectral density (psd) of the OBS vertical component has been computed for 5 minute periods at 3:00h, 9:00h, 15:00h and 21:00h every day between August 14th and October 16th 2005. The same study for the horizontal components has also been done, but the time period for which data are available is much shorter, because these sensors have had many tilt problems. There isn’t any significant difference between the psd at the different moments of the day, so only results at 3:00h are shown.

The average curves show a high noisy behavior in relation to the Peterson models (1993) and to the Catalonia network terrestrial stations (figure 6). The main difference observed is the noise between 0.2Hz and 3Hz. The causes are being analyzed.

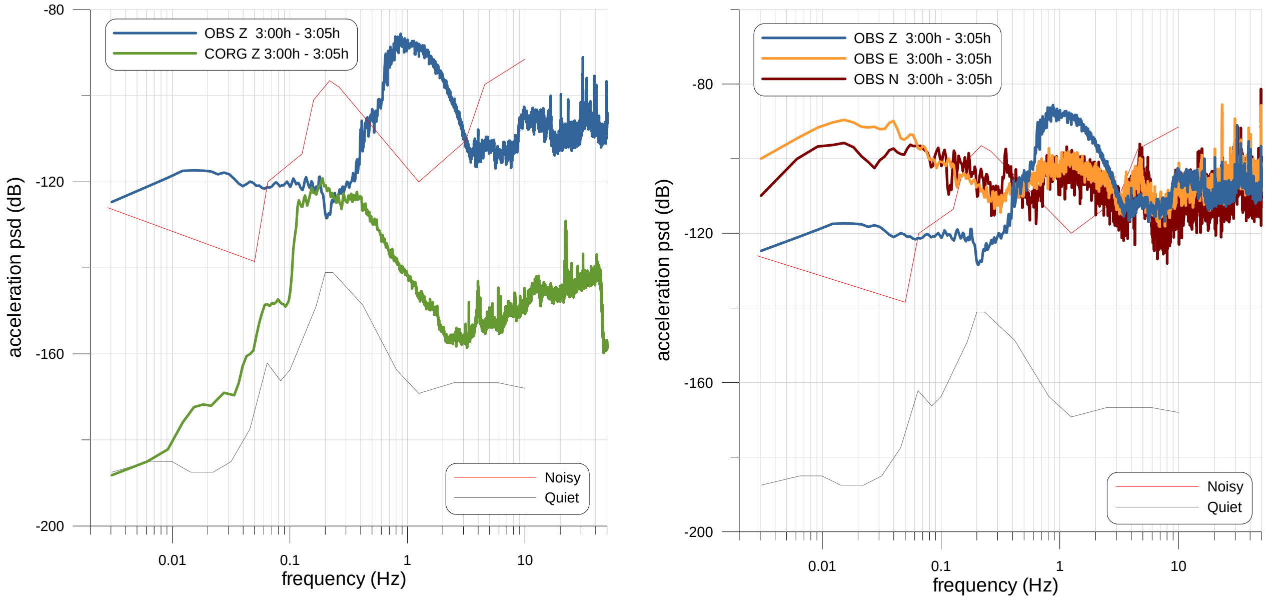

Figure 6: Left: Mean of the acceleration psd for the OBS and CORG terrestrial station vertical components.The Peterson psd curves (1993), noisy and quiet, are also shown. Right: Acceleration psd averages for the three OBS components, together with the Peterson models (1993).

A similar psd study for the differential pressure gauge (DPG) has been done for the same period as the vertical OBS component. Figure 7 shows this result together with the OBS vertical component acceleration psd. The DPG has been calibrated for frequencies between 0.05Hz and 5Hz.

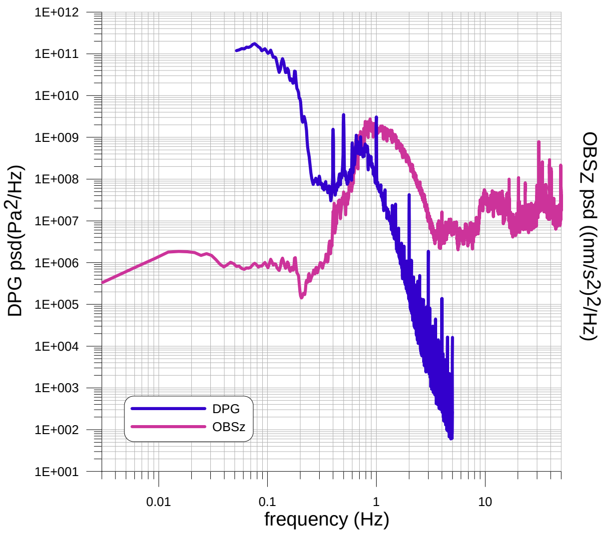

Figure 7: Mean of DPG psd together with the acceleration psd for the OBS vertical component.

6. LOW FREQUENCIES NOISE CORRECTION

The OBS vertical component (OBSz) records not only seismic signal, but also ground deformation under long-period ocean-wave loading (Webb and Crawford, 1999; Crawford and Webb, 2000), which is the seafloor compliance. Measurements of the transfer function combined with pressure records have been used to remove the deformation signal from the vertical seismic records.

The pressure signal from these waves is only significant at frequencies corresponding to wavelengths longer than the water depth. In the case of this site it corresponds to 0.1Hz. There is also the limitation of the DPG calibration at low frequencies, which is at 0.05Hz.

The DPG-OBSz coherence indicates the quality of the vertical seismic data in the band between 0.05Hz and 0.1Hz. If there were no other noise sources, it would be 1. Figure 8 shows the DPG-OBSz coherence for the period between 2:00h and 2:59h on August 25th 2005. It is quite high in the mentioned band.

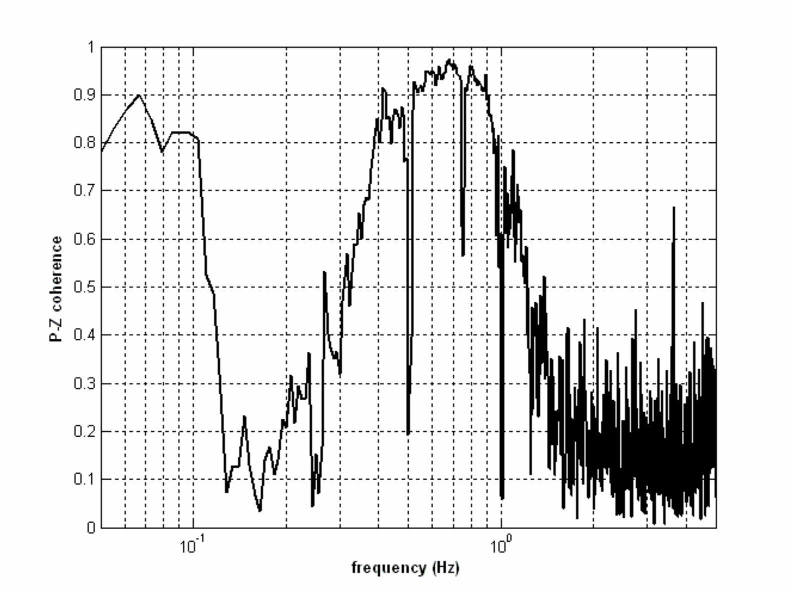

Figure 8: **DPG-OBSz coherence.**

In order to correct the noise due to seafloor compliance, the transfer function between the DPG and the OBSz has been calculated. Figure 9 shows the OBSz psd before and after the correction. It is improved up to about 10dB.

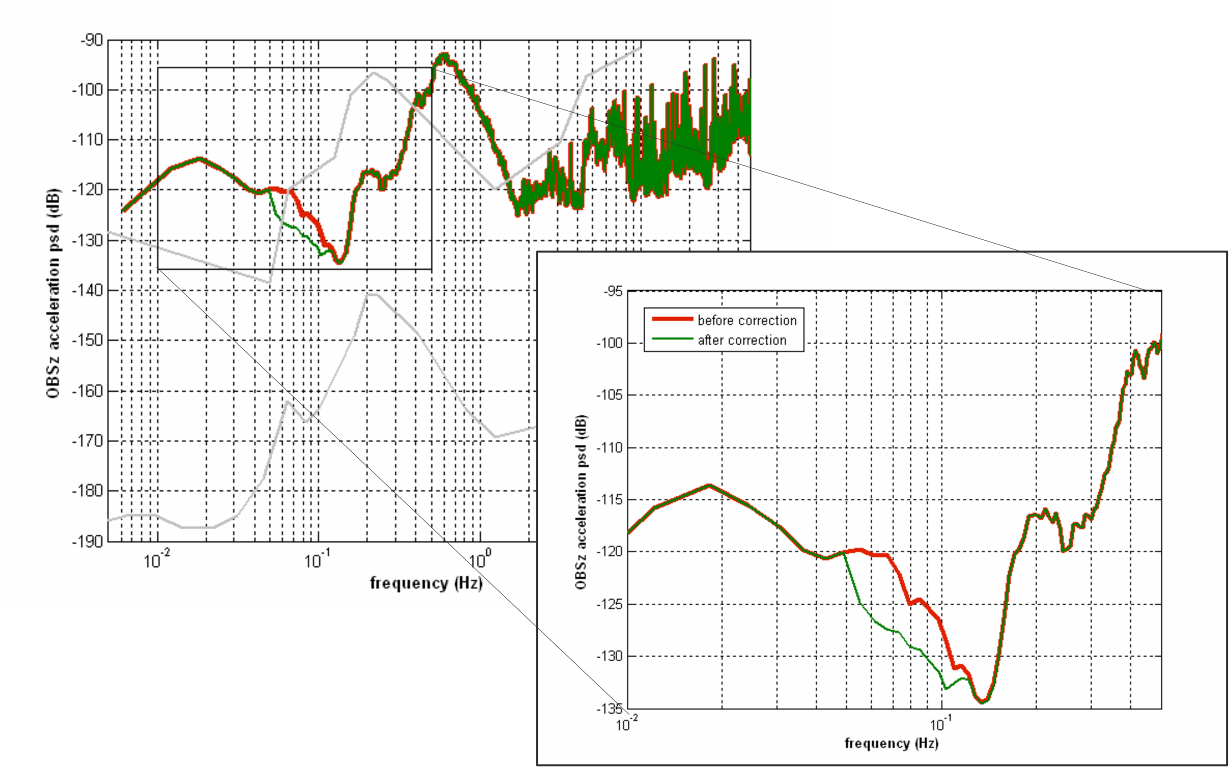

Figure 9: **OBSz psd before (red) and after (green) correction**

7. CONCLUSIONS AND FUTURE GOALS

The OBS is very noisy between 0.2Hz and 3Hz. A site effect study will be performed in order to explain this behaviour.

A low frequency noise correction for the vertical OBS component has been done with DPG data. Horizontal OBS component data will also be used to correct current and tilt effects.

Once made the noise study, an earthquake signal analyse will be performed.

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