

Sigsensual: A Project to Develop an Ocean Bottom Seismometer Prototype and its Associated Signal Processing Software

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1. Introduction

Ocean bottom seismometers (OBS) can be potentially used in a wide number of fields within the Earth Sciences: from seismic monitoring and analysis, hazard evaluation, awareness and stability control of margins and the continental slope, to the study of the structure and physical properties of the crust and the stress state in civil engineer works. However, there is a number of technical and methodological issues that must be addressed before being able to exploit all the possibilities offered by this type of instruments.

The Sigsensual Project aims at actively progressing in the improvement and adjustment of the existing portable underwater sensors acquired by UTM-CSIC to the Bullard Labs. (Univ. of Cambridge) in 1996 to state-of-the-art technology (Figure 1). Therefore, we have critically considered all the previous measurements achieved with the available equipment. From these preceding results, we have already learnt many crucial aspects related with the reliability and robustness of the instrument, including the acquisition system, geophone, and mechanical structure design [1]. In addition, an effort have been made to develop software allowing systematic data acquisition, reading, representation and processing [2], focussing in the optimisation of signal/noise ratio and the attenuation of spurious signal [3], as well as improving and accounting for clock stability and time precision. Another interest is to include systems for on-line control of the whole system including the recording packages and the conditions within the glass sphere when the OBS is at the seafloor.

2. Technical-methodological issues

At present day, the technological development of the new OBS generations at international level is closely linked with the scientific needs and to the



Figure 1: Original Micro-DOBS acquired in 1996 by the Marine Technology Unit.

advance in the signal processing and data modelling methodologies. Therefore, OBS have deserved growing attention from the geoscientific community during the last twenty years, and an increasing number of ongoing international programmes in order to develop, built, and share both permanent and autonomous OBS networks have come up. The main working axes concerning the development of portable, autonomous OBS are the following:

- Increasing the storage capacity and the autonomy of the instruments up to > 1 year in continuous recording, which is key for seismic monitoring in risk areas.

- To make the OBS capable of handling different type of sensors (from short period to broad band) depending on the objectives of the experiment (active/passive seismics, local/regional seismicity, teleseisms).

- Improving the coupling system between the geophone and the seafloor to improve signal to noise ratio in the seismic records.

- To incorporate low consumption A/D converters with wide dynamic range in order to respond to these necessities.

- To include fast data transmission interfaces (e.g., USB 2.0, FireWire, etc) to make faster the recuperation and re-deployment process of a large number of instruments.

- To make more robust the release system in order to minimize instrument loses.

- To incorporate shipboard transducers to be able to communicate with the instruments from the ship, detecting performance anomalies, and positioning the OBS at any time.

- To reduce OBS size and to increase its number in order to have denser receiver coverage in seismic experiments, taking into account the limited storage capacity of scientific vessels.

3. Data processing of active seismic data

The technological development of OBS is concomitant with that of the signal processing techniques.

In contrast to multichannel seismics (MCS), where a wide number of tools have been designed by oil industry to adequately process acquired data, the development of Wide-Angle reflection/refraction seismics (WAS) pre-processing tools has deserved only minor attention to date. Most existing tools have been developed by research institutions in order to read raw data from their own instruments, construct and display the record sections, and

pick the seismic phases. Alternatively, WAS processing is also done using existing tools chiefly designed for MCS geometries and not all the techniques are therefore well-suited for proper WAS processing. One of the objectives of Sigsensual has been to design a new adapted software tool allowing to perform all these operations using a single, easy to use, modular platform [2].

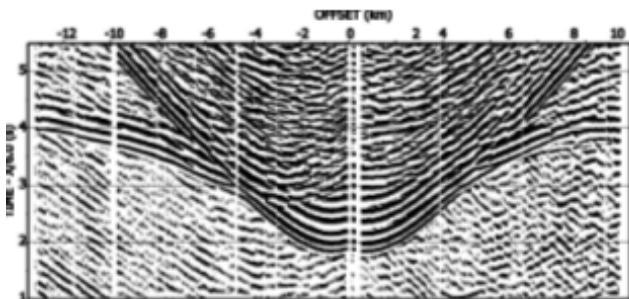


Figure 2: Record section (offset-travel time diagram) corresponding to the recording of airgun shots by an OBS.

In contrast to MCS, wide-aperture WAS acquisition systems are specifically designed to record both the reflections and the continuous refractions of the seismic waves propagating through the medium. This makes that the obtained record sections (Figure 2) do not yield directly interpretable images of the sub-seafloor, being necessary to built models accounting for the propagation velocity of the seismic waves in order to interpret the data.

Until very recently, seismic velocity models were obtained either by forward modelling or by travel time inversion, and therefore the basic data pre-processing consisted of allow identifying and picking the most prominent seismic phases

recorded by the system (chiefly first arrivals). However, the fast increasing on computing facilities have allowed developing tomography techniques that use not only first arrivals but the full wavefield. It is therefore necessary to design more elaborate processing sequences to make WAS data amenable to this type methodology.

Useful seismic phases present in the record sections are usually masked by different types of noise, which may be caused by the instrument (electronic noise, quantification ...), by the environment (ship noise, cetacean, sea wave course, currents ...), or even by the signal itself (higher order reverberations and scattered signals which obscure later arriving prominent phases). Another of the objectives of Sigsensual project is to design filters and processing sequences allowing to obtain as much of the valuable information contained in the record sections as possible, by improving the signal to noise ratio, as well as removing or attenuating some well characterized phases, such as the water wave or its reverberations [3].

References

- [1] Sh. Shariat Panahi et al., Characterization of a High Resolution Acquisition System for Marine Geophysical Applications, Mar. Technol. Workshop, Vilanova i la Geltrú, 2005.
- [2] I. Rodríguez et al., "A new software tool for Wide-Angle reflection/refraction Seismic data Processing and Representation (WASPAR), Mar. Technol. Workshop, Vilanova i la Geltrú, 2005.
- [3] S. Ventosa et al., Signal processing techniques applied to seismic signal detection, Mar. Technol. Workshop, Vilanova i la Geltrú, 2005.

Characterization of the water optical properties using hyperspectral

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1. Introduction

Hyperspectral instrumentation has opened a new door for optical oceanography and related fields that make use of optical remote and in situ sensing of the oceans. Hyperspectral information provides optical oceanographers the potential to accurately quantify and classify complex oceanic environments, finer-scale features (e.g. bottom type and characteristics and phytoplankton blooms), depth-dependent inherent optical properties (IOPs) and specific chemical compounds [1]. For instance, the hyperspectral instrumentation has made possible the remote identification of different taxonomic groups of phytoplankton due to that some pigments are unique to individual phytoplankton group or species [2].

The incorporation of hyperspectral sensors to autonomous sampling platforms of an oceanographic observing system makes essential

to develop new spectral algorithms and techniques for the analysis of the hyperspectral data obtained [3] [4].

The SAMPLER project [5] coordinates the development of an oceanographic sonde in order to measure physical and biological parameters at small scale, and an integrated software package to analyse all the data obtained at small and larger scales. As it has been described, this integrated instrumental system will include a new hyperspectral sensor based on LIGA microsystems technology (figure 1). This sensor will be able to measure upwelling and downwelling irradiance spectra within the water column. Apparent and inherent optical properties (AOPs, IOPs) will be estimated from these spectral values.

2. Hyperspectral Analysis

The development of new spectral techniques for