INSTALLATION REQUIREMENTS FOR SEISMIC OBSERVATION IN THE SEAFLOOR

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1. Introduction

From 2006, a project was started to construct submarine cable network for large earthquakes and tsunami monitoring in the Nankai Trough, Japan (Development of Dense Ocean-floor Network System for Earthquakes and Tsunamis; DONET). 20 sets of state-of-the-art seismic sensor which cover whole frequency band and dynamic range will be deployed in the project.

In seafloor observation, installation method of seismic sensor is very important to improve the measurement performance. A precise observation cannot be achieved without the consideration on environmental effect. This paper introduces the past results of seafloor seismic observation from several conditions of measurement environment and a new approach to conduct high quality seismic observation in the seafloor.

2. Summary

Scientific seismic observation in the seafloor requires very wide dynamic range and frequency band. The target observation range of motion of DONET project is acceleration range from the weakest motion of 10-9 m/s2 to the largest motion as 20 m/s2 and frequency band from 1/years to a few 100 Hz. It is very difficult to cover this broad frequency and dynamic range by single sensor. Development of a complex sensor system which consists of broadband seismometer, strong motion accelerometer, and geophones is necessary to achieves the requirement. This approach is as same as land seismic network in Japan (F-net, Hi-net).

Reduction of background noise is very important to get the best performance of seismic sensor in the seafloor. The past results of seismic observation in the seafloor proved that the quality of data obtained from the seismic sensors is affected by their installation condition. The seismic sensors set up in the seafloor were influenced by seafloor current and fluctuation of thermal condition of seawater. These factors are the major causes of seismic noise encountered in the seafloor setting. Coupling seismic sensors to ground motion in good fidelity is difficult in the seafloor, because most seafloor is covered by soft and water saturated sediment. Burying seismic sensors into the seafloor is a remedy for these factors. By burying seismic sensors, seafloor current is isolated from seismic sensors, and thermal condition of seismic sensors can be stabilized. Methods to install seismic sensors into the seafloor have been developed, and several trial installations have been conducted so far. The most typical example of methods is an observation using boreholes drilled by scientific drill ship from 1999 to 2001. The measurement result of the borehole observation was the quality close to those in the best land observatories.

It was also tried to bury seismic sensors surfacially in the sediment by using remotely operated vehicle and other tools. Long period noise from these buried seismic sensors was reduced in some cases, but there were some cases of unsatisfactory results. Experiences from these surfacially buried seismic sensors suggest that more efforts should be made to increase coupling to ground and to isolate water around seismic sensor.

To obtain the best performance of seismic observation in DONET project, it is scheduled to develop the sophisticated complex sensor system and also to evaluate the most suitable installation method for seafloor.

THE GEOAZUR/GURALP <<HIPPOCAMPE>> OBS/LTOBS

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The study of continental margins, subduction zones and oceanic basins as well as the quantitative assessment of seismic hazard near densely populated coastal areas request the deployment of a large number of Ocean Bottom Seismometers (OBS) during period of several weeks for active tomography, up to several months or years for passive experiment.

Geosciences Azur (joint IRD[1], CNRS[2] , UPMC[3] and UNSA[4] laboratory) has developed a new, easy-to-use, 4-components OBS named "Hippocampe". The Hippocampe OBS exists in a short period version based on 3 gimbaled, 4.5 Hz, geophones self leveled installation, encapsulated in a 150 mm diameter, glass sphere. The broadband sensor was designed in cooperation with Guralp System™ and on the basis of a CMG-40T seismometer gimbaled in a similar glass sphere, with a magnetometer and tiltmeter for position on the bottom (optional).

The data logger developed at Geosciences Azur consists in a 24 bits analog/digital converter synchronized by a high accuracy Seascan clock (2 10-8). Data are buffered in a 1 Gb flash memory then stored on a 80 Gb hard disk. Power consumption is ~500 mW for continuous recording of 4 channels at 200 samples per seconds allowing 6 to 12 months recording autonomy on the sea bottom. The data logger and batteries fit in a 432-mm diameter glass sphere. A second sphere is used to increase the floatability during long-term deployment.

For recovery an acoustic code trigger simultaneously an electro-mechanical release system, (developed in cooperation with Guralp System Ltd) and an electrolytic, burn-wire release. At the surface flash