A technical description of the ISV OBS for a cruise report

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The OBS (Ocean Bottom Seismograph) which was used in the Hakon Mosby Cruise 1998 was originally developed in the University of Tokyo (UT) in the end of 1960's when Shimamura was a faculty member in UT. The OBS has been improved almost every year since Shimamura moved to Hokkaido University (HU) in 1972, in a cooperation of HU and UT, and the latest models are used in the cruise.

Basically the OBS is a pop-up type, which has a positive buoyancy to return to sea surface by releasing the ballast weight (anchor). The releasing is made by sending acoustic coded signals from a shipboard transponder unit. The total weight of the OBS in air is about 40 kg, and its buoyancy is about 7 kg. By attaching the ballast weight made of iron, which weighs about 40 kg, the OBS sinks to the sea bottom, with a speed of about 60 m/min., after launching to the sea surface.

The main components of the OBS are three component short period geophones those are mounted by a Gimbal mechanism, low noise signal amplifiers, magnetic tape recorder(s) or hard disk drives, BCD coded quartz clock, and batteries. These components are included in a pair of hardened glass hemispheres, with an outside diameter of 43 cm. The deepest depth which the OBS can be deployed is 6700 m.

We have used three types of OBS taperecorders in the cruise. One is analogue recording on Phillips compact cassette, which can record 25 days continuously with a frequency band of 0.4-25 Hz. The amplified geophone signals are recorded parallel on "high gain" and "low gain" channels of cassette tape tracks, which enables wider dynamic range recording.

The others are two kinds of digital recording OBSs, where digitized signals are recorded on DAT (Digital Audio Tape) or hard disk drives. The sampling frequencies can be chosen among 64 and 256 sps. In the Hakon Mosby cruise 256 sps was adopted. The AtoD conversion of the digital OBSs is made with 22-24 bit accuracy, depending on the different models. The DAT tape has a recording capacity of 2.5 GB, and the hard disk drives have a recording capacity of 4 GB. A slight data compression algorithm, where the differences of data are recorded, instead of data themselves, when the variation of signal, within one second moving interval, is smaller than a range of 1 byte amplitude, is used to save the memory. The reason which we have not adopted more extensive data

compression was because there are various kind of ambient noises, including spikes and pulses, which may trigger the conventional event detection algorithm. The digital recorder has an internal buffer memory of 5 MB. With the aid of the compression algorithm, the recording period of the digital OBS is up to 90 days, depending on the number of events. A set of alkaline-manganese D size batteries energizes the whole circuit.

BCD coded quartz timer makes use of TCXO (temperature compensated crystal oscillator) with an accuracy of 5 x 10**-7 (0.5 ppm) within the ambient temperature range between 0 and 20 degree celsius. The power consumption of the BCD coded quartz timer is 5 mW. The over-all accuracy of the OBS is usually kept within 10 msecond during the whole observation because we compare the OBS clock with a master clock, which has an oven controlled crystal oscillator with an accuracy of 10**-8, immediately before deployment and immediately after the recovery of the OBS, and usually the ambient temperature during the observation on sea bottom is quite stable. The master clock was calibrated by GPS clock all the time during the cruise.

We use 4.5 Hz short period geophones both for vertical and two horizontal components which are perpendicularly mounted on a Gimbal mechanism. The mechanical damping of the Gimbal mechanism is done by a very high viscous silicon oil. With the over-all design of the OBS, which includes the physical shape of bottom parts of the ballast weight and the specific weight of the OBS, the coupling of the OBS to the sea bottom and the elimination of so called "ringing" effect are ensured.

Acoustic transponders, which make use of acoustic waves with frequencies between 9 and 12 KHz, are used to recover the OBS. By sending a coded acoustic signal, the OBS releases the ballast weight with a mechanism of electrical forced corrosion where a pair of thin stainless steel plates are dissolved by applying electrical current on the plates. It takes 11-18 minutes to dissolve the stainless plate. The time required for the release depends on the condition of sea water temperature and salinity. The ascending speed of the OBS is about 60 m/min. The maximum distance which we can communicate with the OBS on the bottom is about 15 km. The OBSs are equipped with radio beacon transmitters (and xenon flashing units, when the recovery is expected in the darkness) which are activated by a pressure switch, that help to find the surfaced OBSs.

After recovering the OBS, the OBS magnetic tapes are reproduced at ISV (Institute of Seismology and Volcanology, Hokkaido University, which was reorganized from LOBS; Laboratory for Ocean Bottom Seismology, Hokkaido University). The process for the analogue OBSs is to transcribe analogue cassette tapes into audio digital tapes (DAT), and make A to D conversion. Eventually the data of all the OBS tapes are processed digitally in ISV and IFJ.