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Archive and excavation of acoustic data and videos on deep safloor off Hatsushima Island in Sagami Bay

相模湾初島沖海底音響・映像データのアーカイブと発掘

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1. Introduction

Since the first deployment of a cabled observatory on the seafloor at the depth of 1175 m off Hatsushima Island in Sagami Bay in 1993[1)], multidisciplinary long term observation has been carried out for 20 years by JAMSTEC (Japan Agency for Marine-Earth Science and Technology) with several kinds of sensors including a hydrophone (ITC-1010A) and video cameras attached to the observatory. The initial object of the observatory was to investigate the fluctuation of environment on deep seafloor and/or benthos in large chemo-synthetic biological communities besides the observatory mainly consisted of vesicomyid clams that might have some relation with the earthquakes or crustal deformation. In the observation, some geophysically and/or biologically significant episodic events, such as mudflows associated with large earthquakes or spawning of clams, were detected visually with video cameras accompanied by environmental fluctuation of water current or temperature[2)]. Besides them, some acoustic events like the vocalization of sperm whales[3) 4)] or the peculiar very low frequency signals[5)] that had not been initially expected were also detected with the hydrophone.

Meanwhile, the research project "Development of remote species identification technologies for marine organisms" founded by Japan Science and Technology Agency (JST) as one of "Core Researches for Evolutional Science and Technology (CREST)" started in December 2011 as a five year plan. The project is carried out by National Research Institute of Fisheries Engineering in Fisheries Research Agency, Tohoku Gakuin University and JAMSTEC. Under this project, JAMSTEC is archiving legacy acoustic data of off Hatsushima Island observatory along with videos in order to utilize them as one of the *in situ* data for the remote species identification. In this paper, the status of the archiving process and some excavated events through the archive will be reported.

2. Archiving Legacy Data

Acoustic signal obtained with the hydrophone on the seafloor were transmitted, along with another data observed with the other sensors including video signal, through a submarine cable to the shore station in Hatsushima Island. The transmitted acoustic signals were recorded on soundtrack of S-VHS videotapes as audible sound, i.e. ranging over several kHz in frequency with video images of seafloor before the replace of the observatory in 2000. The recording on the tapes was conducted in two way. One was the automatic recording performed usually twice a day - at midnight and at noon - for normally 15 minutes at each time. The other is the manual recording performed once a week usually on Thursday for more than six hours at each time. Unfortunately, since rather large electronic hum noise probably associated with AC power supply from the shore station and periodic pulse associated with digital circuit noise inside the underwater unit are included, there are some difficulties in detecting signals. After the replace in 2000, those noises were eliminated and the acoustic signals have been recorded mainly on DVCAM tapes in almost the same manner as the previous observatory. The automatic recording time was reduced to normally 13 minutes at each time because of the recording capacity of DVCAM tapes. The acoustic signal have also been stored continuously as 200 Hz sampling digital data on 2.6 Gigabyte DVD-RAM media at the present observatory, while recording on the soundtrack was done intermittently only when visual observation with video camera was carried out.

As a first step of archiving those legacy data, in other words, converting them to the digital files ready to utilize in data analysys, the archive of automatic recorded data on DVCAM tape since 2000, i.e. after the replace of the observatory, was conducted. In the archiving process, the video data on DVCAM tapes were converted to AVI files on hard disk drives (HDDs) and then the acoustic data were extracted from those AVI files into WAV files in PCM format, i.e. in noncompressed process conserving original sampling rate (32 kHz or 48 kHz).

There were two kinds of video cameras – 3CCD camera and high sensitivity (Super HARP) camera - at the present observatory. Those two

video signals were recorded with respective DVCAM video decks mostly at the same timing. However, the Super HARP camera brokedown in 2008 and since then only 3CCD camera worked.

At present, the automatically recorded videos observed with either of those two cameras were archived that covers most of the whole observation period since 2000. As the next step, the archive of manually recorded DVCAM tapes of the present observatory and S-VHS tapes obtained with primary obsevatory since 1993 are being conducted. The video and acoustic signal on S-VHS tape are converted to MPEG-2 files, i.e. in lossy compression process, considering the original recording quality.

The 200 Hz sampling digital data on 2.6 Gigabyte DVD-RAM media were copied to HDDs.

3. Some Excavated Events

Through the archiving process, some episodic events were excavated to date.

Fig. 1 is the oldest example of sperm whale clicks observed on May 6th in 1994 with the primary observatory excavated to date. The waveform was high-pass filtered at 1 kHz. Fig. 2 shows the corresponding spectrogram.

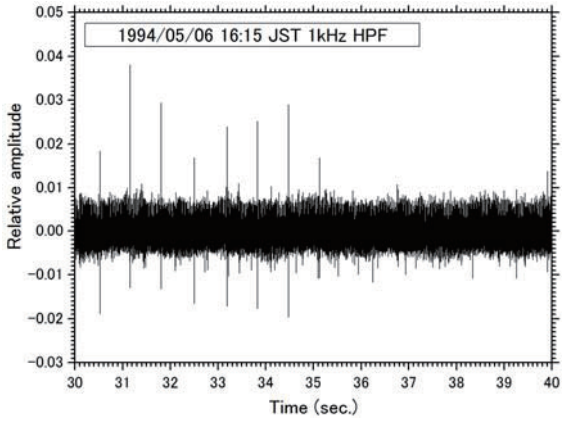

Fig. 1 The oldest example of sperm whale clicks observed on May 6th 1994. (High-pass filtered at 1 kHz)

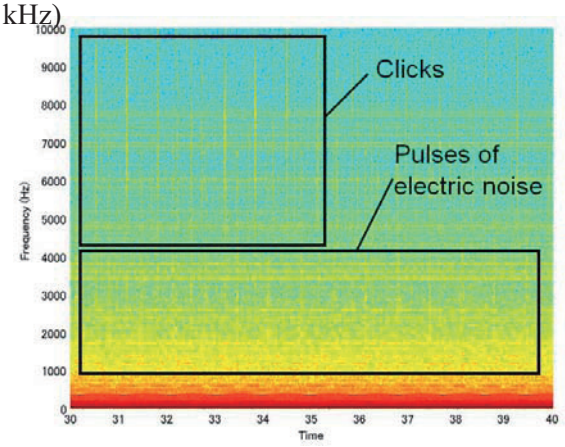

Fig. 2 Spectrogram corresponding to the waveform in Fig. 1.

Al though there are hum noises and pulses of electric noises as is shown in Fig. 2, the sperm whale click can be distinguished since the interval of the noise is constant and its pulse width is larger than the click.

At present, only the vocalization of sperm whale is identified as biological sound. However, in some case, an appearance or a sudden action of fish was followed with episodic sound which could be unknown biogenic acoustic signal[6].

Besides the biological sounds, the episodic sound associated with mudflow caused by a large earthquake, which was observed with the video cameras, was excavated. Most attentions had been paid only to the video images of the mudflow to date, however, careful listening to the acoustic signal this time lead to the recognition of the sound of rocks or pebbles falling down the slope[6] and, moreover, broadband sound like white noise that would correspond to the flow of sand or mud. The excavation of not only acoustic data but also videos would be necessary for the identification of sounds.

4. Concluding remarks

The archive of 20 year legacy acoustic data and videos obtained at the deep seafloor cabled observatory off Hatsushima Island in Sagami Bay is being conducted in order to utilize them as one of the *in situ* data for developing the remote species identification technology. In the previous studies[3) 4) 6)], the vocalizations of sperm whales were excavated fragmentarily with the aid of field notes that had been written while monitoring in real time and recording videos and acoustic signals manually at the shore station. The excavation of the sperm whale clicks for whole through observation period since 2000 is underway utilizing a large number of archived acoustic data that were recorded automatically on DVCAM tapes though their recorded time per day are limited. Some preliminary result will be reported in the presentation.

Acknowledgment
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