

Detection of Sperm Whale Clicks on Deep Seafloor in Sagami Bay

相模湾深海底におけるマッコウクジラのクリック音の検出

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1. Introduction

At the cabled observatory off Hatsushima Island in Sagami Bay, biogenic click sounds have sometimes been observed. The observatory was deployed in 1993 and replaced in 2000, in cold seepage site on deep seafloor at the depth of 1175 m (**Fig. 1**) where large chemo-synthetic biological communities mainly consisted of Vesicomid clams (*Calyptogena*) exist. The aim of the observatory is to investigate the environmental fluctuation or phenomena of the cold seepage that might be related to the swarm earthquakes and associated crustal deformation through long-term multi-disciplinary observation. The observatory is composed of several kind of sensors, including a hydrophone, video cameras, ADCP (Acoustic Doppler Current Profiler) and a seismometer¹.

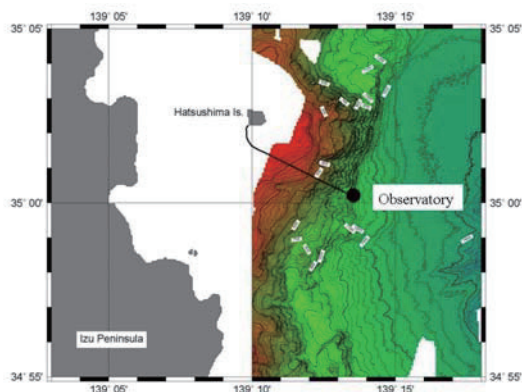


Fig. 1 Location of “Off Hatsushima Island Observatory in Sagami Bay”.

Since the replace of the observatory in 2000, the existence of the click sounds has been recognised. They have been observed with the hydrophone whose signal is recorded on sound track of DVCAM or S-VHS video tapes. However, the origin of click sound had not been identified until quite recently when they were suggested to be sperm whale clicks²⁾, while whales have not been observed with video cameras of the observatory so far. On the other hand, long term monitoring of whales in deepsea has never been carried out not only in Sagami Bay but also around Japan water in the past. The detection of whale clicks is definitely invaluable to investigate ecology of whale. This

time features of the observed click sounds were investigated and that those sounds were confirmed to be sperm whale clicks.

2. Observation Data

Hydrophone signal is transmitted to land station in Hatsushima Island through a submarine cable. It is recorded on sound track of DVCAM or S-VHS videotapes only when visual observation with video camera is carried out, considering the lifetime of light and the recording capacity of the videotapes. Usually, automatic recording is executed 26 minutes a day and manual recording is done 6 hours (or more) a week. Unfortunately, electronic noise gets mixed in hydrophone signal since June in 2005. Nevertheless, there are more than 1500 tapes free of electronic noise that corresponds to more than 4500 hours. So far, more than ten tapes that contain click sounds were found out of those.

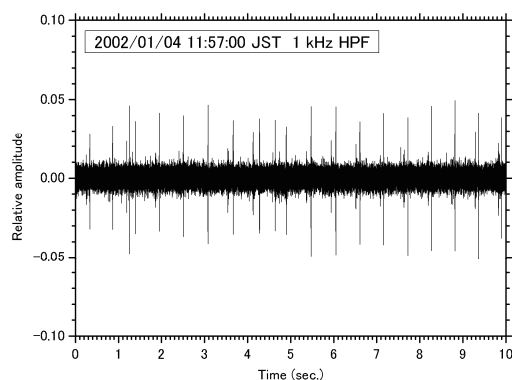


Fig. 2 An example of click train recorded on a videotape of off Hatsushima cabled observatory.

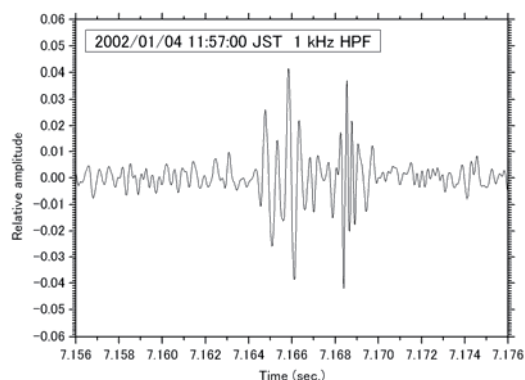


Fig. 3 One of clicks (enlarged) in Fig. 2.

Some examples of click sounds that were observed on January 4th 2002 are shown in **Fig. 2** and **Fig. 3**. **Fig. 2** is ten minute waveform of a click train starting at 11:57 JST and **Fig. 3** is an enlarged click waveform in **Fig. 2**. Those are 1 kHz high-pass filtered waveforms in order to remove low frequency ambient noise. As can be seen in **Fig. 2**, click trains usually have about 0.5 to 1 sec intervals and continue intermittently more than several hours in some cases. A click is composed of more than two pulses as is shown in **Fig. 3**. These features are consistent with those of sperm whale clicks reported in previous studies^{3,4)}. Among those click trains of constant interval, burst clicks of short interval, as is shown between 6 and 7 second in **Fig. 4**, have sometimes been observed. **Fig. 5** is a spectrogram of the hydrophone signal of the same period with **Fig. 4**. Dominant frequency of each click is about 3 to 4 kHz. This feature is also peculiar to sperm whale click, which is called a “creak”³⁾.

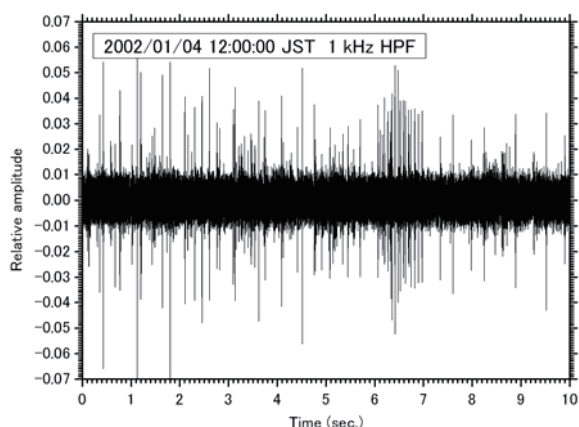


Fig. 4. An example of burst type clicks observed on the same day in Fig. 2.

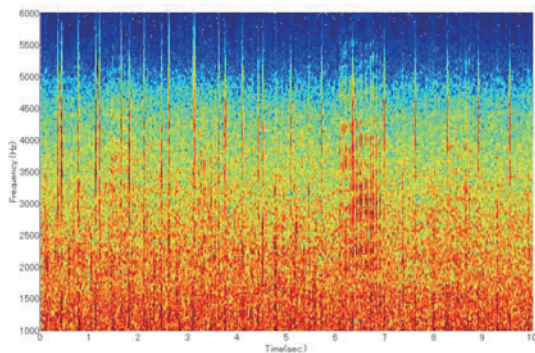


Fig. 5. A spectrogram of the waveform in Fig. 4.

Those features shown above confirm that those click sounds are sperm whale clicks.

Meanwhile, since a sperm whale has not been observed with video cameras of the observatory so far, it is very meaningful to estimate the location of a sperm whale when it emits clicks. As a key to estimate its location, echo intensity of ADCP

mounted on the observatory was investigated. **Fig. 6** shows the echo intensity profile of transducer No.1 of the ADCP between 12:45 and 14:00 JST on January 4th 2002. Sampling interval is 1 minute. ADCP has four transducers attached upward in four directions and beam angle of each transducer is 15 degrees. Although the beam angle is not so large, it has been shown to be capable of detecting a submersible or a remotely operated vehicle in a previous study⁵⁾. In **Fig. 6**, increase of intensity can be seen at the altitude of about 20m and 50 m at around 12:51 and 13:56, respectively. Although sperm whale clicks are known to have directivity, amplitude of click sound differs according to the altitude difference. These echo intensity increases probably indicate the location of sperm whales.

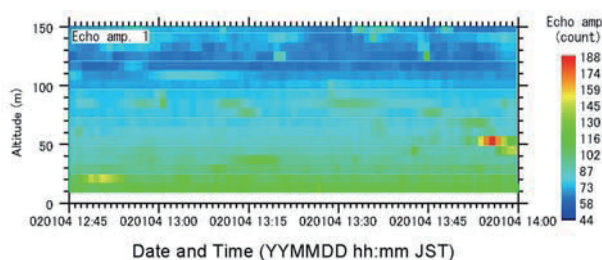


Fig. 6. Echo intensity profile of ADCP transducer.

3. Concluding Remarks

Click sounds observed with the cabled observatory on deep seafloor off Hatsushima Island in Sagami Bay were identified to be sperm whale clicks through the investigation of waveform features. Echo intensity of ADCP indicated that the sperm whales were located at the altitude of tens of meters above seafloor when clicks were observed. Those results are invaluable to investigate ecology of whale, because long term observation of sperm whale has never been carried out around Japan water in the past.

Acknowledgment

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References

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