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Detection of possible biogenic acoustic signals and ambient noise on deep seafloor in Sagami Bay

相模湾深海底における生物鳴音の検出と音響周囲雑音

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1. Introduction

On the deep seafloor off Hatsushima Island in Sagami Bay in central Japan, a series of impulsive sounds vocalized by sperm whales which are called “cliks” or “creaks” have been repeatedly observed with a hydrophone attached to the cable end staion at the depth of 1175 m of a cabled observatory[1) 2)]. Those sperm whale sounds were recorded on soundtrack of videotapes and audible, i.e. ranging over several kHz in frequency. Acoustic signal of the hydropone is also sampled at 200 Hz continuously and is stored as digital files, while recording on the soundtrack is done intermittently only when visual observation with video camera is carried out. In those 200Hz sampled acoustic data, peculiar low frequency signals that are obviously different from those of earthquakes or anthropogenic sources, such as ship noise or air guns, have been observed.

This time the characteristics of those low frequency peculiar acoustic signals.

2. Observation Data

An example of the peculiar low frequency signal observed on December 7th in 2000 is shown in Fig. 1. Top figure of Fig. 1 is a 1-hour waveform at 21:00 JST of that day. Middle and bottom figures of Fig. 1 are 1- minute waveforms that are enlarged ones of box parts in the top figure.

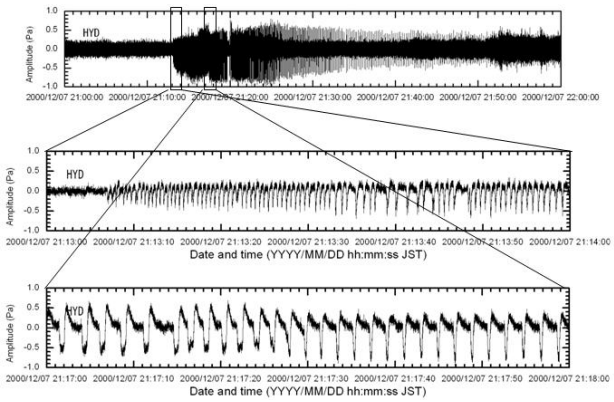

Fig. 1 An example of a peculiar low frequency signal observed on Dec. 7th 2000.

In this case the signal consists of a series of low frequency pulses. The inter pulse interval was about 0.5 seconds in the beginning. It increased through time and reached more than 10 seconds at 30 minutes later.

As far as the stored acoustic data looked over to date are concerned, this kind of peculiar low frequency signals were detected in September and December in 2000, January, February, April, May, June and December in 2003. Duration of those signals is ranging from several ten minutes to more than several hours. Those signals did not accompany ground motion that could be observed with an ocean bottom seismometer that is also attached to the observatory. It indicates that those low frequency signals were transmitted not through the ground but through the water.

Fig. 2 is a spectrogram of the 1-hour waveform shown in the top figure of Fig. 1. Vertical axis is a frequency ranging from 0 to 20 Hz. The same waveform in Fig. 1 is also shown in the bottom.

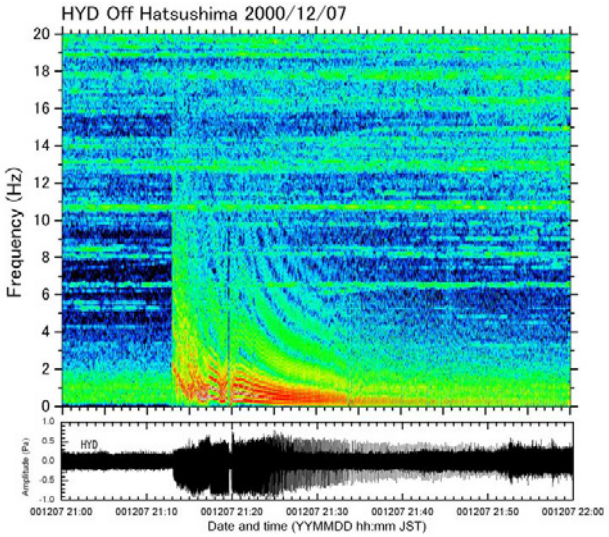

Fig. 2 1-hour spectrogram of the waveform shown in Fig. 1.

Distinctively spectrogram in Fig. 2 shows harmonics that indicates the signal could be biogenic.

There are some other kinds of low frequency signals whose shapes of waveform and spectrogram

are different from Fig. 2 that have been detected in the period mentioned above.

Fig. 3 and Fig. 4 show the other examples of peculiar low frequency signals that were observed in September 5th in 2000 and February 14th in 2003, respectively.

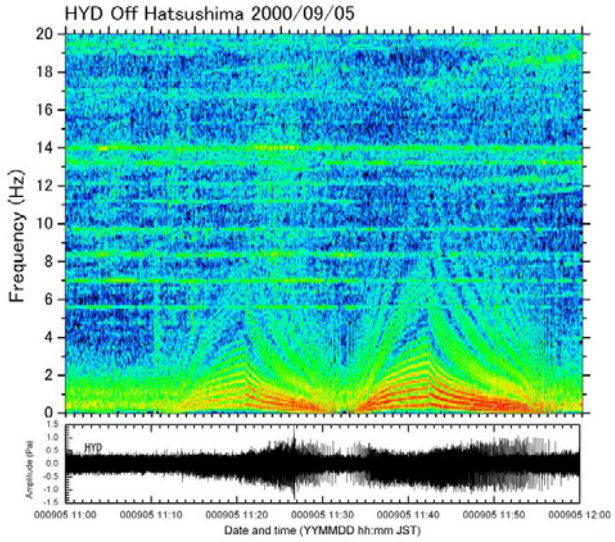

Fig. 3 1-hour spectrogram and waveform observed at 11:00 JST on Sep. 5th 2000.

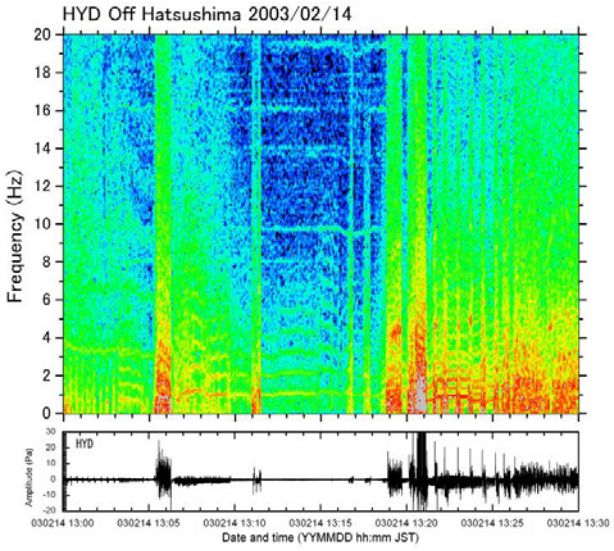

Fig. 4 30-minute spectrogram and waveform observed at 13:00 JST on Feb. 14th 2003.

In each figure, the waveform is shown in the bottom and the associated spectrogram, whose vertical axis is frequency ranging from 0 to 20 Hz, is shown in the top.

In the case of Fig. 3, the signal consists of a series of low frequency pulses similar to the case of Fig. 2. However, in the spectrogram the frequency increased in the beginning and then decreased to the end.

In the case of Fig. 4, the signal consists of a series of low frequency pulses with rather complicated shapes than those in the case of Fig. 2 and Fig. 3. Between those pulses, a series of weak pulses with harmonics, whose shapes were different from those in the other cases, sometimes accompanied.

3. Discussions

Some baleen whales, such as minke whales or humpback whales, are known to vocalize low frequency acoustic signals with harmonics[3]. However, the frequency ranges of those known vocalizations are more than 10 Hz. In all of those cases observed this time, the frequency ranges were less than 10 Hz.

Humpback whales are known to vocalize more than hours in some cases[4], that is the similar characteristic observed this time.

Considering the stranding of baleen whales including minke whales and humpback whales has been reported in Sagami Bay[5], those low frequency signals would be biogenic and possibly be vocalized by baleen whales. One possible reason that the frequency range is less than 10 Hz is that Sagami bay is filled with the ambient ship noise of more than 10 Hz in frequency as shown in Fig. 5 and some baleen whales might vocalize less than 10 Hz in frequency to prevent the ambient ship noise.

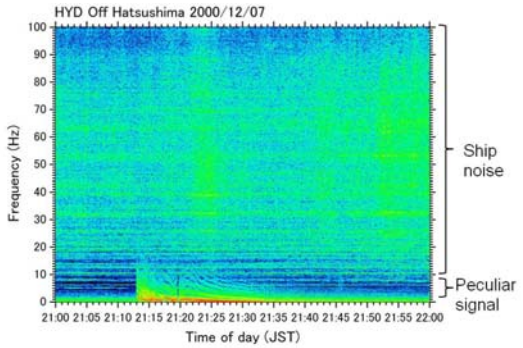

Fig. 5 1-hour spectrogram of the waveform in Fig. 1. Frequency range in vertical axis is 0–100 Hz.

4. Concluding remarks

Low frequency peculiar acoustic signals observed in Sagami Bay would possibly be vocalized by baleen whale. They might vocalize less than 10 Hz to prevent ambient ship noise.

References

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