

On fin whale vocalizations seen on waveforms of ocean bottom seismometers in East Japan Pacific sea area

東日本太平洋海域の海底地震計波形に見られるナガスクジラの鳴音について

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1. Introduction

Fin whales, one kind of the baleen whales, are known to vocalize low frequency sounds in several tens Hz and to exist worldwide¹⁾. It has been believed that they communicate each other by using the deep sound channel to transmit their sounds in the vast ocean and some simulation has been tried for the verification²⁾. The passive acoustic observation of those vocalizations has been carried out and those features have been studied in detail in the Atlantic Ocean and in the East Pacific Ocean by using temporal or permanent underwater observatories or hydrophone arrays. However, in the West Pacific Ocean, especially around Japan, those passive observations has been carried out far less because there are less apparatus of those kinds of acoustic observation that can be used for scientific purpose. Recently, the fin whale vocalizations were found in the acoustic data obtained with hydrophones attached to the ocean bottom seismometers (OBSs) of off Kushiro-Tokachi cabled observatory in Hokkaido Prefecture which is operated by JAMSTEC (Japan Agency for Marine-Earth Science and Technology)^{3) 4) 5)}. More recently the author found that some of the fin whale vocalizations detected with hydrophones were also detected with OBSs of the off Kushiro-Tokachi cabled observatory⁶⁾. In this paper, past OBSs data of the cabled seismic observatories deployed in East Japan Pacific sea area including the off Kushiro-Tokachi cabled observatory were surveyed in order to “excavate” fin whale vocalizations.

2. Observed OBS Data

In this study OBS data of four cabled seismic observatories were surveyed as shown in **Fig. 1**. They are off Kushiro-Tokachi observatory, off Kamaishi observatory operated by Earthquake Research Institute (ERI), University of Tokyo, off Boso observatory operated by Japan Meteorological Agency (JMA) and Sagami Bay observatory operated by National Research Institute for Earth Science and Disaster Prevention (NIED).

As a result, the fin whale vocalizations were

found in the OBS data of those four observatories.

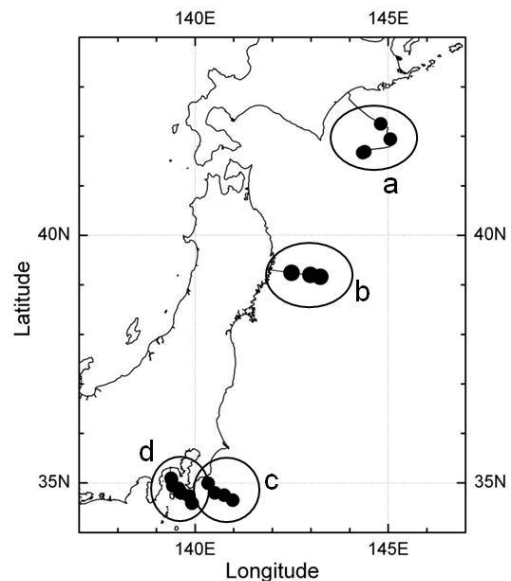


Fig. 1 Locations of the cabled seismic observatories surveyed in this study. a: off Kushiro-Tokachi observatory, b: off Kamaishi observatory, c: off Boso observatory, d: Sagami Bay observatory.

Spectrograms of those “excavated” fin whale vocalizations are shown in Fig. 2, Fig. 3, Fig. 4 and Fig. 5.

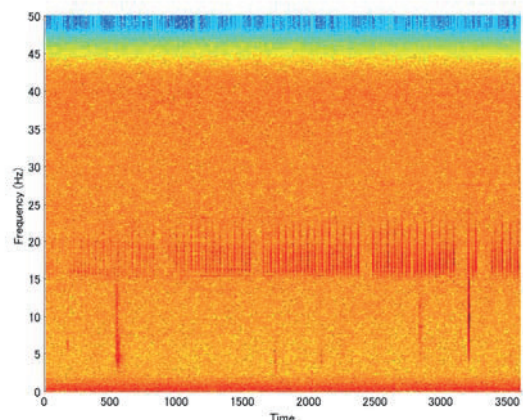


Fig. 2 Spectrogram of fin whale vocalizations observed with Z-component of OBS at OBS1 in off Kushiro-Tokachi observatory from 14:00 to 15:00 (JST) on Dec. 10th 2004.

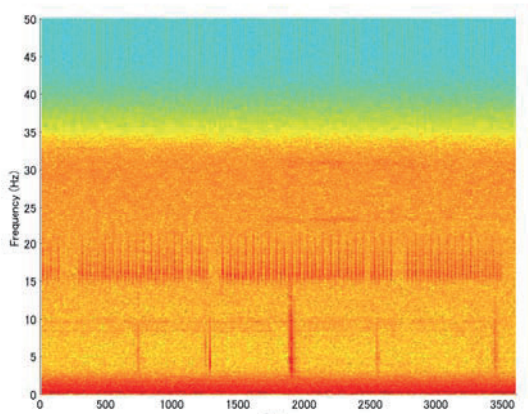


Fig. 3 Spectrogram of fin whale vocalizations observed with X-component of OBS at OBS1 of off Kamaishi cabled observatory from 16:00 to 17:00 (JST) on Feb. 27th 2005.

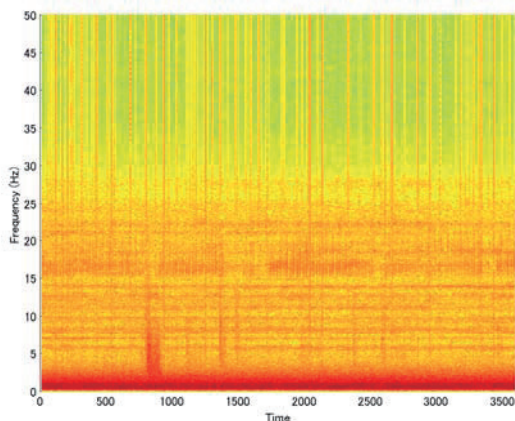


Fig. 4 Spectrogram of fin whale vocalizations observed with vertical component of OBS at OBS1 of off Boso cabled observatory from 00:00 to 01:00 (JST) on Jan. 10th 2005.

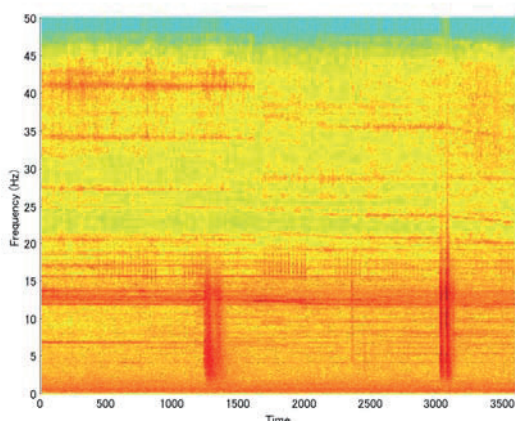


Fig. 5 Spectrogram of fin whale vocalizations observed with X (horizontal) component of OBS at OBS4 of Sagami Bay cabled observatory from 05:00 to 06:00 (JST) on Apr. 16th 2006.

All of those signals have similar frequency range of 15-20 Hz and duration of about 1 second that are the typical feature of fin whale vocalizations, although the signals in Fig. 4 and Fig. 5 are weak

and further verification would be necessary.

Waveforms corresponding to one of the pulses (called “notes”) in Fig. 2 which are band-passed in the range 10-25 Hz are shown in Fig. 6.

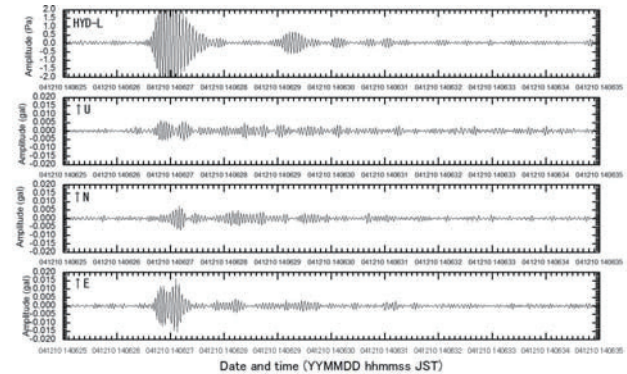


Fig. 6 Waveforms of a fin whale vocalization observed with a hydrophone and OBS in 10 seconds from 14:06:25 JST on Dec. 10th 2004 at OBS1 of off Kushiro-Tokachi observatory. From top, hydrophone, vertical, north-south and east-west component of OBS, respectively.

OBSs have the advantages as vector sensors, and rough localization of the sound source can be estimated by analyzing incident orientation and time difference of multi-path arrival to some extent under some conditions⁶⁾. The further investigation of those signals by applying these methods will be tried in the next step.

3. Concluding Remarks

Although less sensitive than hydrophones, the cabled OBSs would be the useful apparatus for observation of fin whales that compensate less hydrophones in the sea area around Japan.

Acknowledgment

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References

1. A. Watkins, et al.: J. Acoust. Soc. Am. **82** (1987) 1901.
2. T. Tsuchiya et al.: Jpn. J. Appl. Phys. **43** (2004) 3193.
3. K. Hitrata et al.: IEEE J. Ocean. Eng. **27** (2002) 170.
4. M. Andre et al.: Proc. UT11 and SSC11 (2011) 10.1109/UT.2011.5774104.
5. T. Akamatsu et al: 2014 Proc. Meetings of Marine Acoust. Soc. Jpn. (2014) 7 (in Japanese).
6. R. Iwase: IEICE Technical Report **114**(190) (2014) 49.