1P6-4

Acoustic properties of organic-rich sediment at the seabed surface

有機物を含む海底表層堆積物の音響特性

Hanako Ogasawara†, Kazuyosi Mori (National Defense Academy)

小笠原英子†，森 和義（防衛大）

1. Main text

Authors have studied reciprocal sound propagation at the very shallow area to measure ocean environmental changes[1-3]. Two transducers were placed at the bank in Hashirimizu Port at Tokyo Bay with the distance of about 120 m since 2006. As the experimental area is very shallow, the depth of the area is approximately 5 m. Thus, so many reflected waves were observed from the received signals. Even though M-modulated sequence signal was used as the sending signal, it was very hard to separate the direct wave and the reflected waves. From the results obtained in the summer of 2008, the propagation path changed markedly because of the steep thermocline at the surface area. However, the first arrival signal and largest peak of the correlation result were used for analysis[1]. Because of the interference of the surface and bottom reflections, the shape of the correlated signal varied according to the tidal level and water temperature. We could monitor temporal temperature changes and current velocity component along the reciprocal propagation path from the reciprocal sound travel times. Although reflected signals include wider area environmental information than the direct path signal, they were all ignored at this moment. As the experimental area has very calm sea state, the sediment information is required to understand reflected wave analysis. We had surveyed the surface structure with a multibeam sonar and a single-beam echosounder at the experimental area[4]. But it is important to know the sediment structure and its acoustical characteristics. In this paper, we will carry out the core sampling at the experimental area and measure the characteristic of the sediment layer including sound speed. This result will help to understand the reflected waves from the sea bottom and sound propagation simulation in models.

2. Experiment and Results

Figure 1 shows the overview of Hashirimizu Port. Hashirimizu Port locates at Miura Peninsula which is one of the Peninsulas surrounding Tokyo Bay, Japan. The black circles on Fig. 1 indicate the location of the transducers for reciprocal sound propagation. The core samples were collected at the middle point between the reciprocal propagation path indicated by X mark in Fig. 1. As the top sediment contains much water and water content in the sediment must vary according to the depth of the sediment. A gravity core sampler (RIGO: no.5167) were dropped from a small boat drifting around the X mark area shown in Fig. 1. Each core sample was obtained into an acrylic tube with 4 cm diameter which was casted into the core sampler. In some samples, small fractions of sea shells were confirmed on the top of the sediment.

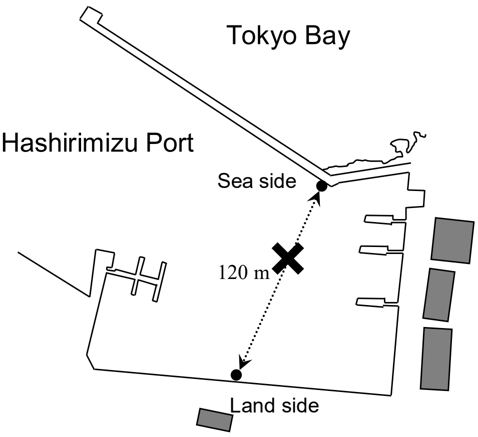

Fig. 1 Map of Hashirimizu Port.

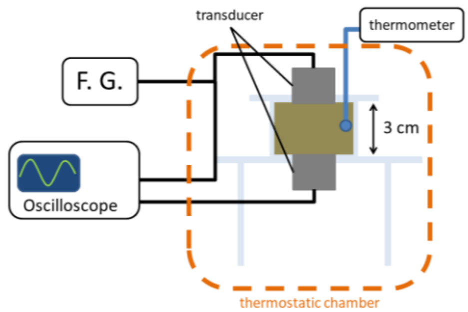

Fig. 2 Sound measurement system in the laboratory experiment.

In this study, acoustical characteristics, especially the sound speed changes according to the depth are the most interesting topic. As the obtained samples by the core sampler were only about 6 cm

ogasawar@nda.ac.jp

depth, authors decided to compare the difference between the upper side and the lower side of the sample. Therefore, a new measurement system to sound speed of a sample in a 4 cm diameter cylinder with 3 cm height is required. **Figure 2** shows a diagram of the sound speed measurement system. A transmitter and a receiver (KGK: 500 kHz) were faced each other across the sample with 3 cm distance fixed with acrylic pipe which has the same diameter and thickness to that of used at the core sampling. A part of the measurement system including the sample which is indicated by dashed line in Fig. 2 was put into an incubator to control the temperature. To monitor temperature changes of the sample, a K-type thermocouple was inserted into the sample from the upper side of the pipe. The second order M-sequence signal was sending from the transmitter and received at the receiver located opposite side of the pipe. The career frequency was 500 kHz which is resonance frequency of the transmitter and the receiver. Both sending and receiving signals were monitored by an oscilloscope (Agilent: 33220A) to measure travel time. After recording the receiving signal through the oscilloscope, peak time was calculated by correlation with the sending signal.

Figure 3 shows sediment sound speed of each sample and layer measured by the sound measuring system. The bias value confirmed by water sound speed was removed from the original calculated results. As some samples it was not succeed for measurement, only samples of good measurement results were shown in Fig.3. The value sound speed of each sample was different, but all of them increase their sound speed according to temperature increasing. These changes may be caused mainly by water temperature changes in the sediment.

Since the received amplitude was weak because of the sediment attenuation, it is important to declare how much the sediment interrupt sound propagation. Especially at the border between the water and sediment, the consistency of the sediment particle should gradually change. **Figure 4** shows received amplitude changes according to the amount of the contaminants in the measuring container in Fig.2. The particle size of contaminants was less than 75 µm. As the amount of the contaminants increase, the amplitude drastically decreased.

3. Conclusion

In this paper, sediment properties were measured by core sampling sediment from Hashirimizu Port. A sound speed measurement system used in this experiment had bias value because of some reasons, but comparative sound speed could be measured by this system. Also, the received amplitude decreased according to the amount of the contaminants in the measurement area. More detailed analyses will be required to compare with the sound propagation results at shallow area.

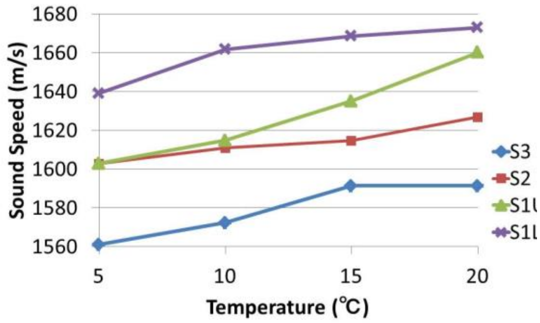

Fig. 3 Measured sound speed of sediment layers.

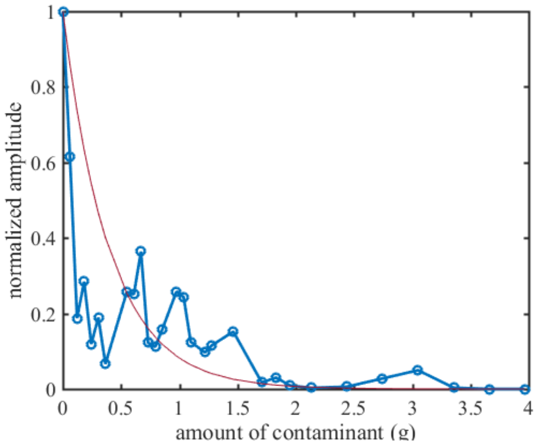

Fig. 4 Received amplitude according to the amount of the contaminants.

Acknowledgment
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References

1. H. Ogasawara and K. Mori, Jpn. J. Appl. Phys. 55, 07KE17 (2016).
2. H. Ogasawara, K. Mori, and T. Nakamura, Jpn. J. Appl. Phys. 49, 07HG15 (2010).
3. S. Kamimura, H. Ogasawara, K. Mori, and T. Nakamura, Jpn. J. Appl. Phys. 51, 07GG08 (2012).
4. S. Kamimura, H. Ogasawara, K. Mori, T. Nakamura, and H. Kan, Kaiyo Onkyo Gakkaishi 39, 3 (2012) [in Japanese].I. Tomonaga and J. Esaki: Jpn. J. Appl. Phys. **44** (2005) 271.