The Acoustic Property Measurement of Piston Core Sediment Using PICAM System

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1. Introduction

Since ocean sediments cause a loss of acoustic energy for acoustic wave propagation in shallow water, it is very important to investigate the acoustic properties such as the phase velocity and the acoustic attenuation of ocean sediments[1-4]. The acoustic properties of ocean sediments can be investigated in the laboratory using piston core sediments. In general, piston core sediments are longitudinally incised for acoustic measurements. Then, its physical properties can be changed by a disturbance in incision process. Since the acoustic properties of the sediments are related with the physical properties, they can be also changed. Therefore, it is important to measure the acoustic properties of the piston core sediment without any disturbance. This study introduces a PICAM (PIston Acoustic Measurement Core) system for measuring the acoustic characteristics without incision of the piston core sediment.

1.1 Problem of Conventional Measurement Method

The physical properties of piston core sediments can be changed in incision process of the sediment, if the sediment contain water, the water in the sediment can be leaked in incision process of the piston core. Also, The resolution of vertical acoustic measurements in the piston core sediments is low and It takes a long time for acoustic measurement the sediment. These problems can cause an uncertainty for acoustic measurements such as sound speed and attenuation of the piston core sediments.

2. PICAM(Piston Core Acoustic Measurement) System

Figure 1 shows a schematic diagram of the PICAM system for measuring acoustic properties of piston core sediments. As shown in Figure 1, the dash line represents the transmitting process of the acoustic signal, and the solid line represents the receiving process of the acoustic signal through the piston core sediment.

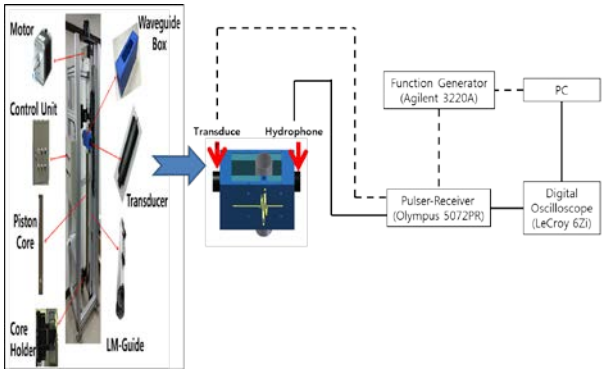

Fig. 1 Schematic diagram of the PICAM system

A pulser/receiver (Panametrics 5900 PR) was used to drive the acoustic transducers and to receive the acoustic signals. It was operated with a pulse repetition time of 25 ms using a PC-controlled function generator. This represents a depth resolution of 1 mm for the measurement of acoustic properties of the piston core sediment. The signal transmitted through the piston core sediment was acquired using an digital oscilloscope (LeCroy 6zi) and stored in a PC for off-line analysis.

2.1 Small Water Bath

The small water bath in Figure 1 was made for measurement of the acoustic properties of the piston core sediment.

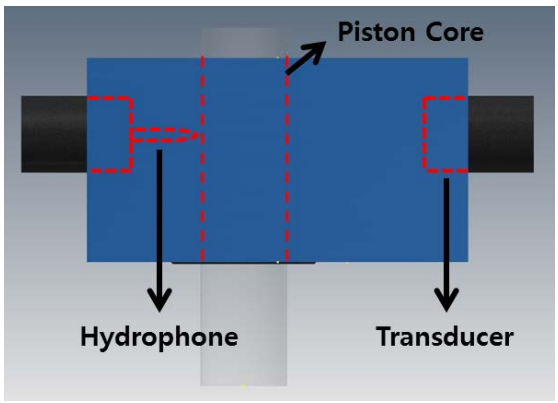

Fig. 2 Small water bath

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The dimension of the small water bath is 155 mm x 320 mm x 195 mm and the diameter of the bottom hole for penetrating the piston core is 73 mm. It is the same as the outer diameter of the piston core. All holes in the small water bath were installed with O-rings to prevent water leakage. As shown in Figure 2, a transducer and a hydrophone were installed at both ends of the small water bath for measurement of acoustic properties of the piston core sediment. The distance between the piston core and the transducer is the distance that satisfies the far field condition in the frequency band of 100 to 500 kHz. In this study, three transducers with the center frequencies of 100 kHz (Olympus V1011), 200 kHz (Olympus V1012), and 500 kHz (Olympus V301) were used. The hydrophone (Bruel & Kjaer 8103) is installed near the core in order to receive the sound wave transmitted through the core excluding the influence of the reflected signal. Also, sound absorbing materials (F 48, Precision Acoustics) were installed on the wall and bottom of the waveguide box for minimize the reflection effect of the sound waves.

3. Measurement of Piston Core Sediment

Figure 3 shows the waveforms and its contour plots at various depths of piston core sediment.

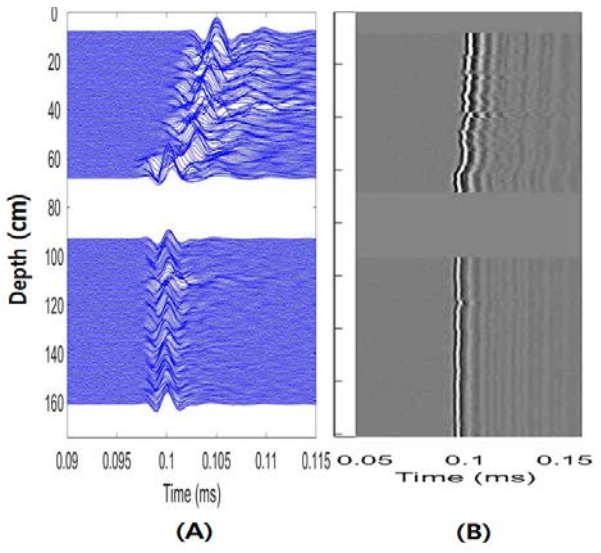

Fig. 3 (A) Waveforms and (B) their contour plots at various depth of piston core sediment

The measured data using the PICAM system analyzed the sound speed and attenuation of piston core sediment sample as a function of depth, as shown in Figure 4.

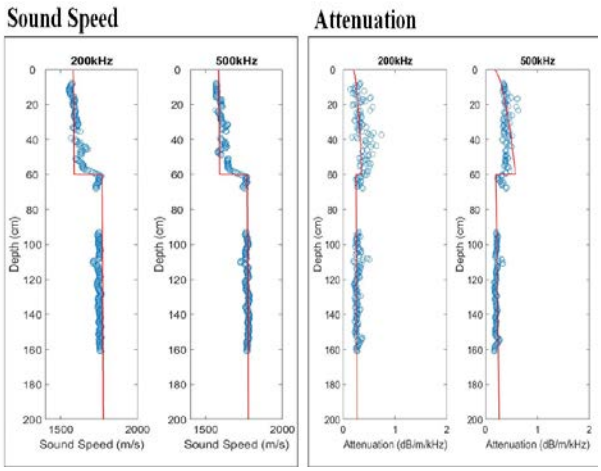

Fig. 4 The sound speed and attenuation of piston core sediment sample as a function of depth

4. Conclusion

As a results, the acoustic properties of piston core sediments can be measured by using PICAM (PIston Core Acoustic Measurement) system without incision of the core sediments. Also, PICAM system can measure the acoustic properties of piston core sediments faster than the conventional method and it shows also high vertical resolution for the acoustic properties of the core sediments.

Acknowledgment
This work was a part of the project titled "Construction of Ocean Research Station and their Application Studies" funded by the Ministry of Oceans and Fisheries, Korea.

References

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