APPENDIX II. TEST OF A SUBMERSIBLE TYPE 3.5 kHz TRANSDUCER IN THE GH78-1 CRUISE

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Introduction

3.5 kHz subbottom profiling data are usually obtained by using a transducer which is set at the bottom of a ship's hull, and then we cannot expect satisfactory records in the case of survey at a steep slope or deep sea, presumably due to the decrease of sound level in water. A device to solve this problem is to lower the transducer into deep sea, so that the signal noise ratio must be better enabling a detailed survey. SPIESS and MUDIE (1968) reported such data obtained by 4 kHz transducer which was attached to a deep tow system. To confirm the applicability of a submersible type transducer to subbottom profiling, a trial model of transducer was manufactured and the system was tested during the GH78-1 cruise.

The transducer has a reflecting cone with a diameter of 920 mm at the open section and with a height of 455 mm (Fig. AII-1). The cone consists of stacks of stainless steel pipe rings. The transducer is fixed to a tripod frame, which was originaly designed for the deep sea television system and is lowered to the sea bottom (Fig. AII-2). The transducer is connected with the 3.5 kHz subbottom profiling system mounted on the vessel through an armored coaxial cable winded on the winch (Fig. AII-3). The cable, which is usually used as the cable of the deep sea television system, has a length of 6,700 meters and a impedance of 50 ohms. The on-board part of the 3.5 kHz subbottom profiling system is composed of a transceiver (Model PTR-105A), a correlation echo sounder processor (CESP-II), a precision depth digitizer (Model PDD-200A), and a universal graphic recorder (UGR-196C), which were manufactured by Raytheon Co. The signals were transmitted at intervals of 6 sec and the received signals were recorded on the graphic recorder at 2-sec sweep rate. The pulse width on the CESP-II was set to 50 msec.

The submergible transducer was tested from 21:20 (GMT), 5th of February, 1978 to 1:00 (GMT), 6th of February at a location 270 miles north of Fiji islands (11°57′S, 178°40′W). The site is 1950 m deep. According to the record of the 3.5 kHz subbottom profiling system mounted on the vessel, the layer under the sea bottom had semi-opaque, stratified pattern.

Estimation

The estimation of effectiveness of the system was as follows: Decrease of sound level in deep sea (6,000 m) is estimated to be approximately −75 dB (return); the decrease by wire cable (6,000 m) should be −12 dB (return); and the decrease due to the change of the usual type transducer attached to ship's hull bottom to ring type one with a reflecting cone may be −10 dB. So,

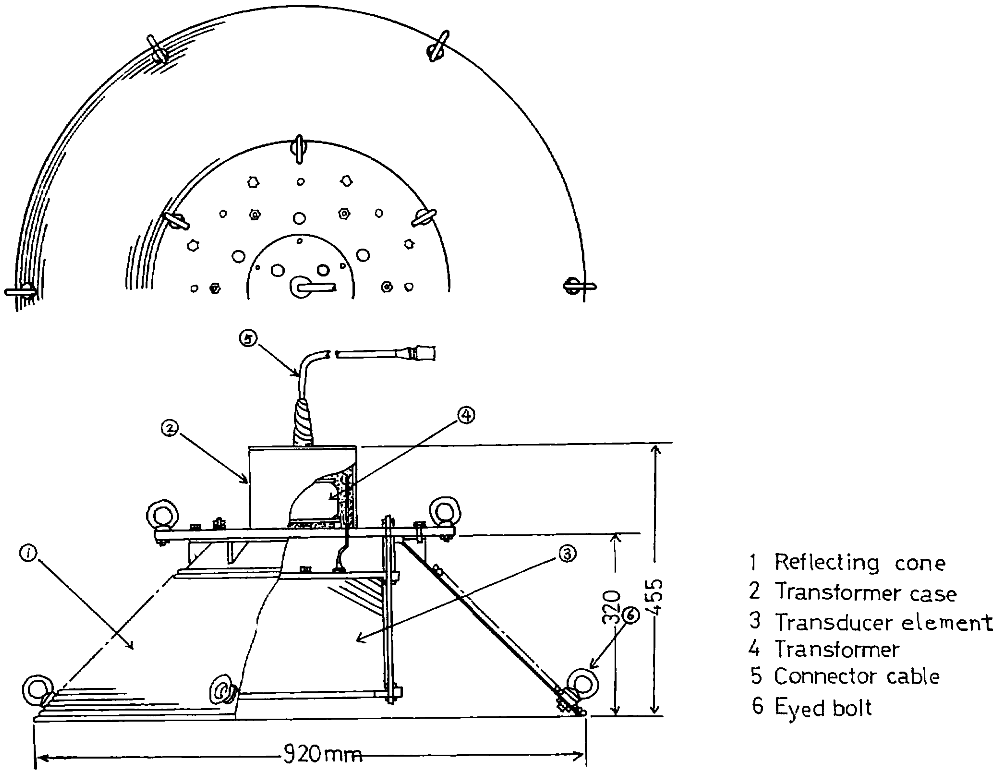

Fig. AII-1 The sketch of 3.5 kHz transducer used in this cruise.

the trial model system should be better than the usual type by the amount of 53 dB (= −12 dB, −10 dB, +75 dB as mentioned above) in gain. The amount of −22 dB (= −12 dB, −10 dB) corresponds approximately to 350 m depth, so the system should be useful at the deeper point than 350 m.

Results

The transducer was lowered into the sea and was stopped at the test height of 1,000 m, 500 m, 200 m and 50 m above the sea bottom (Table AII-1). At each location of the transducer, received signals were recorded. The signal reflected by the sea bottom became visible when the transducer was situated at less than 1,300 m above sea bottom (Fig. AII-4). The detailed structure under the sea bottom was observed at 100 m and 50 m above the sea bottom D and E in Fig. AII-4, but the obtained records were not very good. One of the possible causes of the rather lower level resolution by the submersible type transducer is a mismatching due to that we did not take matching in the system for broadening frequency band because we wanted to get a gain of 20 dB by using CESP system, in which the correlation between give-out sweep and that of returned signal was calculated to be in 3.5 ± 1 kHz frequency band. The

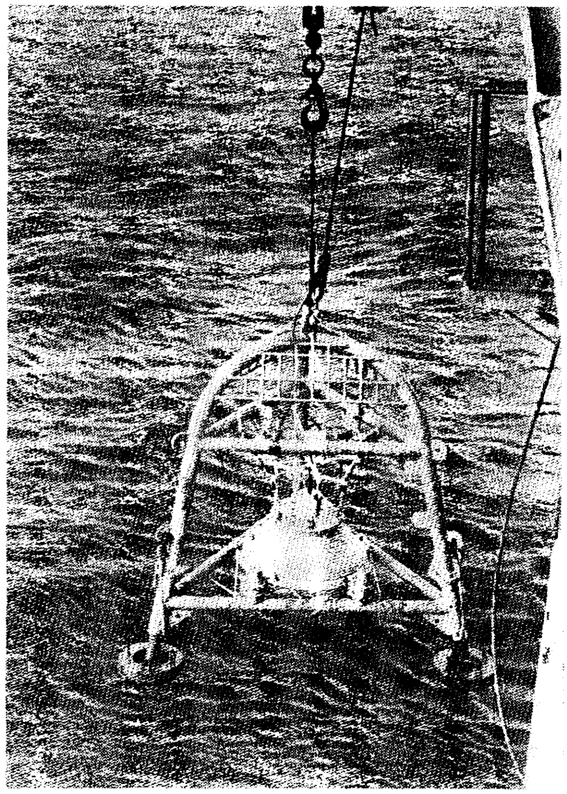

Fig. AII-2 The picture of 3.5 kHz transducer set in a tripod frame.

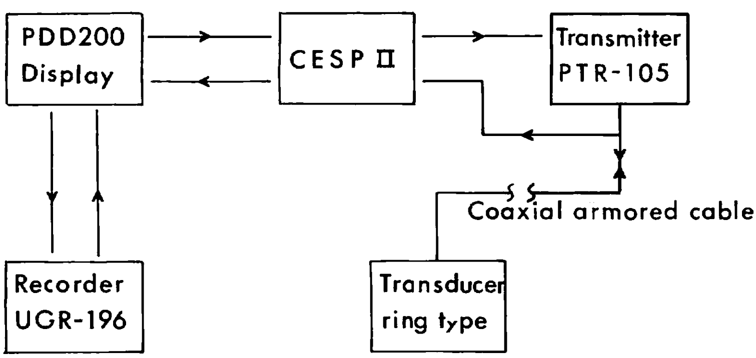

Fig. AII-3 The block diagram of 3.5 kHz sub-bottom profiling system with a submersible type transducer.

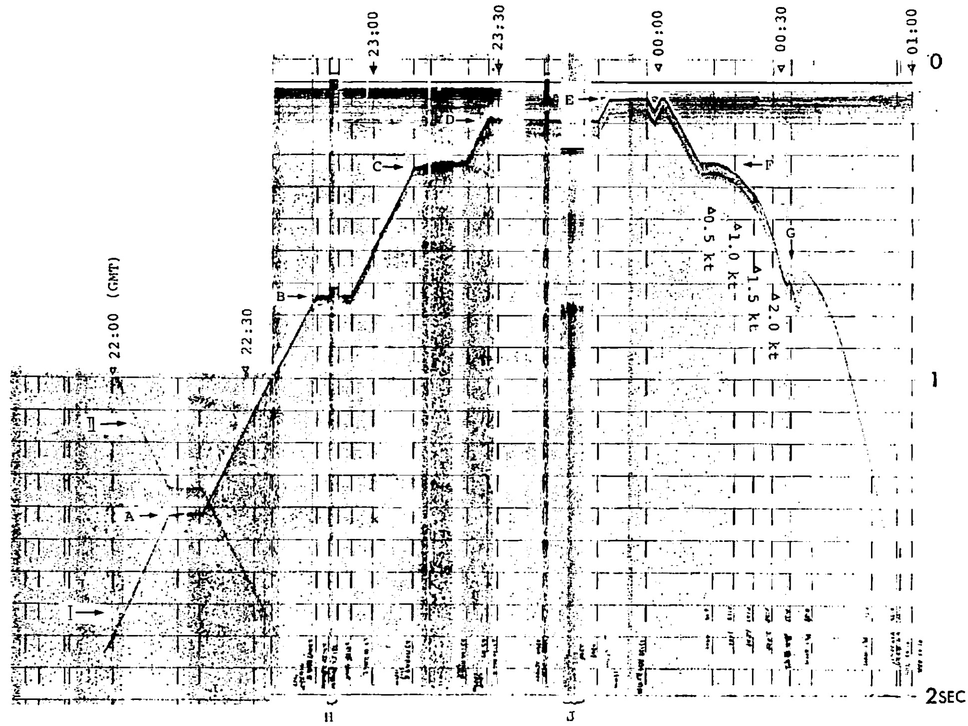

Fig. AII-4 The reflection record by 3.5 kHz transducer.
I: The reflection by the sea bottom. II: The reflection by the sea surface. A, B, C, D and E indicate the records at 1,000 m, 500 m, 200 m, 100 m and 50 m above the sea bottom, respectively. F: Sailing was started. G: Sailing was stopped and winding was started. H: The pulse width on the CESP-II was set to 25 msec. J: The sweep speed of the recorder was set to 1 sec-rate.

loss caused by this mismatching may have been -13 dB. But, the wave shape turned out to be not so good because of the mismatching, and the CESP system aiming at the profit by 20 dB, seemed to be not so efficient, with the total loss amounting to the value of -55 dB (-12 dB, -10 dB, -13 dB, and -20 dB). The loss of -55 dB corresponds to that caused by the transmission in water column at 2,400 m depth. Thus, the similar level of both records by the ship's bottom type and submersible type transducers may be caused by the above mentioned loss, such as sensor loss, cable loss, mismatching loss and inefficiency of the CESP system.

Another problem is the speed of lowering or towing the transducer. The speed was obliged to be too slow as compared with the usual lowering speed for such instrument because of the shape of reflecting cone whose resistance against water was very high, and this suggests the need for devising another form of the transducer. One possible method is to keep the ring type transducer in laid down position without the reflecting cone or only a reflecting board (or

Table AII-1 Operative conditions and the results

Time	Height of the transducer above the sea bottom (m)	Wire length (m)	Description of records	Indication in Fig. 4
22 : 15 ~ 22 : 20	1,000	950	Reflections of the sea bottom were observed only.	A
22 : 47 ~ 22 : 55	500	1,450	The layers under the sea bottom were observed a little but the record was not clear.	B
23 : 10 ~ 23 : 22	200	1,750	ditto	C
23 : 27 ~ 23 : 47	100	1,850	The layers under the sea bottom were observed but record was not clear.	D
23 : 49 ~ 23 : 58	50	1,900	Several layers under the sea bottom were observed.	E

any body) attached above the sensor. Another possible way is to cover the bottom of upper cone with another inverted cone to reduce the water resistance, also attaching a weight at the foot to keep the cone in stable position at high speed lowering. Anyway, we must devise the more efficient body of the submersible transducer system for lowering and towing. Besides, we need to improve the wave shape of the sound for better records by cancelling the CESP system to get better matching.

Reference

SPIESS, F. N. and MUDIE, J. D. (1968) Small scale topographic and magnetic features. *The Sea*, vol. 4, 1, p. 205–250.