Influence of frequency on sound propagation by sound source passing over self-break

大陸棚縁を通過する音源による音波伝搬に関する周波数の影響

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1. Introduction

The configurations of sound propagation are changed when a sound is passed the shelf-break from the continental shelf to the basin. The sound propagation of each regions is the shallow water propagation on the continental shelf, and propagation of the deep ocean region on the basin. In the region from shelf-break to continental slope, the configuration of the sound propagation is different to these one. Then, Tsurugaya et al. were examined for the change of the propagation configuration when the sound source passed over the self-break[1,2]. When the sound radiated on the continental shelf is passed the shelf-break, it increases the depth toward the bottom along the continental slope. And, the sound is changed into the propagation centered on the sound channel axis in the basin region[1]. And, the levels of the convergences of sounds in the continental-slope and the basin depend on the sound speed structure of the shallow water[2]. These are examined by the frequency of 100 Hz. Then, the influences of the frequency on these propagation is examined. The influence of the sound propagation along the continental slope is especially examined.

2. Sound speed structure in East China Sea

The Data line (DL) of East China Sea and the sound speed structure obtained from GDEM is shown in Fig. 1. Kurosio current is flowing to northeast along 200 m isobathic line. The bottom depth of the north-west edge of DL (reference point;RP) is 130 m, and the shelf-break in the depth of 200 m is 55 km from RP. The bottom depth of Ryukyu basin is 2000m. The distance is a typical range from RP. The depth cut of the sound speed structure on the way is a bottom depth. Layered depth is about 50m. So, the cutoff frequency is about 500Hz[3]. The sound propagation code is used FOR3D[4].

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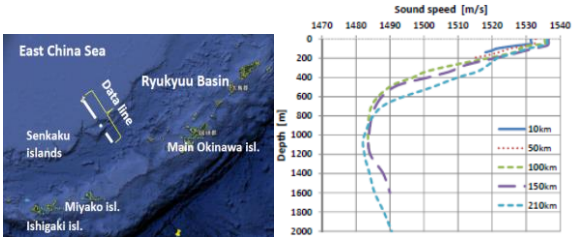

Fig. 1 Data line and Sound speed structures

3. Sound propagation from continental shelf to Basin

The sound field in the frequency of 100 Hz is shown in Fig.2. The vertical axis is the depth in [m], and the horizontal axis is the distance in [km] from RP. The sound radiated from RF is shallow water propagation to the shelf-break (55 km from RF). The sound that reached the shelf-break increases the depth to the basin bottom along the shelf-slope. And, the sound is shifted to the propagation that centers on the depth of minimum sound. The sound field for the frequency of 600 Hz is shown in Fig.3. The used parameter is the same as Fig.2 except the frequency. The frequency of 600 Hz is higher than the cutoff frequency. Therefore, the surface duct propagation is generated. However, a part of sound increases the depth along the shelf-slope as well as the case of 100 Hz. The difference in the state of propagation appears in the envelope of the transmission loss (TL) curve predominated in

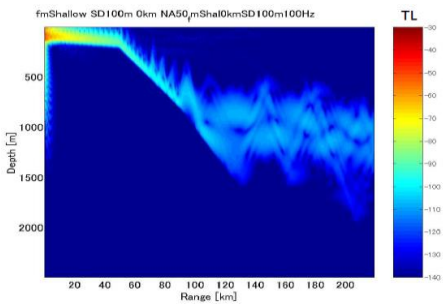

Fig. 2 Sound fields for frequency of 100 Hz
SD;100 m

shallow source, but the duct propagation between the thermocline and the bottom is clarified by increasing source depth (SD).

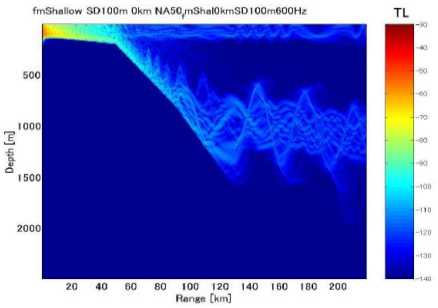

Fig. 3 Sound fields for frequency of 600 Hz SD;100 m

4. Sound propagation on passing shelf-break

4.1 Variation on TL by 100 Hz

To consider the envelopes of TL curve, transmission losses of 10km point and 20 km point from the sound source (SS) are compared. TL of the source depth (SD10 m) in 10 km point and 20km point are plotted in Fig. 4. Each symbol shows the receiving depth. There is no substantial change in TL level though the self-break is in the range of 55 km. But, TL of 20 km point from SS has TL dip. hen the sound source is in 40 km from reference point, 10km point is in the continental-shelf, but 20km point is over the continental slope. Therefore, TL is received the impact of the propagation along the continental-slope. That is, the increasing of TL is seen. When the position of the sound source is passed the shelf-break, 55 km from the reference point, TL is decreasing, and is taken the value around -80dB.

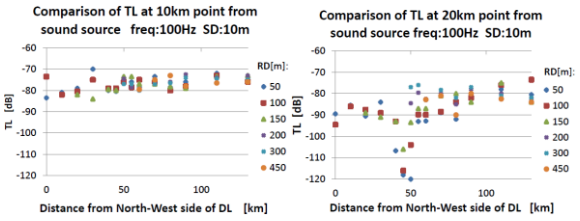

Fig. 4 Comparison of TL in 10km point and 20km point freq; 100 Hz left) 10 km point b) 20 km point

4.2 Variation on TL by 600 Hz

It is examined by TL before and behind the self -break for the comparison. TL of 10km point and 20 km point for SD10m is plotted in Fig. 5. The level of fluctuation on TL to the change in the receiving depth is small as well as 100 Hz. In TL of 20 km point, TL is increasing before and behind the shelf-break. But, the variation of TL is small compared with 100 Hz. And, when the receiving depth becomes deep, the variation of TL is small. The variation width at TL level becomes small in 1kHz.

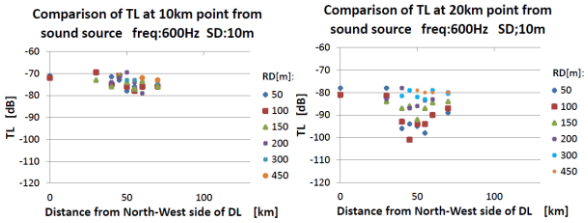

Fig. 5 Comparison of TL in 10 km point and 20 km point freq; 600 Hz left) 10 km point b) 20 km point

5. Summary

The propagation depth is increased along the continental-slope when the sound passed the shelf-break. As a result, the envelope of TL curve is changed. TL at 10 km point is not changed. However, TL at 20 km point is increased when the source approaches the shelf-break. And, TL is decreased when the source passed the shelf-break. The cutoff frequency in this environment is about 500 Hz. Therefore, when the using frequency is higher than 500 Hz, the surface duct propagation is generated. As a result, the level change in 20 km point becomes small when the source approaches to the shelf-break. Moreover, TL change for the shallow receiving depth is greater than the deep one. The influence of the surface duct propagation to the sound propagation becomes strong. And, the increasing of TL in 20 km point is become small.

References

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