

Influence on sound propagation in basin by the relation between change depth of continental slope and depth of sound channel axis

大陸傾斜の変化深度とサウンドチャンネル軸深度の関係による海盆伝搬への影響

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1. Introduction

Under the ocean environment from the continental shelf (C-shelf) to the basin, the sound propagation is changed dynamically by the existence of the shelf-break (S-break), the continental slope (C-slope), and the sea arc (Arc). Tsurugaya et al. are examined for the influence on the sound propagation by the variation of the ocean environment from C-shelf to Arc¹⁻⁴. The sound wave radiated in C-shelf is reached to the basin by passing S-break. When C-Slope is changed monotonically, the sound wave is propagated along C-Slope. And, it is propagated by the bottom reflection and the refraction in the basin region. However, when the shape of C-slope is changed, the shape of the sound propagation in the basin is changed. The shape of the sound propagation is changed into the configuration that looks like the sound channel (SC) propagation⁴.

The factor of the changes is considered the angle of C-slope and the depth and the range in the changed point. Then, the relation between the slope angle of the C-slope and the depth of the change point that influences to the sound propagation in the basin is examined. The calculation code is FOR3D⁵, and the used frequency is 100 Hz. The source depth in the figure is 100 m.

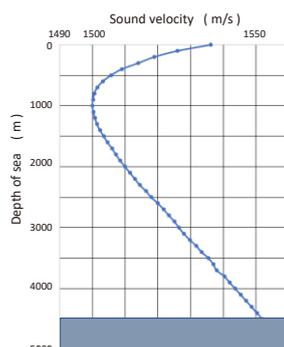


Fig. 1 MUNK profile

2. Influence of C-slope angle

The sound speed structure used for the examination is MUNK profile, and is shown in Fig. 1. The sound speed is de-creased from the surface of

the sea. The depth of minimum sound speed is 1000 m, and the sound speed is 1500 m/s, after that, the sound speed is increased with the depth. The depth of C-shelf is 200 m, and S-break is the distance 50 km from the sound source. The depth of the basin is 2000 m, and the depth change of C-slope is 1800 m.

The sound field (SF) by the difference to C-slope angle is shown in Fig. 2. The left figure is SF on the slope angle of 2.062 degrees that the distance of C-slope is 50 km. The right figure is SF on 0.937 degrees on the distance of 110 km. The sound wave that passed S-break increases the depth according to the slope of C-slope. And, when reached at the bottom of basin, it is reflected at the bottom.

In the basin, the propagation becomes the bottom reflection and the refraction, periodically

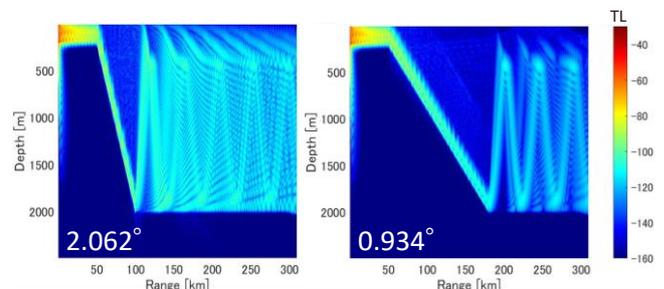


Fig. 2 Comparison of SF by C-slope angle
Left; C-slope dist. 50km Right; 110km

3. Influence of shape variation of C-slope

SF of C-slope on convex to the lower side is shown in Fig.3. The distance of the change is 1/4

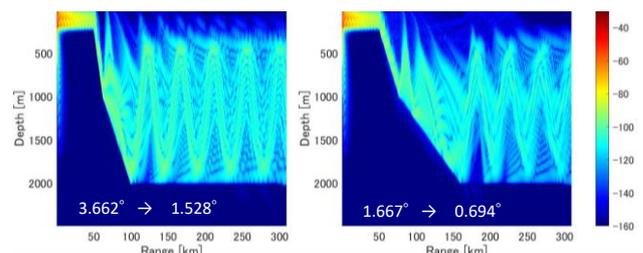


Fig. 3 Comparison of SF by C-slope convex to lower side (1/4 points of C-slope)
Left; distance 50km of C-slope right; for 110km

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point of C-slope. The left figure is 50km of C-slope, and the right figure is 110 km. The depth of changed point on both figures is 350 m deep from 1000 m. The change in the slope angle is shown in the figure. In the change point, it is changed from the propagation along C-slope into the propagation separated from the slope. However, the sound wave that reached the basin bottom is reflected at the basin bottom, and the refraction and the bottom reflection is repeated afterwards.

The comparison in the shape of convex to the upper side is shown in Fig. 4. The distance of the change is 3/4 points about C-slope. In this case, the based depth is 1550m. The left figure is the case of 50km on C-slope, and the right figure is 110km. In both figures, the depth of the changing point is 1000m, and is the convex to the upper side. And, the depth of changing point is shallower 550m to the based depth.

In the case of 50km, the difference of the angle variation is large, then the propagation by the refraction that centered the depth of SC-axis is dominated. On the other hand, for 110km, the propagation by the bottom reflection and the refraction is dominated.

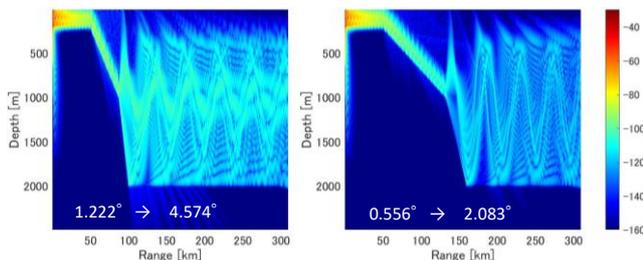


Fig. 4 Comparison of SF by C-slope convex to upper side (3/4 points of C-slope)
 Left; distance 50 km of C-slope right; for 110 km

4. Relation between change point of C-slope and depth of SC-axis

The comparison for the depth variation of the middle point (75km) in the case of 50km is shown in Fig. 5. The based depth in the middle point is

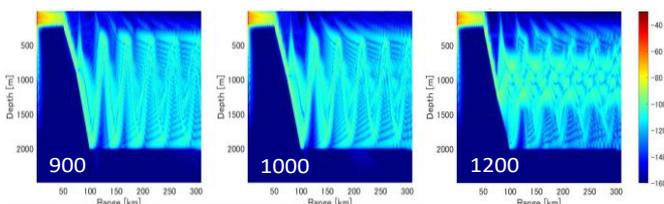


Fig. 5 Comparison of SF by depth for changing point
 left ; shallower 200 m from based depth
 middle; shallower 1000 m (same as the depth of SC-axis)
 right ; deeper 100 m (100 m below the depth of SC-axis)

1100 m. In the left figure, the depth of the changed point is 200 m shallower than the depth of SC-axis. The sound wave along the continental slope is reflected on the basin bottom, and the propagation is changed to the refraction and the bottom reflection in the basin region. In the middle figure, the depth of the changing point is 1000 m at the depth of SC-axis. The propagation in the basin is dominated by the refraction and the reflection, but is the propagation centered at the depth of SC-axis. In the right figure, the depth of the changing point is the depth of SC-axis + 200m. And the propagation by the refraction is dominated.

5. Summary

The shape of the propagation in the basin region to the shape change of C-slope is examined.

If the slope of C-slope is monotonically changed, the sound wave passed S-break is propagated along C-slope.

In the case of the convex to the upper side of C-slope, the sound wave is propagated along the C-slope. and its shape in the basin is the propagation of the bottom reflection and the refraction. And, in the case of the convex to the downward side of C-slope, the sound wave is away from C-slope. Moreover, the propagation in the basin is changed by the relation between the depth of the changed points and the depth of SC-axis. If the change point is shallower than the depth of SC-axis, the propagation is dominated the propagation of the bottom reflection and the refraction. But, if the change point is deeper than the depth of the SC-axis, the propagation by the bottom reflection and the refraction is changed into the propagation by the refraction.

References

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