Bottom Topography and Sedimentation of the Seto Inland Sea Bottom Current due to the Earth Rotation Effect

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1. Introduction

The greater part of the floor of the Seto Inland Sea is covered by soil and sand, rather mobile and fluid than not solid. Therefore the bottom feature of this sea is generally much influenced by currents over the floor. Although it has been mentioned by many researchers that the bottom feature has much relation to the magnitude of tidal currents, this report will show that the bottom topography and the sediment distribution are formed not only by tidal currents but also by residual currents, which generates the bottom currents with the aid of the Earth rotation effect.

2. The bottom current due to the residual current

Figure 1 shows the grain-size distribution shown by Mdϕ (Tanimoto et al., 1984). The grain-size is generally rough around straits with strong tidal currents and fine in bays or sounds with weak ones. It is recognized by a close look, however, that Mdϕ is rather variable in the inner part of bays or sounds. Such variations cannot be explained by the magnitude of the tidal current only by any means. Figure 2 shows the pattern of the residual current obtained by summing up a huge number of observations of tidal currents(Yanagi & Higuchi, 1979). The bottom feature off the straits can be expounded by the action of the residual current with the Earth rotation effect.

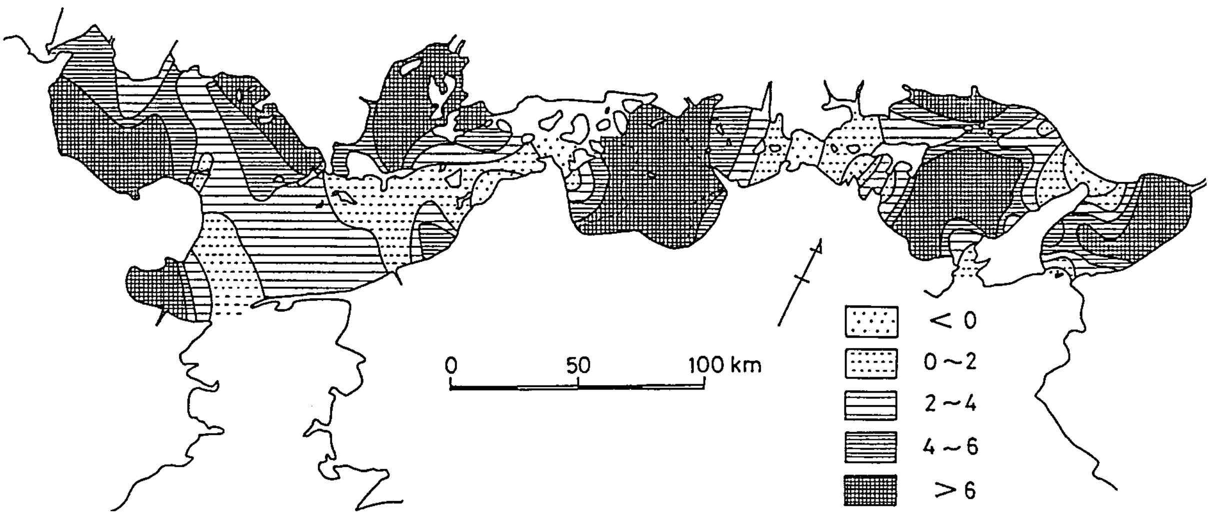

Fig. 1. Grain-size distribution shown by Mdϕ in the Seto Inland Sea

Several experiments on the formation of the Ekman layer have been carried out using a cylindric rotating basin. The outlines of this experiment are described as follows;

* The characteristic thickness of the Ekman layer usually defined as $\sqrt{2\nu_z/f}$, where ν_z and f are respectively the vertical viscosity and Coriolis parameter, is given as $\sqrt{2\nu_z/|f-\omega|}$ if the interior current is curved the angular velocity of which is ω.
* This new formula means that the anticyclonic current makes the layer

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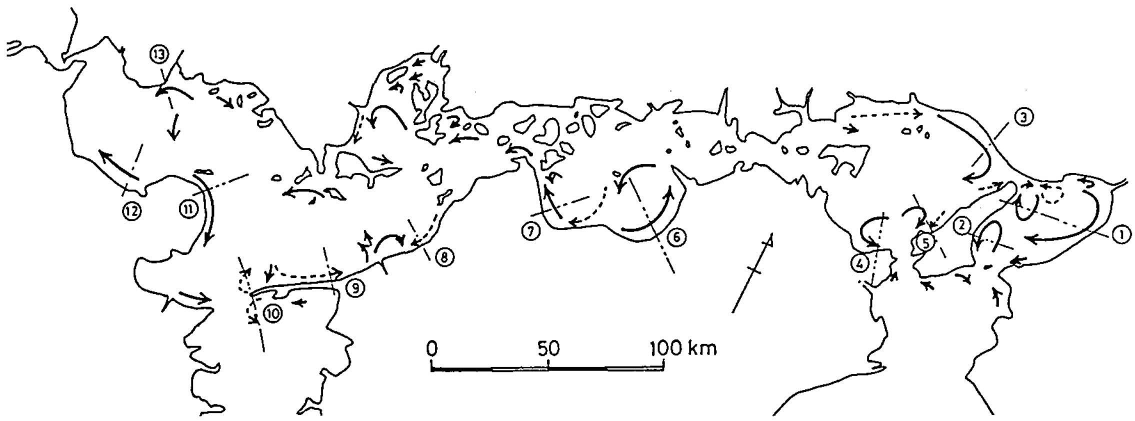

Fig. 2. Residual currents in the upper layer

thicker, on the contrary the cyclonic one makes the layer thinner. The current inner the Ekman layer (the bottom current) gets stronger in the cyclonic current and weaker in the anticyclonic one. The anticyclonic current with the angular velocity equal to f makes the layer thicker than the water depth and induces strong turbulence in the whole depth.

According to this experimental result and the rotating fluid theory (Pedlosky, 1979), the residual currents inducing the bottom current are classified into five types as Fig. 3. Types 1 and 2 are respectively the cases that the residual current flows at the right and left sides of the coast. Types 3 and 4 are respectively the cases of the anti-cyclonic and cyclonic circulations, and Type 5 is the case of the circulation with strong curvature, angular velocity of which is larger than the Coriolis parameter. Each type of residual currents induces its own bottom current as shown in Fig. 3. The combination of Figs. 2 and this generation process reminds us the bottom layer transportation as Fig. 4.

3. The bottom feature under the residual current

It is considered from this study that the strong tidal current stirs up the mud and is apt to dig the floor and that the weak tidal current cannot

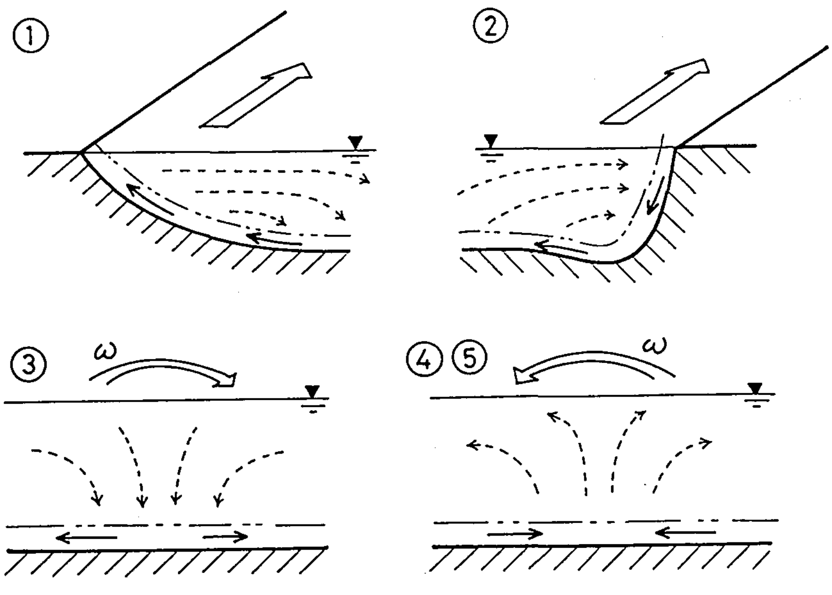

Fig. 3. Classification of the residual and bottom current

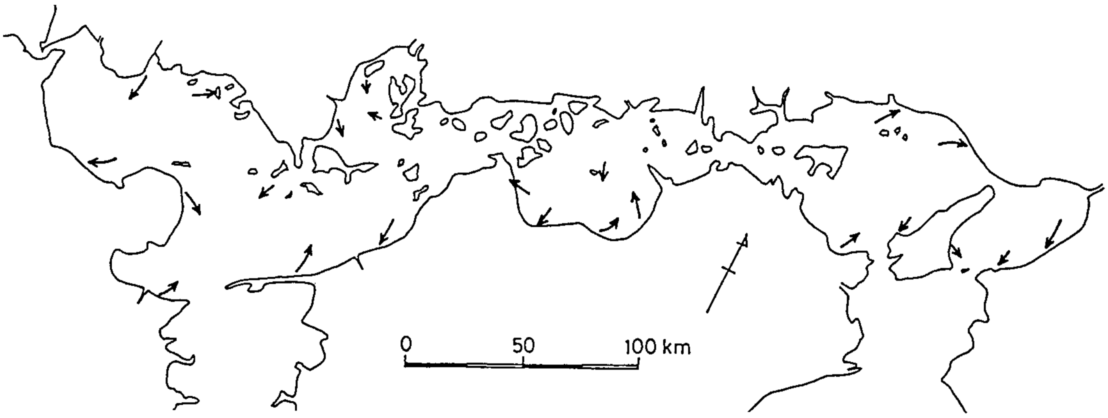

Fig. 4. Mass transport in the bottom layer

keep the mud in the waters and then the settled mud is distributed by the residual and the bottom currents in the weak current area(sound or bay). Figure 5 shows the cross-section of the floor the numbers of which correspond to those of Fig. 2. This figure and Fig. 1 elucidate that the floor of Type 1 is very fine in grain-size and shallow to a considerable distance from the shore and that of Type 2 is rather rough and deep at a short distance from the shore.

This study has presented the formation mechanism of the bottom feature in the bay or sound, elucidated so far by no researchers, in consideration of the residual current with the Earth rotation effect. Since the residual current is generally rather weak, it might be changed with ease by the underwater construction. The bottom current is considered to be one of important factors in modelling the mass transport in the coastal basin.

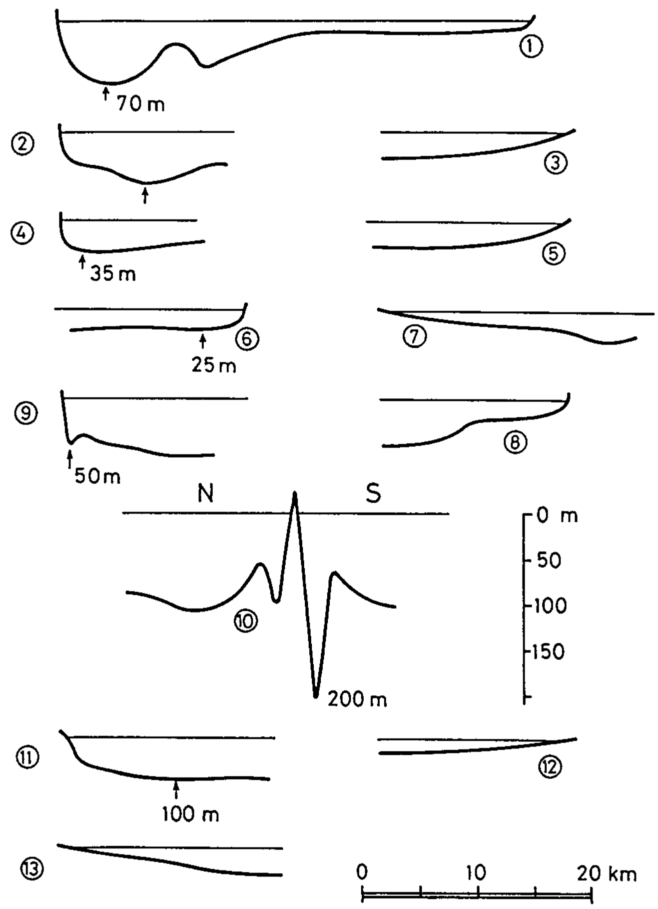

Fig. 5. Cross-sections of the bottom topography at each transverse line in Fig. 2

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