Tide and Tidal Currents in the Tusima Strait, and the Japan Sea Tides

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1. Introduction

New cotidal charts of the Tusima Strait has been edited by ODAMAKI (1989a) using tidal current observation data. For the semidiurnal tide as shown in Fig.1, two distinctive features are detected. One is an anti-amphidromic area located in the south coast of Korea. Another is the amplitude gap between west and east coasts of the Tusima. For the diurnal tide shown in Fig.2, an amphidromic point is found surprisingly near coast of the Korea compared to the traditional cotidal chart (Ogura 1933). O1 amphidromic point is found in the south-west of that of K1. The amplitude gap around the Tusima is found as same as for the semidiurnal tide.

Author consider that the anti-amphidromic area and the amplitude gap are local phenomena concerned to the Tusima Strait itself, but the amphidromic points locations of the diurnal tides are closely related to the tides in the Japan Sea. The Sea has three major straits, Tusima, Tugaru, and Soya Straits. Significance of these Straits adding to the Tusima Strait on the diurnal tides of the Japan Sea has been pointed out since early times (Ogura 1933). However, its mechanism has not been searched. Then, author has considered the amphidromic point location in the Tusima Strait is a key to understand the Japan Sea tides.

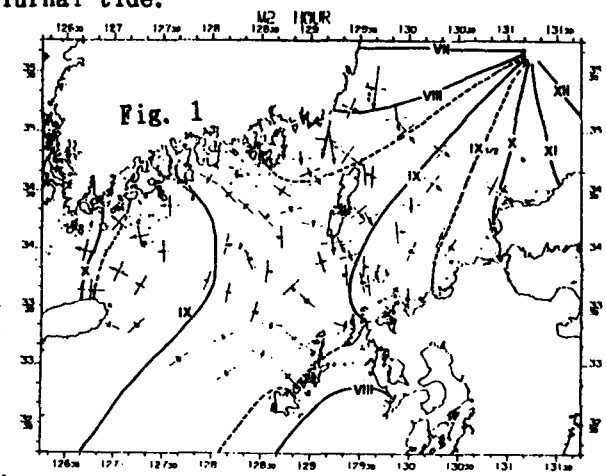
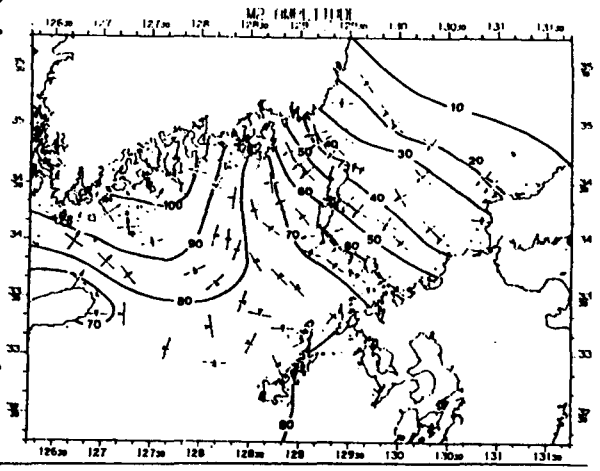


Fig. 1



2. Model

Each contribution of the Straits could not be made clear by Defant's definition of co-oscillating tide because its boundary condition (B.C. given with tide at the mouth is difficult to compose each other.

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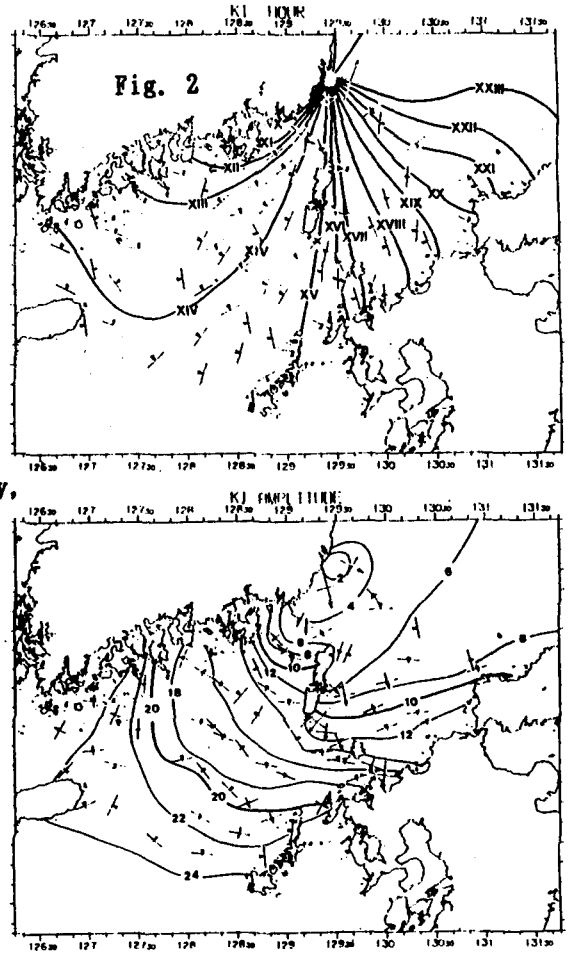
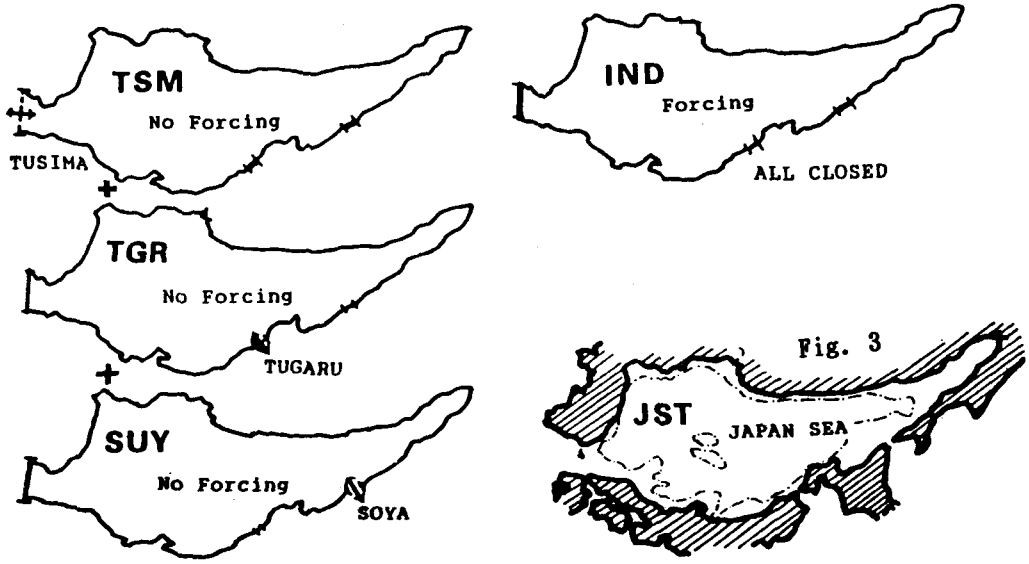
Then, using Garrett's new definition of co-oscillating tide which B.C. given with tidal current is easy to compose, the Japan Sea tide (JST) is considered as the composition of 4 components, independent tide (IND) and three co-oscillating tides (TSM, TGR, SUY) as shown in Fig.3. IND is an oscillation induced by tide generating force under the condition of all straits closed. TSM, TGR, and SUY are co-oscillating tides induced by the tidal currents at the Tusima, Tugaru, and Soya Straits, respctively, under the condition of other straits closed and no tide generating force. Then,

JST = IND + TSM + TGR + SUY .

For easy understanding, a simple one-dimensional model of the Japan Sea is used as shown in Fig.4. Boundary Condition of the tidal current in each strait is given from the observed data.





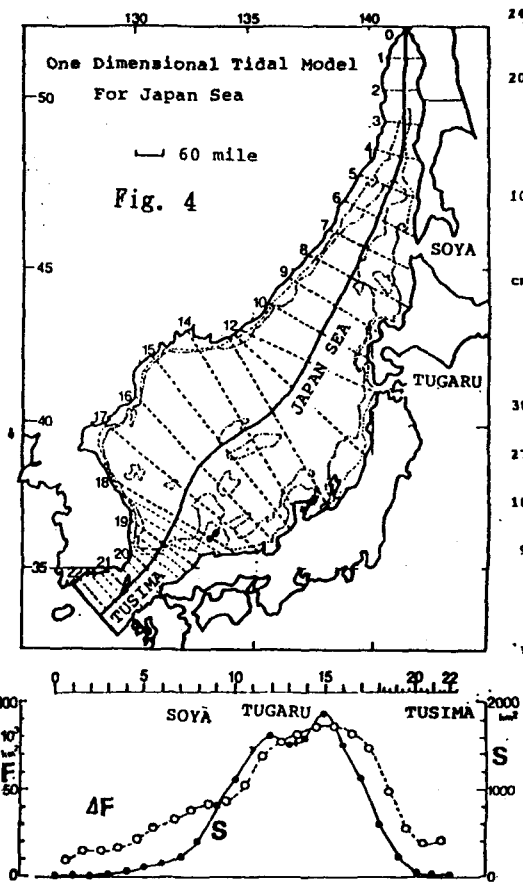


Fig. 4

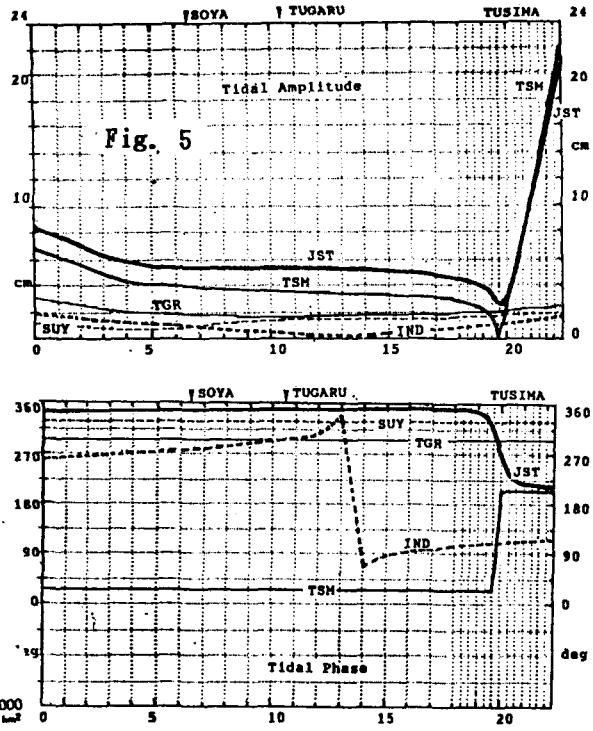


Fig. 5

3. Results

Calculated results for the diurnal tide (K1) is shown in Fig. 5. TSM shows Helmholtz mode oscillation which has a node in the entance, i.e. in the Tusima Strait. Its amplitude is dominant everywhere except near the nodal area. In the central area of the Japan Sea, TGR and SUY are 1.8cm and 1.5cm, respectively, which are about half of TSM 3.3cm. IND is less than 0.5cm. In the Tusima Strait, TSM increase to 22.7cm in the outerside, although the others remain about 1-2cm, and resultingly JST does not become zero. Considering horizontal distribution of co-phase and co-range lines, non-zero amplitude of the nodal point means the shifting of amphidromic point as shown in Fig. 6. Therefore, it is concluded that the location of amphidromic point very close to the Korean coast shown in Fig. 2 is an evidence of the contribution of TGR and SUY to the Japan Sea tide.

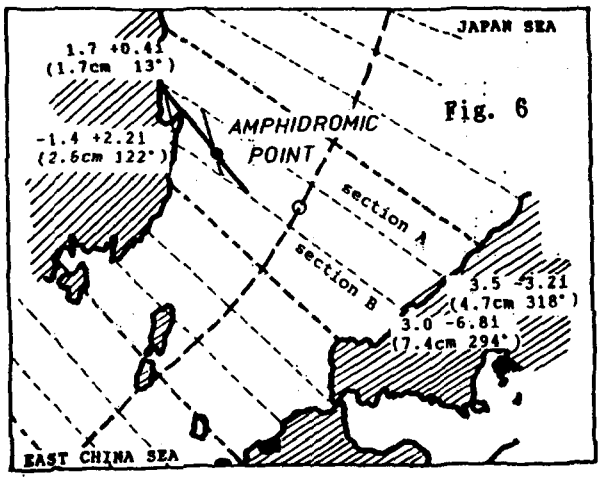


Fig. 6

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