GEOPHYSICS

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1961

SovietRxiv

Abstract

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NEW COTIDAL CHARTS OF THE SEMIDIURNAL TIDAL WAVES (M_2 and S_2) OF THE AUSTRALO-ASIAN SEAS

(Presented by Academician V. V. Shuleikin, 3 VIII 1961)

Tides in the region of the Australo-Asian seas (the Andaman, South China, Sulu, Celebes, Java, Banda, Timor, and Arafura seas and the Gulf of Carpentaria) have been poorly studied. It is known, however, that tides in this region of the World Ocean are of great practical importance, since the height of the tides reaches large values (from 1.0 to 8.0 m), and their character changes substantially from point to point throughout the water area under study. At present there are very few generalizing works on the tides of the Australo-Asian seas. Among them are the work of Van der Stok ([5]), which gives only cotidal lines along certain coasts; the work of Ogura ([4]), which gives cotidal charts of the M_2 and S_2 waves for the eastern part of the Australo-Asian seas, excluding the Timor and Arafura seas; and the last and most complete work, that of Dietrich ([3]), which gives cotidal charts of the M_2 and S_2 waves for the entire water area of the Australo-Asian seas and the characteristics of the tidal oscillations of sea level. Apparently, these works exhaust all the generalized information on the distribution of tidal waves and tidal level oscillations in the Australo-Asian seas.

A substantial shortcoming of the works mentioned is the outdated method of investigation and construction of cotidal charts, which were made by the method of cotidal hours at coastal stations without studying and taking into account the propagation of tidal waves in the open sea. Apparently, this partly explains the fact that the cotidal charts of Van der Stok and Ogura were constructed only for the part of the water area under study where the propagation of tidal waves has a simpler character.

With the increase in the amount of observational material on the coasts and numerous islands of the Australo-Asian seas, and with the development of a more advanced method for constructing cotidal charts, it became possible to construct more accurate cotidal charts for the entire water area of the Australo-Asian seas and to try to fill the gaps present on earlier charts.

For constructing the cotidal charts in the present work, the method of isogyres ([2]) was used, which had repeatedly been applied earlier for constructing cotidal charts of various seas. This method, as applied to seas, has a fairly high accuracy

Fig. 1. Cotidal chart of the wave M_2 (dashed lines show lines of equal amplitudes (H) in centimeters. Dots indicate stations with harmonic tidal constants included in the processing)

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([1]). A great advantage of the isogyre method is the possibility of obtaining an instantaneous picture of the state of the level surface of the water area under study and of tracing its successive change with time. The considerable simplicity of the method should also be counted among its advantages.

The Australo-Asian seas are an ideal region for applying the isogyre method. The comparatively small area of the seas, the great length of the coastline, and the numerous islands create excellent conditions for its application.

The source material for the present work consisted of the harmonic constants of tidal sea-level oscillations for the constituent waves M_2 and S_2 for 650 stations located along the coast and on numerous islands of the water area under study. These data were taken from various foreign sources (publications of the International Hydrographic Bureau and Admiralty tide tables) and reduced to a single system for reckoning position angles.

Fig. 1. Cotidal chart of the wave M_2 (dashed lines show lines of equal amplitude (H), in centimeters. Dots indicate stations with harmonic tidal constants included in the processing)

For ease of comparison with other charts and other regions of the World Ocean, all calculations and the construction of the cotidal charts were carried out in solar time for the Greenwich meridian. Preliminary computations of sea-level heights for each wave separately were made with the following values of the corrections: $B = 1$, $b = 0$, $C = 1$, and $c = 0$.

The preliminary computation of the sea-level height for each hour for all stations served as the basis for constructing charts of the co-phasal lines of the instantaneous sea-level surface in the Australasian seas. The charts of the co-phasal lines of the waves M_2 and S_2 formed the basis for constructing new cotidal charts of M_2 and S_2.

On the new cotidal charts, isolines of the amplitudes of the corresponding waves are shown by dashed lines. The material used to construct the amplitude charts consisted of the values of the harmonic constants H (the semi-amplitude of the wave) selected for stations located on the coast and islands of the Australasian seas. The amplitude charts were constructed by linear interpolation of the values of H over the water area of the Australasian seas.

taking into account the zero values of the amplitudes at the amphidromic points. The maps constructed in this way were combined with the corresponding cotidal

Fig. 2. Cotidal map of the S_2 wave (dashed lines indicate lines of equal amplitudes (H) in centimeters)

Figure 2: Fig. 2. Cotidal map of the S_2 wave (dashed lines indicate lines of equal amplitudes (H) in centimeters)

maps.

In the process of constructing the cotidal maps, substantial difficulties were encountered in interpreting the propagation of tidal waves, due to the great complexity of the phenomenon under study.

Figures 1 and 2 present new cotidal maps of the constituent waves M_2 and S_2. It can be seen from them that the tidal waves enter the waters of the Australo-

Fig. 2. Cotidal map of the S_2 wave (dashed lines indicate lines of equal amplitudes (H) in centimeters)

Asian seas from the east, from the Pacific Ocean, and from the west and south, from the Indian Ocean, as a result of which interference of tidal waves occurs in the waters of the Australo-Asian seas. This circumstance, as well as the complex shape of the seas, sharp changes in depth, and numerous bays and straits, create complex conditions for the propagation of tidal waves within the area under study. On the cotidal maps this is expressed in the presence of a large number of amphidromic systems and an uneven distribution of cotidal lines.

Table 1 gives the coordinates of the centers of the amphidromic systems, taken from the corresponding cotidal maps.

The new cotidal maps differ substantially from earlier maps by other authors. They indicate a number of new amphidromic systems that had never previously been noted in the waters of the Australo-Asian seas. The existence of these systems is confirmed by a number of actual observations, and their reliability cannot be doubted.

The correctness of the construction and the accuracy of the new cotidal charts were checked by predicting the heights of the semidiurnal tide for several island stations that have harmonic tidal constants and that were not included in the processing for constructing the cotidal charts. The curves

Table 1

Coordinates of the centers of amphidromic systems

No.	Index of the amphidromic system	φ	λ	No.	Index of the amphidromic system	φ	λ
Wave M_2	**Wave** M_2	**Wave** M_2	**Wave** M_2	**Wave** S	**Wave** S	**Wave** S	**Wave** S
1	A	11°25′ N	100°15′ E	1	A	11°45′ N	100°45′ E
2		5°10′ N	105°40′ E	2		4°10′ N	107°50′ E
3		0°	105°30′ E	3		1°00′ N	106°30′ E
4		2°07′ S	108°31′ E	4		1°25′ S	109°00′ E
5		4°44′ S	106°30′ E	5		13°28′ S	127°15′ E
6		5°35′ S	112°30′ E	6		10°30′ S	135°30′ E
7		12°00′ S	127°00′ E				
8		14°30′ S	137°30′ E				

of the level variation, predicted for a specified date from the actual harmonic constants and from the values of the harmonic constants taken from the new cotidal charts, almost coincide with one another. It follows from this that the accuracy of the new cotidal charts may be considered sufficiently high.

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Received
3 VIII 1961

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Note: Figure translations are in progress. See original paper for figures.