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# FIFTY YEARS AGO...

The subject of Tides and Tidal Currents, their observation and analysis, has been of concern to the International Hydrographic Organization for more than 50 years as is evidenced from the following extracts on the subject published in *The Hydrographic Review*, Vol. XI, No. 2, of November 1934.

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## ON THE TIDES AND TIDAL CURRENTS IN THE NORTHERN PART OF THE HWANG HAI (YELLOW SEA)

by SINKITI OGURA

In Japanese. *Suiro Yôhô* (Hydrographic Bulletin) 12 (1933)

Extract from the *Japanese Journal of Astronomy and Geophysics*, Vol. XI, No. 3. National Research Council of Japan, Tokyo, 1934, pp. 41-42.

The author first gives the results of current observations at twelve stations remote from land in the Hwang Hai made within recent years by the Hydrographic Department and fisheries institutions of Japan. The observations at each station were made at various depths below the surface and extended for about 24 hours. The author decomposed the observed currents into the north and east components, and then each of them into semi-diurnal and diurnal components by assuming a period of 24 hours 50 minutes. The direction, velocity and time of the maximum and minimum currents were obtained both for semi-diurnal and diurnal currents. By assuming probable relations existing among the amplitudes and phase lags for semi-diurnal component tides and those for diurnal components, the author derived the harmonic constants of $M_2$ and $K_1$ currents for the directions of the maximum and minimum velocities. The results of observations and analysis may be summarized as follows :

1. The oceanic or non-periodic current seems to increase with the depth below the surface, but there is no definite relation between the depth and direction of current. The depths of the sea at current stations are from 31 to 76 metres.

2. For the semi-diurnal current the direction revolves with time counter-clockwise at the greater number of stations; for the diurnal current the number of stations at which the direction revolves counter-clockwise and clockwise is nearly equal, the velocity of diurnal current being generally smaller than that of semi-diurnal current.

3. The results of current observations at six stations show that the time of the maximum velocity of current is nearly the same at various layers below the surface, that the direction of the maximum velocity is nearly the same from the surface of the sea to the bottom, and finally that the velocity of current at a depth D (expressed by unit of the depth of the sea) below the surface at the time of maximum strength can be expressed by the following formula :

$$\text{Velocity} = 0.87 + 1.11\,D - 1.27\,D^2$$

4. The results of current observations above stated as well as those made at a number of coastal stations extending over a shorter period show that semi-diurnal current is nearly simultaneous all over the northern part of the Hwang Hai, running with its maximum strength to the north-east or to the east towards the Oryoku Kô (Yalu River) at 6.4 hours (lunar time of the meridian 135° E) and to the opposite direction at 0.4 hour.

5. The directions of diurnal current in the northern part of the Hwang Hai are principally in the east and west and the time of turn of current slightly retards from the east to west.

6. In the western half of the northern part of the Hwang Hai, or on the north side of the Shantung Peninsula, the diurnal inequality of tidal currents is very conspicuous and the current diagram is very complicated, the current often running once to the east and once to the west in a day when the moon is far from the equator.

In conclusion, the author studies the tides in the northern part of the Hwang Hai by the data of current observations and tidal observations. He calculates the gradient of sea-level and directions of co-tidal and co-range lines by using the data of current observations. From the gradient of sea-level thus obtained, combined with the data of tidal observations on the coast, the tidal constants at each current station were obtained. Finally he prepared a co-tidal and co-range chart of tides $M_2$ and $K_1$. The characteristic feature of the co-tidal chart of $M_2$ is the existence of an amphidromic point very near to the east of the Shantung Promontory, around which the tidal wave revolves counter-clockwise in 12 hours. The co-tidal chart of $K_1$ tide shows that an amphidromic point exists in the Pwok Hai very near to the Pechili Strait, around which the tidal wave revolves counter-clockwise in 24 hours.

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## ON THE CURRENT IN THE OKHOTSK SEA AND THE ORIGIN OF THE "OYASIO"

by Ryôiti SIGEMATU

In Japanese. *Suiro Yôhô* (Hydrographic Bulletin) 12 (1933)

Extract from the *Japanese Journal of Astronomy and Geophysics,* Vol. XI, No. 3. National Research Council of Japan, Tokyo, 1934, pp. 42.

The author has prepared two dynamical charts of the Okhotsk Sea in the summer season, one from the results of hydrographical observations made in 1916 by the *Unyô Maru* belonging to the Imperial Fisheries Institute, and the other from observations made in 1917. These charts reveal a south-going current in the middle part of the sea. One part of this current returns northward off the west coast of Kamchatka, and the remaining part runs out to the Pacific through the middle part of the Kurile Islands. In the western part of the sea it is expected that several systems of vertical currents will be found to exist.

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# AN ANNUAL PERTURBATION IN THE RANGE OF TIDE

by R.H. CORKAN, M.Sc., Liverpool Observatory and Tidal Institute
(Extract from *Proceedings of the Royal Society,* A, Vol. 144, London, 1934, pp. 538-559).

On several occasions seasonal changes in the semi-diurnal tides have been ascertained to exist. In 1902 and 1903, DARWIN noted their presence at Ross Island in the Antarctic; others have been noted in Chesapeake Bay and its tributaries, from monthly averages calculated. In 1925 the Tidal Institute noted their existence in the tides of Newchwang.

Tidal analysis in the past has been restricted to a search for constituents indicated by the tide generating potential and by the shallow water theory. In the Report of the British Association for 1923, Professor PROUDMAN has shown that additional frictional constituents are possible. However, none of the above suggests an annual variation in the range of tide. For the purpose of continuing the investigations, a direct method of analysis for such an annual perturbation was considered desirable.

Constituents which will produce an annual perturbation of $M_2$ may be considered as having either of the following arguments :

$$[(\text{Argument of } M_2) - h]$$
$$[(\text{Argument of } M_2) + h]$$

where h is the mean longitude of the sun. The above two constituents have been called $MA_2$ and $Ma_2$ respectively; they perturb $M_2$, the principal lunar constituent, once in the year. These constituents, which are conjugates with respect to $M_2$, have been chosen so that $MA_2$ loses and $Ma_2$ gains on $M_2$ very approximately 1 degree per day.

Five years' observations of the Liverpool tides, 1918, 1920, 1922, 1924 and 1930, have been analysed for these new constituents and the results indicate that the perturbation shows a definite consistency of phase from year to year. Over the five years examined the average perturbation was 1.25 % of that of $M_2$.

The Tidal Institute has had occasion to determine the values of the constituents $MA_2$ and $Ma_2$ for various places in the British Waters, and to notice that this perturbation exists generally around the British Isles.

Analyses have revealed the existence of this perturbation in many other places also, such as Saint John, N.B., Punta Delgada, Port Hedland, Johore Baru.

The real causes of these perturbations are not yet very well known; they might, perhaps, be attributed to periodical modifications in the conditions of the various seas or rivers, such as ice conditions at the boundary of the polar regions, or predominating winds in the direction of the channels — at any rate the annual perturbation is undoubtedly produced, to a certain degree, by local meteorological conditions.

Generally speaking, at a number of places the importance of the annual perturbation in the range of the tide has been noted as of sufficient importance for inclusion in future tidal predictions, for instance, when a limit amplitude of 1 % of $M_2$ is reached; besides, it has been noted that the phase of the perturbation $MA_2$ or $Ma_2$ has a consistency which can generally be relied upon; on the other hand, the value of the amplitude may vary from year to year. Thus it is necessary to proceed with caution where the amplitude is concerned and it would appear advisable for this reason to have two or three years' analyses available previous to considering the inclusion of these perturbations in the predictions.