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.

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

by

RYÔITI SIGEMATU.

(In Japanese. *Suiro Yôhô* (Hydrographic Bulletin) 12 (1933), pp. 325-8, 3 pl.).
Extract from the *Japanese Journal of Astronomy and Geophysics*, Vol. XI, No. 3,
National Research Council of Japan, Tokyo, 1934, page (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.

AN ANNUAL PERTURBATION IN THE RANGE OF TIDE.

by

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(Extract from *Proceedings of the Royal Society, A, Vol.* 144, London 1934, pages 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:

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

or

$$\left[(\text{Argument of } M_2) + h\right],$$

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.

THE GREATEST DAILY TIDE

by

H. A. MARMER.

(Extract from *Geographical Review*, New York, April 1934, page 334).

The daily type of tide is not of wide occurrence. A glance at a map of types of tide (see H. A. BAUER'S *Types of Tide* map, *Geogr. Rev.* Vol. 23, 1933, facing p. 266) shows such tides to occur in certain regions on the Gulf of Mexico, in Alaska, in the Philippine Islands, on the coast of China, and in a few other scattered localities. And as a rule the range of the tide at such places is small, a matter of only a few feet at most.

Observations made by Russian and Japanese investigators, which have come to light recently, show that the Okhotsk Sea is to be added to the regions in which daily tides occur. And what gives these tides special interest is that they have large ranges. The largest range occurs in Penzhinskaya Bay, which forms the north-eastern head of the Okhotsk Sea. In the upper part of this bay, at Cape Astronomicheski, the Russian Hydrographic Department secured a month of observations. During this month there were only a few days in which two high and two low waters occurred; the greater part of the time there were but one high and one low water each day. The average range of the tide was 22 feet, the average range of the daily tide was 28 feet, and on one day the range was 37 feet. At this point therefore is found the greatest daily tide in the world, as far as known.
