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Results of the Harmonic Analysis of Tidal Observations Made at Various Ports of Japan.

By

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With 28 Plates.

Introduction.

In the following pages are given the harmonic constants of the tides, derived from the marigrams or records of the direct readings of the height of the water at the observing stations provided by the Land Survey Department of the Army or by the Temporary Offices for constructing the harbours at the ports of Yokohama and Kobe. Some descriptive information about the stations and the work is also given.

Before the present work was undertaken exact knowledge about the tides along the coasts of our country was very meagre, and although some observations, both automatic and personal, had been taken, the harmonic constants of the tides, deduced, as they must be, from a long series of observations, were entirely wanting. To fill up this deficiency, I first tried to reduce some observations made at the port of Yokohama as an experiment, and the work of computation was carried on by the members of the Tokyo Astronomical Observatory under my supervision.

As the scheme proved successful, in order to carry it on further, with economy of labour and cost, I proposed to the Geodetic

Committee that it should take up this work in an extended form. Fortunately the Committee approved my proposition, and the work was begun in 1900 under my superintendence.

The method of analysing is entirely that of Prof. Darwin. At first, in order to reach the final results with the least labour and smallest expense, his various methods were tried, and for some of them the clerical labour was reduced by the use of the Japanese abacus (a simple calculating machine). The method of stencils, used in conjunction with the abacus, seemed promising, especially when modified into the form drawn on tracing paper. But finally I came to the conclusion that the last method by Prof. Darwin is the most convenient, and it alone has been used.

Although the work is done by the Geodetic Committee, the Committee has no tidal observatory. Thus at the beginning of the work the material was borrowed from the Land Survey Department. At that time, the number of tidal observatories was not so large as we have now. By and by more observatories were established and our work became necessarily extended. In the course of nearly ten years the frequent changes of the computers made the progress of the work quite slow.

This work relates only to the measurements of the marigrams and their reductions, and we are not concerned at all with the construction of the tidal observatories and the setting of the tide-gauges therein, nor with the operations of the observatories. But for the sake of convenience, some remarks on these matters are included in the present Report, and for these we are indebted to the information kindly supplied by the authorities of the observatories.

As the superintendent of the work, I desire to express my sincere thanks to the following gentlemen who kindly supplied

the material:—General Baron Fujii, formerly director of the Land Survey Department, General Okubo, the present director of the Land Survey Department, General Tasaka, formerly head of the Triangulation Department, Mr. Sugiyama, surveyor in the Land Survey Department, Mr. Niwa, the head of the temporary office for constructing the harbour at Yokohama, and Mr. Saito, the head of the temporary office for constructing the harbour at Kobe.

Among others, Messrs. Naozo Ichinohe, Masao Hashimoto, Shozaburo Tashiro, Kiyohiko Ogawa and Sakae Nasa rendered efficient service in the progress of this work, and it is my pleasure to acknowledge their valuable assistance. I here express my special thanks to Mr. Ichinohe, who has arranged the material and written the present report. Above all, I am very much obliged to Prof. Terao, the president of the Geodetic Committee, who showed continuous interest in the progress of the work.

The Sites of the Observatories.

At present, there are two permanent observatories on the coast of Hokkaido, one of them on the coast of the Pacific Ocean and the other on that of the Japan Sea, six permanent observatories and two temporary ones along the coast of Honshu, three of them on the Pacific coast, one of them on the coast of the Seto Inland Sea and the remaining four on the coast of the Japan Sea; none along the coast of Shikoku; two permanent observatories on the coast of Kyushu, one of them facing the Pacific Ocean and the other the Eastern Sea, and also two permanent observatories on the coast of Taiwan (Formosa), one of them facing the Eastern Sea, and the other the China Sea. Thus classifying the sites

according to the sea on the coast of which the observatory is placed, we have the following summary:—

The Pacific: Hanasaki, Ayukawa, Yokohama, Aburatsubo, Kushimoto, and Hosojima.

The Japan Sea: Otaru, Iwasaki, Wajima, and Tonoura.

The Seto Inland Sea: Kobe.

The Eastern Sea: Fukabori and Kiirun (Keelung).

The China Sea: Takaw (Takow).

These sites were selected by the Land Survey and other Departments after careful investigation, having regard to the following points: ready communication with the sea, deep water at low tides, shelter from storms, freedom from freshets, and non-proximity to the head of a bay or tidal river, in order to represent well the states of the tides in a considerable area. For the two temporary observatories, the selection of the sites was limited to finding the part where the water is comparatively calmest in the port. The distribution of these fourteen sites is indicated in the accompanying map, Plate I, and the approximate geographical co-ordinates of these observatories are given in the following table.

Observatory	Long. E.	Lat. N.
Takaw	120° 16′	22° 37′
Kiirun	121 45	25 9
Fukabori	129 49	32 41
Hosojima	131 40	32 25
Tonoura.....	132 4	34 55
Kobe	135 11	34 41
Kushimoto	135 46	33 28
Wajima	136 54	37 24
Aburatsubo	139 37	35 10
Yokohama.....	139 38	35 27

Observatory	Long. E.	Lat. N.
Iwasaki	139° 54′	40° 35′
Ayukawa	141 31	38 18
Otaru	141 1	43 13
Hanasaki	145 35	43 17

Among these observatories, there are a few whose sites have been changed, because of some trouble that was found after the work of registering was begun, or for some other reason. With respect to these, the special reasons will afterwards be given, when we describe about each station.

All these observatories, except the two temporary ones at Yokohama and Kobe, belong to the Land Survey Department and are permanent in character.

Description of a Tide Observatory.

According to the information received from the Land Survey Department, the construction of the observatories and the instruments set in them are the same in their general features at each place, and only slight modifications are made to suit the sites selected. Thus the description of one observatory will be given as a specimen. As the writer had the opportunity of visiting the observatory at Aburatsubo, it is chosen here for description.

The tide observatory at Aburatsubo is built of brick and lined with wood inside. Its size is very small, leaving only a space of forty square feet inside, and it is divided into two parts. One of them is larger, measuring about twenty-five square feet, and serves as the instrument room. The other portion is considerably smaller and serves as the clerk's office. The outer doors open into the clerk's room and when we open another pair of doors opposite to them, we are admitted into the instrument room. As that

room has two small windows, one at each side, the interior is sufficiently lighted to examine or adjust the instrument and change the sheet, even when the front doors are closed. The clerk is advised not to leave both pairs of doors open at the same time. The foundation of the building is of stone and it rests also on the hard rock. The height of the floor is about two metres above the surface of the sea at the highest high tide, and the cylinder in the centre of the building, in which the float makes vertical motion according to the state of the sea water, communicates with the sea by means of a tube, far below the low tides. The bottom of the cylinder itself is about five metres below the floor. The mouth of the tube opens just outside the building.

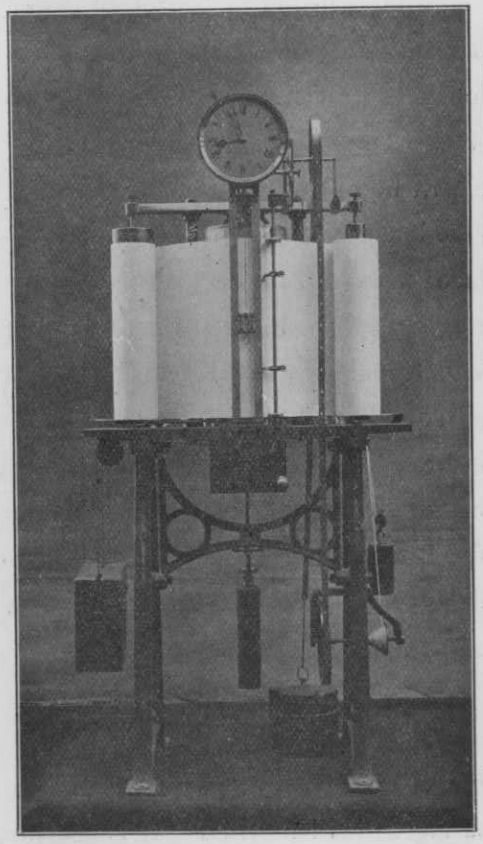
Very near the building there is a tide-staff made of stone and graduated to every decimetre. This is easily read, so that a comparison of the level of the water outside and inside the cylinder can be readily made; this will also be used to record the heights of the water when an interruption in the working of the tide-gauge occurs.

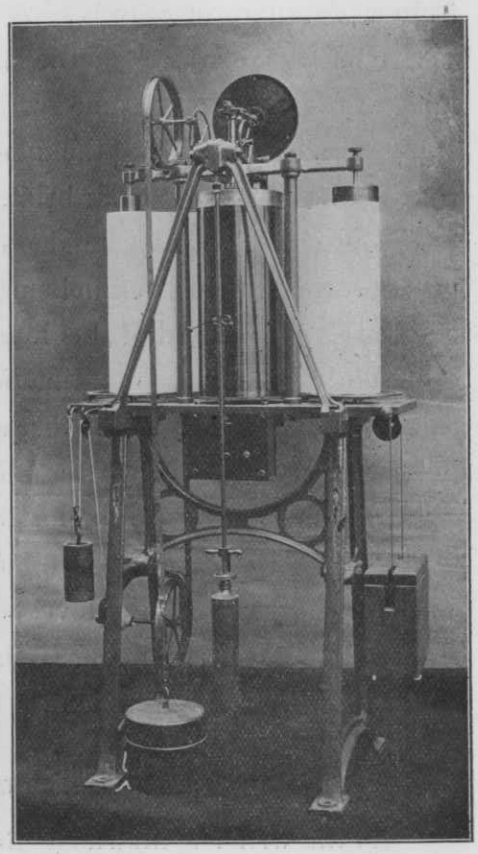
Only a little further from the building there is a benchmark, which is connected with the precise levelling of the whole Survey of the country. The height of the zero-point of the instrument is accurately determined with reference to this mark, and it is frequently checked.

Tide-Gauges.

All the tide observatories, except that at Yokohama, are provided with self-registering tide-gauges of some kind. For those belonging to the Land Survey Department of the Army, the instruments are of the improved form by Sir W. Thomson (Lord Kelvin), and they are constructed by Troughton and Simms. The instrument

at the station of Kobe is of a different type, having the drum horizontal, and was constructed by Bailey and Co. At the port of Yokohama a tide-staff graduated in *shaku* and *sun* is vertically fixed at a place where the water is very calm, and the direct readings of the heights of the water are taken every hour. The instruments of the improved form by Sir W. Thomson are so well known that there is no need to describe them in detail. So only two photographs are inserted here. These instruments are well constructed,





and although they have been in use since the first establishment of these observatories, they are still in good order, and give little trouble.

The approximate scale of the Thomson instruments is one twentieth, and that of the Kobe one is of one twelfth. But more exact scales are determined by comparing the readings of the water outside and inside the cylinder.

Sun-Dial.

In general, the tide observatory is situated at a locality where it is quite difficult to obtain the correct time, as the place is far from a post-office or railway. A simple sun-dial is therefore provided for the clerk from the Land Survey Department, with a table of the equation of time, which is so modified that, when we apply the correction to the observed time, the central standard time or the western standard time will be obtained.

The sun-dial may be described as follows. A rectangular piece of wood having parallel surfaces is taken, and on it a line is marked. At one end of this line a vertical rod is fixed and the other end of the horizontal line is connected with the upper extremity of this rod by a fine thread, so adjusted that the thread lies in the plane defined by the horizontal line and a vertical line erected at a point in the line. This instrument is used on a stand made for the purpose; it is a large stone having a plane surface. The surface is carefully levelled and on it a meridian line is marked. The clerk observes the transit of the sun over the meridian with this instrument.

The Duties of the Clerk.

As the writer is informed, the clerk has the duty of visiting the observatory twice in a day. He examines every part of the instrument and whether the recording is going on without hindrance. He takes the necessary care to put the instrument in

smooth running and good order. He records the comparison of the clock indication with the correct time. The height of the water is read from the tide-staff in order to obtain the working scale of the instrument.

Besides these duties, he observes the temperature of the atmosphere and the sea-water, and estimates the strength of the wind and its direction, when he visits the observatory.

The sheet is changed once in every ten days and the clerk draws on it the time lines at which he visited the observatory. The marigrams so preparad, with the other records and necessary remarks, are sent in to the Land Survey Department every tenth day.

Height of the Zero-Point of the Instruments.

The precise levelling in our country is carried on by the Land Survey Department of the Army, by comparing the heights of all the survey points with the fundamental datum in the garden of the Department. The height of the datum is referred to the mean sea-level observed in the Bay of Tokyo and the value adopted at present is 24.500 metres.

The heights of all the bench-marks about the tide observatories are referred to the mean sea-level of the Bay of Tokyo by means of successive comparisons with the datum at the Land Survey Department. The height of the instrumental zero-point is determined from the comparison of it with that of the bench-mark. Thus, in order to know the heights of the zero-points, referred to the mean sea-level of the Bay of Tokyo, we gathered the necessary constants for all the stations, as in the following table. There H_1 represents the height of the bench-mark referred to the mean sea-level of the Bay of Tokyo; H_2 the height of the zero-point of the

instrument referred to the bench-mark, and in this column the positive sign indicates that the bench-mark is lower than the zero-point, and the negative the contrary. In the column H_0 the sum of H_1 and H_2 is given; obviously it is the required height of the zero-point of the instrument, referred to the mean sea-level of the Bay of Tokyo.

Station	H_1	H_2	H_0
Takaw	—	—	—
Kiirun	—	—	—
	m	m	m
Fukabori	3.047	1.164	4.211
Hosojima.....	2.526	1.740	4.266
Tonoura	2.792	1.125	3.917
Kobe	—	—	—
Kushimoto	3.333	0.515	3.848
Wajima.	2.704	1.239	3.943
Aburatsubo.....	3.635	−0.039	3.596
Yokohama	—	—	−1.477
Iwasaki	3.244	2.229	5.473
Ayukawa.....	2.769	0.759	3.528
Otaru	—	—	—
Hanasaki.....	—	—	—

The Determination of the Distance of the Surface below the Zero-Point.

The tide-gauge is provided with two pencils, besides the one which actually draws the tidal oscillations; we can easily see them at the right-hand side of the right-hand scale in the figure of the instrument. Of course, these pencils may be moved up or down as much as we please, so that to adjust the distance between them. In this way, when the clock starts, the two straight lines which

they draw will appear on the sheet beside the tidal curve. Generally, the positions of the pencils are so adjusted that the curve is wholly included between these two lines. The measurement of the marigram is made downwards from the upper line, so that when the number is large the tide is lower, and when it is smaller the tide higher. Now if we wish to know the actual distance of the sea-water from the zero-point of the instrument, at a given time, we must determine the actual position of the line to which the upper datum line on the sheet corresponds. In order to accomplish this, the following arrangement is provided for the tide observatories belonging to the Land Survey Department. A board is placed at a fixed level between the zero-point of the instrument and the surface of the water. Every few days, the float is slowly drawn up until the bottom of the float is just above the upper surface of the board. Of course, while this process is going on, the registering pencil makes a corresponding vertical motion and finally marks the whole amount of displacement of the bottom of the float. If we measure the distance between the final mark and the curve at a given time, it will be the distance on the reduced scale corresponding to the actual distance between the upper surface of the board and the sea surface *plus* the sink of the float. Then the distance of the sea surface in the cylinder from the zero-point of the instrument will be determined if we know the distance between the zero-point and the upper surface of the board. We have accordingly gathered the necessary constants below, where D represents the distance between the zero-point and the upper surface of the plank, and S the amount of the sink of the float.

Takaw.

	D m	S m
1904	1.559	0.153
1905	1.559	0.153

Kiirun.

1905	0.849	0.097
1906	0.849	0.097
1907	0.849	0.098
1908	0.849	0.098

Fukabori.

1897	1.442	0.098
1898	1.442	0.098
1899	1.442	0.098
1901	1.447	0.098
1905	1.447	0.098

Hosojima.

1895	1.563	0.109
1896	1.563	0.109
1897	1.559	0.109
1906	1.559	0.109

Tonoura.

1895	1.536	0.122
1896	1.536	0.122

Tonoura.

	D_m	S_m
1901	1.536	0.122
1902	1.536	0.122
1903	1.536	0.122
1904	1.534	0.122

Kushimoto.

1897	1.474	0.100
1898	1.474	0.100
1899	1.474	0.100
1904	1.431	0.106
1905	1.431	0.106

Wajima.

1901	1.751	0.112
1902	1.751	0.112
1903	1.742	0.112
1904	1.742	0.113
1905	1.742	0.113

Aburatsubo.

1895	1.563	0.107
1896	1.563	0.107
1897	1.563	0.107
1898	1.563	0.107
1904	1.563	0.107

Iwasaki.

	D m	S m
1902	1.569	0.114
1903	1.568	0.114
1904	1.568	0.115
1905	1.568	0.115
1906	1.568	0.115
1907	1.568	0.115

Ayukawa.

1894	1.680	0.125
1895	1.680	0.125
1903	1.563	0.131
1904	1.563	0.131
1906	1.531	0.062

Otaru.

1902	1.398	0.092
1903	1.398	0.094

Hanasaki.

1897	1.270	0.083
1899	1.270	0.083
1900	1.200	0.083
1901	1.195	0.083
1902	1.195	0.083

The Working Scale of the Instrument.

As we have already stated, the approximate scale of the instruments at the permanent observatories is one-twentieth; but the following exact values of the working scales were obtained by the members of the Land Survey Department:—

Takaw.....	$1/20.09$	Wajima.....	$1/19.95$
Kiirun	$1/20.04$	Aburatsubo	$1/20.06$
Fukabori.....	$1/20.08$	Iwasaki	$1/20.11$
Hosojima	$1/20.08$	Ayukawa.....	$1/20.12$
Tonoura	$1/20.00$	Otaru	$1/20.41$
Kushimoto.....	$1/20.13$	Hanasaki.....	$1/20.03$

Preparation of the Marigram for Reduction.

The tide-gauges have pins round the drum both at the top and the bottom. These pins, perforating the sheet, mark the beginning of each hour and carry the sheet forward as the drum revolves. The perforations thus made in the sheet are used as hour marks, but as the clock rate is not uniform, the due correction is applied to draw the hour lines. This preliminary operation being made, the measurement of the height of the water is performed for each hour. To ensure that the records are free from mistakes, the same marigram was measured by two independent computers and their readings were carefully compared together. When these agree well within the error of measurement, one of them is taken for the further reduction and the other is preserved for future reference. Of course, in case one measurement differs too much from the other the marigram is again measured to rectify the mistake of the reading. For the measurement, a scale which is two decimetres long

graduated to half millimetres, is used, so that when we estimate each division to its tenth part, the actual height of the water is measured to a millimetre. But as one-twentieth is only the approximate value of the scale of the instrument, it is necessary to multiply the reading by the ratio, the assumed scale by the working scale, in order to obtain the true height of the water. In our case, we did not multiply each reading by this ratio, as our object was to derive the harmonic constants and the mean sea-level; so only the results of the analysis are reduced to the working scale.

The measurements on the marigrams provided by the temporary office for constructing the harbour of Kobe are different from the above, as the curve is drawn on a sectioned paper, properly scaled in hours and feet. The height of the water is read here to the one-hundredth part of a foot.

The observations at the port of Yokohama were read to the one-tenth part of a *shaku*.

All these results are entered in the form S. Each series of S-sheets begins at the beginning of each corresponding year and extends to the end of the year.

Harmonic Analysis.

The method of analysis is entirely that of Professor George H. Darwin: the reduction forms are made according to him. The rearrangements of the observed heights from the form S for variety of time to be reckoned for have been made by means of strips with short pins on their under sides, so that they can be stuck on to a drawing board in any desired position, according to the guide sheets prepared by Professor Darwin. In this work the Japanese abacus, a very simple but exceedingly convenient computing

machine, did good service in the addition. Harris's "Manual of Tides," and especially the tables at the end of each volume, were also consulted with great advantage.

In our case, the number of waves on which harmonic analysis are made is limited to twenty-eight, and these are as follows:— S_1, S_2, S_4, S_6, M_1, M_2, M_3, M_4, M_6, O_1, K_1, K_2, P_1, J_1, Q_1, L_2, N_2, μ_2, ν_2, R_2, T_2, MS, 2SM, Mm, Mf, MSf, Sa, and Ssa; namely,

6 semi-diurnal lunar tides,
5 diurnal lunar tides,
3 long period lunar tides,
3 semi-diurnal solar tides,
2 diurnal solar tides,
2 long period solar tides,
5 overtides,
and 2 compound tides.

The Results of the Analysis.

The results of the harmonic analysis are given in detail in the following tables. Here the results at each station are described in a separate table. The arrangement of the tables will be understood by the explanations below. First, a map of the ground surrounding the tidal observatory is attached at the end of the report, which is generally a reproduction from the hydrographic chart of the Hydrographic Department of the Navy. In it the exact location of the observatory is clearly marked. The scale of these maps is not uniform, as we wished to give a general idea of each station and this made it necessary to change the scale to suit the conditions of each place. Next, short notes relating to the station are made, including the mean sea-level derived from each series and referred to the zero-point of the instrument.

In the tables following the notes, the amplitude and the phase constant of each component of tides are given for each year-series. So far the values of the amplitude and the mean sea-level are measured by the assumed scale, for the series of the observations made by the Land Survey Department. But the material provided by the temporary offices for constructing the harbours at Yokohama and Kobe has been converted into the metric system.

Finally specimens of the marigrams at high and low water are appended; these are four in number, the first two showing the highest high and lowest low water, and the latter two the tides of the largest and smallest range.

In pp 62-67, we gave the mean values of the amplitude and the phase constant for each station, and here the former is reduced to the working scale. In these tables, the second row shows the number of years on which the mean values rest.

TAKAW.

Long. 120° 16′ E. Lat. 22° 37′ N.

This is one of the permanent observatories in the island of Formosa, belonging to the Land Survey Department of the Army, and the site was chosen at the northern side of the bay and at the mouth of it, as indicated in the accompanying map. The first registration of the height of the water was made on the first of November, 1903, and since then continuous observations have been carried on without serious trouble.

The instrument is Thomson's self-registering tide-gauge and the scale is nearly one-twentieth.

At present, only the reductions for the two years, 1904 and 1905 are completed.

The highest high-water recorded in these two years was 2.61^{m}, referred to the zero-point of the instrument, and it occurred on July 17, 1904. The lowest low-water recorded was 4.04^{m}, referred to the same origin and occurred on December 26, 1905. Thus the extreme range is 1.43 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained as follows for each series:—

1904	3.382^{m}
1905	3.424

Harmonic Constants at Takaw.

Tide	1904		1905		Tide
	H	κ	H	κ	
	m	°	m	°	
S_1	0.0062	52.21	0.0028	81.87	S_1
S_2	0.0615	248.44	0.0631	246.65	S_2
S_4	0.0005	11.31	0.0003	270.00	S_4
S_6	0.0002	116.57	0.0006	135.00	S_6
M_1	0.0084	273.99	0.0108	248.68	M_1
M_2	0.1526	244.94	0.1538	241.37	M_2
M_3	0.0028	243.91	0.0024	266.24	M_3
M_4	0.0006	212.73	0.0012	229.66	M_4
M_6	0.0018	44.38	0.0020	33.80	M_6
O	0.1505	256.63	0.1513	255.84	O
K_1	0.1569	296.26	0.1540	293.71	K_1
K_2	0.0190	255.66	0.0138	257.67	K_2
P	0.0518	293.70	0.0524	288.56	P
J	0.0047	321.39	0.0045	298.70	J
Q	0.0275	239.50	0.0308	249.73	Q
L	0.0027	235.89	0.0100	206.26	L
N	0.0337	237.00	0.0343	237.61	N
ν	0.0108	297.75	0.0095	233.67	ν
μ	000.35	149.05	0.0015	171.77	μ
R	0.0016	285.95	0.0016	203.72	R
T	0.0066	202.05	0.0035	260.17	T
MS	0.0063	225.52	0.0055	225.51	MS
2SM	0.0029	272.35	0.0025	234.48	2SM
Mm	0.0130	329.35	0.0109	6.82	Mm
Mf	0.0098	296.21	0.0049	39.65	Mf
MSf	0.0050	36.72	0.0106	335.19	MSf
Sa	0.1445	149.26	0.0941	144.49	Sa
Ssa	0.0343	323.61	0.0109	20.76	Ssa

KIIRUN.

Long. 121° 45′ E., Lat. 25° 9′ N.

As one of the permanent observatories in the island of Formosa, it is placed on the western side of Sharyo-To, an islet at the mouth of the harbour of Kiirun. This observatory was originally established by the government of Formosa, and was afterwards transferred to the Land Survey Department.

The instrument here used is also Thomson's tide-gauge.

The first registration took place on May 13, 1904, and the recording has gone on continuously since that date. The harmonic analysis is applied to the series obtained in the years 1905, 1906 and 1907.

The highest high-water recorded was 2.19, referred to the zero-point of the instrument, and occurred on November 13, 1906. The lowest low-water was 4.00, referred to the same origin, and occurred on January 1, 1908. Thus the extreme range of the tides is 1.81 metres.

The height of the mean sea-level, based on the marigrams obtained in each year, is derived as follows, the values being referred to the zero-point of the instrument:—

	m
1905	3.099
1906	3.048
1907	3.047
1908	3.040

Harmonic Constants at Kiirun.

Tide	1905		1906		Tide
	H	$\varkappa$	H	$\varkappa$	
	m	*o*	*m*	*o*	
S_1	0.0040	100.18	0.0042	105.02	S_1
S_2	0.0532	281.06	0.0513	279.32	S_2
S_4	0.0015	331.70	0.0016	317.49	S_4
S_6	0.0003	180.00	0.0008	66.80	S_6
M_1	0.0096	178.26	0.0063	263.39	M_1
M_2	0.1957	286.57	0.1885	290.73	M_2
M_3	0.0066	181.96	0.0056	180.07	M_3
M_4	0.0092	292.06	0.0091	304.06	M_4
M_6	0.0035	238.78	0.0034	258.83	M_6
O	0.1533	204.28	0.1525	206.81	O
K_1	0.1857	227.61	0.1865	229.90	K_1
K_2	0.0145	267.50	0.0115	258.94	K_2
P	0.0621	225.68	0.0571	227.23	P
J	0.0104	243.08	0.0108	244.92	J
Q	0.0319	192.78	0.0315	192.88	Q
L	0.0141	16.19	0.0126	8.05	L
N	0.0543	264.86	0.0485	267.11	N
ν	0.0212	272.50	0.0065	253.14	ν
μ	0.0252	155.83	0.0258	150.55	μ
R	0.0077	150.22	0.0053	205.01	R
T	0.0050	270.94	0.0050	281.12	T
MS	0.0141	292.06	0.0144	301.62	MS
2SM	0.0074	245.36	0.0055	268.32	2SM
Mm	0.0156	36.20	0.0104	295.80	Mm
Mf	0.0131	136.90	0.0160	41.45	Mf
MSf	0.0043	96.50	0.0092	2.80	MSf
Sa	0.0795	135.07	0.1391	124.64	Sa
Ssa	0.0290	235.00	0.0109	346.37	Ssa

Harmonic Constants at Kiirun.

Tide	1907		1908		Tide
	H	κ	H	κ	
	m	o	m	o	
S_1	0.0052	86.70	0.0061	74.83	S_1
S_2	0.0493	282.77	0.0502	280.91	S_2
S_4	0.0011	344.74	0.0017	327.26	S_4
S_6	0.0003	90.00	0.0000	90.00	S_6
M_1	0.0080	231.77	0.0134	238.68	M_1
M_2	0.1905	291.47	0.1895	292.31	M_2
M_3	0.0059	172.98	0.0051	164.20	M_3
M_4	0.0087	300.90	0.0085	302.23	M_4
M_6	0.0033	272.67	0.0035	252.91	M_6
O	0.1511	204.47	0.1553	203.34	O
K_1	0.1826	231.42	0.1848	230 29	K_1
K_2	0.0141	269.29	0.0137	274·97	K_2
P	0.0598	231.18	0.0626	229.21	P
J	0 0094	246.91	0.0084	254.34	J
Q	0.0305	189.79	0.0306	185.49	Q
L	0.0075	26.77	0.0116	56.35	L
N	0.0506	263.07	0.0517	262.15	N
ν	0.0104	337.54	0.0203	314.77	ν
μ	0.0237	150.39	0.0288	157.92	μ
R	0.0015	106 40	0.0056	220.28	R
T	0.0049	263.36	0.0044	235.87	T
MS	0.0134	301.52	0.0141	298.74	MS
2SM	0.0062	250.80	0.0064	251.83	2SM
Mm	0.0153	104.79	0.0045	28.55	Mm
Mf	0.0166	323.60	0.0074	70.81	Mf
MSf	0.0102	294.27	0.0075	12.96	MSf
Sa	0.1518	139.42	0.1333	140.62	Sa
Ssa	0.0320	343.58	0.0552	284.43	Ssa

FUKABORI.

Long. 129° 49′ E., Lat. 32° 41′ N.

This is one of the permanent observatories belonging to the Land Survey Department of the Army and is located on the western coast of the island of Kyushu, not very far from the port of Nagasaki. The coast line in this region is very irregular and forms a bay, which has the city of Nagasaki at its head. The observatory is not in the bay itself, but as there are many islands almost closing the mouth of the bay, the sea about the observatory makes a channel.

The first observatory was established very near the present location and from June 1, 1891, to January 1, 1895, continuous registration was tried, but as the pipe was very frequently choked with mud, it was thought that the marigram obtained there probably did not represent the true state of the sea-level.

The building was therefore moved to the present site and the first registration at it took place on April 1, 1895, and since then continuous work has gone on without great hindrance.

We have measured the new series only, and the harmonic constants obtained from the series of the marigrams of 1897, 1898, 1899, 1901, and 1905, are gathered in the present report.

The highest high-water recorded here was 2.17, referred to the zero-point of the instrument, and occurred on September 2, 1905. The lowest low-water recorded was 6.23, referred to the same origin, and occurred on March 30, 1900. Thus the extreme range is 4.06 metres.

The mean sea-level, referred to the zero-point of the instrument, results as follows from each year-series:—

	m
1897	3.986
1898	3.982
1899	3.996
1901	4.017
1905	3.994

Harmonic Constants at Fukabori.

Tide	1897		1898		1899		Tide
	H	κ	H	κ	H	κ	
	m	o	m	o	m	o	
S_1	0.0020	159.77	0.0020	40.91	0.0016	290.62	S_1
S_2	0.3784	267.91	0.3695	266.26	0.3704	267.88	S_2
S_4	0.0013	206.57	0.0013	184.40	0.0010	127.60	S_4
S_6	0.0005	306.87	0.0006	315.00	0.0008	113.20	S_6
M_1	0.0122	170.44	0.0042	94.70	0.0079	233.69	M_1
M_2	0.8348	240.43	0.8366	240.64	0.8318	239.13	M_2
M_3	0.0095	293.52	0.0110	267.08	0.0100	294.45	M_3
M_4	0.0097	339.54	0.0131	338.18	0.0102	338.44	M_4
M_6	0.0027	181.96	0.0032	205.05	0.0024	193.24	M_6
O	0.1953	191.34	0.2025	191.78	0.1948	190.74	O
K_1	0.2556	212.56	0.2515	213.48	0.2518	212.41	K_1
K_2	0.0959	267.46	0.1154	259.35	0.1024	265.00	K_2
P	0.0826	208.71	0.0896	208.61	0.0768	204.56	P
J	0.0152	233.15	0.0169	226.59	0.0188	225.60	J
Q	0.0431	184.05	0.0394	179.11	0.0391	170.58	Q
L	0.0223	203.15	0.0207	248.85	0.0243	186.86	L
N	0.1630	236,01	0.1544	237.03	0.1348	229.59	N
ν	0.0368	206.21	0.0083	66.99	0.0399	297.30	ν
μ	0.0398	227.66	0.0285	220.73	0.0292	251.23	μ
R	0.0111	79.42	0.0156	214.77	0.0238	235.35	R
T	0.0092	228.47	0.0292	269.15	0.0360	270.87	T
MS	0.0179	215.02	0.0171	225.52	0.0170	216.55	MS
2SM	0.0142	278.83	0.0096	256.46	0.0152	280.02	2SM
Mm	0.0081	241.17	0.0167	10.12	0.0014	122.44	Mm
Mf	0.0103	224.26	0.0058	211.33	0.0114	206.43	Mf
MSf	0.0141	3.60	0.0117	0.60	0.0108	4.34	MSf
Sa	0.1275	147.61	0.1525	148.80	0.1775	143.26	Sa
Ssa	0.0159	12.27	0.0565	71.81	0.0235	251.61	Ssa

Harmonic Constants at Fukabori.

Tide	1901		1905		Tide
	H	κ	H	κ	
	m	o	m	o	
S_1	0.0017	302.74	0.0028	237.99	S_1
S_2	0.3750	266.24	0.3694	266.35	S_2
S_4	0.0014	143.97	0.0029	139.19	S_4
S_6	0.0005	143.13	0.0011	254.74	S_6
M_1	0.0133	167.56	0.0103	163.44	M_1
M_2	0.8371	239.31	0.8318	238.93	M_2
M_3	0.0090	259.56	0.0097	296.49	M_3
M_4	0.0112	336.35	0.0105	337.04	M_4
M_6	0.0039	191.93	0.0032	210.25	M_6
O	0.1984	189.01	0.1954	189.93	O
K_1	0.2585	212.02	0.2553	210.36	K_1
K_2	0.0974	260.04	0.0986	262.22	K_2
P	0.0864	206.89	0.0840	205.02	P
J	0.0110	223.05	0.0161	227.17	J
Q	0.0408	180.85	0.0400	187.76	Q
L	0.0222	212.32	0.0310	234.32	L
N	0.1593	233.87	0.1666	231.07	N
ν	0.0463	203.05	0.0458	214.98	ν
μ	0.0390	226.49	0.0371	231.63	μ
R	0.0073	196.28	0.0071	252.10	R
T	0.0230	273.26	0.0265	262.85	T
MS	0.0174	215.16	0.0153	210.98	MS
2SM	0.0170	262.89	0.0161	269.89	2SM
Mm	0.0166	40.38	0.0057	62.38	Mm
Mf	0.0257	173.85	0.0135	133.61	Mf
MSf	0.0219	10.31	0.0046	120.19	MSf
Sa	0.2080	141.19	0.1784	162.17	Sa
Ssa	0.0382	327.17	0.0021	3.72	Ssa

HOSOJIMA.

Long. 131° 40′ E., Lat. 32° 25′ N.

This is one of the permanent observatories belonging to the Land Survey Department of the Army. As will be seen from the accompanying map, it is situated on the coast of the island of Kyushu, facing the Pacific Ocean. More exactly, the observatory is located at the eastern end of the town bearing the same name in a small inlet—Hosojima-Wan. The first registration being made on June 7, 1892, continuous work has gone on without any serious interruption since then.

The series of marigrams obtained in the years 1895, 1906, 1897, and 1906 were harmonically reduced and completed.

The highest high-water recorded here was 2.72, referred to the zero-point of the instrument, and occurred on August 24, 1895. The lowest low water recorded was 5.51, referred to the same origin, and occurred on January 13 of the same year. Thus the extreme range of the tides is 2.79 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, was derived as follows:—

	m
1895	4.194
1896	4.192
1897	4.116
1906	4.138

Harmonic Constants at Hosojima.

Tide	1895		1896		Tide
	H	$\varkappa$	H	$\varkappa$	
	m	o	m	o	
S_1	0.0140	88.77	0.0086	44.06	S_1
S_2	0.2164	208.60	0.2026	210.39	S_2
S_4	0.0012	90.00	0.0018	42.71	S_4
S_6	0.0008	240.26	0.0004	255.97	S_6
M_1	0.0068	227.20	0.0084	186.15	M_1
M_2	0.4990	183.82	0.4955	183.37	M_2
M_3	0.0060	207.28	0.0078	194.15	M_3
M_4	0.0024	306.78	0.0072	316.44	M_4
M_6	0.0011	332.24	0.0028	311.25	M_6
O	0.1555	172.18	0.1493	173.13	O
K_1	0.2032	193.89	0.1944	193.72	K_1
K_2	0.0538	195.00	0.0697	197.62	K_2
P	0.0568	192.32	0.0605	196.92	P
J	0.0101	202.65	0.0124	220.75	J
Q	0.0367	165.79	0.0317	165.56	Q
L	0.0245	165.02	0.0179	175.32	L
N	0.0950	176.43	0.0918	181.54	N
ν	0.0180	183.20	0.0181	161.09	ν
μ	0.0158	194.07	0.0170	194.26	μ
R	0.0164	137.05	0.0291	180.75	R
T	0.0226	241.82	0.0189	224.54	T
MS	0.0129	163.16	0.0088	166.03	MS
2SM	0.0086	322.89	0.0111	352.67	2SM
Mm	0.0336	21.71	0.0187	333.00	Mm
Mf	0.0173	13.89	0.0073	135.75	Mf
MSf	0.0134	45.25	0.0081	198.10	MSf
Sa	0.1600	170.03	0.1805	155.50	Sa
Ssa	0.0268	40.13	0.0395	72.32	Sa

Harmonic Constants at Hosojima.

Tide	1897		1906		Tide
	H	κ	H	κ	
	m	o	m	o	
S_1	0.0104	10.55	0.0066	96.05	S_1
S_2	0.2103	211.88	0.2055	223.94	S_2
S_4	0.0010	66.04	0.0021	60.95	S_4
S_6	0.0002	116.57	0.0005	168.69	S_6
M_1	0.0089	147.11	0.0054	224.50	M_1
M_2	0.4983	185.33	0.4878	200.50	M_2
M_3	0.0084	183.60	0.0080	216.81	M_3
M_4	0.0072	318.86	0.0135	336.69	M_4
M_6	0.0029	310.66	0.0019	8.64	M_6
O	0.1530	172.48	0.1509	180.80	O
K_1	0.2014	194.40	0.1940	201.91	K_1
K_2	0.0616	191.75	0.0744	213.29	K_2
P	0.0703	195.91	0.0650	205.98	P
J	0.0111	201.77	0.0113	228.61	J
Q	0.0279	163.53	0.0350	173.98	Q
L	0.0085	156.92	0.0221	195.95	L
N	0.0817	181.38	0.0991	196.11	N
ν	0.0252	155.46	0.0149	97.01	ν
μ	0.0210	180.39	0.0111	160.30	μ
R	0.0206	194.68	0.0021	247.58	R
T	0.0258	204.68	0.0173	236.02	T
MS	0.0076	172.51	0.0038	186.32	MS
2SM	0.0110	320.18	0.0094	314.92	2SM
Mm	0.0207	228.15	0.0051	181.51	Mm
Mf	0.0117	200.75	0.0011	288.26	Mf
MSf	0.0140	14.00	0.0161	51.15	MSf
Sa	0.0769	126.25	0.1271	140.67	Sa
Ssa	0.0852	34.62	0.0376	21.11	Ssa

TONOURA.

Long. 132° 4′ E., Lat. 34° 55′ N.

As one of the permanent observatories, this belongs to the Land Survey Department of the Army, and is located on the coast of the mainland, facing the Japan Sea. The site is on the eastern side of a branch of Hamada-Wan. The first registration was made on July 5, 1891, and since then recording has gone on pretty smoothly.

The series of marigrams obtained in the years 1895, 1896, and 1901-4 were harmonically reduced and their results are given in the accompanying table.

The highest high-water recorded here was 3.00, referred to the zero-point of the instrument, and occurred on August 21, 1904. The lowest low-water was 4.30, referred to the same origin, and occurred on January 30, 1903. Thus the extreme range of height becomes 1.30 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, was derived as follows:—

	m
1895	3.699
1896	3.720
1901	3.703
1902	3.735
1903	3.732
1904	3.689

Harmonic Constants at Tonoura.

Tide	1895		1896		1901		Tide
	H	κ	H	κ	H	κ	
	m	o	m	o	m	o	
S_1	0.0018	257.47	0.0018	319.40	0.0030	0.00	S_1
S_2	0.0404	13.31	0.0393	11.74	0.0400	14.18	S_2
S_4	0.0007	270.00	0.0008	299.74	0.0011	307.88	S_4
S_6	0.0006	0.00	0.0009	347.47	0.0005	323.13	S_6
M_1	0.0036	89.53	0.0039	355.58	0.0045	314.17	M_1
M_2	0.0810	191.99	00.821	358.06	0.0818	1.18	M_2
M_3	0.0047	342.91	0.0043	33.97	0.0021	25.02	M_3
M_4	0.0010	262.69	0.0011	232.95	0.0023	234.63	M_4
M_6	0.0011	124.16	0.0015	247.18	0.0010	249.42	M_6
O	0.0816	169.74	0.0807	328.37	0.0820	328.89	O
K_1	0.0679	345.93	0.0675	354.74	0.0674	355.40	K_1
K_2	0.0102	352.68	0.0108	6.00	0.0101	6.85	K_2
P	0.0242	357.81	0.0236	359.71	0.0244	351.02	P
J	0.0040	235.53	0.0026	18.07	0.0038	355.54	J
Q	0.0180	257.78	0.0207	312.16	0.0214	308.86	Q
L	0.0045	23.78	0.0028	25.68	0.0021	315.76	L
N	0.0170	294.10	0.0193	357.42	0.0182	5.30	N
ν	0.0044	328.86	0.0064	357.51	0.0039	345.34	ν
μ	0.0068	11.39	0.0057	338.39	0.0076	339.43	μ
R	0.0026	2.34	0.0021	314.82	0.0017	308.12	R
T	0.0027	23.65	0.0021	53.78	0.0028	43.79	T
MS	0.0044	133.60	0.0045	309.57	0.0048	301.05	MS
2SM	0.0026	281.61	0.0027	161.93	0.0016	117.95	2SM
Mm	0.0098	9.50	0.0017	226.95	0.0203	82.12	Mm
Mf	0.0078	228.97	0.0095	158.44	0.0179	168.69	Mf
MSf	0.0121	26.59	0.0170	259.49	0.0075	253.86	MSf
Sa	0.1416	146.58	0.1990	152.43	0.1868	151.13	Sa
Ssa	0.0057	154.36	0.0147	169.48	0.0469	282.46	Ssa

Harmonic Constants at Tonoura.

Tide	1902		1903		1904		Tide
	H	κ	H	κ	H	κ	
	m	^{o}	m	^{o}	m	^{o}	
S_1	0.0036	294.45	0.0035	40.43	0.0029	321.95	S_1
S_2	0.0399	11.70	0.0396	11.37	0.0403	10.00	S_2
S_4	0.0008	262.88	0.0012	245.56	0.0004	296.57	S_4
S_6	0.0008	270.00	0.0006	288.42	0.0002	243.43	S_6
M_1	0.0012	47.17	0.0038	355.91	0.0035	6.08	M_1
M_2	0.0822	358.40	0.0812	359.17	0.0820	356.92	M_2
M_3	0 0031	20.52	0.0038	46.28	0.0044	16.13	M_3
M_4	0.0028	229.40	0.0027	205.03	0.0029	215.43	M_4
M_6	0.0009	209.69	0.0011	97.85	0.0003	172.97	M_6
O	0.0880	328.51	0.0857	325.88	0.0854	324.85	O
K_1	0.0693	354.25	0.0754	356.55	0.0693	353.77	K_1
K_2	0.0104	359.69	0.0085	11.81	0.0109	4.88	K_2
P	0.0238	346.16	0.0226	354.41	0.0237	350.17	P
J	0.0018	352.65	0.0021	26.53	0.0028	14.30	J
Q	0.0180	307.93	0.0211	306.62	0.0185	308.70	Q
L	0.0025	3.74	0.0020	338.71	0.0012	313.13	L
N	0.0198	5.66	0.0205	358.08	0.0200	357.00	N
ν	0.0031	284.95	0.0024	89.26	0.0057	34.47	ν
μ	0.0061	335.25	0.0055	331.66	0.0054	336.75	μ
R	0.0015	59.71	0.0014	324.58	0.0003	327.33	R
T	0.0019	64.63	0.0029	355.54	0.0033	16.56	T
MS	0.0041	291.77	0.0036	291.05	0.0042	280.69	MS
2SM	0.0017	170.52	0.0016	174.86	0.0013	154.78	2SM
Mm	0.0090	294.07	0.0154	330.35	0.0134	63.83	Mm
Mf	0.0073	178.79	0.0141	184.01	0.0265	183.97	Mf
MSf	0.0052	30.86	0.0146	130.45	0.0124	176.94	MSf
Sa	0.1610	147.66	0.2095	158.90	0.2097	152.17	Sa
Ssa	0.0143	124.65	0.0227	208.61	0.0260	256.58	Ssa

KOBE.

Long. 135° 11′ E., Lat. 34° 41′ N.

This is a temporary observatory established for the harbour work. The instrument used is different from those used at the tide observatories of the Land Survey Department, as has been already stated.

The series of marigrams obtained in the years 1900, 1901, 1902, 1903, 1904, and 1906 have been completely reduced.

The highest high-water recorded here was 2.539, and occurred on Sept. 7, 1902, and the lowest low-water was 0.142, on Jan. 25, 1902; thus the extreme range of the tides in this period was 2.397 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained from each series of marigrams as follows:—

	m
1900	1.409
1901	1.402
1902	1.415
1903	1.463
1904	1.490
1906	1.430

Harmonic Constants at the Port of Kobe.

Tide	1900		1901		1902		Tide
	H	κ	H	κ	H	κ	
	m	o	m	o	m	o	
S_1	0.0116	71.04	0.0146	67.11	0.0074	58.59	S_1
S_2	0.1726	228.63	0.1734	229.64	0.1748	226.82	S_2
S_4	0.0016	125.54	0.0002	172.88	0.0004	180.00	S_4
S_6	0.0011	336.37	0.0005	295.02	0.0002	180.00	S_6
M_1	0.0113	196.00	0.0117	177.12	0.0078	348.78	M_1
M_2	0.3022	211.99	0.2976	214.59	0.3036	210.27	M_2
M_3	0.0019	219.43	0.0055	239.69	0.0062	236.28	M_3
M_4	0.0129	57.00	0.0122	60.82	0.0116	59.78	M_4
M_6	0.0124	228.53	0.0116	242.62	0.0125	231.36	M_6
O	0.1874	180.11	0.1951	180.84	0.1932	180.50	O
K_1	0.2544	204.85	0.2584	205.40	0.2552	203.48	K_1
K_2	0.0458	233.41	0.0409	230.68	0.0445	232.72	K_2
P	0.0775	200.58	0.0867	199.07	0.0804	197.27	P
J	0.0125	228.85	0.0104	221.92	0.0137	227.00	J
Q	0.0378	167.54	0.0372	173.67	0.0428	169.22	Q
L	0.0219	4.74	0.0065	307.48	0.0090	314.14	L
N	0.0619	203.90	0.0571	209.21	0.0661	203.34	N
ν	0.0240	230.36	0.0094	203.48	0.0069	132.76	ν
μ	0.0452	161.67	0.0406	167.53	0.0457	159.75	μ
R	0.0092	197.95	0.0114	181.04	0.0054	196.72	R
T	0.0194	244.62	0.0170	257.62	0.0141	225.81	T
MS	0.0109	135.65	0.0108	140.17	0.0106	139.49	MS
2SM	0.0170	275.15	0.0185	267.63	0.0081	288.12	2SM
Mm	0.0130	7.25	0.0153	53.63	0.0026	260.70	Mm
Mf	0.0242	135.02	0.0198	153.51	0.0283	88.76	Mf
MSf	0.0058	264.84	0.0073	178.52	0.0058	336.60	MSf
Sa	0.1505	155.96	0.1648	130.78	0.1962	154.55	Sa
Ssa	0.0131	16.84	0.0278	216.35	0.0477	80.39	Ssa

Harmonic Constants at the Port of Kobe.

Tide	1903		1904		1906		Tide
	H	κ	H	κ	H	κ	
	m	^{o}	m	^{o}	m	^{o}	
S_1	0.0076	93.21	0.0093	53.50	0.0085	62.53	S_1
S_2	0.1745	231.73	0.1757	230.58	0.1688	225.58	S_2
S_4	0.0012	144.29	0.0008	194.04	0.0009	180.00	S_4
S_6	0.0008	8.13	0.0004	75.96	0.0012	75.96	S_6
M_1	0.0071	231.50	0.0104	211.98	0.0048	267.86	M_1
M_2	0.3082	212.14	0.3137	212.32	0.3048	208.36	M_2
M_3	0.0118	242.38	0.0124	232.21	0.0088	223.82	M_3
M_4	0.0110	55.40	0.0114	62.27	0.0121	56.86	M_4
M_6	0.0139	235.66	0.0132	238.29	0.0121	222.59	M_6
O	0.1900	180.99	0.1914	179.93	0.1945	179.70	O
K_1	0.2561	205.16	0.2548	204.53	0.2539	202.88	K_1
K_2	0.0435	215.89	0.0474	230.43	0.0464	234.09	K_2
P	0.0774	203.07	0.0838	201.16	0.0745	198.87	P
J	0.0088	233.77	0.0120	235.42	0.0124	221.42	J
Q	0.0354	171.37	0.0339	170.35	0.0373	170.80	Q
L	0.0052	255.05	0.0147	32.61	0.0173	316.01	L
N	0.0698	205.01	0.0659	207.55	0.0609	203.22	N
ν	0.0043	267.76	0.0171	247.84	0.0076	144.30	ν
μ	0.0409	166.58	0.0489	165.38	0.0476	160.41	μ
R	0.0083	203.27	0.0067	198.09	0.0070	187.83	R
T	0.0155	239.58	0.0131	226.96	0.0103	232.90	T
MS	0.0114	145.40	0.0125	152.61	0.0109	140.25	MS
2SM	0.0135	266.10	0.0130	284.83	0.0091	287.42	2SM
Mm	0.0241	304.11	0.0161	258.67	0.0021	130.65	Mm
Mf	0.0140	77.59	0.0182	185.74	0.0130	249.80	Mf
MSf	0.0153	128.83	0.0100	144.73	0.0076	49.95	MSf
Sa	0.1887	142.22	0.1899	153.68	0.1312	158.41	Sa
Ssa	0.0290	191.59	0.0297	316.31	0.0518	293.72	Ssa

KUSHIMOTO.

Long. 135° 46′ E., Lat. 33° 28′ N.

This observatory was founded in the year 1891, as one of the permanent observatories of the Land Survey Department, on eastern side of the mouth of Kii Channel. As will be seen from the accompanying map, its location is in a very small bay near the neck of a peninsula. The water is not deep and its mean depth was found to be 5.0 m. and its 1.3 km length, according to Drs. Honda and Terada and others.

The first registration of the tides, took place on May 21st, 1898. From that date the work was continued for about four years, but during this interval the tube was very frequently choked. Thus, the entire observatory was moved a little further from the old location. The former series being closed on March 5, 1898, the new series was begun on May 21st of the same year. This observatory is near the pretty large town of Kushimoto, and presumably there is no great difficulty in obtaining the correct time.

The marigrams to which our reductions were applied are entirely of the new series and the four series obtained in the years 1897, 1898, 1899 and 1904 are now reported below.

The highest high-water recorded here was 2.32, referred to the zero-point of the instrument, and occurred on September 28, 1899. The lowest low-water recorded was 6.16, referred to the same origin, and occurred on December 24, 1897. Thus the extreme range is 2.84 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained for each year-series as follows:—

	m
1897	3.780
1898	3.794
1899	3.776
1904	3.742
1905	3.741

Harmonic Constants at Kushimoto.

Tide	1897		1898		1899		Tide
	H	κ	H	κ	H	κ	
	m	^{o}	m	^{o}	m	^{o}	
S_1	0.0081	28.16	0.0055	335.30	0.0040	0.00	S_1
S_2	0.2055	200.15	0.2062	195.93	0.2022	197.17	S_2
S_4	0.0003	198.44	0.0015	132.27	0.0014	146.31	S_4
S_6	0.0003	251.57	0.0004	104.04	0.0005	191.31	S_6
M_1	0.0118	146.00	0.0055	80.44	0.0097	201.39	M_1
M_2	0.4456	175.04	0.4499	172.43	0.4546	171.81	M_2
M_3	0.0053	292.11	0.0066	170.42	0.0051	161.41	M_3
M_4	0.0013	233.57	0.0006	282.72	0.0007	153.98	M_4
M_6	0.0019	140.74	0.0006	49.82	0.0007	49.91	M_6
O	0.1658	165.50	0.1682	167.11	0.1657	165.07	O
K_1	0.2186	188.34	0.2150	187.85	0.2167	186.99	K_1
K_2	0.0575	196.04	0.0598	190.91	0.0567	193.70	K_2
P	0.0757	184.25	0.0734	180.73	0.0714	181.85	P
J	0.0117	202.92	0.0119	208.15	0.0128	222.06	J
Q	0.0351	156.78	0.0362	157.56	0.0371	155.20	Q
L	0.0151	174.99	0.0155	188.66	0.0174	150.45	L
N	0.0853	171.07	0.0821	172.83	0.0780	166.89	N
ν	0.0174	132.93	0.0044	123.17	0.0184	200.56	ν
μ	0.0114	169.64	0.0069	153.32	0.0154	180.29	μ
R	0.0115	167.55	0.0094	148.43	0.0030	73.63	R
T	0.0188	215.25	0.0193	194.57	0.0156	178.72	T
MS	0.0122	158.77	0.0136	156.17	0.0136	153.37	MS
2SM	0.0075	321.50	0.0079	355.54	0.0092	337.01	2SM
Mm	0.0461	185.54	0.0052	23.77	0.0043	314.47	Mm
Mf	0.0115	249.67	0.0091	177.06	0.0045	263.77	Mf
MSf	0.0205	10.74	0.0060	325.90	0.0117	3.87	MSf
Sa	0.1163	149.71	0.1136	177.87	0.1702	149.11	Sa
Ssa	0.0045	4.64	0.0636	99.56	0.0298	275.33	Ssa

Harmonic Constants at Kushimoto.

Tide	1904		1905		Tide
	H	κ	H	κ	
	m	^{o}	m	^{o}	
S_1	0.0054	33.69	0.0066	7.88	S_1
S_2	0.2033	196.58	0.2009	194.73	S_2
S_4	0.0005	143.13	0.0008	97.12	S_4
S_6	0.0002	0.00	0.0015	227.73	S_6
M_1	0.0115	198.90	0.0097	136.66	M_1
M_2	0.4635	172.53	0.4554	171.59	M_2
M_3	0.0045	181.56	0.0041	185.98	M_3
M_4	0.0010	115.31	0.0013	190.73	M_4
M_6	0.0005	71.66	0.0008	186.34	M_6
O	0.1633	163.02	0.1670	163.36	O
K_1	0.2219	186.66	0.2179	185.65	K_1
K_2	0.0511	191.61	0.0564	194.45	K_2
P	0.0740	182.73	0.0769	180.58	P
J	0.0118	214.27	0.0119	184.66	J
Q	0.0313	157.91	0.0366	158.05	Q
L	0.0074	186.62	0.0228	162.17	L
N	0.0855	166.28	0.0865	170.25	N
ν	0.0288	181.83	0.0234	152.20	ν
μ	0.0133	157.48	0.0151	173.02	μ
R	0.0034	40.40	0.0034	177.35	R
T	0.0113	191.94	0.0162	182.10	T
MS	0.0156	155.53	0.0139	152.17	MS
2SM	0.0091	339.43	0.0068	1.63	2SM
Mm	0.0125	258.30	0.0095	130.85	Mm
Mf	0.0147	154.49	0.0203	162.70	Mf
MSf	0.0094	140.06	0.0082	139.61	MSf
Sa	0.1643	158.52	0.1604	193.11	Sa
Ssa	0.0234	292.72	0.0686	316.97	Ssa

WAJIMA.

Long. 136° 54′ E., Lat. 37° 24′ N.

This is one of the permanent observatories situated on the coast of the Japan Sea in the province of Noto. As will be seen from the map, the building is at the eastern side of a promontory near the town of Wajima.

The series of marigrams to which the harmonic analysis is applied are of the years, 1901–05. The principal oscillations of the water here are very small, but are accompanied with secondary oscillations of comparatively large amplitude.

The highest high-water recorded here was 3.12, referred to the zero-point of the instrument, and occurred on August 16, 1901. The lowest low-water recorded was 4.33, referred to the same origin, and occurred on March 27, 1905. Thus the extreme range is 1.21 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained for each year-series as follows:—

	m
1901	3.715
1902	3.728
1903	3.714
1904	3.697
1905	3.707

Harmonic Constants at Wajima.

Tide	1901		1902		1903		Tide
	H	κ	H	κ	H	κ	
	m	o	m	o	m	o	
S_1	0.0039	1.47	0.0032	7.13	0.0028	334.36	S_1
S_2	0.0218	104.35	0.0204	104.51	0.0217	108.52	S_2
S_4	0.0006	99.46	0.0003	225.00	0.0001	0.00	S_4
S_6	0.0009	324.46	0.0005	0.00	0.0001	0.00	S_6
M_1	0.0044	291.25	0.0015	224.64	0.0029	326 66	M_1
M_2	0.0599	73.86	0.0588	77.53	0.0593	78.90	M_2
M_3	0.0004	10.01	0.0002	236.28	0.0002	232.99	M_3
M_4	0.0015	26.33	0.0014	33 06	0.0015	38.92	M_4
M_6	0.0000	0.00	0.0002	247.57	0.0003	71.29	M_6
O	0.0514	314.47	0.0529	320.76	0.0521	318.54	O
K_1	0.0502	343.09	0.0516	346.25	0.0535	345.45	K_1
K	0.0070	95.52	0.0060	103.74	0.0058	106.28	K_2
P	0.0169	340.45	0.0179	341.42	0.0166	339.63	P
J	0.0031	340.60	0.0028	337.30	0.0015	1.55	J
Q	0.0138	301.64	0.0097	295.67	0.0111	305.21	Q
L	0.0011	102.07	0.0006	124.56	0.0030	68.71	L
N	0.0149	59.97	0.0158	62.69	0.0162	60.41	N
ν	0.0050	35.54	0.0009	41.43	0.0024	167.37	ν
μ	0.0046	17.86	0.0033	21.49	0.0033	33.66	μ
R	0.0015	29.05	0.0012	112.30	0.0013	12.59	R
T	0.0017	138.83	0.0008	190.36	0.0022	156.62	T
MS	0.0036	60.55	0.0038	64.77	0.0034	72.64	MS
2SM	0.0016	76.69	0.0012	83.41	0.0010	18.38	2SM
Mm	0.0210	80.05	0.0162	314.56	0.0180	341.41	Mm
Mf	0.0155	187.35	0.0181	205.85	0.0282	208.75	Mf
MSf	0.0148	255.39	0.0072	40.56	0.0155	158.47	MSf
Sa	0.1542	165.02	0.1407	156.20	0.1548	159.30	Sa
Ssa	0.0567	247.70	0.0152	210.99	0.0576	197.75	Ssa

Harmonic Constants at Wajima.

Tide	1904		1905		Tide
	H	κ	H	κ	
	m	^{o}	m	^{o}	
S_1	0 0042	16.70	0.0028	343.50	S_1
S_2	0.0230	102.29	0.0206	96.95	S_2
S_4	0.0007	26.57	0.0005	306.87	S_4
S_6	0.0003	90.00	0.0003	225.00	S_6
M_1	0.0038	357.46	0.0023	293.18	M_1
M_2	0.0612	73.49	0.0589	71.32	M_2
M_3	0.0006	338.04	0.0006	29.48	M_3
M_4	0.0014	50.08	0.0011	41.69	M_4
M_6	0.0007	2.43	0.0005	76.90	M_6
O	0.0527	314.16	0.0528	315.54	O
K_1	0.0515	343.24	0.0531	343.13	K_1
K_2	0.0042	88.36	0.0035	109.61	K_2
P	0.0161	336.37	0.0182	342.01	P
J	0.0012	288.25	0.0030	352.09	J
Q	0.0115	301.82	0.0094	286.00	Q
L	0.0016	125.00	0.0010	170.77	L
N	0.0163	53 93	0.0148	52.53	N
ν	0.0029	60.20	0.0049	37.03	ν
μ	0.0024	8.63	0.0022	21.85	μ
R	0.0007	208.27	0.0019	22.03	R
T	0.0008	47.92	0.0009	41.40	T
MS	0.0038	54.57	0.0028	62.43	MS
2SM	0.0006	112.85	0.0017	50.00	2SM
Mm	0.0101	59.64	0.0092	189.33	Mm
Mf	0.0368	197.21	0.0230	148.77	Mf
MSf	0.0100	198.71	0.0099	285.65	MSf
Sa	0.1879	165,86	0.1960	178.00	Sa
Ssa	0.0369	224.96	0.0255	202.99	Ssa

ABURATSUBO.

Long. 139° 37′ E., Lat. 35° 10′ N.

This observatory is also one of the permanent observatories and is located on a shallow inlet, very near to the Marine Zoological Station of the Tokyo Imperial University. The accompanying map shows the position of the observatory. At first, the present building and the tide-gauge were located at Inubo, where there is a lighthouse. One year'a experience there was a failure, since the pipe was very frequently choked and registrations could not performed regularly. It was therefore decided to move the entire observatory to the present site in the Miura Peninsula. The first registration here was made on June 11th, 1894. Since then the registration has gone on continuously, without receiving any serious break.

The series to which the reduction was applied are those obtained in the years 1895, 1896, 1897, 1898 and 1904. The harmonic constants are given in the accompanying table.

The highest high-water recorded here was 2.77, referred to the zero-point of the instrument, and occurred on October 10, 1904. The lowest low-water recorded was 4.83, referred to the same origin, and occurred on February 1 of the same year. Thus the extreme range is 2.06 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained for each year-series as follows:—

	m
1895	3.668
1896	3.679
1897	3.638
1898	3.650
1904	3.634

Harmonic Constants at Aburatsubo.

Tide	1895		1896		1897		Tide
	H	κ	H	κ	H	κ	
	m	o	m	o	m	o	
S_1	0.0067	114.66	0.0098	52 07	0.0103	50.91	S_1
S_2	0.1733	174.39	0.1670	171.32	0.1636	173.51	S_2
S_4	0.0005	158.20	0.0005	101.31	0.0016	161.56	S_4
S_6	0.0006	161.57	0.0005	182.54	0.0009	173.66	S_6
M_1	0.0177	215.60	0.0104	165.87	0.0082	157.20	M_1
M_2	0.3520	140.54	0.3534	141.14	0.3474	143.34	M_2
M_3	0.0034	136.14	0.0043	130.17	0.0049	140.38	M_3
M_4	0.0028	62.48	0.0024	84.96	0.0030	83.38	M_4
M_6	0.0008	103.41	0.0007	350.44	0.0007	31.84	M_6
O	0.1802	156.52	0.1780	154.22	0.1805	155.61	O
K_1	0.2324	172.93	0.2277	175.20	0.2245	175.93	K_1
K_2	0.0401	184.00	0.0476	166.66	0.0452	171.22	K_2
P	0.0842	171.03	0.0732	172.38	0.0790	176.73	P
J	0.0167	135.34	0.0127	195.19	0.0113	191.30	J
Q	0.0409	157.76	0.0371	143.96	0.0384	150.49	Q
L	0.0329	236.55	0.0208	161.50	0.0125	129.04	L
N	0.0651	143.90	0.0588	138.91	0.0577	149.84	N
ν	0.0123	119.76	0.0196	128.19	0.0164	99.28	ν
μ	0.0143	119.45	0.0087	126.73	0.0081	162.00	μ
R	0.0223	208.06	0.0031	114.70	0.0102	162.48	R
T	0.0187	146.86	0.0091	201.71	0.0145	212.85	T
MS	0.0127	118.14	0.0122	124.86	0.0121	125.16	MS
2SM	0.0028	28.18	0.0063	9.14	0.0095	339.47	2SM
Mm	0.1300	90.33	0.0137	184.10	0.0334	215.15	Mm
Mf	0.0338	331.47	0.0073	78.00	0.0076	205.53	Mf
MSf	0.0225	238.13	0.0116	104.32	0.0161	60.59	MSf
Sa	0.0974	194.78	0.1082	172.07	0.0728	161.02	Sa
Ssa	0.0223	246.01	0.0175	321.13	0.0342	110.49	Ssa

Harmonic Constants at Aburatsubo.

Tide	1898		1904		Tide
	H	κ	H	κ	
	m	*o*	*m*	*o*	
S_1	0.0073	1.57	0.0102	9.55	S_1
S_2	0.1689	167.94	0.1619	175.47	S_2
S_4	0.0015	156.80	0.0014	192.09	S_4
S_6	0.0006	149.04	0.0003	198.44	S_6
M_1	0.0086	60.29	0.0127	181.65	M_1
M_2	0.3537	140.09	0 3477	146.37	M_2
M_3	0.0061	133.13	0.0045	140,36	M_3
M_4	0.0021	69.03	0.0026	126.62	M_4
M_6	0.0006	335.08	0.0015	10.07	M_6
O	0.1809	154.19	0.1749	155.28	O
K_1	0.2291	175.24	0.2278	177.89	K_1
K_2	0.0422	164.18	0.0438	152.49	K_2
P	0.0778	166.18	0.0742	181.61	P
J	0.0119	195.86	0.0101	191.34	J
Q	0.0373	143.73	0.0356	146.13	Q
L	0.0163	158.62	0.0171	198.30	L
N	0.0537	138.16	0.0603	132.02	N
ν	0.0047	28.30	0.0132	142.38	ν
μ	0.0058	100.26	0.0104	139.64	μ
R	0.0050	143.08	0.0127	164.74	R
T	0.0184	178.13	0.0249	174.91	T
MS	0.0127	121.95	0.0126	137.44	MS
2SM	0.0097	26.99	0.0080	5.43	2SM
Mm	0.0141	106.96	0.0107	305.85	Mm
Mf	0.0045	32.96	0.0099	179.14	Mf
MSf	0.0098	1.25	0.0083	91.38	MSf
Sa	0.0542	177.67	0.1280	170.31	Ss
Ssa	0.0166	119.49	0.0128	240.47	Ssa

YOKOHAMA.

Long. 139° 38′ E., Lat. 35° 27′ N.

This is a temporary tide observatory established for the sake of the construction of the harbour. The first observation record was made on the 28th of June in the year 1899. The observations are made every half-hour in the daytime and every hour in the night-time. As has been already stated, this observatory is not furnished with a tide-gauge in its elaborate from, but a tide-staff was fixed at a place where the state of the water seemed comparatively calm, and the direct readings are recorded. We copied their observations made every hour, and the series obtained in the years 1900, 1901, 1902, 1903, 1904 and 1905 have been reduced.

The highest high-water recorded in the years which we have reduced was 2.64, referred to the zero-point of the instrument, and occurred on September 23, 1903. The lowest low-water recorded was -0.09, referred to the same origin, and occurred on May 1, 1900. Thus the extreme range is 2.73 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained for each year-series as follows:—

	m
1900	1.306
1901	1.363
1902	1.347
1903	1.362
1904	1.373
1905	1.367

Harmonic Constants at the Port of Yokohama.

Tide	1900		1901		1902		Tide
	H	κ	H	κ	H	κ	
	m	*o*	*m*	*o*	*m*	*o*	
S_1	0.0045	109.66	0.0067	63.43	0.0024	104.03	S_1
S_2	0.2280	175.05	0.2303	176.38	0.2267	175.09	S_2
S_4	0.0015	90.00	0.0027	147.99	0.0003	135.00	S_4
S_6	0.0018	80.54	0.0012	90.00	0.0003	270.00	S_6
M_1	0.0127	165.84	0.0127	145.84	0.0045	327.32	M_1
M_2	0.4685	144.16	0.4682	145.21	0.4685	145.13	M_2
M_3	0.0152	133.45	0.0103	135.74	0.0097	139.15	M_3
M_4	0.0145	80.65	0.0139	80.03	0.0154	71.61	M_4
M_6	0.0009	140.78	0.0030	55.38	0.0003	22.57	M_6
O	0.1865	153.32	0.1973	153.66	0.1952	156.40	O
K_1	0.2490	175.02	0.2503	175.85	0.2489	175.44	K_1
K_2	0.0616	170.63	0.0609	170.28	0.0621	172.56	K_2
P	0.0822	172.57	0.0855	171.04	0.0821	169.94	P
J	0.0133	192.49	0.0121	181.54	0.0151	185.44	J
Q	0.0415	142.96	0.0403	148.06	0.0403	149.65	Q
L	0.0127	178.70	0.0133	130.49	0 0136	175.74	L
N	0.0676	135.04	0.0641	140.18	0.0700	138.75	N
ν	0.0227	153.75	0.0224	111.91	0.0121	85.04	ν
μ	0.0115	164.61	0.0136	174.72	0.0106	167.29	μ
R	0.0042	331.38	0.0058	28.62	0.0048	5.72	R
T	0.0143	160.44	0.0139	144.86	0.0136	156.85	T
MS	0.0303	112.28	0.0331	114.08	0.0315	113.89	MS
2SM	0.0088	350.89	0.0072	349.58	0.0118	5.41	2SM
Mm	0.0209	17.32	0.0130	326.68	0.0206	234.49	Mm
Mf	0.0194	126.92	0.0191	236.07	0.0203	150.28	Mf
MSf	0.0042	294.51	0.0070	93.84	0.0091	144.20	MSf
Sa	0.0677	184.22	0.1291	165.45	0.0921	163.18	Sa
Ssa	0.0142	123.55	0.0188	296.86	0.0285	127.00	Ssa

Harmonic Constants at the Port of Yokohama.

Tide	1903		1904		1905		Tide
	H	κ	H	κ	H	κ	
	m	*o*	*m*	*o*	*m*	*o*	
S_1	0.0064	73.30	0.0088	72.18	0.0109	68.50	S_1
S_2	0.2242	177.21	0.2282	175.81	0.2270	175.33	S_2
S_4	0.0027	159.45	0.0003	180.00	0.0009	18.44	S_4
S_6	0.0003	180.00	0.0003	0.00	0.0006	0.00	S_6
M_1	0.0073	205.41	0.0127	180.08	0.0106	123.76	M_1
M_2	0.4652	145.23	0.4694	144.70	0.4600	144.87	M_2
M_3	0 0103	157.91	0.0094	159.78	0.0094	157.62	M_3
M_4	0.0158	85.22	0.0155	75.08	0.0136	77.65	M_4
M_6	0.0018	97.85	0.0015	82.97	0.0018	51.34	M_6
O	0.1921	155.78	0.1930	152.91	0.1915	154.73	O
K_1	0.2461	174.47	0.2491	174.74	0.2506	174.83	K_1
K_2	0.0606	170.20	0.0639	174.59	0.0594	173.20	K_2
P	0.0770	172.34	0.0830	174.21	0.0833	172.33	P
J	0.0127	192.91	0.0109	195.99	0.0133	195.29	J
Q	0.0385	149.21	0.0394	143.57	0.0412	153.35	Q
L	0.0176	159.99	0.0127	182.64	0.0239	140.90	L
N	0.0694	138.30	0.0709	135.50	0.0736	143.29	N
ν	0.0091	170.64	0.0224	156.46	0.0212	128.07	ν
μ	0.0133	168.82	0.0136	165.10	0.0273	175.69	μ
R	0.0042	333.30	0.0052	26.37	0.0015	309.62	R
T	0.0130	157.95	0.0127	156.63	0.0148	162.18	T
MS	0.0309	112.08	0.0300	116.09	0.0294	115.66	MS
2SM	0.0124	10.20	0.0115	355.74	0.0067	5.20	2SM
Mm	0.0258	300.23	0.0118	308.08	0.0176	168.09	Mm
Mf	0.0203	88.34	0.0088	233.75	0.0039	129.32	Mf
MSf	0 0012	260.12	0.0091	85.92	0.0033	26.88	MSf
Sa	0.1179	156.69	0.1361	164.25	0.0867	171.39	Sa
Ssa	0.0367	202.03	0.0197	232.76	0.0170	126.78	Ssa

IWASAKI.

Long. 139° 54′ E., Lat. 40° 35′ N.

As one of the permanent observatories belonging to the Land Survey Department of the Army, this was established in the year 1882 in a small islet very near the town of Iwasaki. The exact site in the islet is indicated in the map. The first observatory was opened on July 7th, 1892, and the registrations were continued for nearly four years. At the end of this time it was decided to move the observatory about ten metres southwards from the old site, and the registrations were resumed on the first of September, 1896.

The six series of marigrams obtained from 1902 to 1907 have been completely reduced and their results are gathered in the accompanying table.

The highest high-water recorded in the years which we have reduced was 4.52, referred to the zero-point of the instrument, and occurred on December 21, 1907. The lowest low-water recorded was 5.90, referred to the same origin, and occurred on April 22, 1605. Thus the extreme range is 1.38 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained as follows for each year-series:—

	m
1902	5.235
1903	5.218
1904	5.193
1905	5.203
1906	5.218
1907	5.230

Harmonic Constants at Iwasaki.

Tide	1902		1903		1904		Tide
	H	κ	H	κ	H	κ	
	m	o	m	o	m	o	
S_1	0.0020	20.22	0.0041	337.17	0.0038	353.99	S_1
S_2	0.0220	129.64	0.0212	125.58	0.0209	126.05	S_2
S_4	0.0002	180.00	0.0003	18.44	0.0001	135.00	S_4
S_6	0.0006	135.00	0.0006	260.54	0.0003	108.44	S_6
M_1	0.0018	149.11	0.0016	337.85	0.0029	6.65	M_1
M_2	0.0535	93.12	0.0529	92.01	0.0541	89.20	M_2
M_3	0.0015	247.59	0.0010	223.12	0.0020	239.92	M_3
M_4	0.0008	14.79	0.0015	38.92	0.0010	54.37	M_4
M_6	0.0003	157.57	0 0007	181.51	0.0005	262.97	M_6
O	0.0527	325.25	0.0483	325.35	0.0522	320.71	O
K_1	0.0529	350.34	0.0507	349.10	0.0517	347.21	K_1
K_2	0.0074	122.20	0.0086	126.57	0.0060	114.14	K_2
P	0.0192	345.31	0.0158	336.87	0.0169	344.98	P
J	0.0022	353.45	0.0026	351.54	0.0021	358.60	J
Q	0.0066	322.35	0.0128	304.25	0.0118	306.05	Q
L	0.0006	87.68	0.0003	112.70	0.0007	196.57	L
N	0.0123	77.54	0.0129	65.58	0.0137	61.47	N
ν	0.0006	27.85	0.0014	149.26	0.0025	95.15	ν
μ	0.0030	43.94	0.0036	40.68	0.0039	40.68	μ
R	0.0018	86.45	0.0015	28.54	0.0011	34.13	R
T	0.0026	146.61	0.0009	179.94	0.0010	149.23	T
MS	0.0033	73.68	0.0028	80.73	0.0021	135.74	MS
2SM	0.0005	63.76	0.0016	20.55	0.0011	58.88	2SM
Mm	0.0243	339.99	0.0169	355.64	0.0141	94.86	Mm
Mf	0.0143	207.89	0.0336	229.76	0.0444	205.71	Mf
MSf	0.0120	40.22	0.0161	175.71	0.0064	202.04	MSf
Sa	0.1022	155.45	0.1505	160.40	0.1591	168.39	Sa
Ssa	0.0130	127.96	0.0781	201.72	0.0563	206.24	Ssa

Harmonic Constants at Iwasaki.

Tide	1905		1906		1907		Tide
	H	κ	H	κ	H	κ	
	m	*o*	*m*	*o*	*m*	*o*	
S_1	0.0027	349.51	0.0040	351.47	0.0039	337.38	S_1
S_2	0.0223	126.61	0.0218	123.03	0.0219	127.97	S_2
S_4	0.0003	71.57	0.0003	270.00	0.0002	206.57	S_4
S_6	0.0003	180.00	0.0001	0.00	0.0000	0.00	S_6
M_1	0.0029	278.45	0.0018	359.45	0.0020	14.40	M_1
M_2	0.0540	90.11	0.0525	89.82	0.0524	91.61	M_2
M_3	0.0003	110.02	0.0012	139.33	0.0014	176.85	M_3
M_4	0.0007	23.26	0.0014	43.62	0.0005	344.63	M_4
M_6	0.0006	61.83	0.0016	315.80	0.0006	138.50	M_6
O	0.0532	323.72	0.0505	322.62	0.0513	323.01	O
K_1	0.0511	349.29	0.0516	350.79	0.0510	351.18	K_1
K_2	0.0048	115.33	0.0062	114.13	0.0070	114.41	K_2
P	0.0193	341.34	0.0170	341.68	0.0172	344.56	P
J	0.0026	4.81	0.0010	351.36	0.0032	50.02	J
Q	0.0099	302.10	0.0099	304.37	0.0085	298.64	Q
L	0.0010	357.69	0.0007	60.53	0.0008	45.81	L
N	0.0130	68.71	0.0131	76.99	0.0119	73.95	N
ν	0.0043	63.10	0.0034	60.37	0.0014	111.13	ν
μ	0.0037	43.74	0.0039	36.98	0.0025	17.41	μ
R	0.0004	27.10	0.0010	65.93	0.0016	84.12	R
T	0.0013	148.50	0.0014	98.24	0.0015	88.76	T
MS	0.0028	76.45	0.0026	77.02	0.0026	95.64	MS
2SM	0.0010	95.44	0.0002	99.88	0.0009	341.09	2SM
Mm	0.0128	188.35	0.0067	8.06	0.0246	110.87	Mm
Mf	0.0294	158.82	0.0231	240.67	0.0199	208.45	Mf
MSf	0.0081	272.10	0.0092	43.36	0.0170	115.86	MSf
Sa	0.1699	178.39	0.0745	176.01	0.1083	171.60	Sa
Ssa	0.0284	192.86	0.0050	327.91	0.0348	183.86	Ssa

AYUKAWA.

Long. 141° 31′ E., Lat. 38° 18′ N.

This is one of the permanent observatories belonging to the Land Survey Department of the Army. The situation is on a small bay of the north-eastern part of the Pacific coast. According to Drs. Honda and Terada and others, the length of the bay is one and a half kilometres, and the mean depth of the water is 12.7 metres. The first registration was made on October 25th, 1891, and the observations were continued until June 11th, 1901, without finding any serious obstacle, but about the latter date it was found that a corner of the foundation was sinking and this necessitated the moving of the building about three metres southwards from the old location. But after interruption of only eleven days, the new series of registrations was begun, and continued until June of 1905, when the old tide-gauge was replaced by a new one. The latter is of the same pattern as the old one, and is similar in every particular.

The series on which the reductions were made are only five, obtained in 1894, 1895, 1903, 1904 and 1906, and the results will be found in the accompanying table.

The highest high-water recorded here was 2.65, referred to the zero-point of the instrument, and occurred on December 21, 1907. The lowest low-water recorded was 4.63, referred to the same origin, and occurred on January 14, 1903. Thus the extreme range is 1.98 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained for each year-series as follows:—

1894 ..... 3.654 m

	m
1895	3.651
1903	3.522
1904	3.525
1906	3.474

Harmonic Constants at Ayukawa.

Tide	1894		1895		1903		Tide
	H	κ	H	κ	H	κ	
	m	*o*	*m*	*o*	*m*	*o*	
S_1	0.0063	15.57	0.0046	76.26	0.0057	20.67	S_1
S_2	0.1479	140.63	0.1429	141.08	0.1407	137.97	S_2
S_4	0.0006	210.96	0.0005	291.80	0.0010	174.29	S_4
S_6	0.0005	168.69	0.0004	116.57	0.0007	164.05	S_6
M_1	0.0048	89.47	0.0101	182.93	0 0096	198.06	M_1
M_2	0.3140	103.31	0.3109	105.50	0.3083	100.67	M_2
M_3	0.0051	97.76	0.0058	93.93	0.0062	96.83	M_3
M_4	0.0015	110.74	0.0028	100.42	0.0033	84.61	M_4
M_6	0.0009	232.43	0.0007	239.51	0.0004	322.85	M_6
O	0.1928	145.57	0.1895	146.99	0.1845	144 27	O
K_1	0.2386	164.31	0.2359	165.59	0.2363	162.22	K_1
K_2	0.0380	130.81	0.0381	136.99	0.0255	134.92	K_2
P	0.0759	157.72	0.0649	162 65	0.0660	159.39	P
J	0.0121	170.34	0.0120	174.21	0.0124	180.23	J
Q	0.0423	137.64	0.0430	136.90	0.0408	136.64	Q
L	0.0127	125.56	0.0147	152.69	0.0144	113.20	L
N	0.0464	88.62	0.0465	89.19	0.0460	83.46	N
ν	0.0005	140.70	0.0114	79.75	0.0114	66.57	ν
μ	0.0073	128.49	0.0051	108.32	0.0077	106.08	μ
R	0.0039	343.97	0.0050	312.82	0.0084	126.06	R
T	0.0025	182.36	0.0021	233.52	0.0150	157.69	T
MS	0.0084	98.48	0.0087	101.35	0.0096	88.75	MS
2SM	0.0068	40.71	0.0067	42.08	0.0090	35.46	2SM
Mm	0.0132	163.44	0.0043	78.96	0.0076	301.42	Mm
Mf	0.0115	195.56	0.0042	62.28	0.0093	68.70	Mf
MSf	0.0083	112.73	0.0068	238.80	0.0112	211.21	MSf
Sa	0.1304	167.67	0.1164	188.17	0.1086	166.47	Sa
Ssa	0.0264	214.18	0.0184	180.87	0.0395	203.45	Ssa

Harmonic Constants at Ayukawa.

Tide	1904		1906		Tide
	H	$\varkappa$	H	$\varkappa$	
	m	^{o}	m	^{o}	
S_1	0.0120	47.02	0.0099	323.59	S_1
S_2	0.1417	135.40	0.1405	139.44	S_2
S_4	0.0014	140.71	0.0011	111.80	S_4
S_6	0.0010	90.00	0.0004	146.31	S_6
M_1	0.0113	169.33	0.0070	206.31	M_1
M_2	0.3116	98.78	0.3042	103.61	M_2
M_3	0.0061	88.33	0.0072	96.45	M_3
M_4	0 0022	72.16	0.0024	89.40	M_4
M_6	0.0006	234.77	0.0002	295.57	M_6
O	0.1905	142.04	0.1865	147.92	O
K_1	0.2362	161.03	0.2341	164.14	K_1
K_2	0.0428	139.36	0.0460	133.95	K_2
P	0.0786	158.51	0.0784	161.72	P
J	0.0108	178.37	0.0122	168.81	J
Q	0.0387	132.64	0.0388	139.73	Q
L	0.0112	112.43	0.0103	130.25	L
N	0.0432	86.74	0.0394	94.97	N
ν	0.0087	109.01	0.0098	83.58	ν
μ	0.0070	94.52	0.0018	132 18	μ
R	0.0086	31.62	0 0193	137.57	R
T	0.0074	199.84	0.0160	135.62	T
MS	0.0093	90.66	0.0088	93.33	MS
2SM	0.0068	26.52	0.0060	69.35	2SM
Mm	0.0059	278.93	0.0093	107.90	Mm
Mf	0.0127	196.11	0.0115	232.65	Mf
MSf	0.0027	127.40	0.0064	295.86	MSf
Sa	0.1483	176.00	0 0699	181.72	Sa
Ssa	0.0311	207.58	0.0284	264.11	Ssa

OTARU.

Long. 141° 01′ E., Lat. 43° 13′ N.

This is one of the two parmanent observatories belonging to the Land Survey Department on the coast of Hokkaidô, and the first site was situated near the pier of Otaru. The first record was obtained on the ninth of October in the year 1901, and the registration was continued for four years, till the eighth of September in the year 1905. At that time, the observatory was closed for a time, to move the building, according to a request from the Hokkaido Coal-mine Railway Co., on account of some unavoidable necessity to them. The above written geographical co-ordinates are those of the old site.

A new site was chosen in the Bay of Oshoro, near its mouth, and its approximate co-ordinates are

Long. 140° 51′ E., Lat. 43° 13′ N.

We have only reduced the marigrams obtained at the old observatory, and the new series will be postponed till the next report.

The highest high-water recorded in those years was 2.64, referred to the zero-point of the instrument, and occurred on September 23, 1904. The lowest low-water recorded was 3.83, referred to the same origin, and occurred on March 18, 1904. Then the extreme range is 1.19 metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained for each year-series as follows:—

1902	3.248 m
1903	3.242

Harmonic Constants at the Port of Otaru.

Tide	1902		1903		Tide
	H	κ	H	κ	
	m	*o*	*m*	*o*	
S_1	0.0014	342.90	0.0075	99.96	S_1
S_2	0.0239	138.56	0.0187	135.87	S_2
S_4	0.0006	90.00	0.0005	323.13	S_4
S_6	0.0004	116·56	0.0002	116.57	S_6
M_1	0.0040	184.30	0.0049	236.13	M_1
M_2	0.0492	102.44	0.0385	108.10	M_2
M_3	0.0017	181.82	0.0025	217.73	M_3
M_4	0.0009	210.04	0.0015	173.92	M_4
M_6	0 0001	22.57	0.0007	251.29	M_6
O	0.0490	321.34	0.0427	330.30	O
K_1	0.0527	341.48	0.0416	351.82	K_1
K_2	0.0074	131.04	0.0024	117.87	K_2
P	0.0175	340.88	0.0101	356.03	P
J	0.0011	18.89	0.0030	20.28	J
Q	0.0083	324.63	0.0115	289.82	Q
L	0.0023	146.88	0.0031	116.89	L
N	0.0112	87.00	0.0113	65.20	N
ν	0.0028	11.47	0.0016	317.44	ν
μ	0.0033	1.80	0.0036	46.40	μ
R	0.0012	32.82	0.0039	21.56	R
T	0.0011	235.36	0.0049	132.42	T
MS	0.0020	99.62	0.0012	62.88	MS
2SM	0.0020	325.31	0.0007	15.78	2SM
Mm	0.0134	334.25	0.0162	16.77	Mm
Mf	0.0338	201.24	0.0326	199.24	Mf
MSf	0.0145	72.93	0.0061	159.38	MSf
Sa	0.0853	171.73	0.0857	158.76	Sa
Ssa	0.0486	114.32	0.0856	237.21	Ssa

HANASAKI.

Long. 145° 35′ E., Lat. 43° 17′ N.

This is one of the permanent observatories belonging to the Land Survey Department on the coast of Hokkaido, and faces the Pacific Ocean. The first registration of the tidal states took place on the first of November in the year 1895. The accompanying map shows the position of the observatory with reference to its surroundings.

The series to which the harmonic analysis has been applied and the reduction is already completed, are the five series of the year 1899, 1900, 1901, 1902 and 1897.

The highest high-water recorded in these years was 2.48, referred to the zero-point of the instrument, and occurred on December 26, 1901. The lowest low-water recorded was 4.82, referred to the same origin, and occurred on November 17, 1902. Thus, the extreme range is 2.34 in metres.

The height of the mean sea-level, referred to the zero-point of the instrument, is obtained as follows for each year-series:—

	m
1897	3.696
1899	3.705
1900	3.659
1901	3.666
1902	3.665

Harmonic Constants at Hanasaki.

Tide	1897		1899		1900		Tide
	H	κ	H	κ	H	κ	
	m	*o*	*m*	*o*	*m*	*o*	
S_1	0.0282	25.39	0.0023	315.00	0.0124	33.18	S_1
S_2	0.1156	145.68	0.1235	139.20	0.1244	139.86	S_2
S_4	0.0015	227.73	0.0011	190.30	0.0006	141.34	S_4
S_6	0.0006	231.34	0 0007	164.06	0.0007	206.56	S_6
M_1	0.0098	143.66	0.0128	194.30	0.0104	160.01	M_1
M_2	0.2303	98.72	0.2754	95.31	0.2769	97.06	M_2
M_3	0.0027	127.83	0.0046	92.13	0.0054	104.51	M_3
M_4	0.0033	64.67	0.0047	90.82	0.0042	84.98	M_4
M_6	0.0007	31.84	0.0010	101.83	0.0006	103.92	M_6
O	0.2112	155.58	0.2188	153.09	0.2154	154.94	O
K_1	0.2040	167.59	0.2117	167.82	0.2107	168.59	K_1
K_2	0.0340	143.50	0.0309	124.09	0.0373	132.07	K_2
P	0.0742	167.52	0.0605	166.66	0.0681	171.27	P
J	0.0114	136.92	0.0114	174.23	0.0132	162.03	J
Q	0 0474	143.49	0.0494	138.97	0.0488	142.57	Q
L	0.0186	100.93	0.0163	112.94	0.0068	109.09	L
N	0.0329	79.55	0.0319	64.58	0.0360	65.12	N
ν	0.0025	88.91	0.0112	107.70	0.0115	102.01	ν
μ	0.0088	110.43	0.0045	112.55	0.0042	114.70	μ
R	0.0274	134.76	0.0058	329.32	0.0030	109.07	R
T	0.0307	173.08	0.0028	92.89	0.0108	174.70	T
MS	0.0065	86.81	0.0098	96.32	0.0086	90.70	MS
2SM	0.0032	59.26	0.0049	50.63	0.0074	41.28	2SM
Mm	0.0235	139.24	0.0245	59.64	0.0166	115.24	Mm
Mf	0.0140	216.83	0.0169	123.97	0.0234	182.98	Mf
MSf	0.0202	101.98	0.0200	162.31	0.0052	1.92	MSf
Sa	0.0424	193.79	0.0723	199.88	0.0231	199.86	Sa
Ssa	0.0116	184.49	0.0230	217.80	0.0420	257.68	Ssa

Harmonic Constants at Hanasaki.

Tide	1901		1902		Tide
	H	κ	H	κ	
	m	o	m	o	
S_1	0.0136	34.85	0.0016	345.96	S_1
S_2	0.1274	133.51	0.1200	133.75	S_2
S_4	0.0005	158.20	0.0013	225.00	S_4
S_6	0.0009	186.34	0.0006	141.34	S_6
M_1	0.0138	136.64	0.0056	302.01	M_1
M_2	0.2797	90.89	0.2773	91.73	M_2
M_3	0.0056	92.20	0.0051	80.36	M_3
M_4	0.0028	78.38	0.0022	114.51	M_4
M_6	0.0006	81.95	0.0002	139.14	M_6
O	0.2228	151.43	0.2237	152.69	O
K_1	0.2137	164.70	0.2056	164.96	K_1
K_2	0.0350	119.62	0.0359	132.72	K_2
P	0.0717	165.32	0.0738	161.95	P
J	0.0172	156.80	0.0113	164.73	J
Q	0.0480	137.05	0.0519	138.76	Q
L	0.0082	87.06	0.0097	134.28	L
N	0.0345	64.35	0.0373	67.96	N
ν	0.0110	32.51	0.0068	350.72	ν
μ	0.0048	116.39	0.0041	94.15	μ
R	0.0026	82.54	0.0055	333.85	R
T	0.0123	176.83	0.0093	85.91	T
MS	0.0082	81.03	0.0068	88.05	MS
2SM	0.0053	68.04	0.0059	37.03	2SM
Mm	0.0037	113.79	0.0033	299.60	Mm
Mf	0.0201	186.56	0.0213	148.38	Mf
MSf	0.0027	352.29	0.0110	88.86	MSf
Sa	0.0500	234.21	0.0184	337.13	Sa
Ssa	0.0386	238.17	0.0279	223.02	Ssa

Mean Values of Harmonic Constants (China Sea & Eastern Sea.)

Station	Takaw		Kiirun		Fukabori		Station
No. of Years	2		4		5		No. of Years
TIDE	H	$\varkappa$	H	$\varkappa$	H	$\varkappa$	TIDE
	m	o	m	o	m	o	
S_1	0.0045	67.04	0.0049	91.68	0.0020	278.41	S_1
S_2	0.0626	247.55	0.0511	281.02	0.3740	266.93	S_2
S_4	0.0004	320.66	0.0015	330.30	0.0016	160.35	S_4
S_6	0.0004	125.79	0.0004	106.70	0.0007	226.59	S_6
M_1	0.0096	261.34	0.0093	228.03	0.0096	165.97	M_1
M_2	0.1539	243.16	0.1915	290.27	0.8377	239.69	M_2
M_3	0.0026	255.08	0.0058	174.80	0.0098	282.22	M_3
M_4	0.0009	221.20	0.0089	299.81	0.0109	337.91	M_4
M_6	0.0019	39.09	0.0034	255.80	0.0031	196.49	M_6
O	0.1516	256.24	0.1534	204.73	0.1981	190.56	O
K_1	0.1562	294.99	0.1853	229.81	0.2555	212.17	K_1
K_2	0.0165	256.67	0.0135	267.68	0.1023	262.81	K_2
P	0.0523	291.13	0.0605	228.33	0.0842	206.76	P
J	0.0046	310.05	0.0098	247.31	0.0157	227.11	J
Q	0.0293	244.62	0.0312	190·24	0.0407	180.47	Q
L	0.0064	221.08	0.0115	26.84	0.0242	217.10	L
N	0.0342	237.31	0.0514	264.30	0.1562	233.51	N
ν	0.0102	265.71	0.0146	294.49	0.0355	197.71	ν
μ	0.0025	160.41	0.0260	153.67	0.0348	231.55	μ
R	0.0016	244.84	0.0050	170.48	0.0131	195.58	R
T	0.0051	231.11	0.0048	262.82	0.024_9	260.92	T
MS	0.0059	225.52	0.0140	298.49	0.0170	216.65	MS
2SM	0.0027	253.42	0.0064	254.08	0.0145	269.62	2SM
Mm	0.0121	348.09	0.0115	26.34	0.0097	95.30	Mm
Mf	0.0074	347.93	0.0133	53.19	0.0134	189.90	Mf
MSf	0.0078	59.55	0.0078	11.63	0.0127	27.81	MSf
Sa	0.1198	146.88	0.1262	134.94	0.1695	148.61	Sa
Ssa	0.0227	352.19	0.0319	302.35	0.0273	349.32	Ssa

Mean Values of Harmonic Constants (Pacific Ocean.)

Station	Hosojima		Kushimoto		Aburatsubo		Station
No. of Years	4		5		5		No. of Years
TIDE	H	κ	H	κ	H	κ	TIDE
	m	o	m	o	m	o	
S_1	0.0099	59.86	0.0059	9.01	0.0089	45.75	S_1
S_2	0.2095	213.70	0.2049	196.91	0.1674	172.53	S_2
S_4	0.0015	64.93	0.0009	143.45	0.0011	153.99	S_4
S_6	0.0005	195.37	0.0006	154.93	0.0006	173.05	S_6
M_1	0.0074	196.24	0.0097	152.68	0.0115	156.12	M_1
M_2	0.4972	188.26	0.4567	172.68	0.3519	142.30	M_2
M_3	0.0076	200.46	0.0051	198.30	0.0046	136.04	M_3
M_4	0.0076	319.69	0.0010	195.26	0.0026	85.29	M_4
M_6	0.0022	330.70	0.0009	99.69	0.0009	22.17	M_6
O	0.1528	174.65	0.1671	164.81	0.1794	155.16	O
K_1	0.1991	195.98	0.2194	187.10	0.2290	175.44	K_1
K_2	0.0652	199.42	0.0567	193.34	0.0439	167.71	K_2
P	0.0635	197.78	0.0748	182.03	0.0779	173.59	P
J	0.0112	213.45	0.0121	206.41	0.0125	181.81	J
Q	0.0329	167.22	0.0355	157.10	0.0380	148.41	Q
L	0.0184	173.30	0.0157	172.58	0.0200	176.80	L
N	0.0923	183.87	0.0840	169.46	0.0593	140.57	N
ν	0.0192	149.19	0.0186	158.14	0.0132	103.58	ν
μ	0.0163	182.26	0.0125	167.35	0.0095	129.62	μ
R	0.0172	190.02	0.0061	121.47	0.0107	158.61	R
T	0.0213	226.77	0.0163	192.52	0.0172	182.89	T
MS	0.0083	172.01	0.0139	155.20	0.0125	125.51	MS
2SM	0.0100	327.67	0.0081	343.02	0.0073	9.84	2SM
Mm	0.0196	281.09	0.0156	182.58	0.0405	180.48	Mm
Mf	0.0094	159.16	0.0121	201.54	0.0126	93.42	Mf
MSf	0.0130	77.13	0.0113	52.04	0.0137	99.13	MSf
Sa	0.1366	148.11	0.1459	165.66	0.0924	175.17	Sa
Ssa	0.0475	42.05	0.0382	341.84	0.0208	207.52	Ssa

Mean Values of Harmonic Constants (Pacific Ocean.)

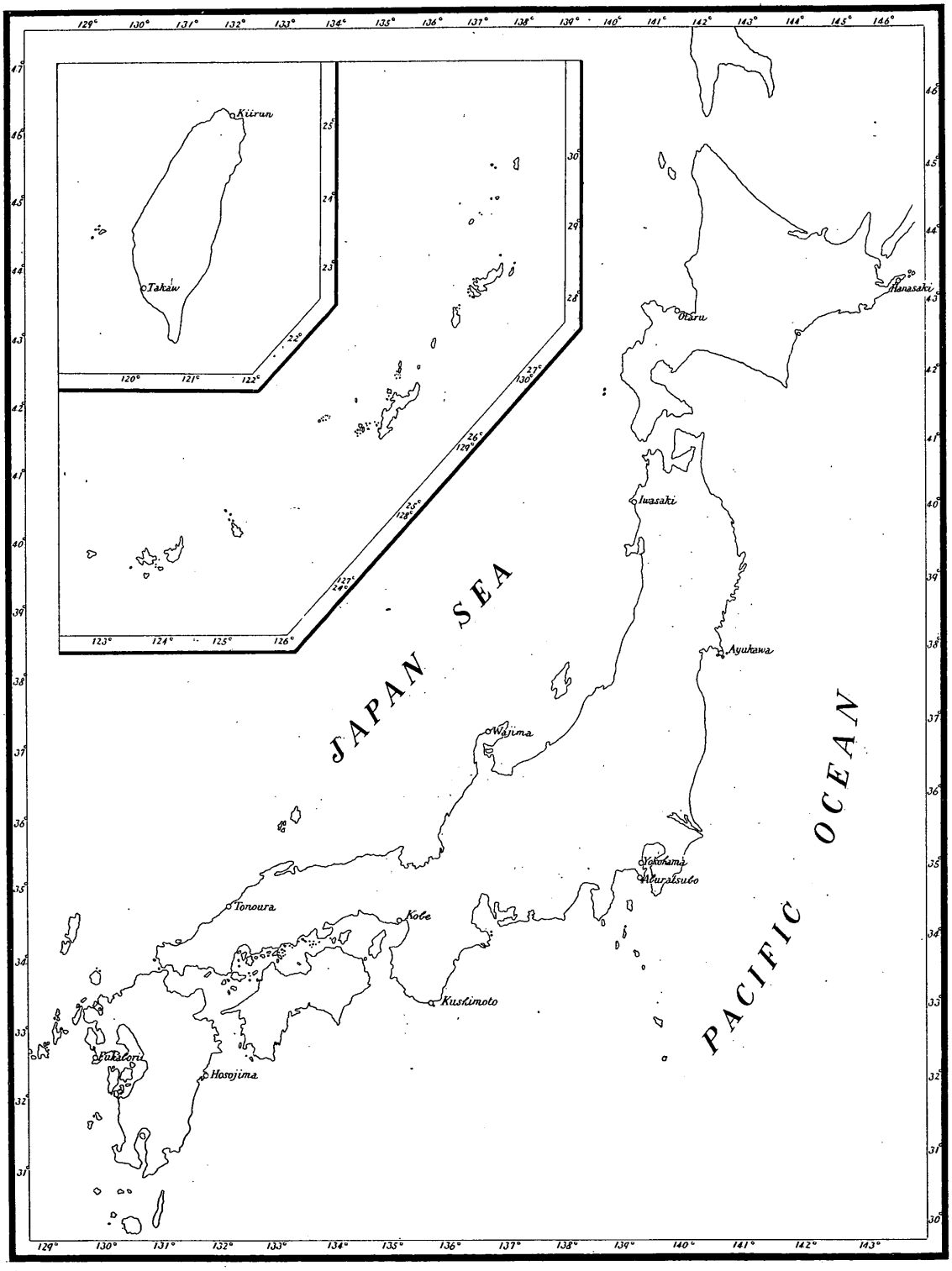
Station	Yokohama		Ayukawa		Hanasaki		Station
No. of Years	6		5		5		No. of Years
TIDE	H	κ	H	κ	H	κ	TIDE
	m	o	m	o	m	o	
S_1	0.0066	81.85	0.0077	24.62	0.0116	6.88	S_1
S_2	0.2274	175.81	0.1437	138.90	0.1224	138.40	S_2
S_4	0.0014	121.81	0.0009	185.91	0.0010	188.51	S_4
S_6	0.0008	43.42	0.0006	137.12	0.0007	185.93	S_6
M_1	0.0101	191.38	0.0087	169.22	0.0105	187.32	M_1
M_2	0.4666	144.88	0.3117	102.37	0.2743	94.74	M_2
M_3	0.0107	147.28	0.0061	94.66	0.0047	99.41	M_3
M_4	0.0148	78.37	0.0024	91.47	0.0034	86.67	M_4
M_6	0.0016	75.15	0.0006	275.03	0.0006	91.74	M_6
O	0.1926	154.47	0.1899	145.36	0.2187	153.55	O
K_1	0.2490	175.06	0.2376	163.46	0.2094	166.73	K_1
K_2	0.0614	171.91	0.0383	135.21	0.0347	130 40	K_2
P	0.0822	172.07	0.0732	160.00	0.0698	166.54	P
J	0.0129	190.61	0.0120	174.39	0.0129	158.94	J
Q	0.0402	147.80	0.0409	136.71	0.0492	140.17	Q
L	0.0156	161.41	0.0128	126.83	0.0119	108.86	L
N	0.0693	138.51	0.0446	88.60	0.0346	68.31	N
ν	0.0183	134.31	0.0085	95.92	0.0086	64.37	ν
μ	0.0150	169.37	0.0058	113.92	0.0053	109.64	μ
R	0.0043	352.50	0.0091	46.41	0.0089	53.91	R
T	0.0137	156.49	0.0087	181.81	0.0132	140.68	T
MS	0.0309	114.01	0.0091	94.51	0.0080	88.58	MS
2SM	0.0097	359.50	0.0071	42.82	0.0053	51.25	2SM
Mm	0.0183	285.82	0.0081	186.14	0.0143	73.50	Mm
Mf	0.0153	160.78	0.0099	151.06	0.0191	171.74	Mf
MSf	0.0057	90.91	0.0071	197.20	0.0118	69.47	MSf
Sa	0.1049	167.53	0.1154	176.01	0.0413	232.97	Sa
Ssa	0.0225	184.83	0.0290	214.04	0.0286	224.23	Ssa

Mean Values of Harmonic Constants (Japan Sea.)

Station	Tonoura		Wajima		Iwasaki		Station
No. of Years	6		5		6		No. of Years
TIDE	H	κ	H	κ	H	κ	TIDE
	m	o	m	o	m	o	
S_1	0.0028	325.62	0.0034	356.63	0.0034	351.62	S_1
S_2	0.0399	12.05	0.0214	103.32	0.0218	126.48	S_2
S_4	0.0008	280.44	0.0004	131.58	0.0002	146.93	S_4
S_6	0.0006	305.41	0.0004	127.89	0.0003	114.00	S_6
M_1	0.0034	14.74	0.0030	298.64	0.0022	10.99	M_1
M_2	0.0817	330.95	0.0595	75.02	0.0585	90.98	M_2
M_3	0.0037	20.81	0.0004	313.36	0.0012	189.47	M_3
M_4	0.0021	230.02	0.0014	38.02	0.0010	26.60	M_4
M_6	0.0010	183.55	0.0003	7.64	0.0007	186.36	M_6
O	0.0839	301.04	0.0523	316.69	0.0517	323.44	O
K_1	0.0695	353.44	0.0519	344.23	0.0518	349.65	K_1
K_2	0.0102	3.65	0.0053	100.70	0.0067	117.80	K_2
P	0.0237	353.21	0.0171	339.98	0.0177	342.46	P
J	0.0029	347.10	0.0023	335.96	0.0023	4.96	J
Q	0.0196	300.34	0.0111	298.07	0.0100	306.29	Q
L	0.0025	350.13	0.0015	118.22	0.0007	83.50	L
N	0.0191	349.59	0.0156	57.91	0.0129	70.71	N
ν	0.0043	0.07	0.0032	68.31	0.0023	84.48	ν
μ	0.0062	342.15	0.0032	20.70	0.0034	37.24	μ
R	0.0016	342.82	0.0013	76.85	0.0012	54.38	R
T	0.0026	32.99	0.0013	115.03	0.0015	135.21	T
MS	0.0043	267.96	0.0035	62.99	0.0027	89.88	MS
2SM	0.0019	176.94	0.0012	68.27	0.0009	53.27	2SM
Mm	0.0116	347.80	0.0149	341.00	0.0167	62.96	Mm
Mf	0.0139	183.81	0.0242	189.59	0.0277	208.55	Mf
MSf	0.0115	266.37	0.0115	187.76	0.0116	81.55	MSf
Sa	0.1846	151.48	0.1663	164.88	0.1281	168.37	Sa
Ssa	0.0217	199.36	0.0383	216.88	0.0361	206.76	Ssa

Mean Values of Harmonic Constants (Japan Sea & Seto Inland Sea.)

Station	Otaru		Kobe		Station
No. of Years	2		6		No. of Years
TIDE	H	κ	H	κ	TIDE
	m	o	m	o	
S_1	0.0045	41.43	0.0098	67.66	S_1
S_2	0.0213	137.22	0.1733	228.83	S_2
S_4	0.0006	26.57	0.0009	166.13	S_4
S_6	0.0003	116.57	0.0007	41.91	S_6
M_1	0.0045	210.22	0.0089	238.87	M_1
M_2	0.0439	105.27	0.3050	211 61	M_2
M_3	0.0021	199.78	0.0078	232.30	M_3
M_4	0.0012	191.98	0.0119	58.69	M_4
M_6	0.0004	316.93	0.0126	233.18	M_6
O	0.0459	325.82	0.1919	180.35	O
K_1	0.0472	346.65	0.2555	204.38	K_1
K_2	0.0049	124.46	0.0448	229.54	K_2
P	0.0138	348.46	0.0801	200.00	P
J	0.0021	19.59	0.0116	228.06	J
Q	0.0099	307.23	0.0374	170.49	Q
L	0.0027	131.89	0.0124	325.01	L
N	0.0113	76.10	0.0636	205.37	N
ν	0.0022	344.46	0.0116	204.42	ν
μ	0.0035	24.10	0.0448	163.55	μ
R	0 0026	27.19	0.0080	194.15	R
T	0.0030	183.89	0.0149	237.92	T
MS	0.0016	81.25	0.0112	142.26	MS
2SM	0.0014	350.55	0.0132	278.21	2SM
Mm	0.0148	355.51	0.0122	349.17	Mm
Mf	0.0332	200.24	0.0196	149.24	Mf
MSf	0.0103	116.16	0.0086	123.91	MSf
Sa	0.0855	165.25	0.1702	149.27	Sa
Ssa	0.0671	175.77	0.0332	305.87	Ssa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Hosojima

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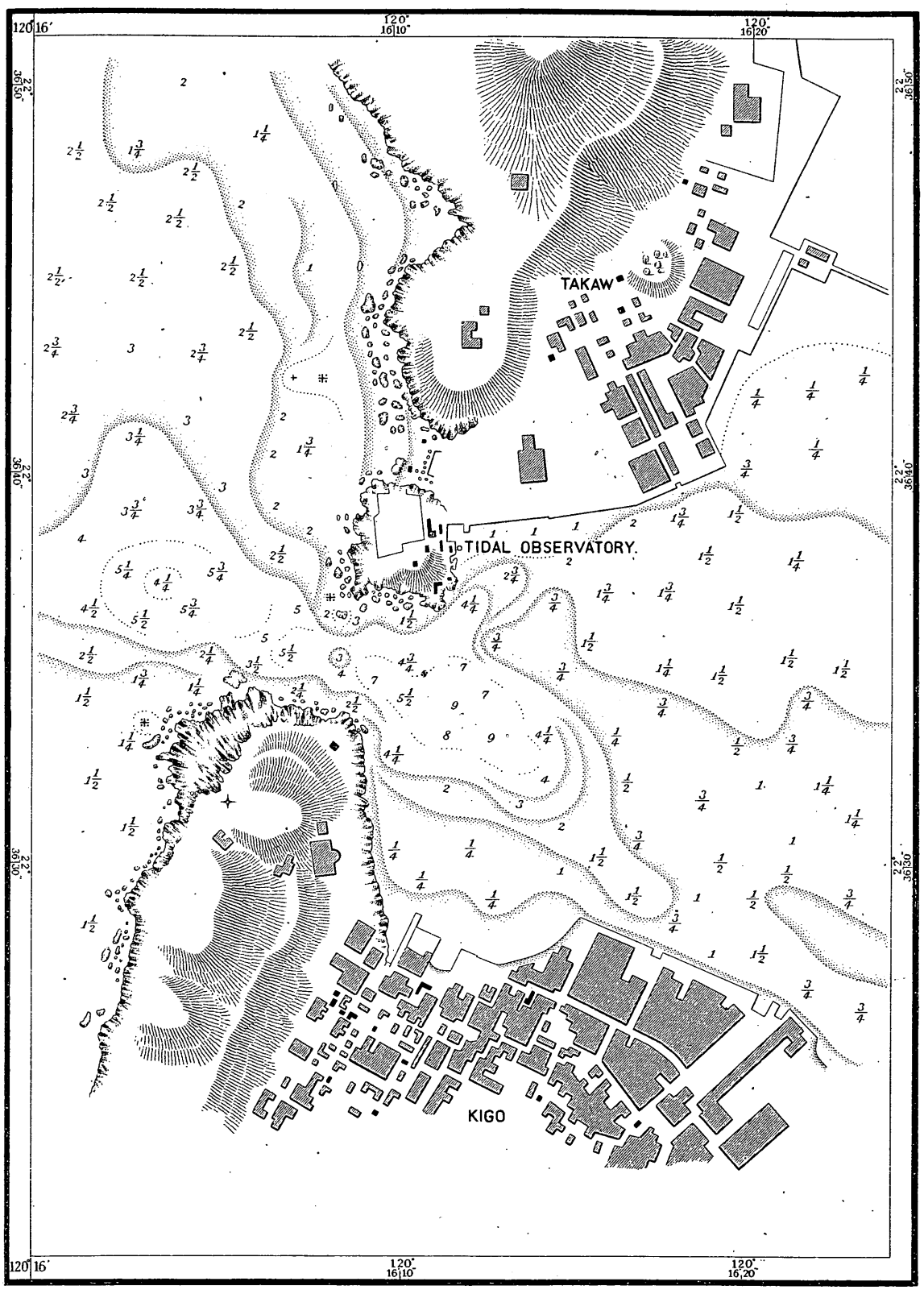
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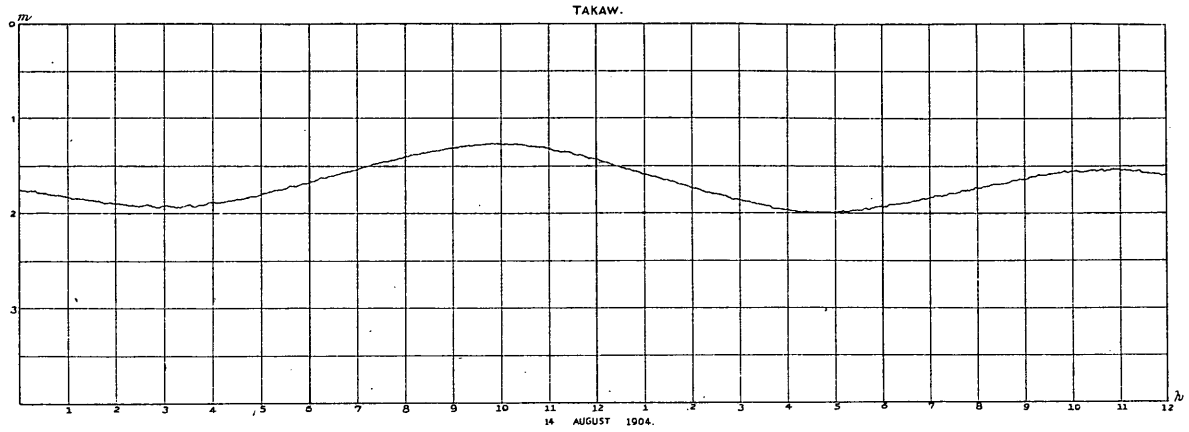
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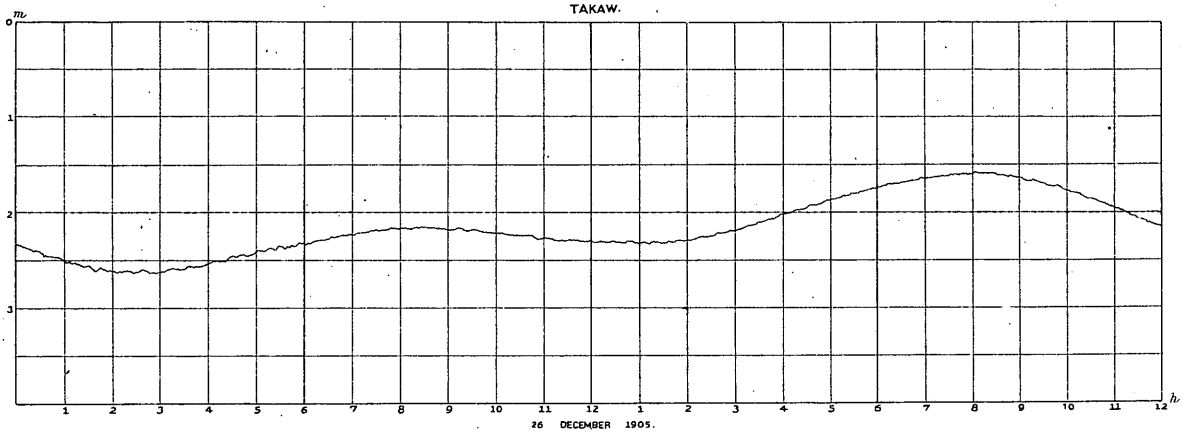
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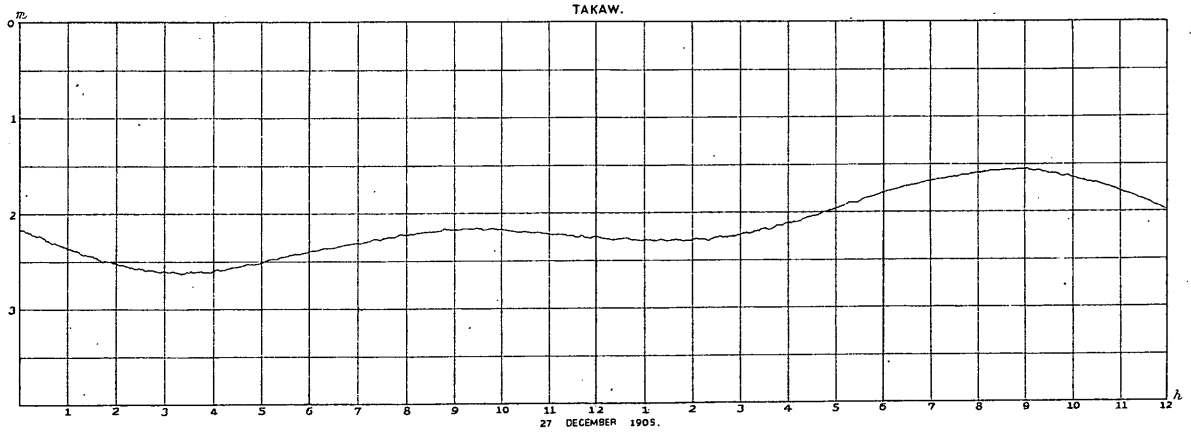
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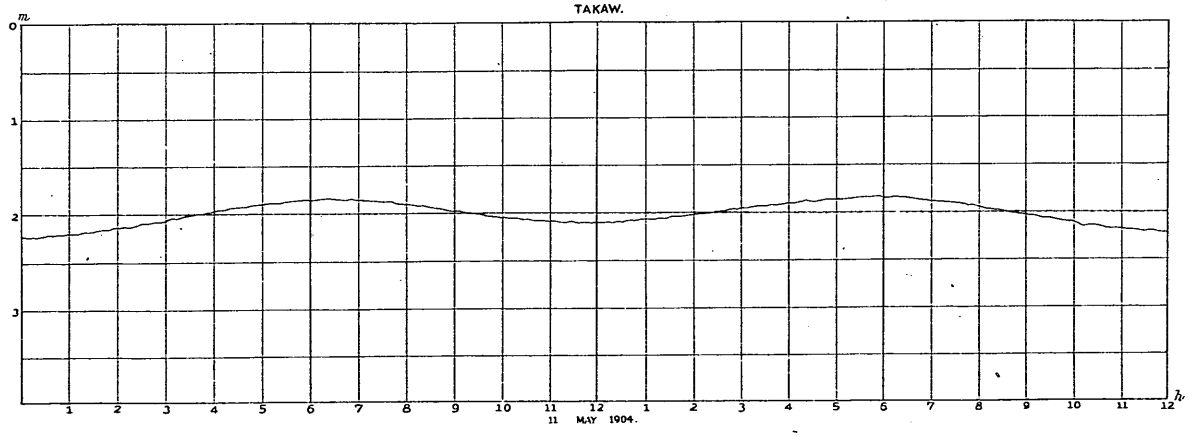
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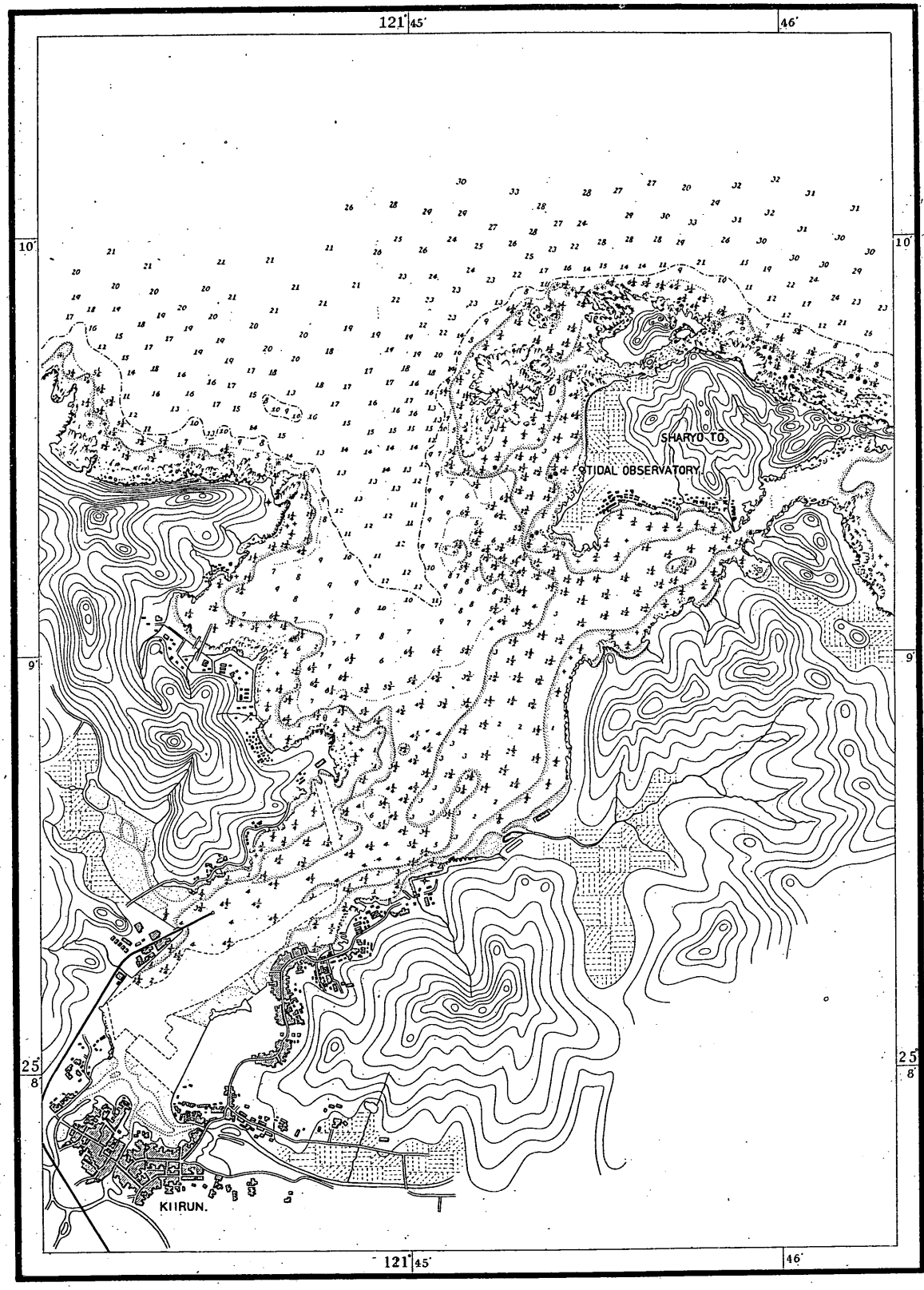

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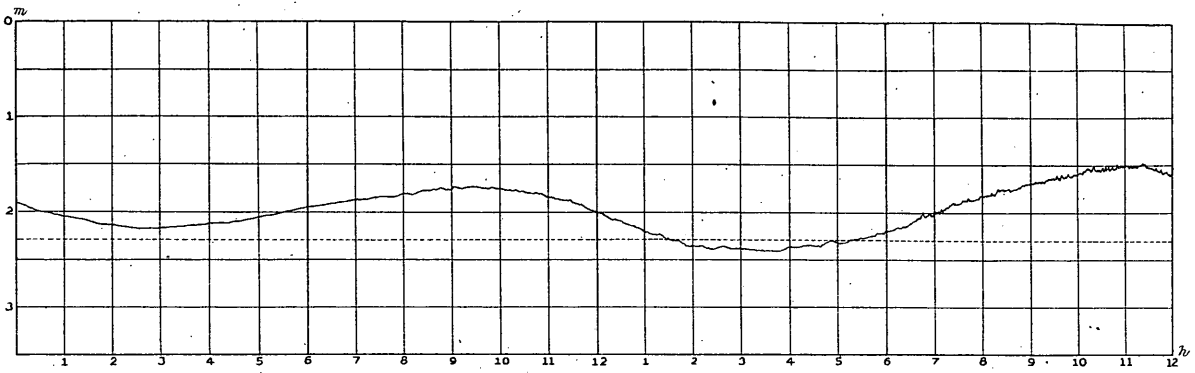

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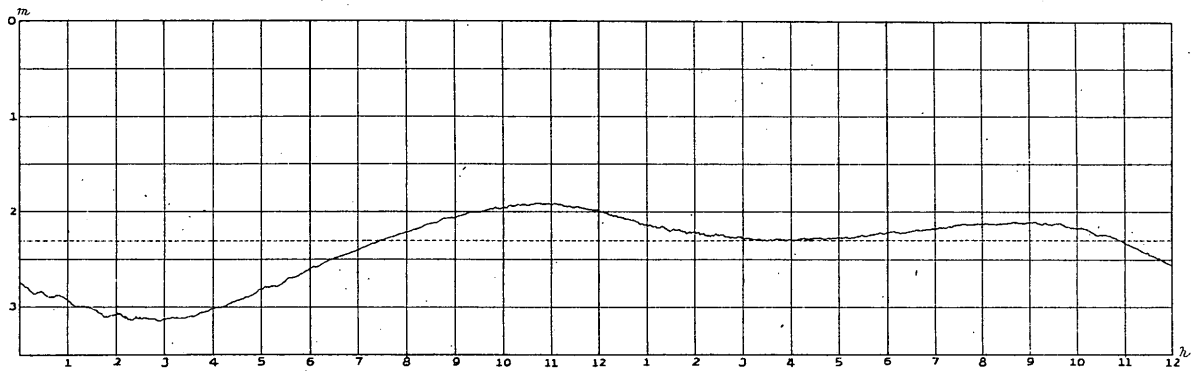

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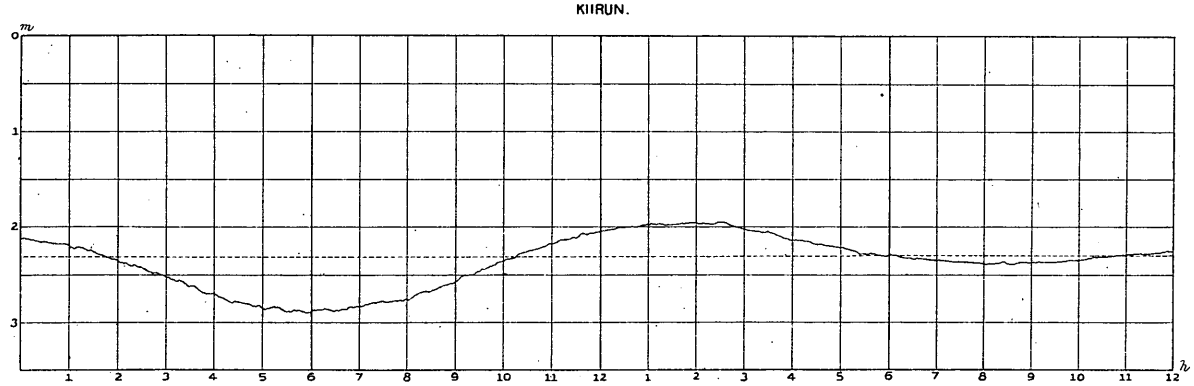

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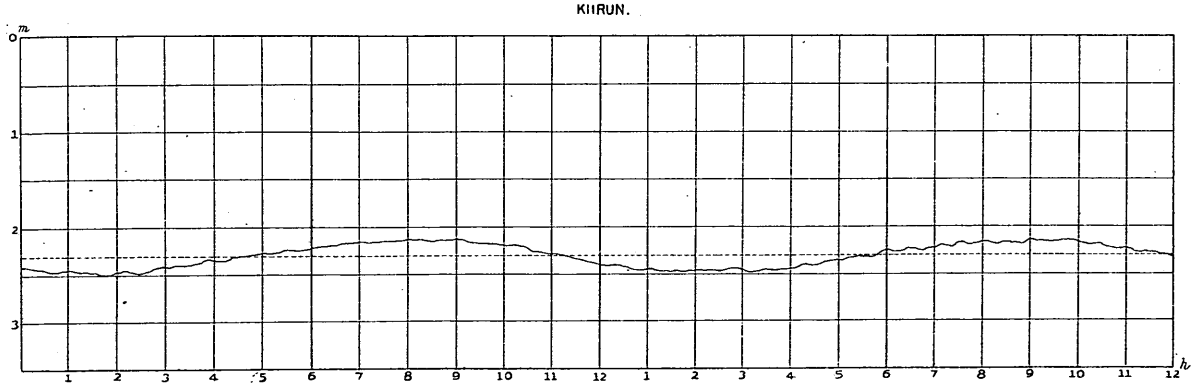

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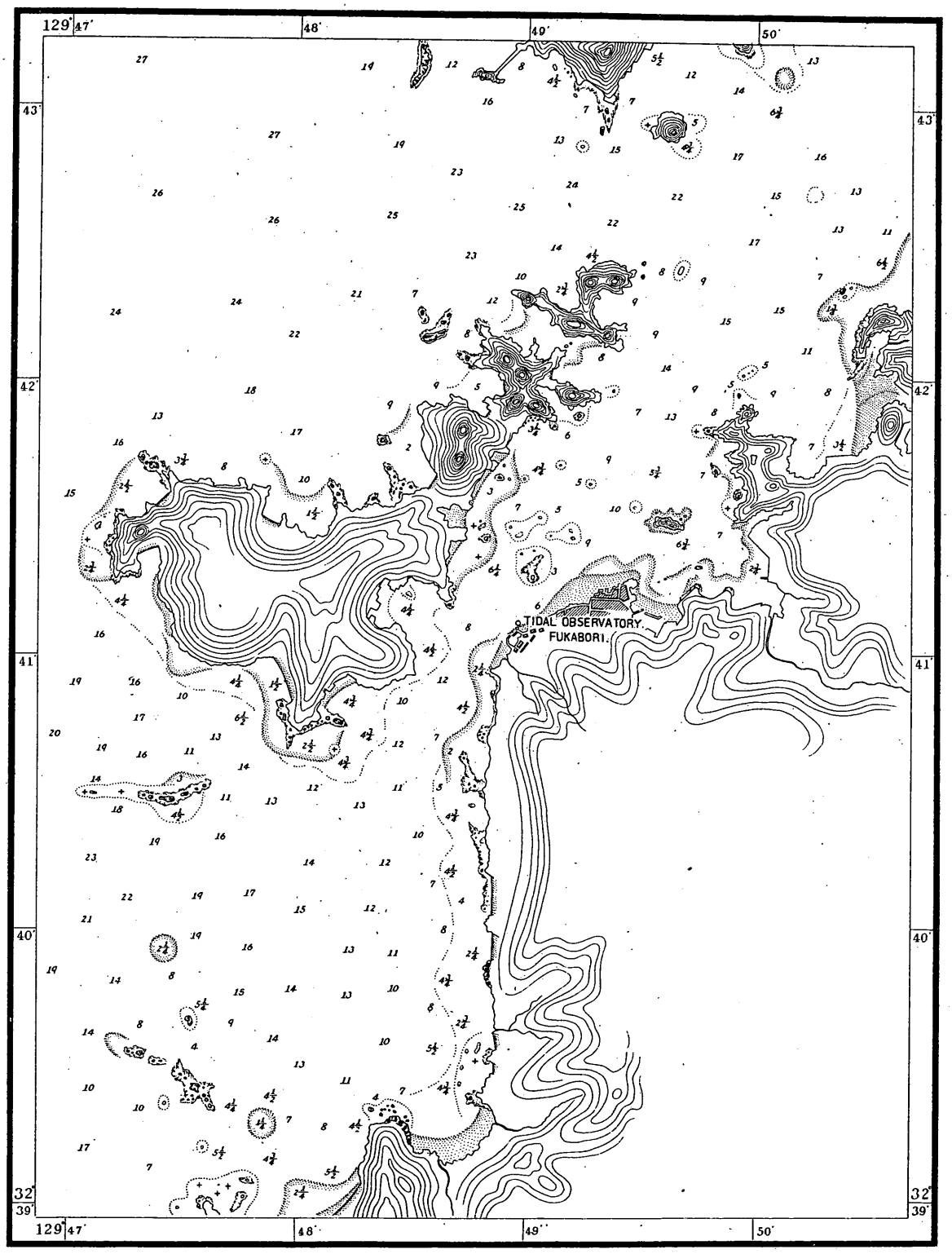

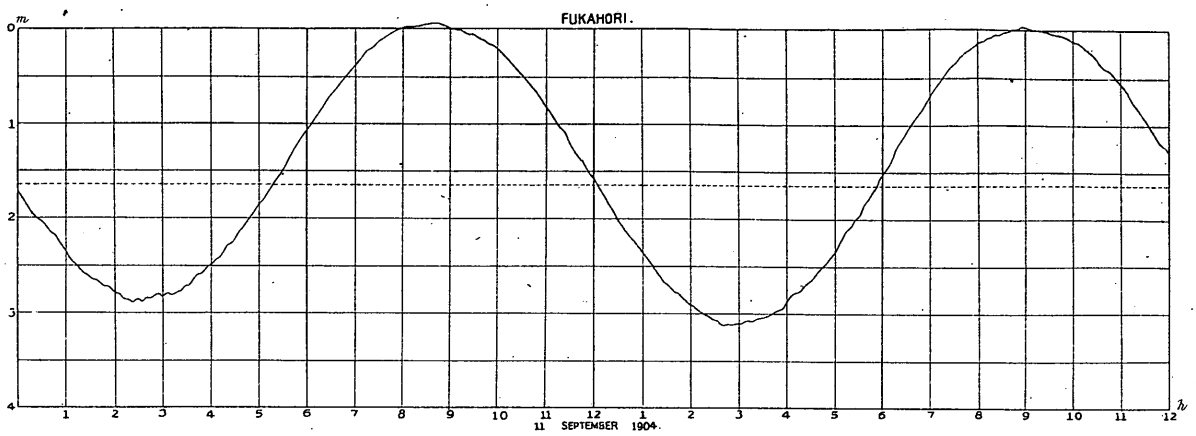
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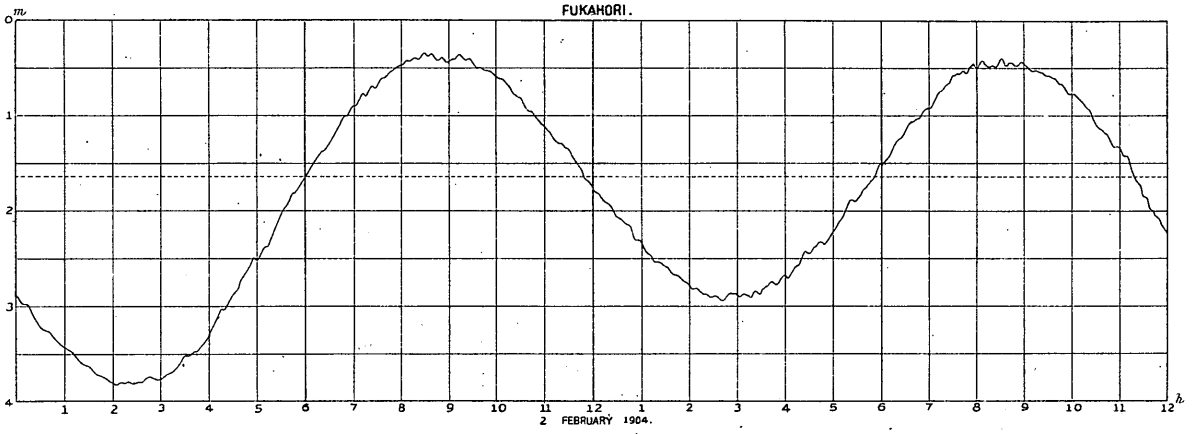
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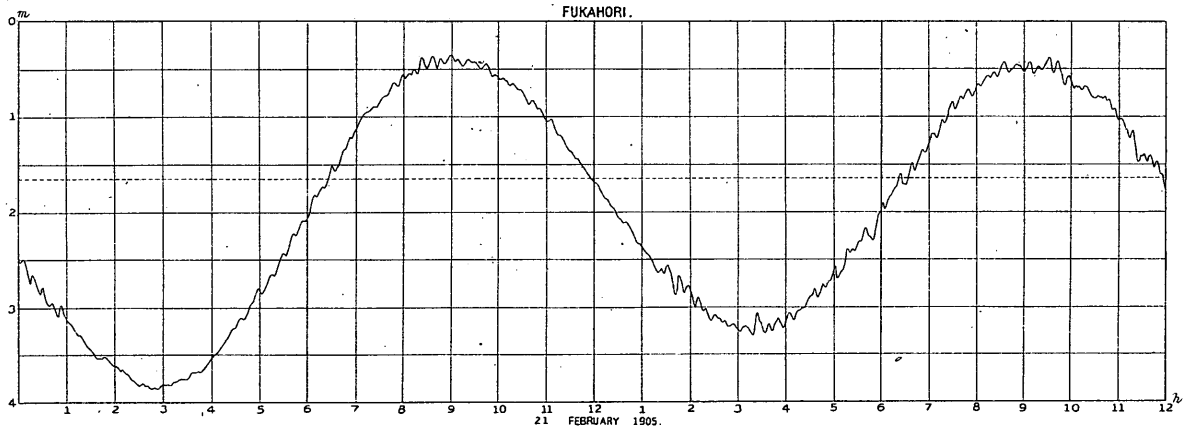
2 FEBRUARY 1904.


FUKAHORI.
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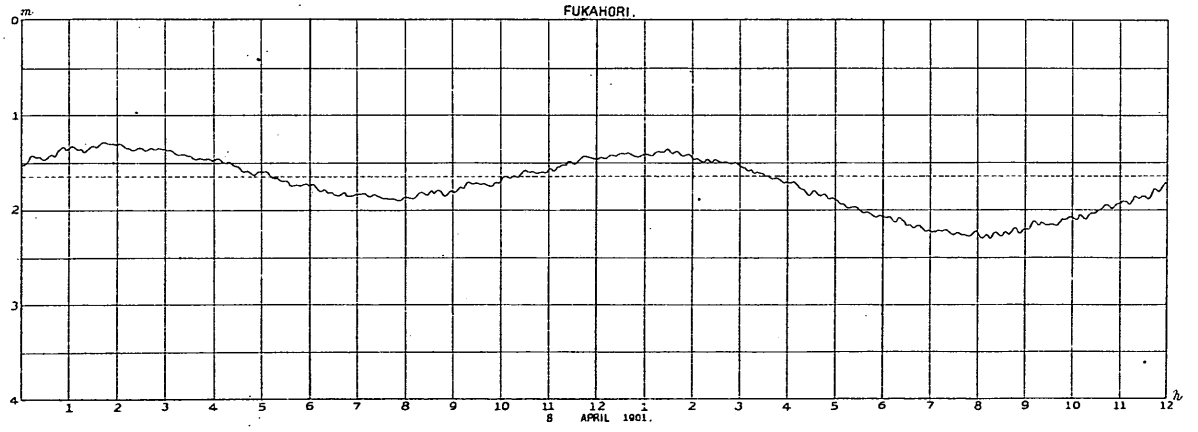
21 FEBRUARY 1905.


FUKAHORI.
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1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
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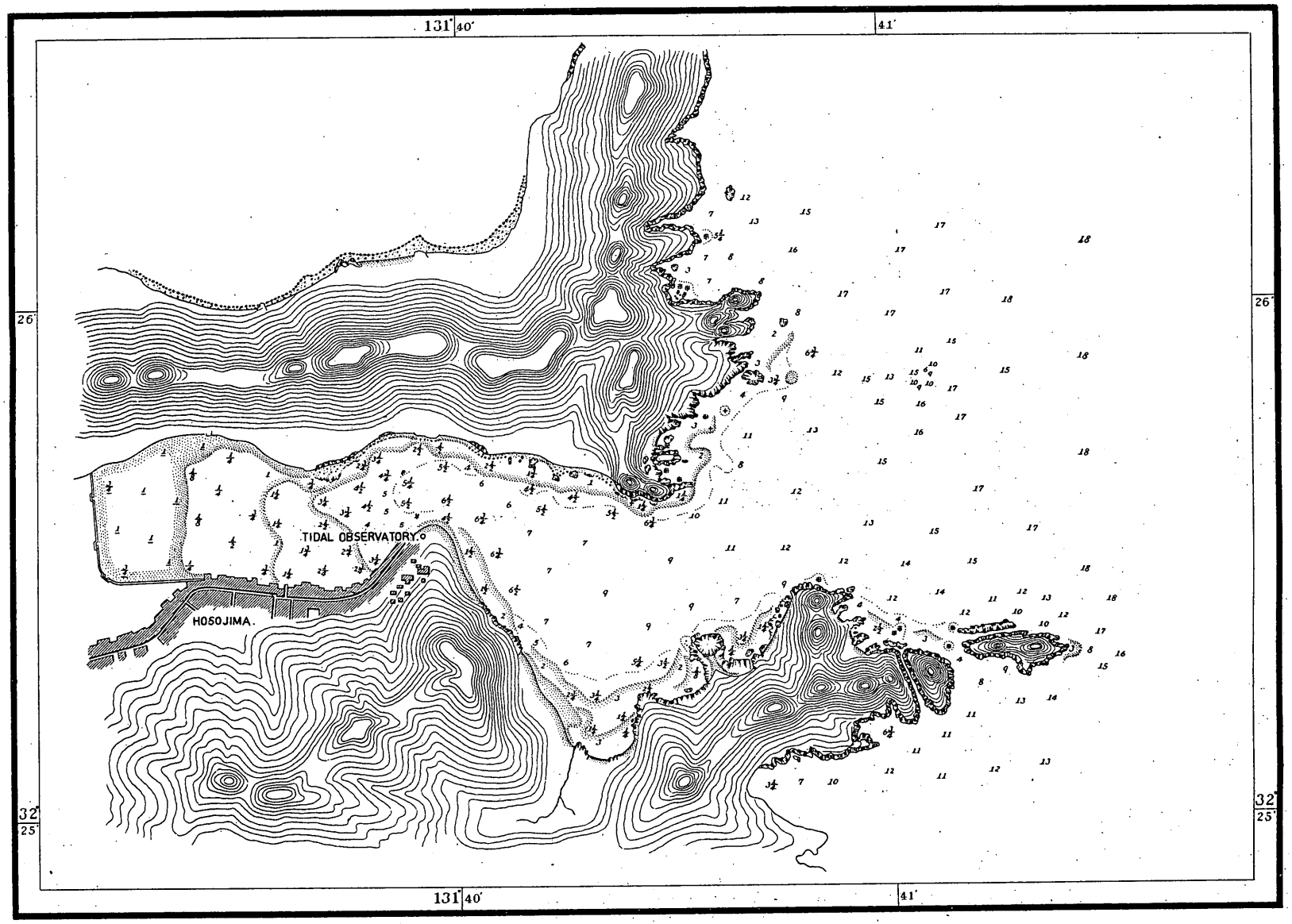
8 APRIL 1901.

HOSOJIMA



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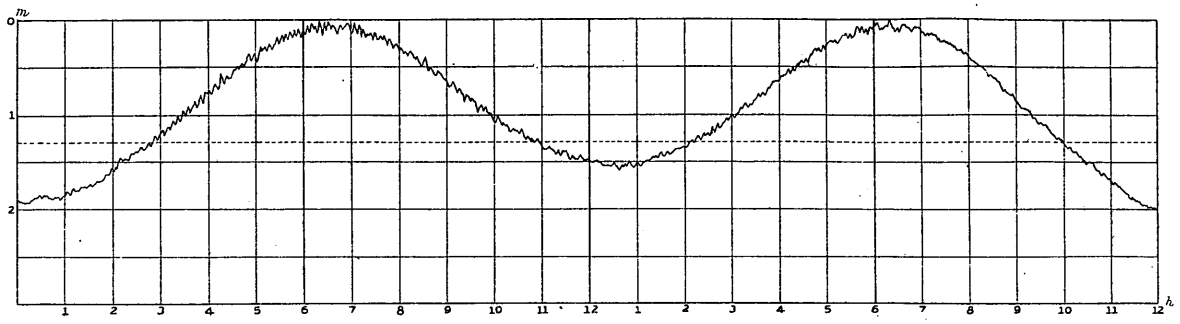

16 NOVEMBER 1906.

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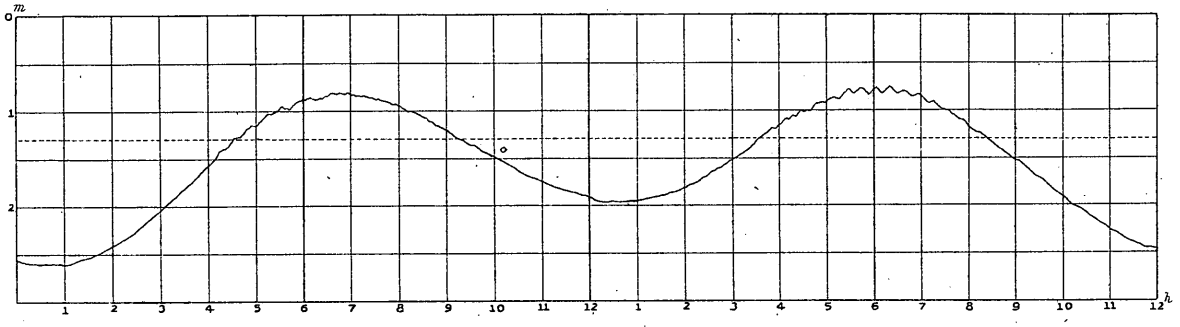

15 DECEMBER 1906.

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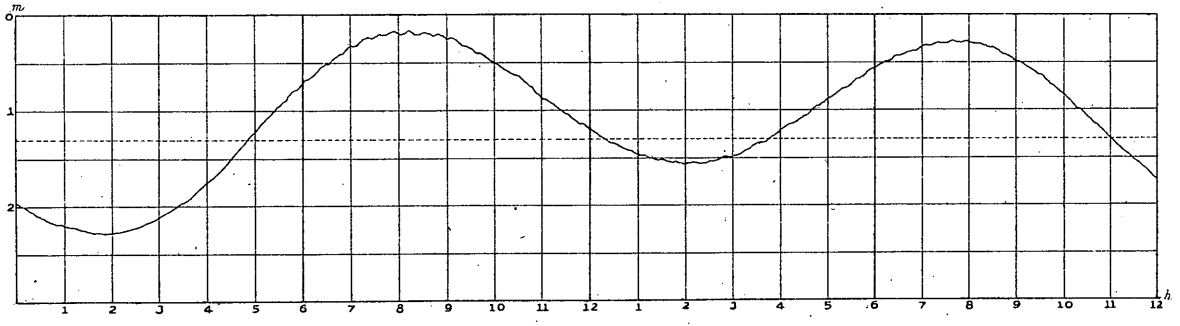

18 NOVEMBER 1906.

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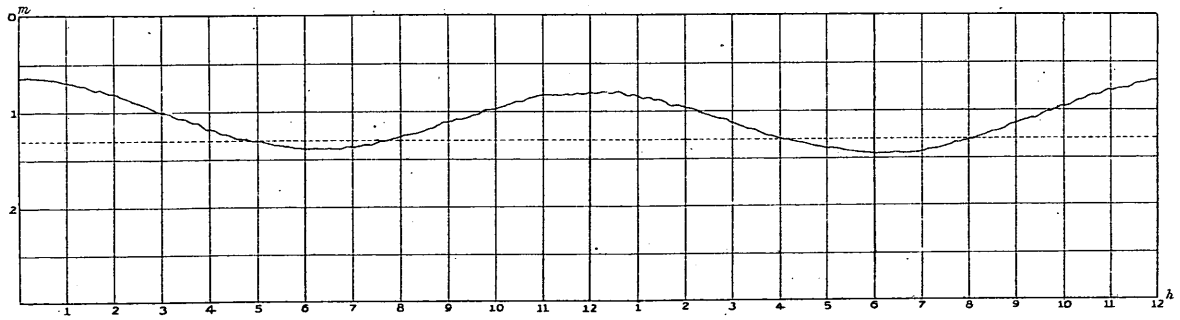
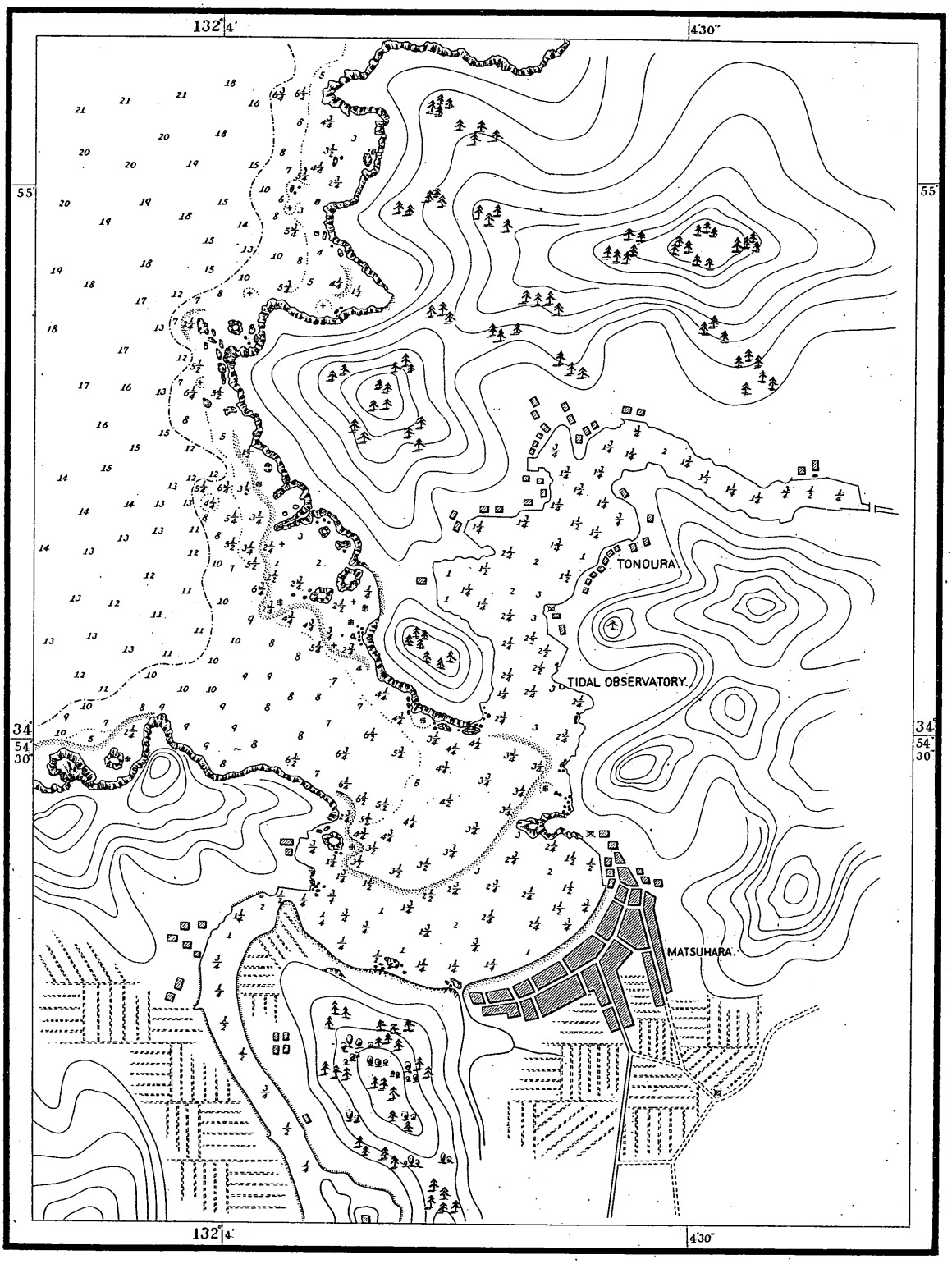


13 JULY 1906.

TONOURA



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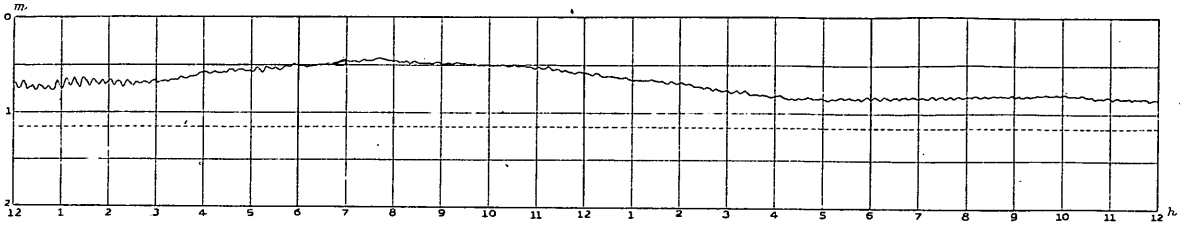

21 AUGUST 1904.

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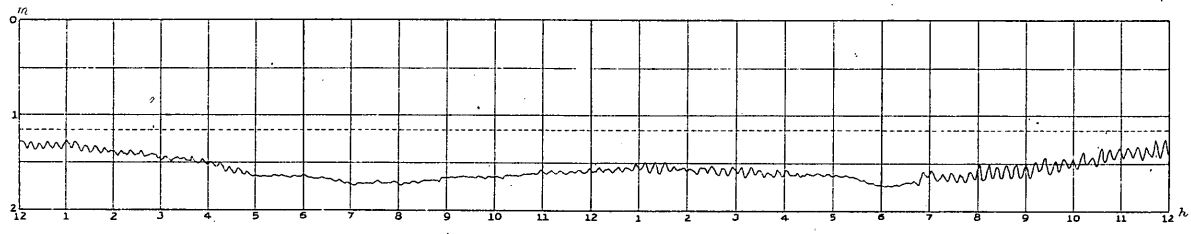
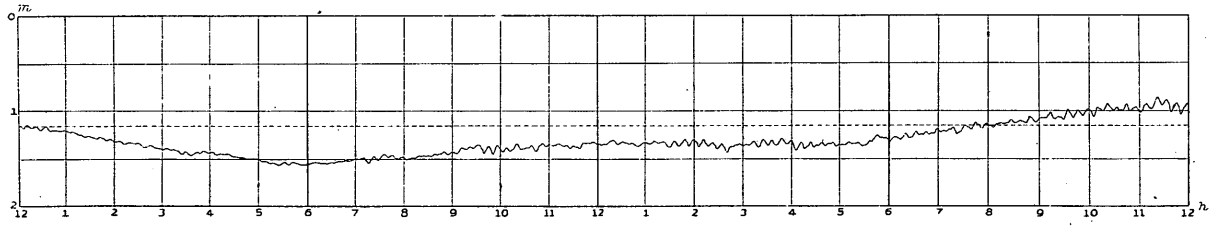


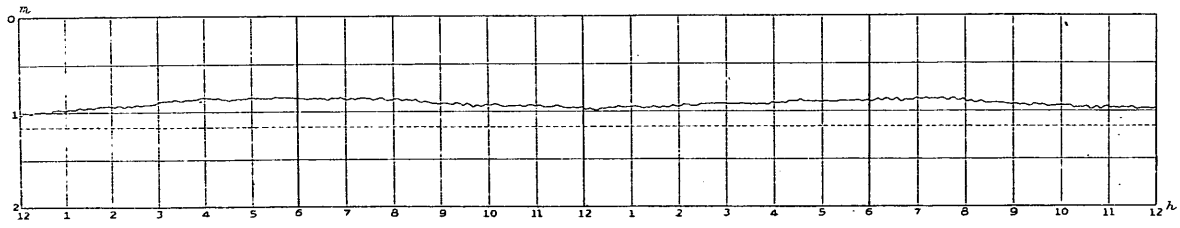
30 JANUARY 1903.

TONOURA.



3 JANUARY 1903.

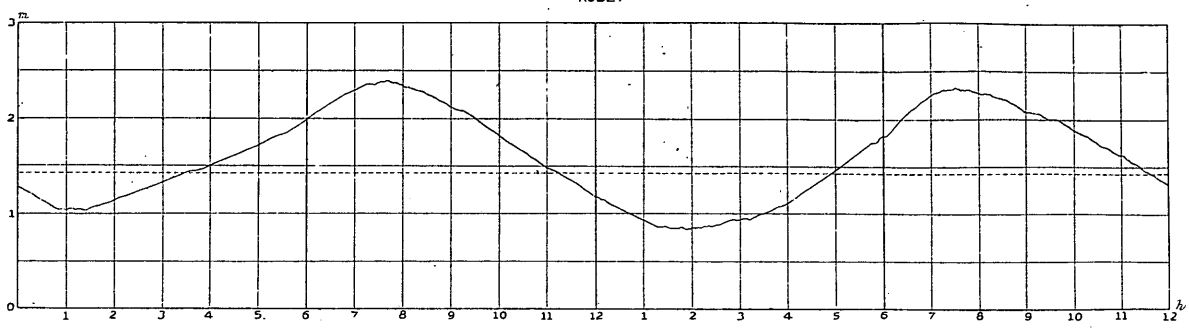
TONOURA.



20 JULY 1904.

KOBE

KOBE.



11 SEPTEMBER 1904.

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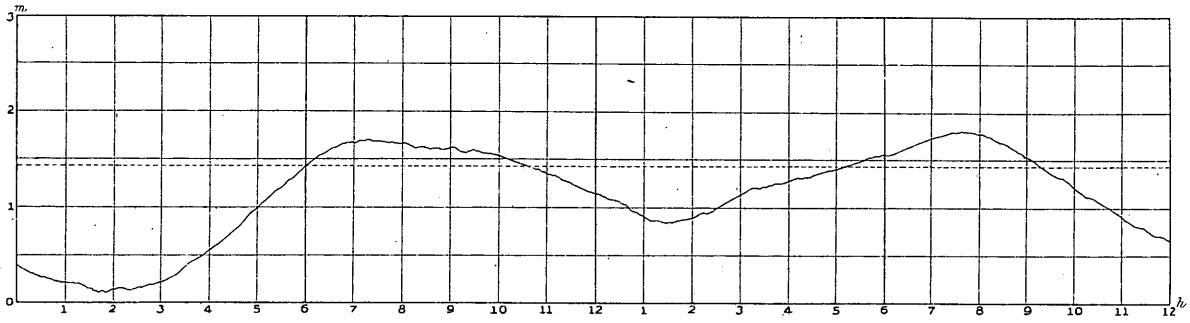
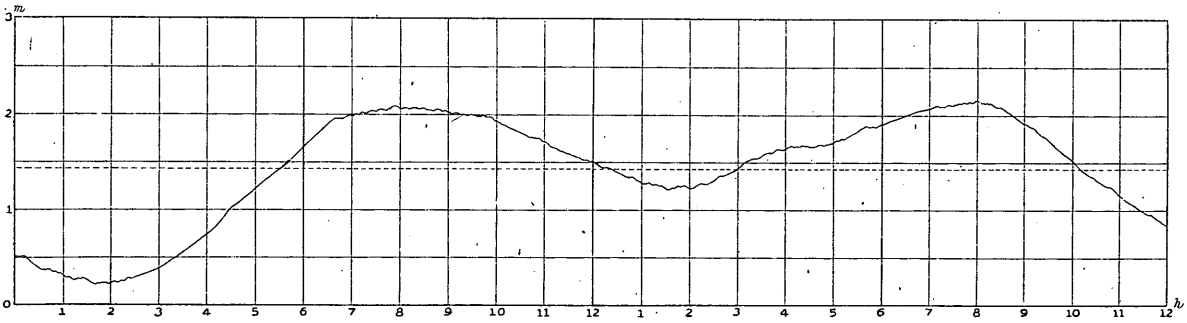


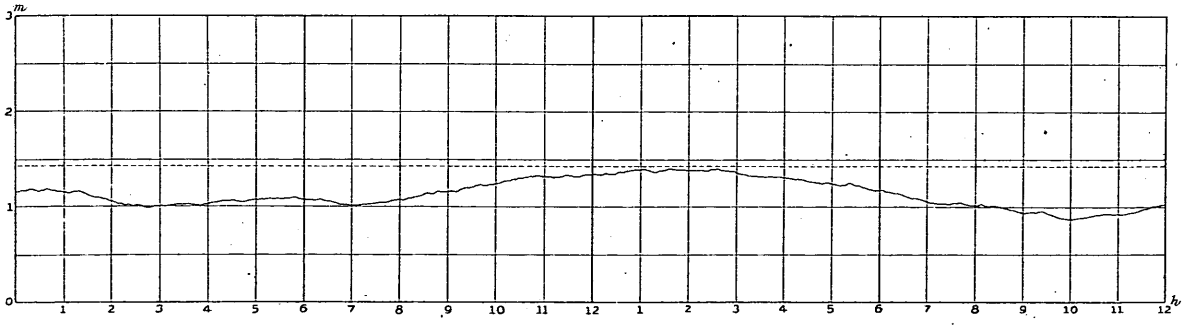
25 JANUARY 1902.

KOBE.



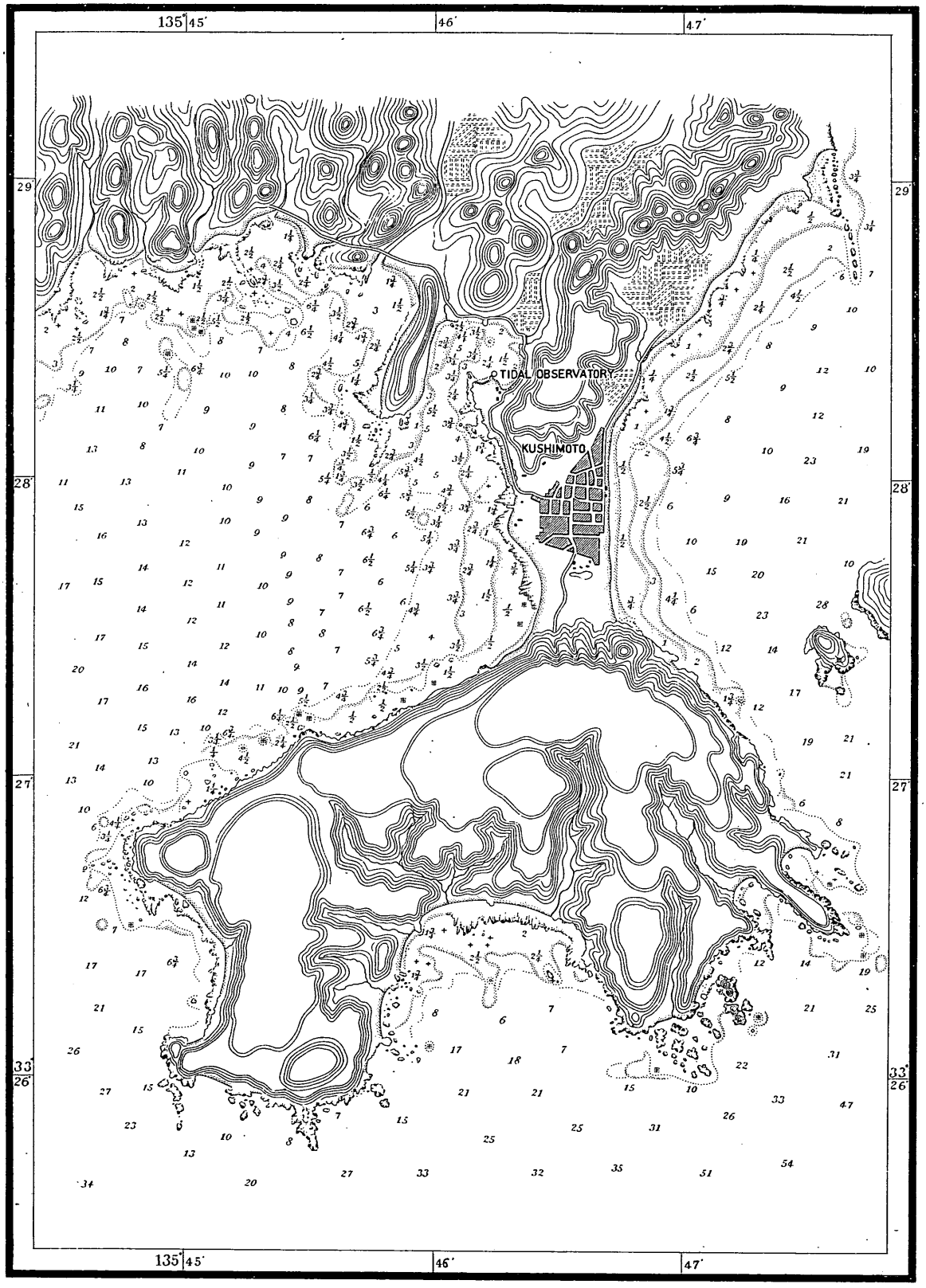
4 JANUARY 1904.

KOBE.



2 JANUARY 1902.

KUSHIMOTO



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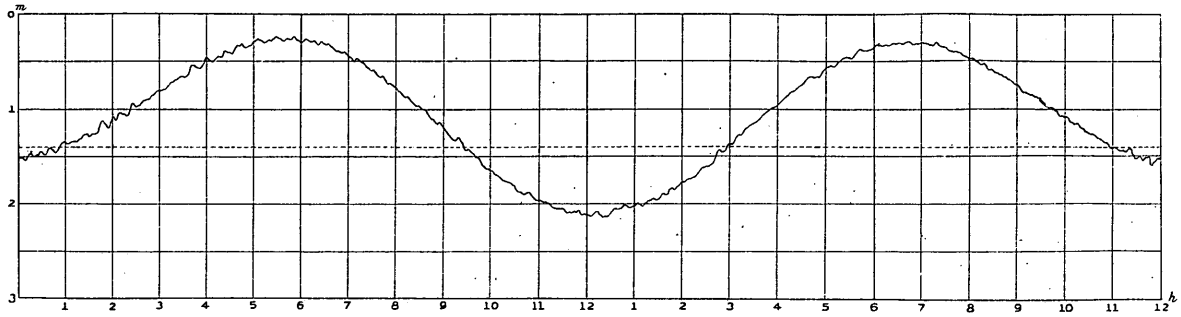
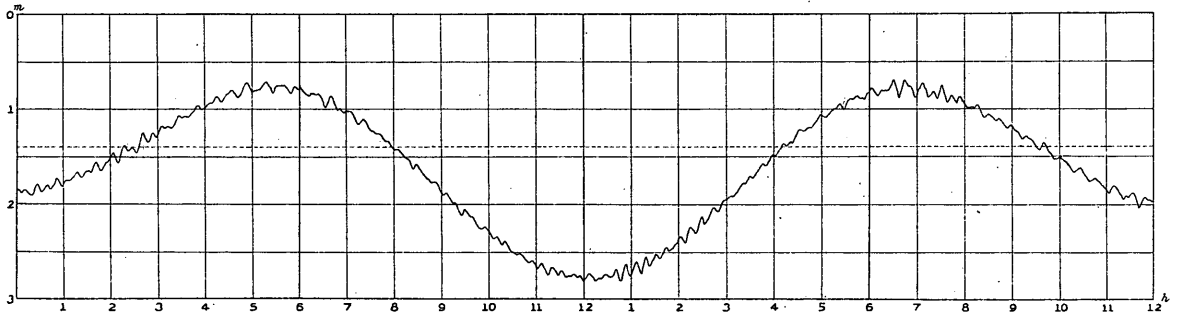


24 AUGUST 1907.

KUSHIMOTO.



FEBRUARY 1904.

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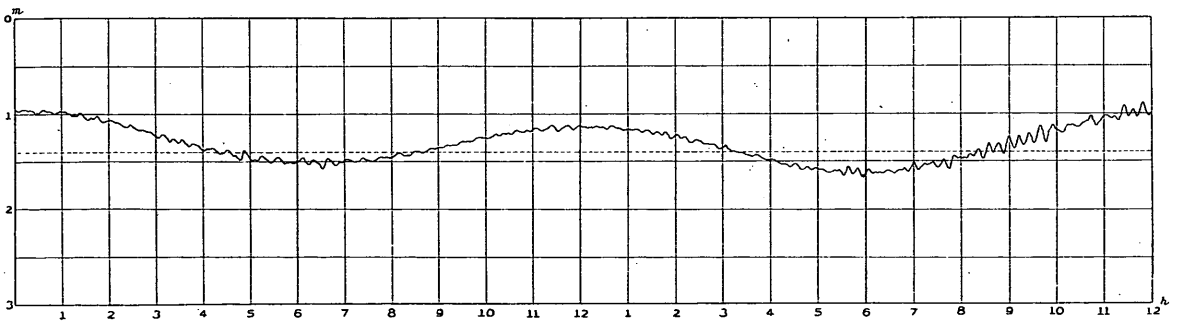
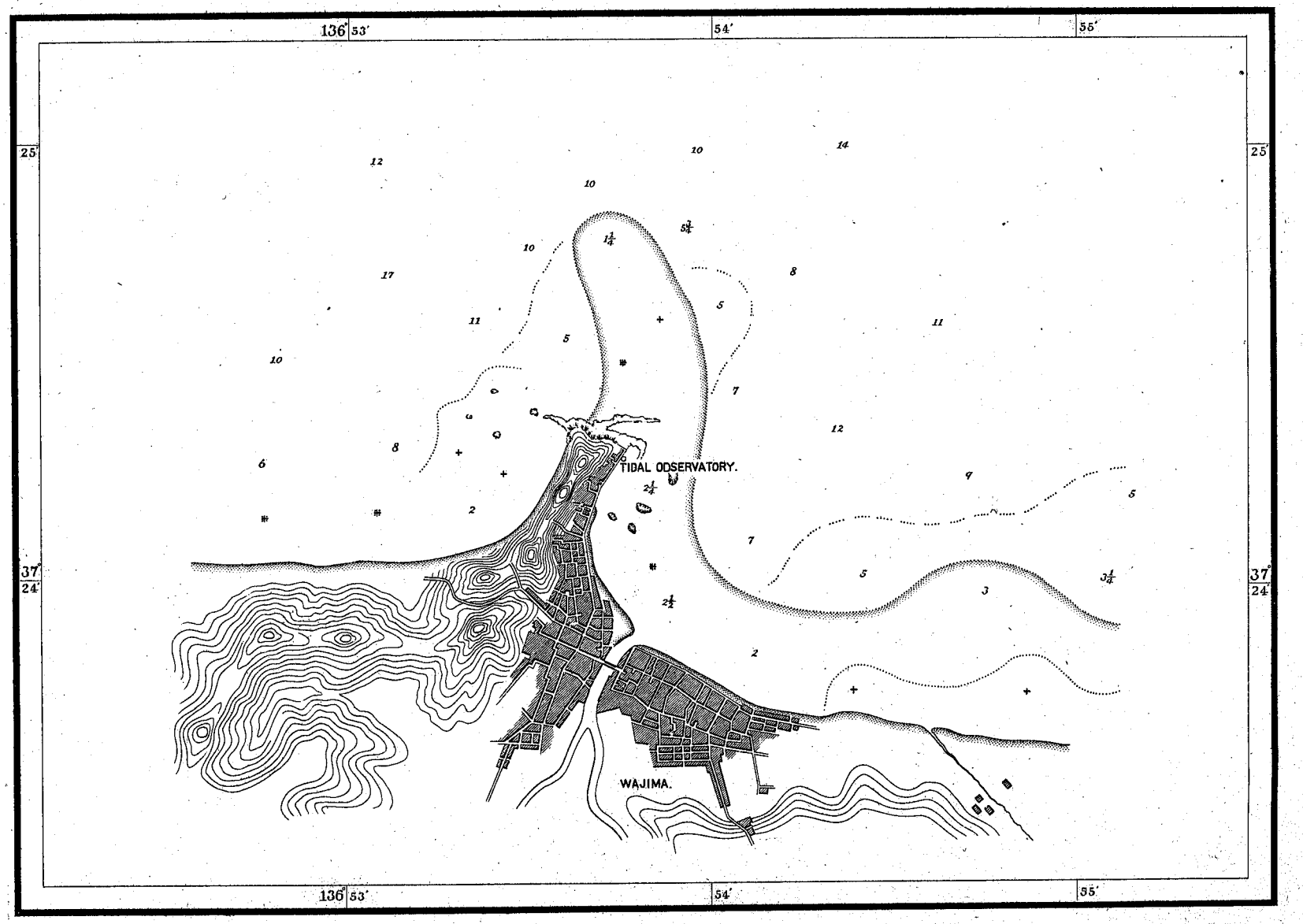


7 JUNE 1904.

WAJIMA



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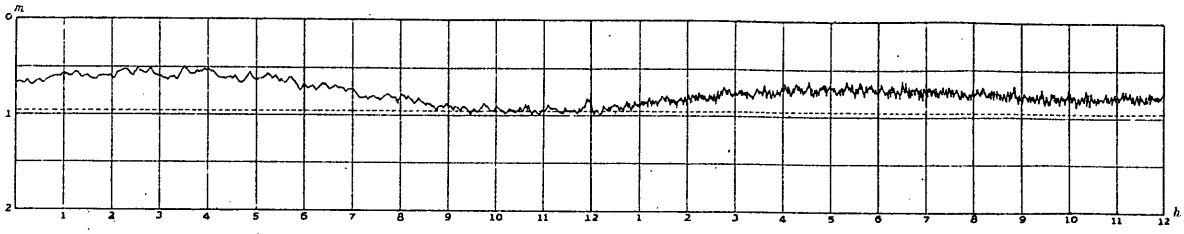
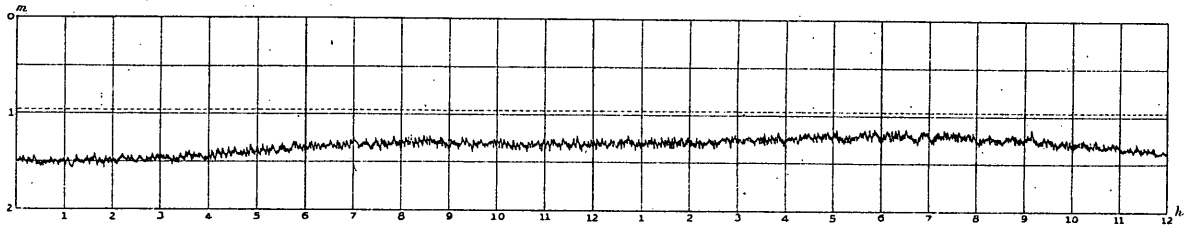


29 NOVEMBER 1905.

WAJIMA.



27 MARCH 1905.

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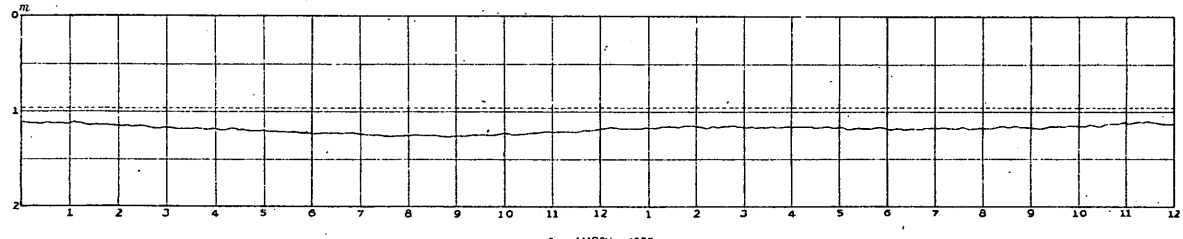

3 MARCH 1905.

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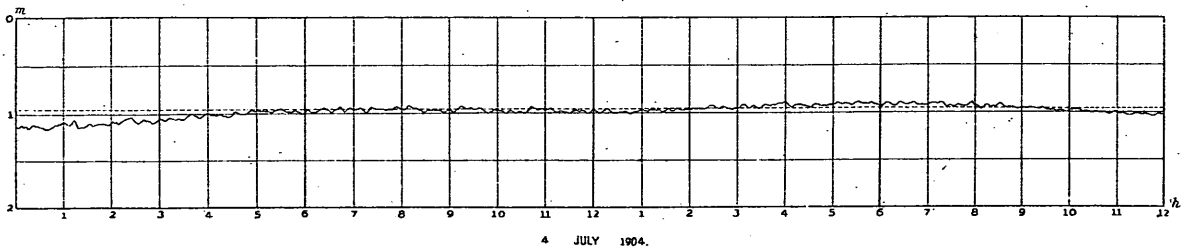
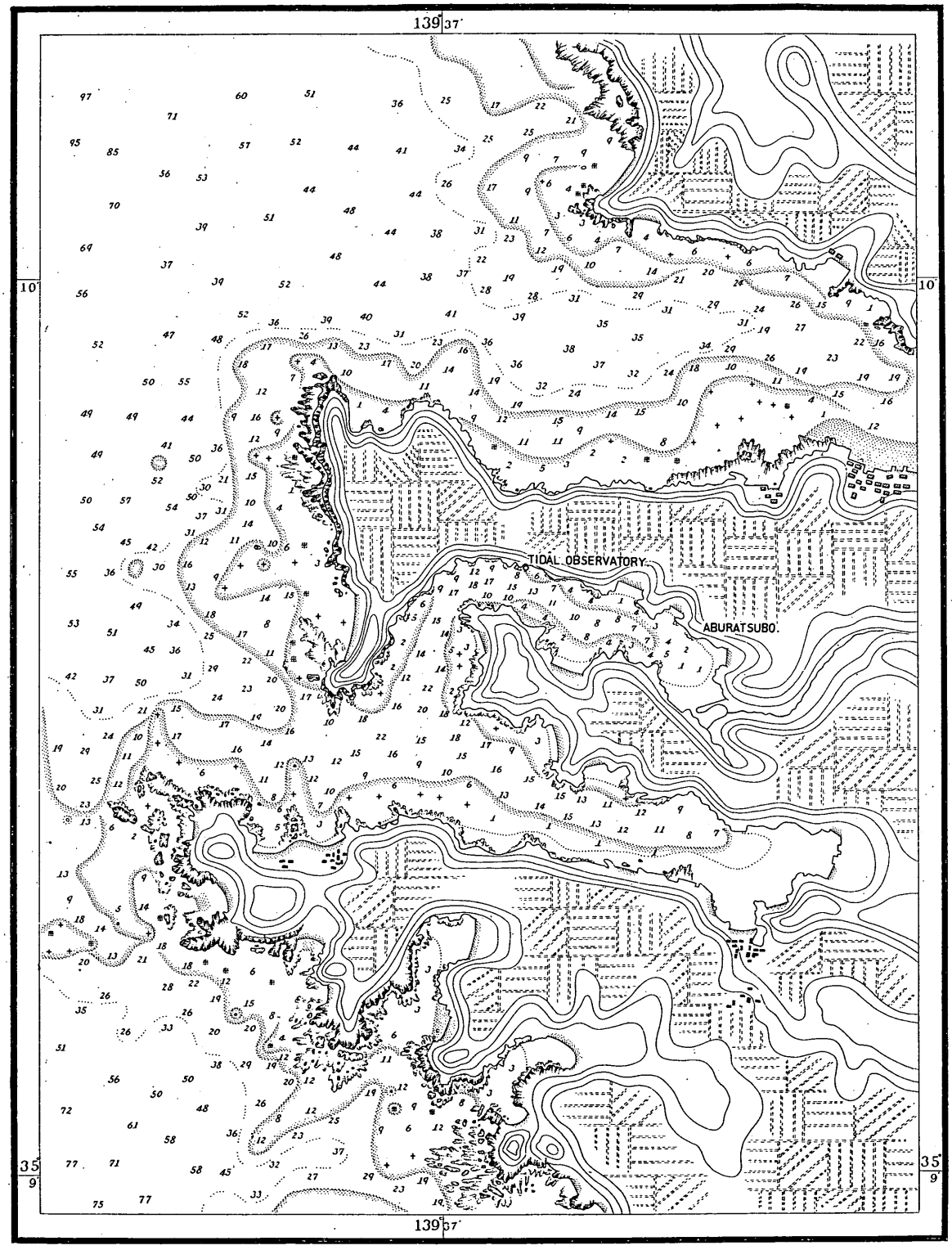


4 JULY 1904.

ABURATSUBO



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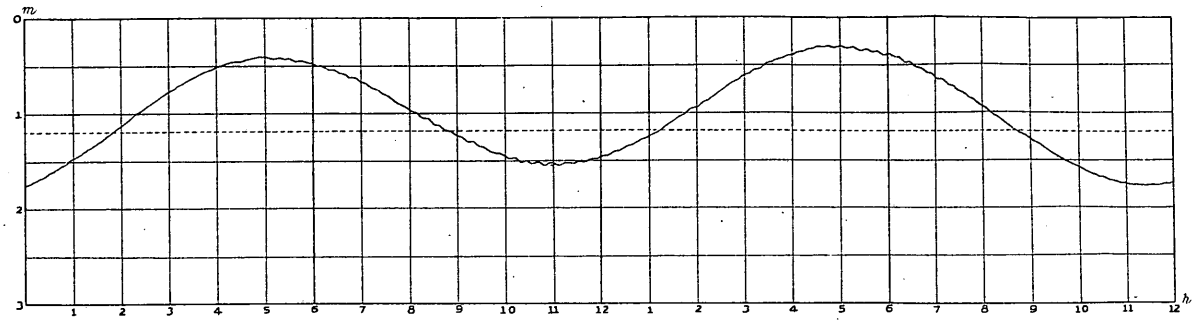
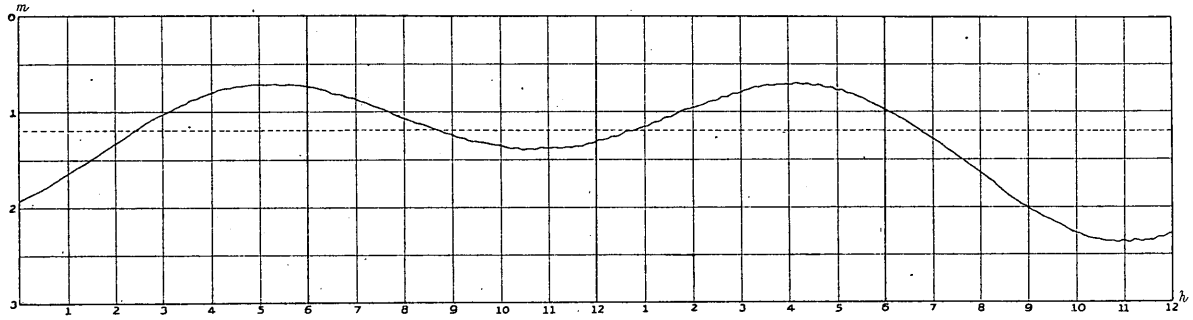


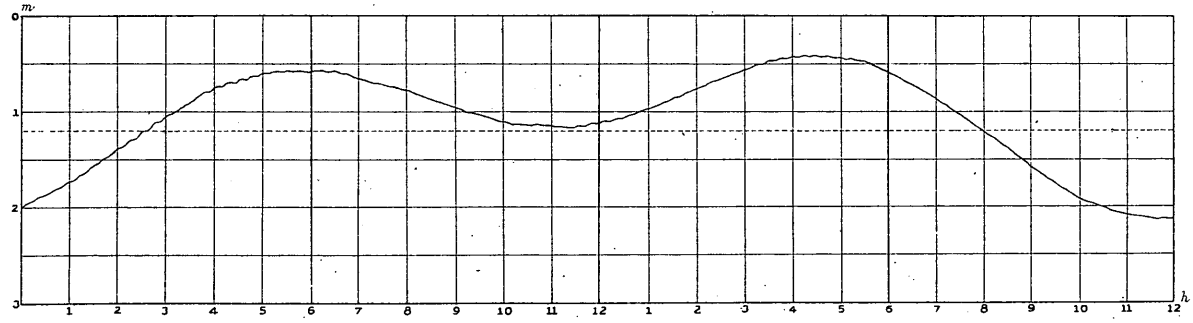
10 OCTOBER 1904.

ABURATSUBO.



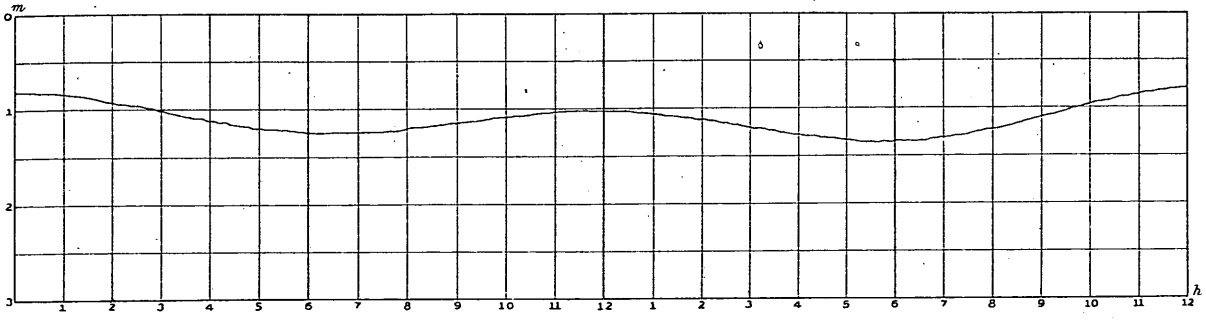
1 FEBRUARY 1904.

ABURATSUBO.



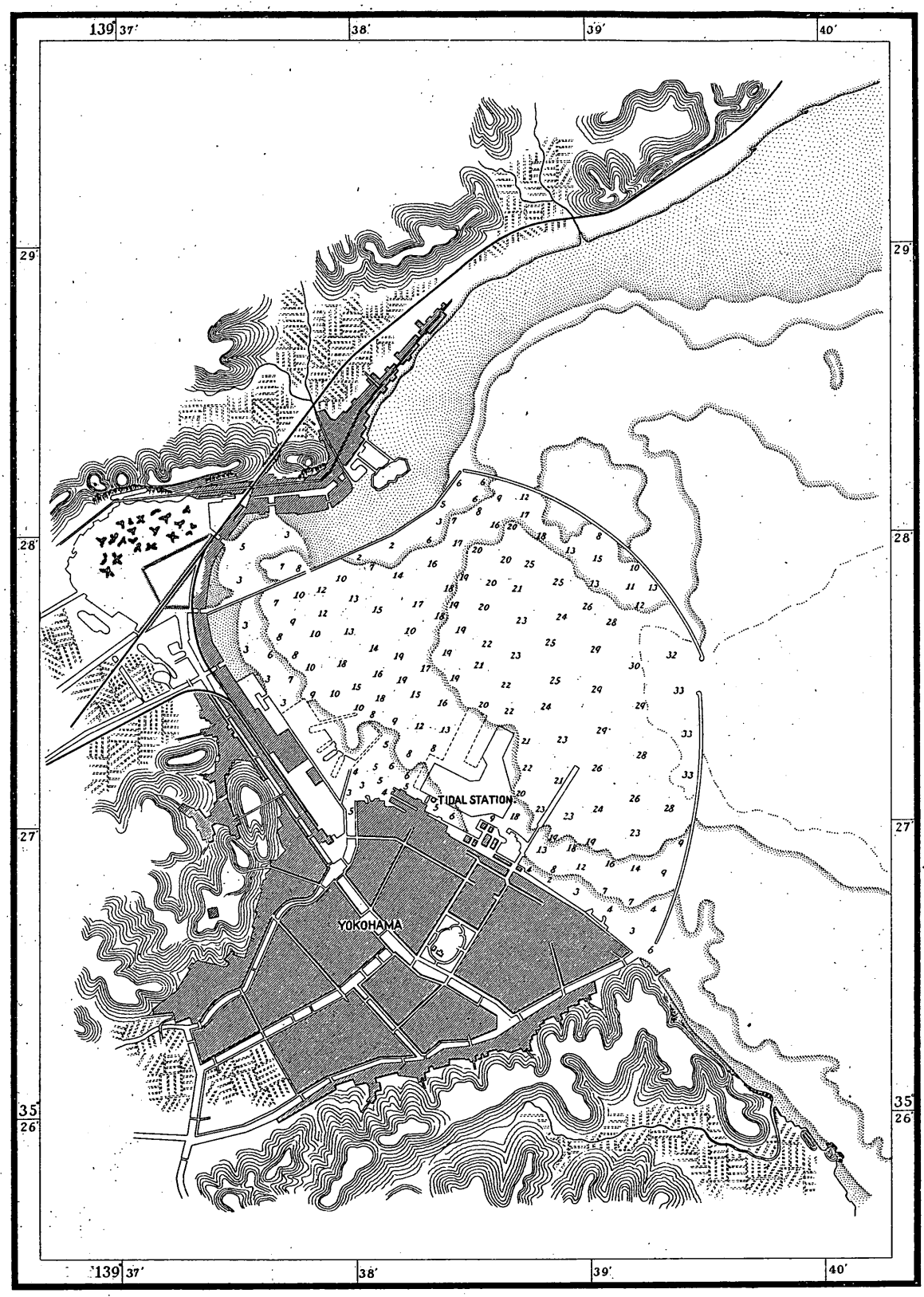
JANUARY 1904.

ABURATSUBO.

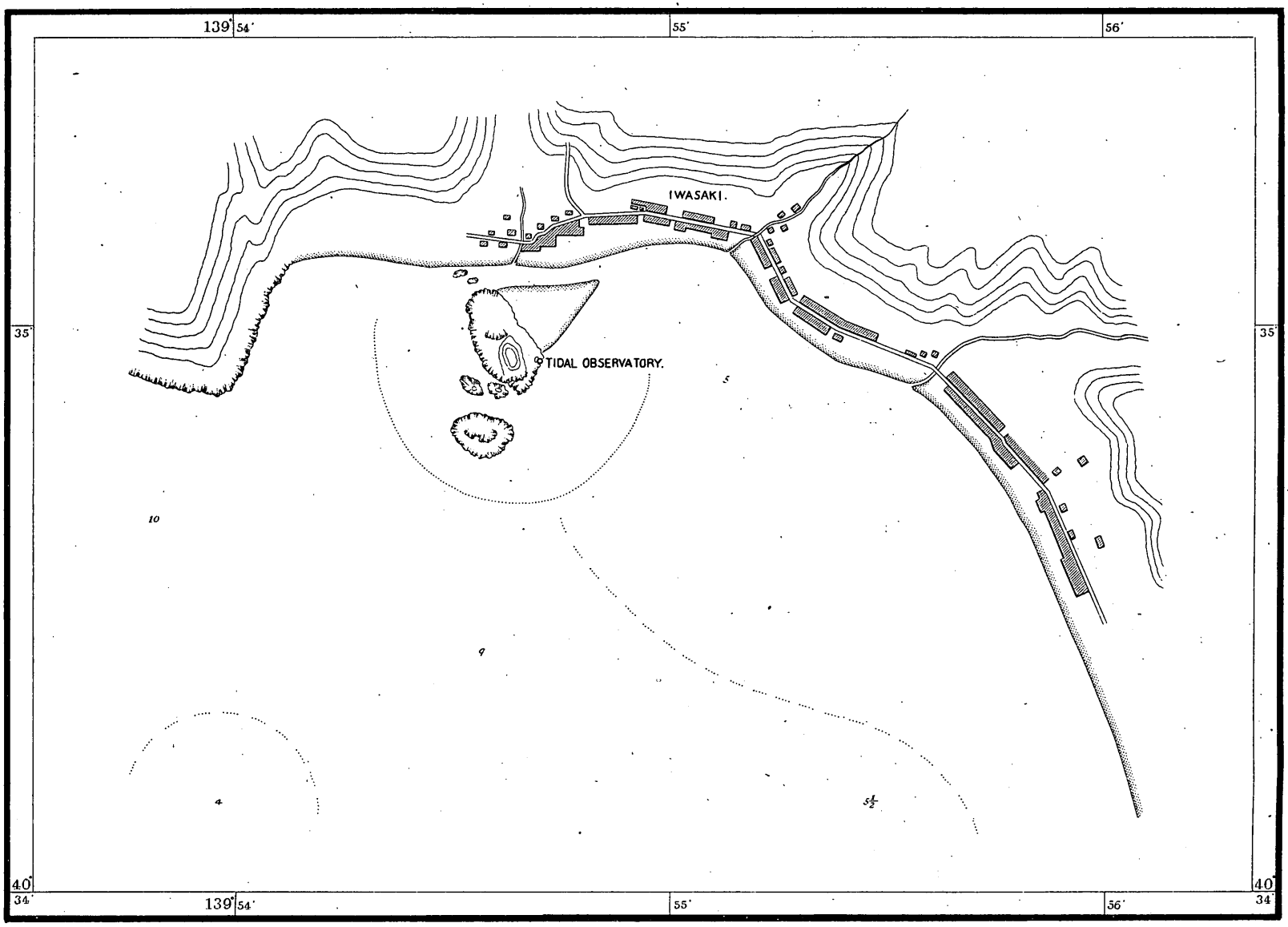


7 JUNE 1904.

YOKOHAMA



IWASAKI



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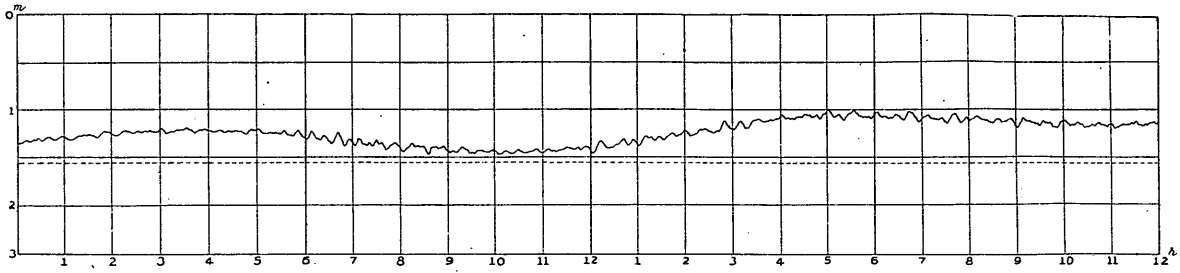

DECEMBER 1904.

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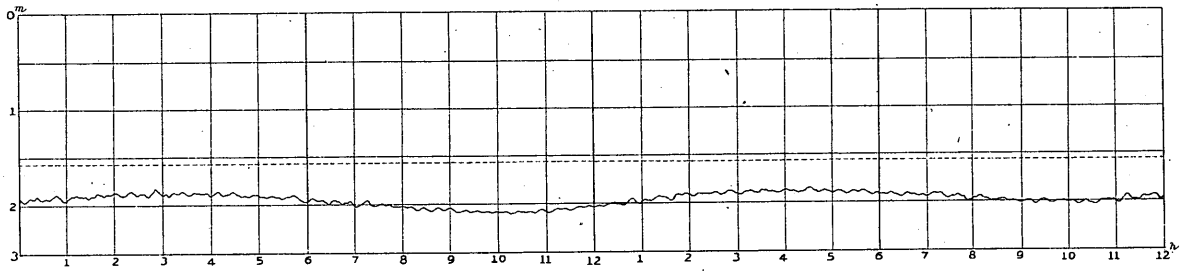

18 MARCH 1904.

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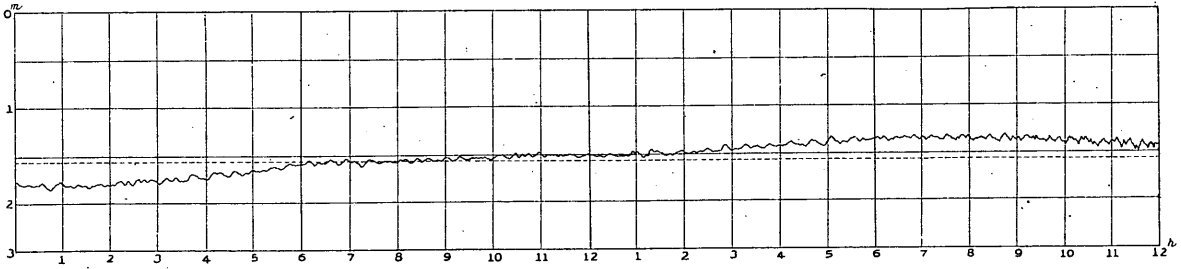

5 MAY 1904.

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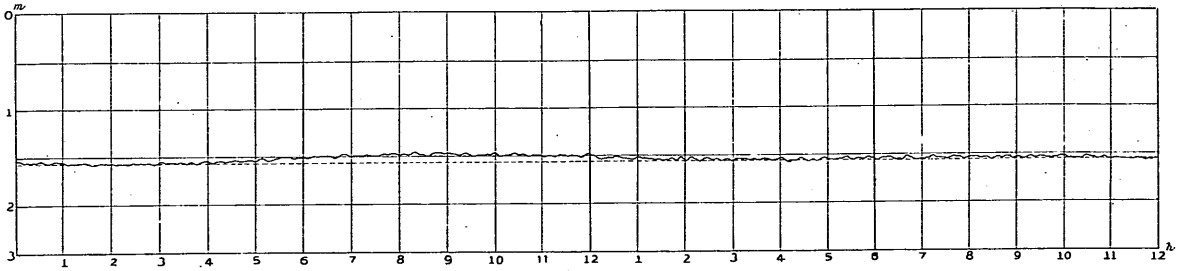
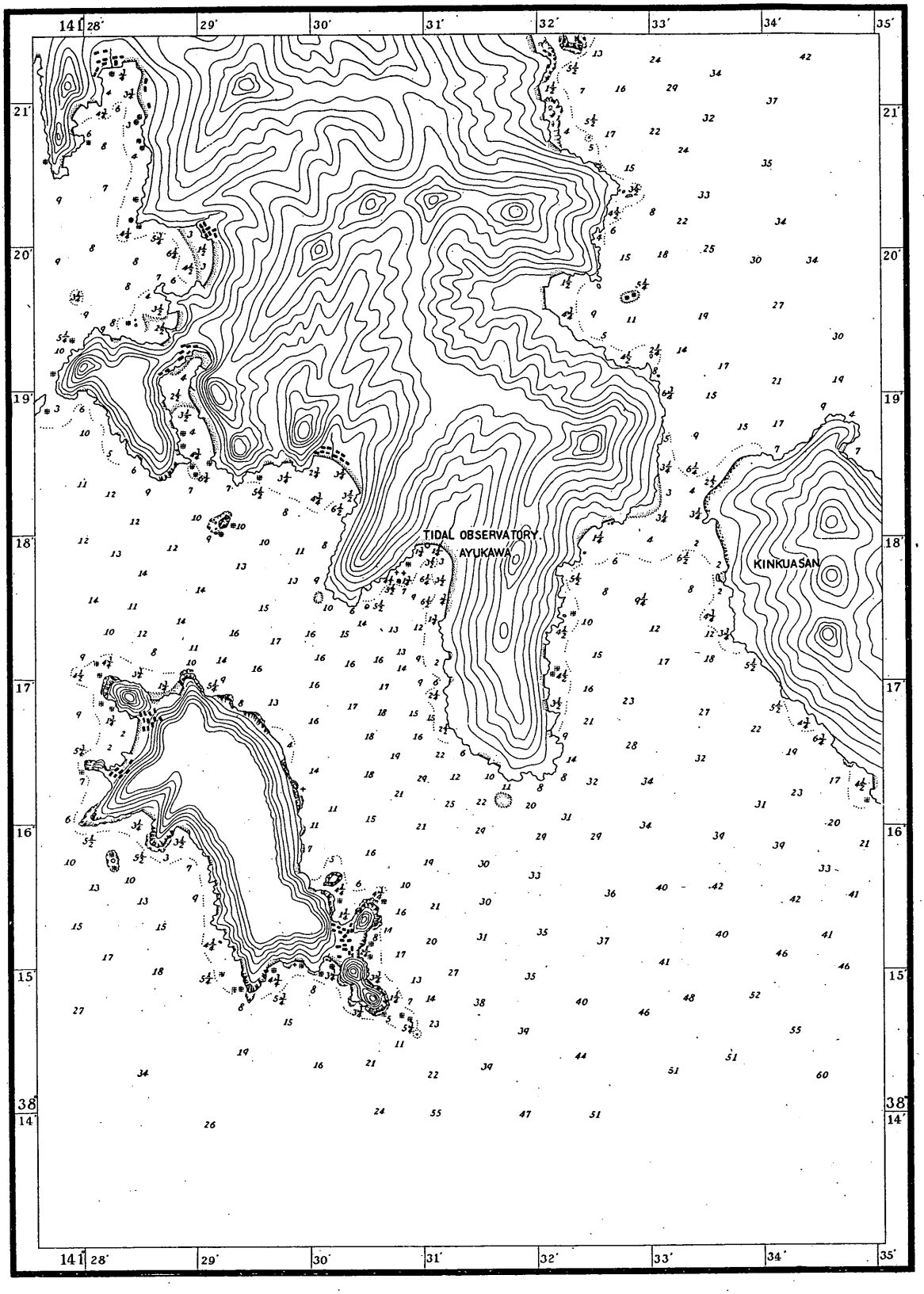


6 JULY 1904.

AYUKAWA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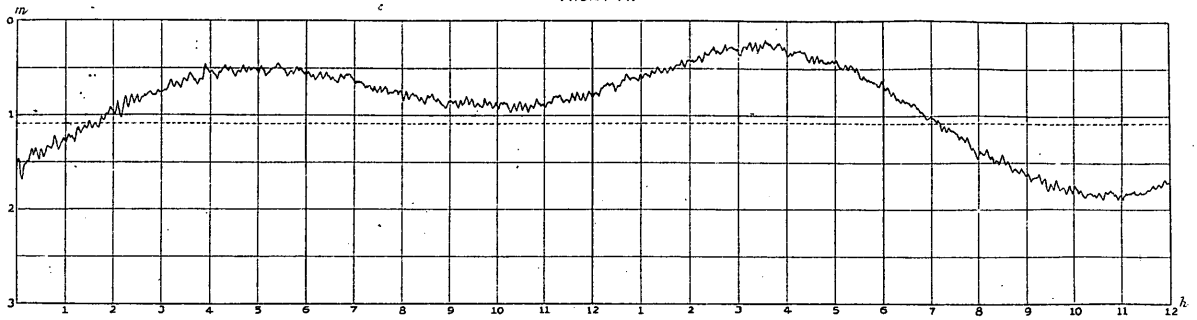
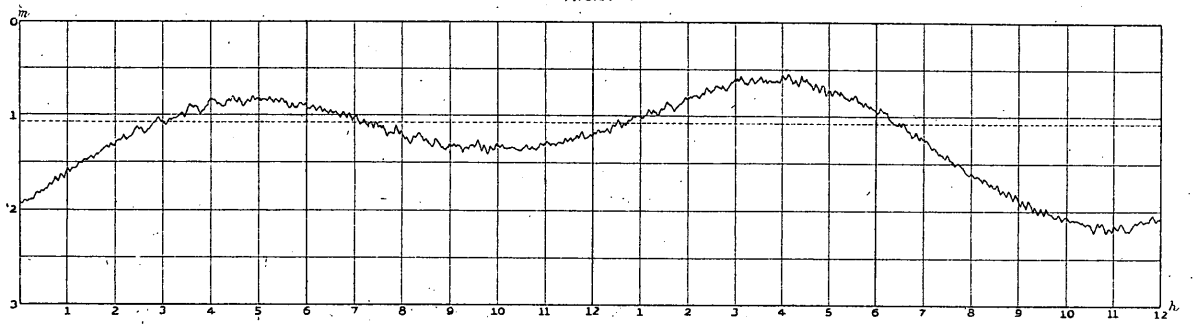
AYUKAWA.



23 DECEMBER 1904.

AYUKAWA.



2 FEBRUARY 1904.

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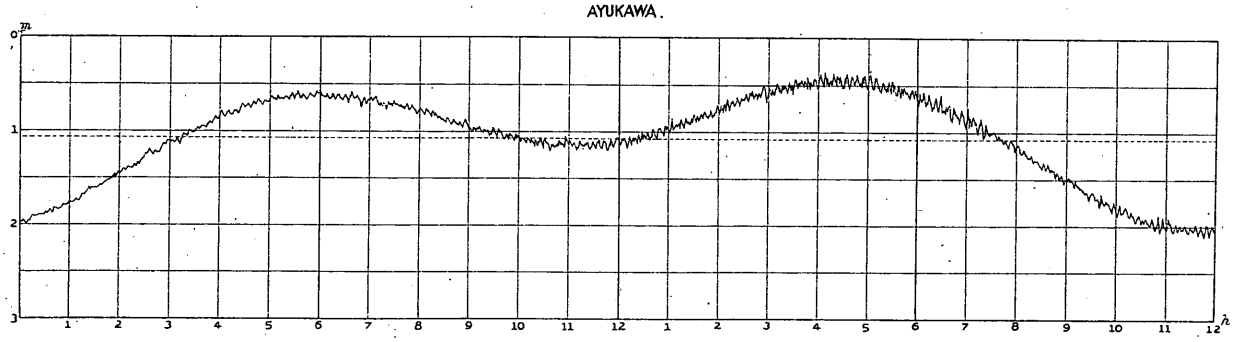

5 JANUARY 1904.

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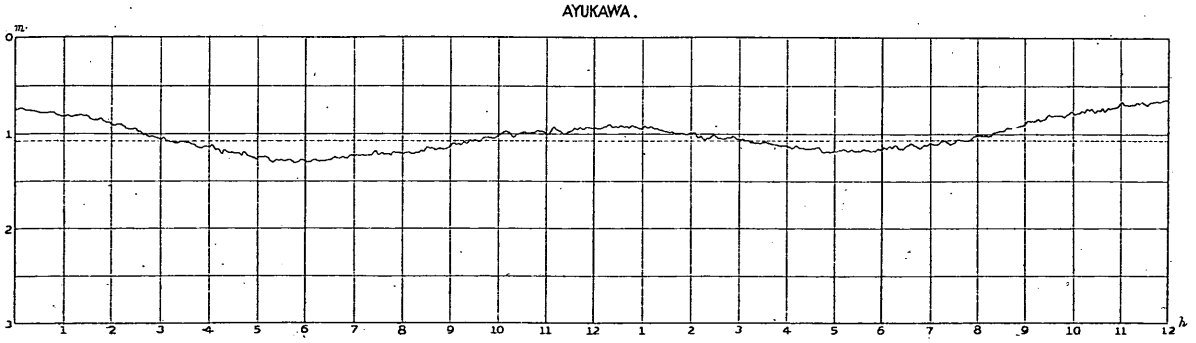
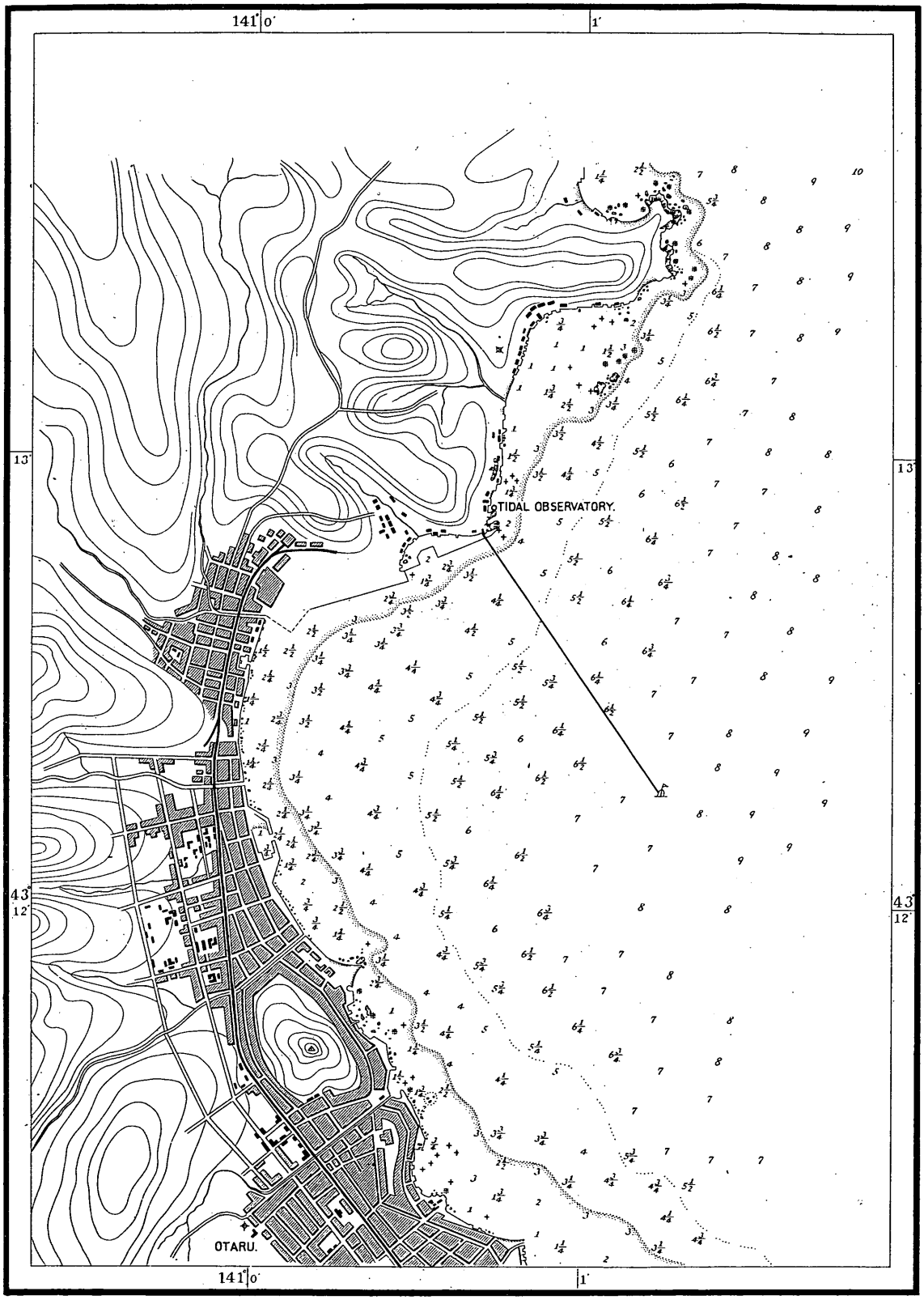
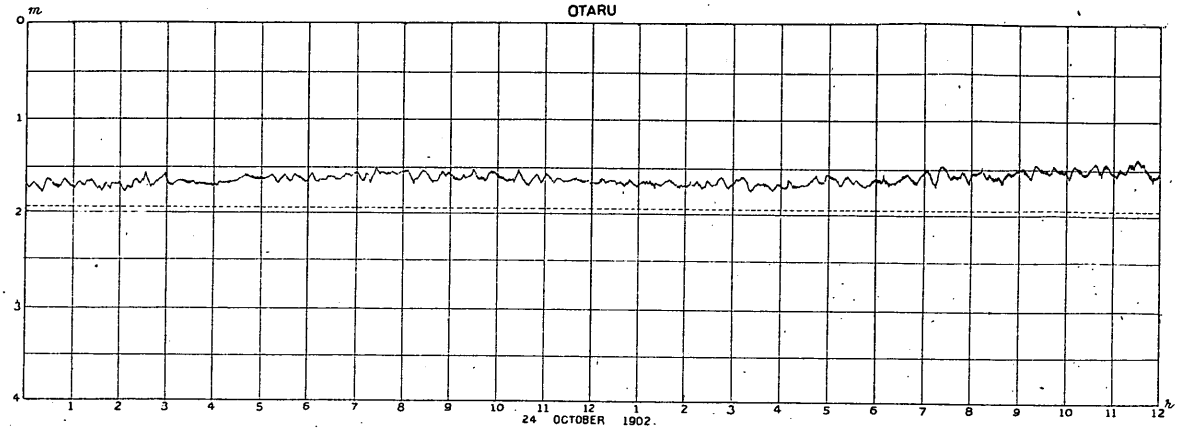


16 JUNE 1906.

OTARU

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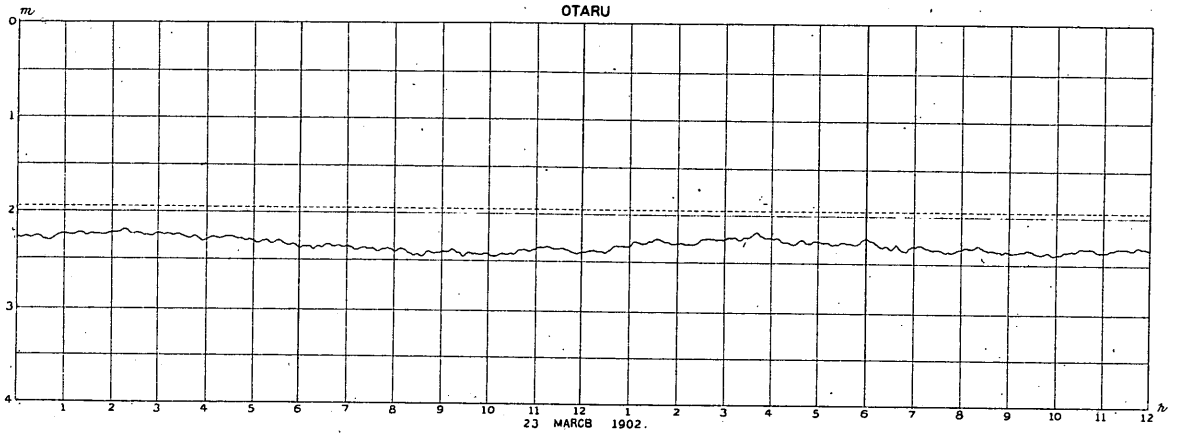
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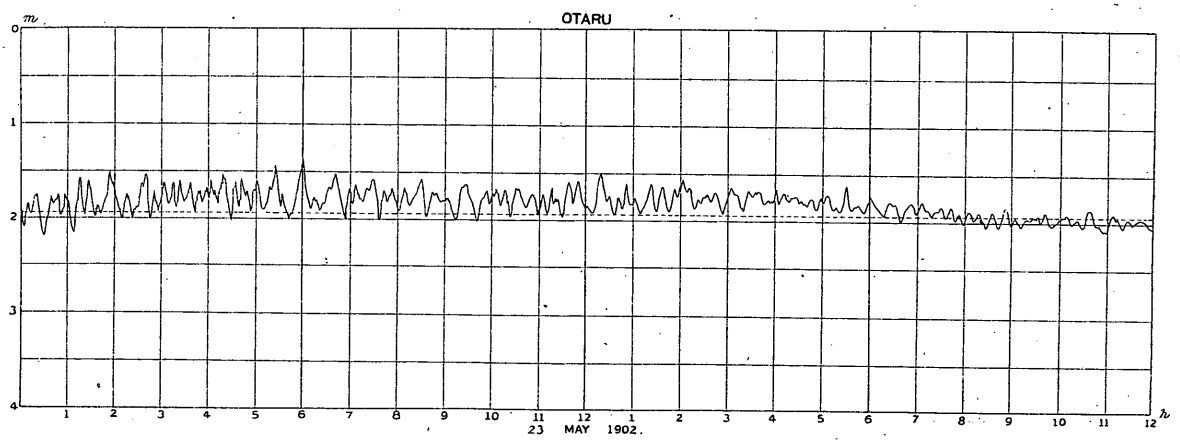
23 MARCB 1902.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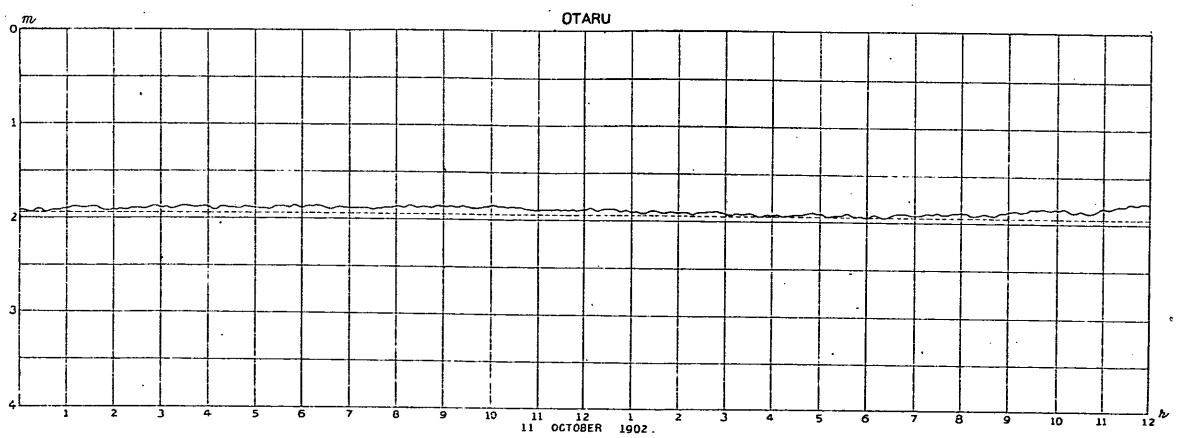
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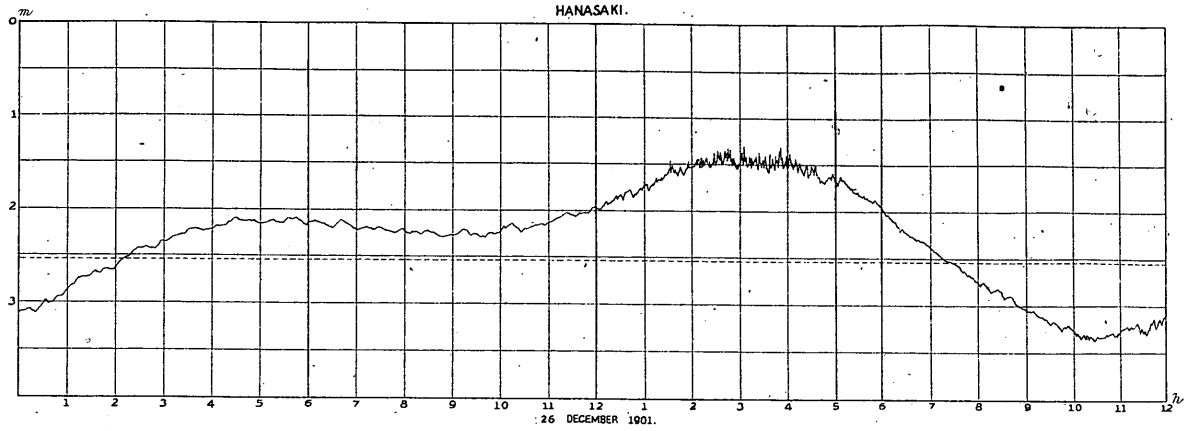
11 OCTOBER 1902.

HANASAKI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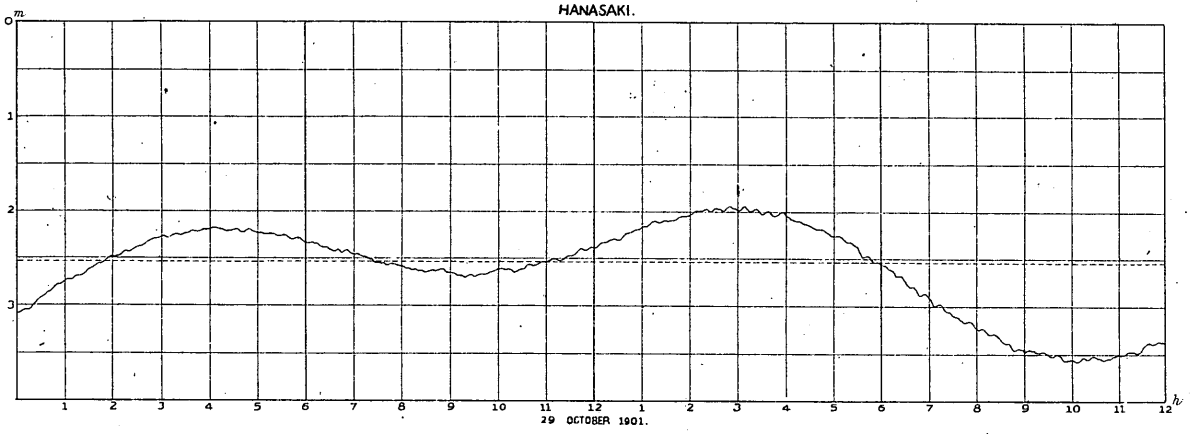
26 DECEMBER 1901.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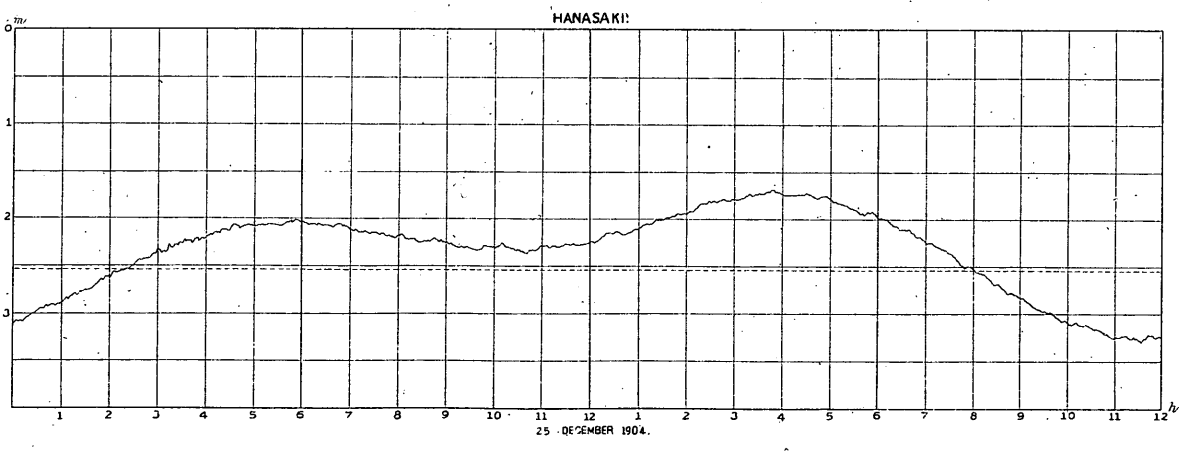
29 OCTOBER 1901.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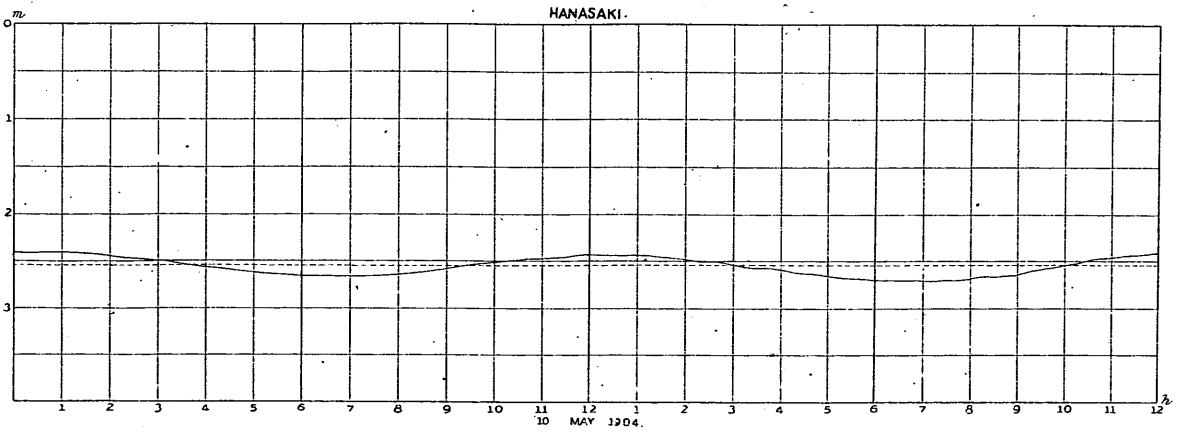
h
25 DECEMBER 1904.


HANASAKI.
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h
10 MAY 1904.