8. *On the Changes in the Heights of the Monthly Mean Sea-level at Aburatubo and Hosozima.*

A Supplementary Note.

By Seiti YAMAGUTI,

Earthquake Research Institute.

(Read Oct. 16, 1941.—Received Dec. 20, 1941.)

One of my recent papers[1] led to discussions by Dr. M. Uda, Dr. S. Watanabe, Dr. K. Hidaka, and others, at the Hirosima Meeting of the Physico-Mathematical Society of Japan.

The discussions were centered on the effects of seasonal wind and the cold ocean current "Oyasiwo" on sea-levels, the latter effect being already suggested by the diagram, Fig. 4, in the paper referred to.

In this supplementary note, first, the monthly mean wind velocities at Yokosuka, Siwonomisaki, and Miyazaki were taken corresponding to the sea-levels at Aburatubo, Kusimoto, and Hosozima, respectively, the directions of the winds being assumed to coincide with the directions of maximum frequencies at those stations. As usual, the square of the wind velocity was regarded as a factor governing the sea-level, the north component of the wind in the cases of Aburatubo and Kusimoto, and the west component in the case of Hosozima, being taken, these being denoted by w_n^2 and w_w^2 respectively. The values of the deviations Δw_n^2 and Δw_w^2 from the mean values for the eleven years and eight months were calculated. The correlation coefficients between those values and the observed sea-levels, or the sea-levels corrected with sea water temperature and barometric pressure, were calculated for the said three stations, the results being shown in the annexed Table I. It is interesting to note that, for Hosozima, the correlation coefficient between the wind factor and the observed sea-level is $-0{\cdot}448$, whereas that between the wind factor and the sea-level, as corrected, is $-0{\cdot}085$ —a fact that may show that the seasonal wind effect upon sea-level is included in the barometric effect for the monthly mean value.

Second, in order to study the effect of the cold ocean current "Oyasiwo" upon sea-levels, the sea water temperature about 100 kilometres off Isinomaki was taken instead of those at various depths.

1) *Bull. Earthq. Res. Inst.*, **19** (1941), 39.

off Aburatubo, Kusimoto, and Hosozima. The values of the deviations $\Delta T'$ from the mean values for 140 months were calculated and compared with the sea-levels at these three stations. Here, considering the time lags from zero to four months of the effect of sea water temperature upon sea-levels at the respective stations, the correlation coefficients between $\Delta T'$ and ΔL, as well as $\Delta L''$, in five cases in which the change in sea-level lags zero, one, two, three, and four months behind that of the sea water temperature 100 km off Isinomaki for each station, were calculated, the correlation coefficients which give maximum values being taken, as shown in the same Table I, above mentioned.

TABLE I. Correlation Coefficients between the two elements in the first column, top row.

	Aburatubo		Kusimoto		Hosozima	
	ΔL	$\Delta L''$	ΔL	$\Delta L''$	ΔL	$\Delta L''$
Δb	−0·294 ±0·077		−0·425 ±0·069		−0·578 ±0·056	
ΔT	0·750 ±0·037		0·741 ±0·038		0·765 ±0·035	
ΔV_n	0·165 ±0·082	0·044 ±0·084			0·076 ±0·084	−0·171 ±0·082
ΔV_e	0·157 ±0·082	0·100 ±0·084			−0·072 ±0·084	−0·023 ±0·084
ΔW_n^2	−0·186 ±0·081	0·288 ±0·077	−0·249 ±0·080	0·133 ±0·083		
ΔW_w^2					−0·448 ±0·068	−0·085 ±0·084
$\Delta T'$	0·074 ±0·085	0·524 ±0·062	0·378 ±0·073	0·303 ±0·077	0·239 ±0·080	0·112 ±0·084
Time lag in month=	3		2		2	

Δb =barometric pressure.
ΔT =sea water temperature close off the station.
ΔV_n =north component of current velocity.
ΔV_e =east component of current velocity.
ΔW_n^2 =north component of the square of the wind velocity.
ΔW_w^2 =west component of the square of the wind velocity.
$\Delta T'$ =sea water temperature about 100 km off Isinomaki.
ΔL =observed sea-level.
$\Delta L''$ =sea-level, corrected with Δb and ΔT.

Since, as will be seen from this Table, the effect of seasonal wind upon sea-level (corrected) is not very marked, although the effect of the cold ocean current "Oyasiwo" is fairly marked, corrections for the cold ocean current alone were applied in the case of Aburatubo and Kusimoto, besides the corrections for the warm ocean current and the barometric pressure, taking $\frac{\Delta L''}{\Delta T'}=3{\cdot}0$ and $\frac{\Delta L''}{\Delta T'}=5{\cdot}0$ respectively, from the $\Delta L''-\Delta T'$ diagrams, which are omitted here. The corrections due to seasonal winds for the three stations and that due to the cold ocean current for Hosozima were neglected, the correlation coefficients being comparatively small. The residual sea-levels thus obtained were denoted by $\Delta L'''$.

The yearly mean sea-levels, corrected, were taken and plotted as ordinates against the year, as shown in Fig. 1, which are almost similar to the diagrams already given in Fig, 4, in the original paper above cited.

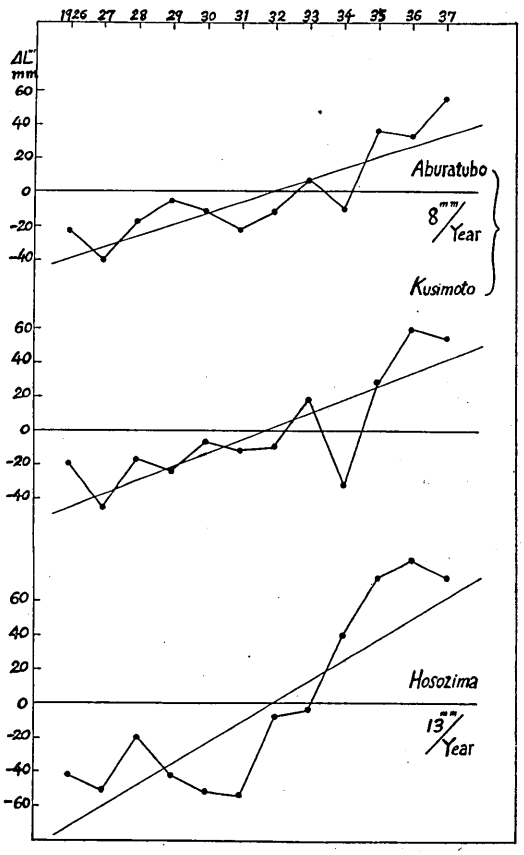

Fig. 1. Annual mean sea-levels.

Deducing the deviations in the sea-levels $\Delta L''''$ from the inclined time axis with proper inclination, namely, 8 mm a year, the means of these values for every successive 3 months were taken, and the results again smoothed by taking $\frac{1}{4}(\Delta L'''_{n-1}+2\Delta L'''_{n}+\Delta L'''_{n+1})$, instead of $\Delta L'''_n$, where n is the order of the duration of time, and plotted as ordinates against the successive seasons of the years, as shown in Fig. 2.

The probable errors, $\varepsilon=0{\cdot}6745\sqrt{\frac{\Sigma\Delta^2}{n-1}}$, can be reduced from $\Delta L'''$ and $\Delta L''''$. The results are shown in the third and the fourth columns of Table II. In this case, the values of the probable errors for the residual values of the sea-levels are about 50 percent of the probable errors of the observed values for Aburatubo

and Kusimoto, while in that case, without the correction due to the cold ocean current, they are about 60 percent.

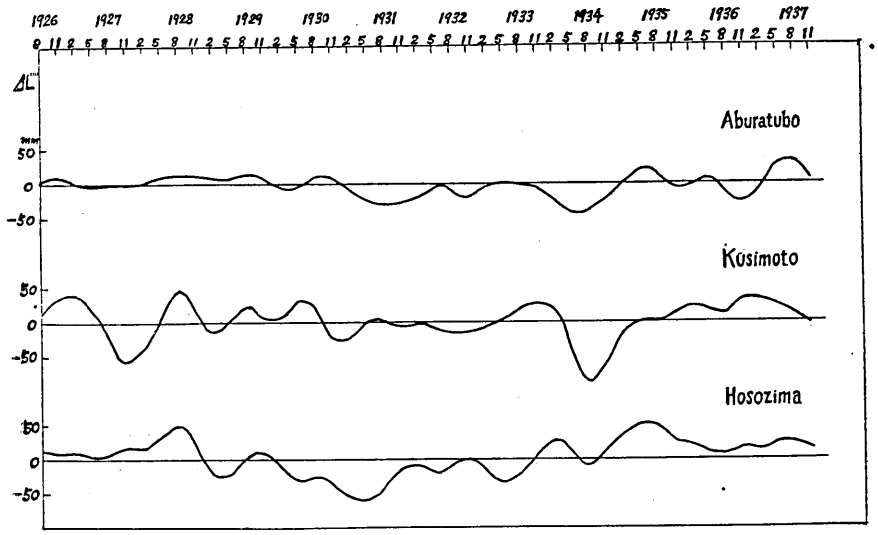

Fig. 2. Weighted mean sea-levels $\frac{1}{4}\left\{(\Delta L''')_{n-1}+2(\Delta L''')_n+(\Delta L''')_{n+1}\right\}$ for every three months' data, corrected with monthly mean Δb, ΔT, $\Delta T'$ and the inclined time axis.

Table II. Probable Errors ε in millimetres.

	Sea levels				
	Observed ε_0	Corrected, with Δb and ΔT ε_2	Corrected, with Δb, ΔT, and $\Delta T'$ ε_3	Corrected, with Δb, ΔT, $\Delta T'$ and inclined time axis ε_4	$\frac{\varepsilon_4}{\varepsilon_0}$
Aburatubo	49	32	31	26	0·53
Kusimoto	69	46	39	36	0·52
Hosozima	75	46		34	0·45

Consequently, after applying the corrections for atmospheric pressure and for the warm as well as for the cold ocean currents upon the observed values of the monthly mean sea-levels, we may, at any rate, be able to say that the appreciable downward displacement of the earth's crust during the period from 1927 to the end of 1937 at the rates of 8 mm a year for Aburatubo and Kusimoto, and 13 mm a year for Hosozima, still continues.

8. 油壺及細島に於ける海水面變化に就いて 補遺的註釋

地震研究所 山口生知

前論文に於て，月々の平均海水面に及ぼす暖流の影響及氣壓の影響を除去した殘りのものに就いて，油壺，串本及細島の每月平均海水面曲線を比較して見ると．尙ほ未だ何か海洋學氣象學的の共通な影響が殘はれるので，更に季節風の影響及寒流の影響をも調査して見た．その結果は次の通りである．

1. 氣節風の影響は比較的小であつて，大方は氣壓の影響の中に含まれてゐる．
2. 寒流は油壺及串本の海水面には相當影響を及ぼしてゐるが，細島の場合には比較的僅少である．
3. 氣壓の影響及暖流の影響の外に，寒流の影響も除外した殘りの每月平均海水面の變動量を考慮してみると，觀測値の變動量に比して油壺及串本に於ては，約半分に細島に於ては四割五分に減少してゐる．
4. 上に述べた各種の主なる影響を除去した殘りの月平均海水面に關して，每三ケ月平均少なくとも年平均を採るならば，之を基準として地盤の上り下りを論じても先づ差支なからうと考へるに至つた．

以上の結果を綜合すれば，油壺串本附近に於ては關東大震災以來地盤が 1 年に約 8 粍の割合，細島附近に於ては，1 年に約 13 粍の割合を以て沈降を續けて居ると言ふ前論文の結果は，事實らしく思はれる．