53. *Observations of the Deformation of the Earth's Surface at Aburatsubo, Miura Peninsula. Part V.*

By Takahiro HAGIWARA and Keichi KASAHARA,

Earthquake Research Institute.

(Read June 19, 1951—Received Sept. 20, 1951.)

E. Nishimura[1], Kyoto University, has reported that the amplitude of earth-tide observed with the fused silica tiltmeter at Makimine, Kyushu Province, showed a wide variation with the lapse of time. He stated that this curious phenomenon may be considered to be caused by the change in the elasticity of the earth crust near the observation point and seems to have some relations with the occurrence of earthquakes. The present writers felt a keen interest in his report and investigated their own data obtained at Aburatsubo in order to examine whether such a phenomenon existed or not.

As reported in the writers' previous papers[2], the observations of the deformation of the earth's surface have been continued at Aburatsubo since 1948 to the present. In the present paper, the following problems were examined.

1. Is the ratio of the tilt observed with the water-tube tiltmeter to the change in sea level constant with respect to time?
2. Is the ratio of the linear strain observed with the silica-tube extensometer to the change in sea level constant with respect to time?
3. Is the M_2-component of the linear strain recorded by the extensometer constant with respect to time?

The investigation was restricted only to the E'W'-component of the tilt and to the E_{10}-component of the linear strain, because these components were mostly affected by the oceanic tide.

1. Ratio of the tilt observed with the water-tube tiltmeter to the change in sea level.

Since the reading of the water-tube tiltmeter was made twice a

1) E. NISHIMURA, *Trans. Am. Geophys. Union*, **31** (1950), 357.

2) T. HAGIWARA and collaborators, *Bull. Earthq. Res. Inst.*, **26** (1948), 23; **27** (1949), 35; **27** (1949), 39; **29** (1951), 455.

day, namely, at 8h and 16h, we obtained $\delta W.T.$ and $\delta S.L.$ for determining the amount of tilt caused by the oceanic tide; where $\delta W.T.$ is the difference of the tilt measured by the water-tube tiltmeter at 8h and 16h, and $\delta S.L.$ the difference of the sea level at 8h and 16h of each day. We then assumed that $\delta W.T.$ and $\delta S.L.$ were in the linear relation expressed by the following equation

$$(\delta W.T.)=\alpha(\delta S.L.),$$

where α is a numerical constant. By using this equation, we determined the value of α by the least square method for a particular month. As an example, the relation between $\delta W.T.$ and $\delta S.L.$ in January, 1951 is shown in Fig. 1. The values of α of each month thus determined are shown in Table I and Fig. 3.

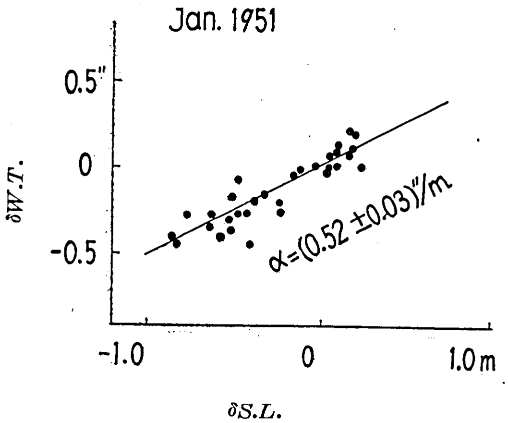

Fig. 1.

2. Ratio of the linear strain observed with the extensometer to the change in sea level.

We applied the method just mentioned to the linear strain. We thus obtained δE and $\delta S.L.$; where δE is the difference of linear strain in E_{10}-component at 8h and 16th and $\delta S.L.$ the difference of sea level at 8h and 16h. The values of δE were obtained from the record of the extensometer. Then, we determined the value of α for a particular month by the use of the following equation

$$\delta E=\alpha(\delta S.L.),$$

where α is a numerical constant. As an example, the

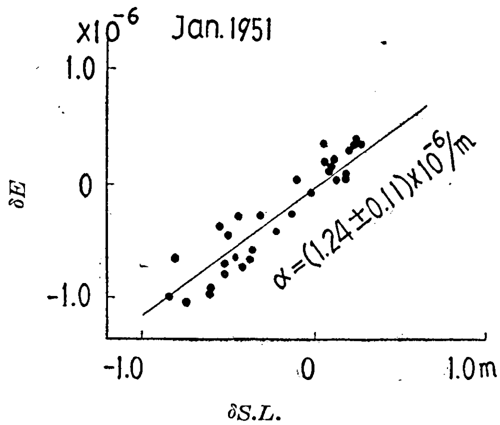

Fig. 2.

determination of α of January 1951 is shown in Fig. 2. The values of α determined by the least square method with respect to each month are shown in Table I and Fig. 3.

3. M_2-component of the linear strain recorded by the extensometer.

In the next place, we computed the M_2-component of the linear strain from the record of the extensometer by using the ordinary method of tidal analysis. The analysis was made with respect to each month by using data of 29 days for the corresponding month. The amplitudes and phase lags of the M_2-component of the linear strain thus determined are shown in Table I and Fig. 3.

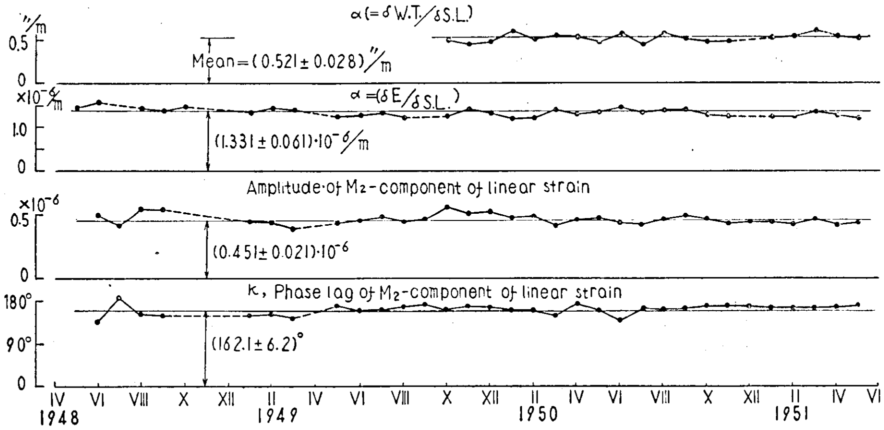

Fig. 3.

Conclusion.

As will be seen in Table I and Fig. 3, the ratio of the tilt or of the liner strain to the change in sea level does not show any large secular variation. Considering the errors in observation, we can say that it remained constant throughout the interval of observation. The same conclusion may be given in regard to the M_2-component of the linear strain. At all events, we could not find such a phenomenon as was observed in Makimine.

Table I.

Month		$\alpha(=\delta W.T./\delta S.L.)$	$\alpha(=\delta E/\delta S.L.)$	Amplitude of M_2 (E_{10})	Phase lag of M_2 (E_{10})
1948	5		1.43×10^{-6}/m	— $\times10^{-6}$	— °
	6		1.55	0.496	132
	7		—	(0.407)	(185)
	8		1.41	(0.538)	(156)
	9		1.38	(0.536)	(149)
	10		1.46	—	—
	11		—	—	—
	12		—	—	—
1949	1		1.31	(0.434)	(147)
	2		1.43	0.430	149
	3		1.40	(0.383)	(141)
	4		—	—	—
	5		1.26	0.429	168
	6		1.26	0.449	161
	7		1.33	0.478	164
	8		1.23	0.453	170
	9		—	0.462	176
	10	0.50″/m	1.26	(0.547)	(162)
	11	0.46	1.41	0.508	171
	12	0.48	1.34	0.515	168
1950	1	0.60	1.21	0.467	160
	2	0.51	1.21	0.481	166
	3	0.55	1.38	0.417	149
	4	0.53	1.30	0.464	171
	5	0.49	1.34	0.468	158
	6	0.57	1.43	0.430	132
	7	0.45	1.32	0.413	162
	8	0.57	1.36	0.463	163
	9	0.51	1.41	0.487	169
	10	0.49	1.28	0.460	167
	11	0.48	1.25	0.422	166
	12	—	—	0.428	168
1951	1	0.52	1.24	0.435	163
	2	0.53	1.24	0.409	163
	3	0.60	1.35	0.454	164
	4	0.54	1.26	0.406	166
	5	0.52	1.20	0.421	169
Mean value		0.521 ± 0.028	1.331 ± 0.061	0.451 ± 0.021	162.1 ± 6.2

The values put in parentheses are unreliable by lack of continuous observation and were not used in figuring the mean value given at the bottom.

The amplitude and phase lag of the M_2-component of the oceanic tide in Aburatsubo Bay are respectively 35.2 cm and 152.6°.

---

53. 油壺における地殼變動の觀測 (第5報)

地震研究所 { 萩原尊禮 / 笠原慶一

京大の西村英一氏は，九州槇峰においてシリカ傾斜計による地殼潮汐の觀測を行つた結果，地殼潮汐の分潮の振幅が時と共に非常に大きな變動を示すことを報告している。氏はこの現象を觀測點近傍の地殼の彈性の大きな變化によるものと考え，地震發生とも關連が見られると言つている。このような現象——相當廣い範圍の地殼の彈性率が數ケ月の中に數十 % も變わる現象——は物理的には考えにくいことであるが，實際そのような事柄が觀測されたとすれば重大なことであるので，このような現象が著者等が數年來行つている油壺における土地の傾斜や伸縮の觀測結果にも見られるかどうかを調べて見た。

その結果，海洋潮汐の荷重によつて起される土地變形の量は，油壺においては時と共に變わらないことが確められた。

Errata.

Part II of the present study (Bull. Earthq. Res. Inst., **27** (1949)).
For page 37, equation (2), read as follows:

$$\left.\begin{aligned} e_{xx} &= 0.586\, e_1 - 0.196\, e_2 + 0.611\, e_3 \\ e_{yy} &= 0.198\, e_1 + 1.040\, e_2 - 0.238\, e_3 \\ e_{xy} &= -1.348\, e_1 - 0.064\, e_2 + 1.412\, e_3 \end{aligned}\right\}$$

〃 〃, symbols e_1, e_2, and e_3 in Fig. 2 read e_2, e_3, and e_1, respectively.

〃 〃, 22nd line, axes, read strains.

For page 37, between the 24th and 25th line, following letters should be interposed:

$\theta = 66°$ (Direction of maximum principal strain).

Part IV of the present study (Bull. Earthq. Res. Inst., **29** (1951)).
For page 456, 19th line, degrees, read seconds.