46. *Sinking of the Earth's Crust in Hukagawa, Tokyo, as Deduced from Mareogram Data.*

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It has already been, reported that the earth's crust sank considerably in Honzyô and Hukagawa, Tokyo[1]. In order to study the progress of the sinking, a mareograph was installed at Kiba, in Hukagawa, and the heights of the sea level recorded continuously since January 1932 up to the present, so that it is possible to deduce the rate of sinking of the earth's crust at this point from these data. The locality of the mareograph is specially indicated in Fig. 1.

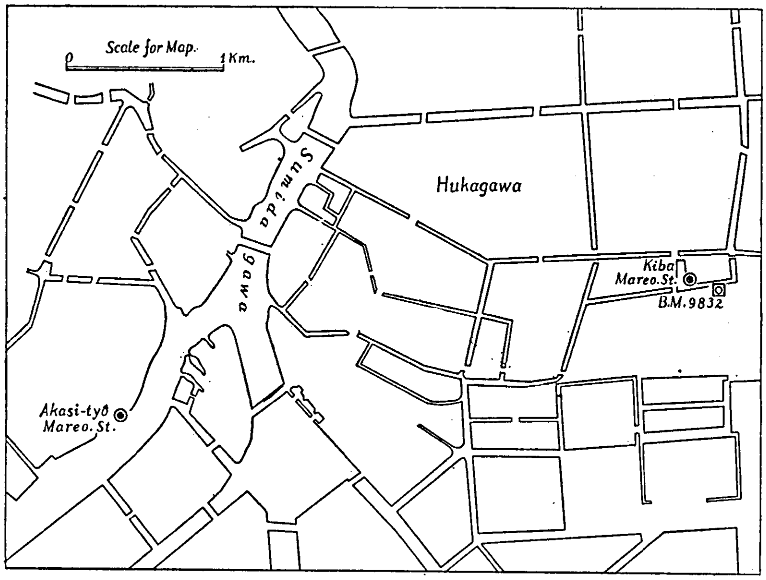

Fig. 1. Localities of mareograph stations.

The mareograph in use, which was constructed by Mr. R. Takahasi[2], a member of our Institute staff, consists of a U-tube contain-

1) N. MIYABE, *Bull. Earthq. Res. Inst.*, **10** (1932), 844~857, etc.
2) R. TAKAHASI, *ibid.*, **7** (1929), 95~102.

ing mercury, one end of which connects with sea water by means of a rubber tube. The movements of the other end of the mercury column following the rise and fall of the sea level, are recorded on the Richard's rotating drum by means of a mechanical lever.

In the present paper, the changes in heights of the monthly mean sea levels as deduced from the mareograms thus obtained are studied.

The monthly mean sea levels, calculated by means of the data of the heights of the sea levels for every hour as read from the mareograms, are shown in Fig. 2. Since, in this figure, we notice an annual

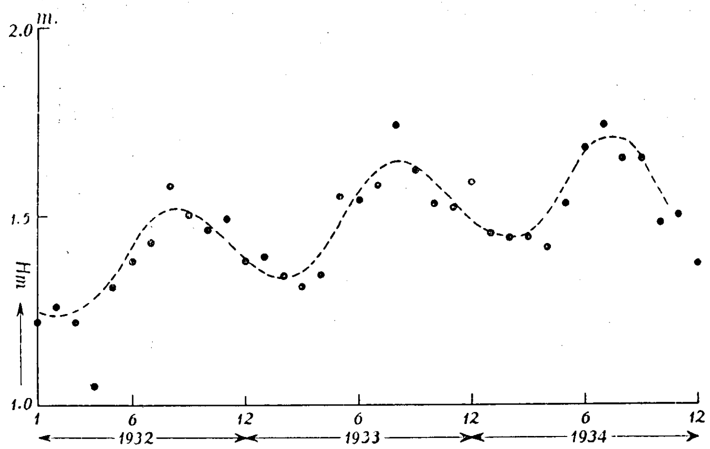

Fig. 2. Variation in heights of monthly mean sea level observed at Kiba, since Jan., 1932.

variation with a double amplitude of about 30 cm, in analysing the curve in Fig. 2, we assume the existence of the component of annual variation in heights of the monthly mean sea level, putting

$$h = h_0 + at + A \sin \frac{\pi}{6} t + B \cos \frac{\pi}{6} t.$$

The constants in the above expression, h_0, a, A, B, are determined by means of the actual data of h by the method of least squares.

The actual data of h used for determining the constants are those observed in the period between Jan., 1932 and March, 1933; this being the only interval during which observations were continued without disturbance from mishaps, such as instrumental damage or overflow of mercury due to abnormal rise of sea level owing to strong wind from the SW.

The constants thus determined, taking the origin of the time at

Jan., 1932, are given below with the probable errors:

$$h_0 = \ 1{\cdot}3042 \text{ m} \ \pm 0{\cdot}0043 \text{ m},$$
$$a = \ 0{\cdot}0102 \text{ m} \ \pm 0{\cdot}0005 \text{ m},$$
$$A = -0{\cdot}0708 \text{ m} \ \pm 0{\cdot}0030 \text{ m},$$
$$B = -0{\cdot}1210 \text{ m} \ \pm 0{\cdot}0030 \text{ m}.$$

The amplitude of annual variation of the monthly mean sea level is then given by

$$\sqrt{A^2+B^2} = 14{\cdot}02 \text{ cm},$$

the double amplitude of which is about 30 cm, as estimated above.

From the rate of rise per month in the monthly mean sea level, we estimate the amount of rise in the monthly mean sea level in 1932 to be 12 cm approximately.

To deduce the rate of rise in heights of monthly mean sea level during the years 1933 and 1934, the term of annual variation calculated by using constants A and B that were determined above, is subtracted from the actual values of the monthly mean sea level. Thus, in Fig. 3, the values of

$$\Delta h = h - \left\{ h_0 - 0{\cdot}7708 \sin \frac{\pi}{6} t - 0{\cdot}1210 \cos \frac{\pi}{6} t \right\}$$

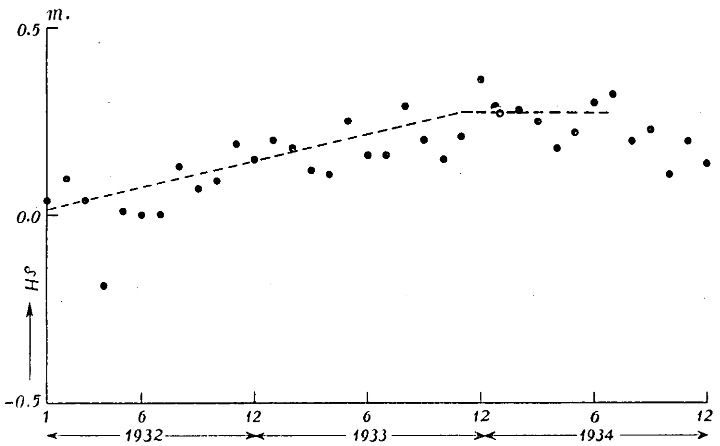

Fig. 3. Secular variation in heights of sea level at Kiba.

are plotted against the time. By means of the data of Δh thus deduced, the values of a were determined as follows:

$$a = 11{\cdot}2 \text{ mm per month, for 1933,}$$
$$a = 1{\cdot}8 \sim -1{\cdot}7 \text{ mm per month, for 1934.}$$

It is rather striking that the rate of rise in heights of mean sea level was very small or negative in 1934. The fact that the mean sea level depressed considerably since September, 1934, may probably be due to the overflow of considerable amount of mercury from the U-tube of the mareograph at the time of the abnormal rise of sea level associated with the cyclone of September 21, 1934.

The secular rise of the sea level in Hukagawa obtained above may be attributed chiefly to local depression of the earth's crust. The following points may serve to render the above conclusion more plausible:

i) The rate of secular rise of sea level in 1932 and 1933 is approximately equal to the rate of depression of B.M. 9832 situated at Hirai-tyô, Hukagawa, very near the mareograph station as shown in Fig. 1. In Table I, the rates of depression of B.M. 9832 are compared with those where the mareograph is situated, as deduced from mareogram data.

Table I. Rate of sinking.

Period \ Station	B·M·9832	Kiba Mareog. St.
1925~1930	−85·0 mm/year	—— mm/year
1930~1931	−107·1 〃	—— 〃
1929~1932	−90·5 〃	—— 〃
1932	——	−122·4 〃
1933	——	−134·4 〃

ii) Although the order of magnitude of the rate of rise in the heights of the monthly mean sea level greatly exceeds those of variation in heights of the sea level due to the change in moon's altitudes (nearly a 19 year period), in order to allay all doubts as to whether the remarkable rise of sea level mentioned might be a part of the variation with the period of 19 years, curve of Fig. 2 is compared

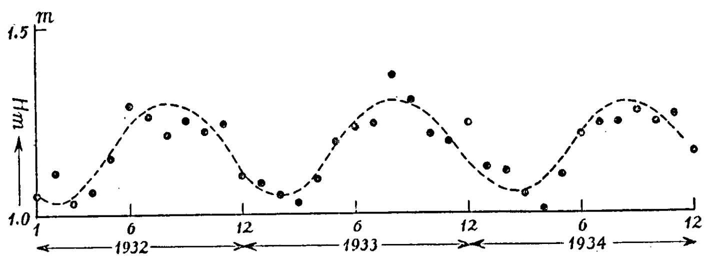

Fig. 4. Variation in heights of monthly mean sea level observed at Akasi-tyô, since Jan., 1932.

with that of Fig. 4, in which latter is given the variation in heights of monthly mean sea level obtained at Akasi-tyô, Kyôbasi, the locality shown in Fig. 1, from which it was proved that the remarkable secular rise of mean sea level as observed in Hukagawa was not noticed in the course of variation in heights of sea level at Akasi-tyô, where relevellings showed that slight crustal depression had also taken place.

As to the cause of such remarkable sinking of the earth's crust in Hukagawa, however, we cannot say anything until more data have accumulated.

As already stated, the sinking of the earth's crust seems to have ceased from the beginning of 1934, as deduced from mareogram data obtained at Kiba, Hukagawa. This cannot however be interpreted to mean that the downward movement of the earth's crust has really ceased, for there is the possibility that during the period in question the mareograph station itself happened to lie on the axis of a tilting movement of the earth's crust.

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46. 驗潮記錄より知られたる深川に於ける地盤の沈降

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深川に於ける地盤の沈下を不斷に計測する爲めに，深川區平井町所在の東京市木場喞筒場內の一隅に驗潮儀を設置し，昭和7年1月以來觀測を繼續してゐる．昨年末までに得た資料を整理してみたところ，次の如き結果を得た．

毎月の平均潮高を時について plot してみると，第2圖の如くになり，年週期の變化の外に，著しき永年變化があることが氣付かれる．月平均潮高を

$$h=h_0+at+A\sin\frac{\pi}{6}t+B\cos\frac{\pi}{6}t$$

として h_0，a，A，B 等の常數を最小二乘法で定めてみると a の値，卽ち，毎月の永年變化量は各年度につき，次のやうになる．

1932（昭和7年），a=10·2 mm/month
1933（〃　8〃），a=11·2　〃
1934（〃　9〃），a= 1·8～−1·7　〃

これでみると，昭和9年（1934），の變化量が非常に小さい事が知れる．

是等の著しい潮位の上昇は地盤が沈下する結果生ずるものであると思はれる．昭和9年度の沈下量の小さい事の理由はよく分らないが，1點のみに於ける觀測の結果であるから，これが，地盤全體としての沈下又は隆起を示すものであるか否かは遽かに斷定し兼ねる所である．
