8. *Geophysical Studies of Volcano Mihara, Oosima Island. V.*

Torsion Balance Survey on Mt. Mihara (Part 1).

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(Read Dec. 20, 1938.—Received Dec. 20, 1938.)

1. Accompanying the ejection of large quantities of lava associated with great volcanic activity, a variation in the gravity potential field may not be impossible. In order to study this problem, M. Matuyama[1], C. Tsuboi[2], and I. Yamamoto[3] respectively observed the second derivatives of the gravity potential on Mt. Sakura-zima, Mt. Komagadake, and Mt. Asama, three of the most active volcanoes in Japan. Quite recently, T. Minakami[4] also observed the second derivatives of the gravity potential on Mt. Asama with a view to studying the variations in them, if any, accompanying the frequent violent explosions of that volcano. As frequently reported by R. Takahasi and the writer,[5] one of the most active volcanoes in Japan, Mt. Mihara, in Idu-Oosima Island, ejected large quantities of lava during the period of 1911~1914. For the purpose of studying the same problem on Mt. Mihara and to ascertain, if possible, the subterranean structure of the volcano, especially of its caldera, the second derivatives of the gravity potential were observed at 18 stations around Mt. Mihara, the gravity value g having also been measured at three stations in Oosima Island.

2. The instrument used in the present survey was a large torsion balance, No. 120, made by the Askania Company, the same instrument that was used by Minakami on Mt. Asama.

As one of the pendulums was out of order, the five-position method, by means of the remaining sound pendulum (No. II), was adopted throughout the present survey, with the result that the calculation

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[1] M. MATUYAMA, *Jap. Journ. Astro. Geophys.*, **4** (1927), 121.

[2] C. TSUBOI, *Bull. Earthq. Res. Inst.*, **8** (1930), 301.

[3] I. YAMAMOTO, *Rep. Imp. Jap. Geod. Comm.*, **3** (1923), 1.

[4] T. MINAKAMI, *Bull. Earthq. Res. Inst.*, **15** (1937), 50.

[5] R. TAKAHASI and T. NAGATA, *Bull. Earthq. Res. Inst.*, **15** (1937), 441; **15** (1937), 1047; **16** (1938), 87.
T. NAGATA, *Bull. Earthq. Res. Inst.*, **16** (1938), 714.

formulae for getting $\frac{\partial^2 V}{\partial z\partial x}$, $\frac{\partial^2 V}{\partial y\partial z}$, $\frac{\partial^2 V}{\partial y^2}-\frac{\partial^2 V}{\partial x^2}$, and $2\frac{\partial^2 V}{\partial x\partial y}$ from the observed data are

$$\left.\begin{aligned}
\frac{\partial V^2}{\partial z\partial x}&=-\frac{0\cdot23512}{b}(d_4-d_3)-\frac{0\cdot38041}{b}(d_5-d_2),\\
\frac{\partial^2 V}{\partial y\partial z}&=+\frac{0\cdot72361}{b}(d_3+d_4)+\frac{0\cdot27638}{b}(d_2+d_5),\\
\frac{\partial^2 V}{\partial y^2}-\frac{\partial^2 V}{\partial x^2}&=+\frac{0\cdot76082}{2a}(d_4-d_3)-\frac{0\cdot47024}{2a}(d_5-d_2),\\
2\frac{\partial^2 V}{\partial x\partial y}&=-\frac{0\cdot55276}{2a}(d_3+d_4)-\frac{1\cdot44724}{2a}(d_2+d_5),
\end{aligned}\right\} \tag{1}$$

where

$$d_n=s_n-s_0,\quad s_0=\sum_{n=1}^{5}s_n\Big/5,$$

$$s_n=\text{scale readings of deflection of pendulum.}$$

As the constants of the Askania instrument are

$$2a=0\cdot16072[1+0\cdot0013(t-20)]\times10^{-9},$$
$$b=0\cdot23008[1+0\cdot0013(t-20)]\times10^{-9},$$

the actual calculation formulae adopted by the writer were

$$\left.\begin{aligned}
\frac{\partial^2 V}{\partial z\partial x}&=\Big\{+1\cdot0219(d_4-d_3)+1\cdot6534(d_5-d_2)\Big\}\\
&\quad\times\Big\{1-0.0013\,(t-20)\Big\},\\
\frac{\partial^2 V}{\partial y\partial z}&=\Big\{-3\cdot1451(d_3+d_4)-1\cdot2013(d_2+d_5)\Big\}\\
&\quad\times\Big\{1-0\cdot0013\,(t-20)\Big\},\\
\frac{\partial^2 V}{\partial y^2}-\frac{\partial^2 V}{\partial x^2}&=\Big\{+4\cdot7337(d_4-d_3)-2\cdot9258(d_5-d_2)\Big\}\\
&\quad\times\Big\{1-0\cdot0013\,(t-20)\Big\},\\
2\frac{\partial^2 V}{\partial x\partial y}&=\Big\{-3\cdot4392(d_3+d_4)-9\cdot0045(d_2+d_5)\Big\}\\
&\quad\times\Big\{1-0\cdot0013\,(t-20)\Big\},\\
&\qquad\text{(in Eötvös unit)}
\end{aligned}\right\} \tag{2}$$

where t is the temperature of the instrument in degrees Centigrade.

3. The observing stations were selected so that they shall be as near-

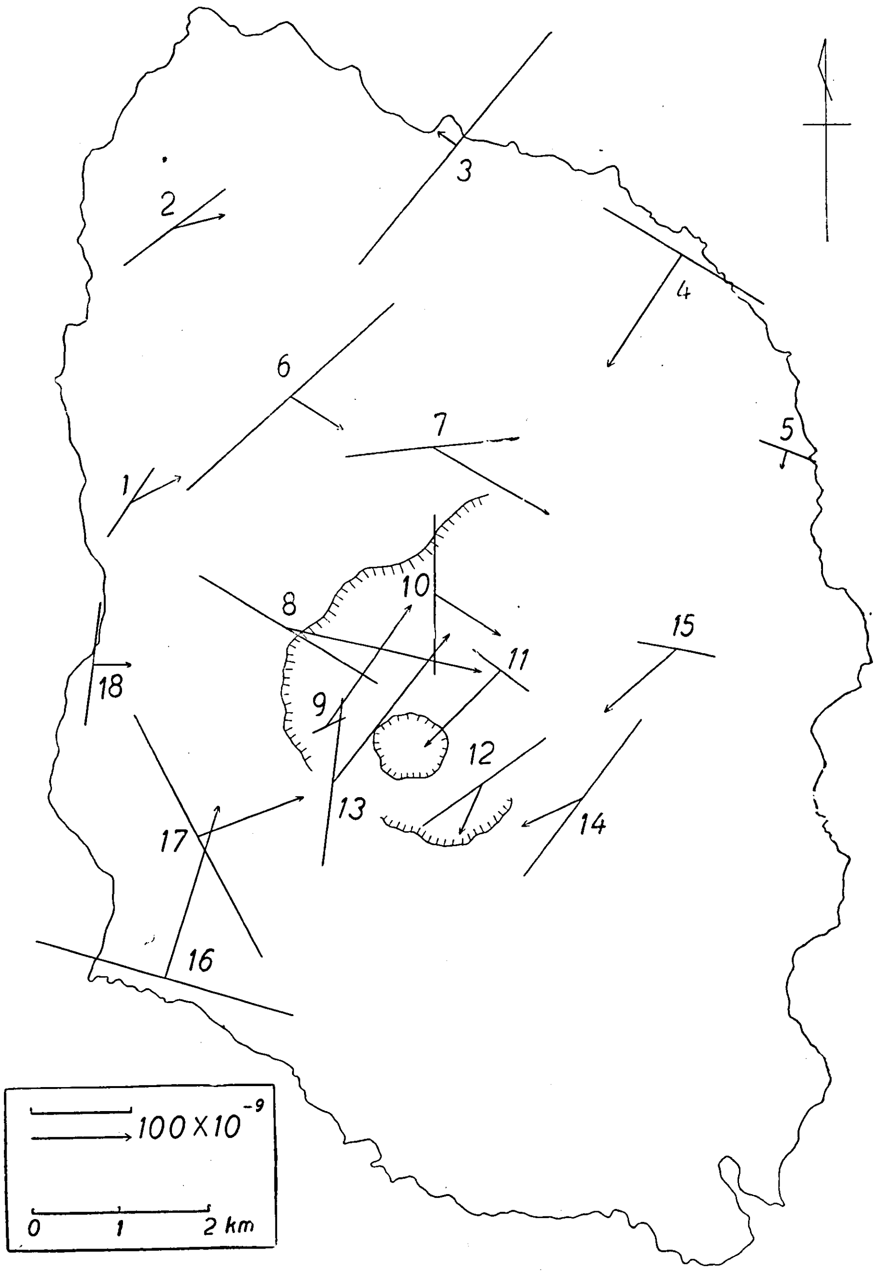

Fig. 1. Graphical Representation of Eötvös Quantities. Numerals denote the numbers of the stations.

ly equidistant as possible, the distance separating two adjoining stations being about 2 km, as shown in Fig. 1.

Although it was desired that the topography surrounding each station shall be the simplest, and as level as possible in order to minimize its effect on the torsion balance, these conditions could not be satisfied for every station, particularly the topographical effect, which was far from negligible in the cases of such station as No. 4 (Okata), No. 5 (Sendu), and No. 16 (Senbasaki).

Unfortunately, weather conditions were poor throughout the present survey, we had typhoons, gales, dense fog, etc., all of which interfered with the best accuracy in the results. With the object of making the observations under the best conditions possible, all measurements were carried out between the evening and the following morning, the period during which atmospheric conditions were the most stable.

The observed data are given in Table I～XX with the times of observation and the temperature of the instrument, the unit of the scale values being 1/2 mm on the photographic plate. Seeing that the magnitude of the fluctuations of the observed values due to air-convection around the pendulum is larger than that due to temperaturechanges, the temperature-effect on the torsion-force of the suspending fibre was neglected in the calculations by eq. (2).

Throughout the survey, the initial position of the instrument was determined with reference to the magnetic meridian of each station. The magnetic declinations in Oosima Island were, however, observed by R. Takahasi and the writer[6] in 1936. Using the results of this magnetic survey, the values of the second derivatives of the gravity potential as referred to the magnetic N, E, and "down" rectangular coordinate system (x, y, z) were reduced to values as referred to the true N, E, and the "down" rectangular coordinate system (x', y', z') with the aid of the following relations:

$$\left.\begin{aligned}
\frac{\partial^2 V}{\partial z \partial x'} &= +\frac{\partial^2 V}{\partial z \partial x}\cos\delta + \frac{\partial^2 V}{\partial y \partial z}\sin\delta, \\
\frac{\partial^2 V}{\partial y' \partial z} &= -\frac{\partial^2 V}{\partial z \partial x}\sin\delta + \frac{\partial^2 V}{\partial y \partial z}\cos\delta, \\
\frac{\partial^2 V}{\partial y'^2} - \frac{\partial^2 V}{\partial x'^2} &= +\left(\frac{\partial^2 V}{\partial y^2} - \frac{\partial^2 V}{\partial x^2}\right)\cos 2\delta - 2\frac{\partial^2 V}{\partial x \partial y}\sin 2\delta, \\
2\frac{\partial^2 V}{\partial x' \partial y'} &= +\left(\frac{\partial^2 V}{\partial y^2} - \frac{\partial^2 V}{\partial x^2}\right)\sin 2\delta + 2\frac{\partial^2 V}{\partial x \partial y}\cos 2\delta,
\end{aligned}\right\} \qquad (3)$$

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[6] R. TAKAHASI and T. NAGATA, *Bull. Earthq. Res. Inst.*, **15** (1937), 441.

Table I.

Station, Motomura.
Date, Sept. 29~30.
Lat.=34° 44·9′, Long.=122° 21·6′,
Height=60 m.
Deflection of Initial Pos. from N.
δ=8·5°W.

pos.	Scale Reading *d*	Temperature *t*	Time
		°C	h m
1	111·8	15·6	21 03
2	108·0	15·6	22 〃
3	87·6	16·0	23 〃
4	102·0	16·6	0 03
5	121·4	16·8	1 〃
1	112·2	16·8	2 〃
2	108·8	16·7	3 〃
3	88·6	16·4	4 〃
4	101·4	15·4	5 〃
5	120·0	14·4	6 〃
1	111·4	14·3	7 〃
2	108·8	15·2	8 〃

Table II.

Station, Kitano-yama.
Date, Sept. 30~Oct. 1.
Lat.=34° 46·4′, Long.=122° 21·7′,
H=45 m. δ=5·5°W.

pos.	*d*	*t*	Time
		°C	h m
1	114·0	19·0	19 30
2	118·4	18·8	20 〃
3	97·8	18·2	21 〃
4	96·6	17·4	23 〃
5	129·0	17·0	0 30
1	——	16·7	1 〃
2	119·2	15·8	2 〃
3	97·8	15·4	3 〃
4	97·2	15·0	4 〃
5	128·0	14·6	5 〃

Table III.

Station, Okata.
Date, Oct. 6~7.
Lat.=34° 47·0′, Long.=122° 23·5′,
H=50 m. δ=6·0°W.

pos.	*d*	*t*	Time
		°C	h m
1	57·3	24·6	19 14
2	101·3	22·6	20 〃
3	75·2	20·5	21 〃
4	85·0	18·7	22 〃
5	102·4	17·3	23 〃
1	54·6	16·6	0 14
2	101·0	16·5	1 〃
3	74·6	16·8	2 〃
4	87·4	16·9	3 〃
5	102·4	16·1	4 〃
1	54·8	15·3	5 〃
2	101·4	14·6	6 〃
3	74·0	13·9	7 〃

Table IV.

Station, Sendu.
Date, Oct. 4~5.
Lat.=34° 46·6′, Long.=122° 25·3′,
H=45 m. δ=5·0°W.

pos.	*d*	*t*	Time
		°C	h m
1	78·6	18·8	18 15
2	88·2	18·6	19 〃
3	124·6	18·0	20 〃
4	79·6	17·6	21 〃
5	48·0	17·0	22 〃
1	79·6	16·7	23 〃
2	89·6	16·0	0 15
3	124·8	15·6	1 〃
4	79·2	15·2	2 〃
5	47·8	15·0	3 〃
1	80·2	14·8	4 〃
2	87·6	15·0	5 〃
3	125·0	15·0	6 〃

Table V.

Station, Zoo.
Date, Oct. 5~6.
Lat.=34° 45·2′, Long.=122° 26·7′,
H=55 m. δ=6·0°W.

pos.	d	t	Time	
		°C	h	m
1	87·4	21·2	18	45
2	83·4	19·4	19	″
3	91·2	18·4	20	″
4	78·6	18·3	21	″
5	78·4	18·4	22	″
1	85·6	18·2	23	″
2	83·8	17·8	0	45
3	92·8	17·4	1	″
4	79·4	16·8	2	″
5	78·2	16·0	3	″
1	85·0	14·8	4	″
2	82·8	13·8	5	″
3	90·4	13·8	6	″

Table VI.

Station, Meteorological Observatory.
Date, Oct. 7~8.
Lat.=34° 45·5′, Logn.=123° 22·7′,
H=210 m. δ=4·5°W.

pos.	d	t	Time	
		°C	h	m
1	76·4	21·6	18	10
2	110·0	18·1	19	″
3	75·8	15·9	20	″
4	71·0	14·2	21	″
5	102·0	13·0	22	″
1	74·4	11·8	23	″
2	111·8	10·6	0	10
3	76·4	9·2	1	″
4	71·0	7·8	2	″
5	100·4	6·4	3	″
1	74·4	5·4	4	″
2	110·8	4·6	5	″
3	75·0	4·5	6	″

Table VII.

Station, Yuba (1).
Date, Oct. 11~12.
Lat.=34° 45·3′, Long.=122° 23·8′,
H=470 m. δ=3·5°W.

pos.	d	t	Time	
		°C	h	m
1	110·0	16·8	18	02
2	101·8	15·8	19	″
3	84·0	15·2	20	″
4	40·4	15·0	21	″
5	90·0	15·0	22	″
1	110·2	15·2	23	″
2	102·2	15·2	0	02
3	84·8	15·2	1	″
4	40·2	15·4	2	″
5	90·4	15·4	3	″
1	110·4	15·2	4	″
2	102·2	14·6	5	″
3	84·4	14·2	6	″
4	40·6	13·4	7	″

Table VIII.

Station, Yuba (2).
Date, Oct. 12~13.
(Repeated at the same station)

pos.	d	t	Time	
		°C	h	m
1	——	13·0	19	08
2	101·6	13·0	20	″
3	84·0	13·2	21	″
4	39·4	13·4	22	″
5	89·8	13·4	23	″
1	110·2	13·4	0	08
2	102·2	13·4	1	″
3	84·2	13·6	2	″
4	39·4	13·7	3	″
5	89·2	14·2	4	″
1	110·0	14·4	5	″
2	102·8	14·6	6	″
3	84·6	14·8	7	″

Table IX.

Station, Gozinka-Tyaya (1).
Date, Oct. 14∼15.
Lat.=34° 44·1′, Long.=122° 23·0′,
H=555 m. δ=3·0°W.

pos.	*d*	*t*	Time	
		°C	h	m
1	——	17·6	18	40
2	91·8	16·4	19	〃
3	68·0	15·2	2	〃
4	42·0	14·2	21	〃
5	82·2	13·2	22	〃
1	141·8	12·2	23	〃
2	91·8	11·2	0	40
3	67·8	10·8	1	〃
4	41·8	10·2	2	〃
5	81·6	9·6	3	〃
1	——	9·0	4	〃
2	91·6	8·7	5	〃
3	67·6	8·3	6	〃
4	——	8·2	7	〃
5	82·0	8·3	8	〃

Table X.

Station, Gozinka-Tyaya (2).
Data, Oct. 15∼16.
(Repeated at the same station, equilibrium position of pendulum being removed.)

pos.	*d*	*t*	Time	
		°C	h	m
1	120·0	12·2	18	30
2	68·4	11·6	19	〃
3	44·6	11·0	20	〃
4	19·4	10·4	21	〃
5	58·0	9·6	22	〃
1	119·4	8·8	23	〃
2	——	8·2	0	30
3	44·0	7·8	1	〃
4	——	7·4	2	〃
5	——	7·2	3	〃
1	118·6	7·0	4	〃
2	68·4	6·7	5	〃
3	43·8	6·6	6	〃
4	18·0	6·5	7	〃
5	55·0	6·4	8	〃

Table XI.

Station, Sabaku-I.
Date, Oct. 19∼20.
Lat.=34° 43·6′, Long.=122° 23′4,
H=530 m. δ=1·5°W.

pos.	*d*	*t*	Time	
		°C	h	m
1	78·8	14·2	20	57
2	44·8	13·4	21	〃
3	32·4	12·8	22	〃
4	61·2	12·6	23	〃
5	97·0	12·4	0	57
1	77·6	12·4	1	〃
2	43·2	12·3	2	〃
3	29·8	12·3	3	〃
4	61·2	11·8	4	〃
5	97·6	11·1	5	〃

Table XII.

Station, Sabaku-II.
Date, Oct. 24∼25.
Lat.=34° 44·3′, Long.=122° 23·6′,
H=510 m. δ=5·0°W.

pos.	*d*	*t*	Time	
		°C	h	m
1	77·6	19·2	20	36
2	68·6	18·4	21	〃
3	68·0	17·4	22	〃
4	33·8	16·6	23	〃
5	66·6	15·4	0	36
1	77·4	14·6	1	〃
2	68·6	13·4	2	〃
3	67·4	12·6	3	〃
4	32·1	12·0	4	〃
5	66·4	11·6	5	〃

Table XIII.

Station, Sabaku-III.
Date, Oct. 25~26.
Lat.=34° 43·9′, Long.=122° 24·8′,
H=540 m. δ=10·0°W.

pos.	d	t	Time
		°C	h m
1	——	16·8	19 55
2	67·8	15·6	20 ″
3	88·6	14·6	21 ″
4	65·4	13·4	22 ″
5	——	12·0	23 ″
1	49·2	10·8	0 55
2	67·8	10·4	1 ″
3	89·4	9·4	2 ″
4	64·8	8·2	3 ″
5	36·0	7·2	4 ″
1	49·6	6·2	5 ″

Table XIV.

Station, Sabaku-IV.
Date, Oct. 26~27.
Lat.=34° 43·2′, Long.=122° 24·5′,
H=630 m. δ=11·5°W.

pos.	d	t	Time
		°C	h m
1	46·6	18·6	20 02
2	80·0	16·8	21 ″
3	74·8	14·8	22 ″
4	53·4	13·2	23 ″
5	61·8	11·4	0 02
1	45·3	10·6	1 ″
2	80·0	9·8	2 ″
3	74·8	9·2	3 ″
4	52·5	8·6	4 ″
5	61·6	8·0	5 ″

Table XV.

Station, Sabaku-V.
Date, Oct. 29~30.
Lat.=34° 43·3′. Long.=122° 23·1′,
H=560 m. δ=0·5°W.

pos.	d	t	Time
		°C	h m
1	93·0	24·2	20 18
2	53·8	22·4	21 ″
3	13·6	21·2	22 ″
4	——	20·0	23 ″
5	103·2	18·6	0 18
1	92·2	17·6	1 ″
2	52·8	17·2	2 ″
3	12·0	17·4	3 ″
4	78·6	17·6	4 ″
5	103·4	17·8	5 ″
1	92·2	18·0	6 ″
2	53·8	18·6	7 ″
3	12·4	18·8	8 ″
4	77·6	19·1	9 ″

Table XVI.

Station, Siraisi.
Date, Oct. 27~28.
Lat.=34° 43·1′, Long.=122° 25·4′,
H=500 m. δ=9·0°W.

pos.	d	t	Time
		°C	h m
1	39·8	18·2	20 01
2	81·0	16·4	21 ″
3	73·0	15·4	22 ″
4	72·6	14·8	23 ″
5	67·2	14·0	0 01
1	——	13·6	1 ″
2	82·0	13·2	2 ″
3	72·8	13·0	3 ″
4	72·8	12·8	4 ″
5	66·8	12·4	5 ″

Table XVII.

Station, An'ei Lava-Flow.
Date, Oct. 28~29.
Lat.=34° 44·4′, Long.=122° 26·0′,
H=405 m. δ=6·0°W.

pos.	*d*	*t*	Time	
		°C	h	m
1	51·2	22·8	20	42
2	71·6	19·4	21	″
3	94·0	17·2	22	″
4	67·2	15·6	23	″
5	53·2	14·4	0	42
1	51·0	13·8	1	″
2	71·2	13·4	2	″
3	95·2	13·2	3	″
4	66·8	13·4	4	″
5	52·4	14·0	5	″

Table XVIII.

Station, Senbasaki.
Date, Oct. 31~Nov. 1.
Lat.=34° 42·0′, 122° 21·9′ H=15 m.
δ=5·0°W.

pos.	*d*	*t*	Time	
			h	m
1	95·0	——	22	00
2	15·0	——	23	″
3	56·9	——	0	00
4	70·2	——	1	
5	112·4	——	2	
1	95·0	——	3	
2	16·2	——	4	
3	57·2	——	5	
4	69·2	——	6	
5	112·4	——	7	

Table XIX.

Station, Hosori.
Date, Nov. 1~2.
Lat.=34° 43·0′, Long.=122° 22·2′,
H=190 m. δ=4·5°W.

pos.	*d*	*t*	Time	
		°C	h	m
1	110·4	21·4	18	25
2	59·0	20·8	19	″
3	41·0	19·0	20	″
4	71·8	17·2	21	″
5	61·0	15·8	22	″
1	109·2	15·0	23	″
2	58·6	14·4	0	25
3	39·0	13·8	1	″
4	71·2	13·4	2	″
5	60·8	13·2	3	″
1	11·06	13·2	4	″
2	——	13·2	5	″
3	38·8	13·2	6	″

Table XX.

Station, Nomasi.
Date, Nov. 2~3.
Lat.=34° 43·8′, Long.=122° 21·4′,
H=15 m. δ=4·5°W.

pos.	*d*	*t*	Time	
		°C	h	m
1	74·8	24·6	19	13
2	78·2	23·0	20	″
3	52·0	22·0	21	″
4	69·6	21·2	22	″
5	67·6	20·8	23	″
1	73·8	20·4	0	13
2	78·4	20·0	1	″
3	51·4	20·0	2	″
4	67·4	20·2	3	″
5	67·2	20·4	4	″
1	——	20·4	5	″
2	——	20·2	6	″
3	52·0	20·0	7	″
4	67·4	19·4	8	″

Table XXI.

Station	Lat.	Long.	Height	$\frac{\partial^2 V}{\partial z \partial x'}$	$\frac{\partial^2 V}{\partial y' \partial z}$	$\frac{\partial^2 V}{\partial y'^2} - \frac{\partial^2 V}{\partial x'^2}$	$2\frac{\partial^2 V}{\partial x' \partial y'}$
1. Motomura	34° 44·9′	122° 21·6′	60 m	+ 31·3 ×10⁻⁹	+ 46·6 ×10⁻⁹	+ 48·9 ×10⁻⁹	− 62·0 ×10⁻⁹
2. Kita-no-Yama	34 46·4	122 21·7	45	+ 20·5	+ 55·3	− 7·4	−132·9
3. Okata	34 47·0	122 23·5	50	+ 11·7	− 21·8	+112·4	−278·9
4. Sendu	34 46·6	122 25·3	45	−119·5	− 65·9	−122·6	+141·0
5. Zoo	34 45·2	122 26·7	65	− 21 3	− 1·5	− 51·6	+ 28·9
6. Meteor. Obs.	34 45·5	122 22·7	210	− 26·9	+ 54·6	+ 1·4	−272·8
7. Yuba	34 45·3	122 23·8	470	− 57·9	+123·5	−167·9	− 56·3
8. Gozinka-Tyaya	34 44·1	122 23·0	555	− 33·0	+189·0	−110·4	+170·9
9. Sabaku I	34 43·6	122 23·4	530	+121·0	+ 79·3	− 11·9	− 31·5
10. 〃 II	34 44·3	122 23·6	510	− 33·0	+ 69·1	−155·3	− 29·9
11. 〃 III	34 43·9	122 24·8	540	− 88·8	− 60·4	− 41·4	+ 55·0
12. 〃 IV	34 43·2	122 24·5	630	− 56·3	− 12·8	+ 10·8	−154·2
13. 〃 V	34 43·3	122 23·1	560	+150·0	+116·1	+162·8	− 29·6
14. Siraisi	34 43·1	122 25·4	500	− 33·1	− 54·6	+ 96·8	−163·5
15. An'ei Lava Flow	34 44·4	122 26·0	405	− 66·8	− 62·6	− 75·9	− 3·1
16. Senbasaki	34 42·0	122 21·9	15	+177·2	+ 40·4	−245·7	+110·7
17. Hosori	34 43·0	122 22·2	190	+ 43·8	+ 96·5	+105·9	+252·2
18. Nomasi	34 43·8	122 21·4	15	+ 3·0	+ 37·1	+118·5	− 10·9

where δ is the westerly declination angle at each station. The final results thus reduced are given in Table XXI.

4. The results are graphically shown in Fig. 1, where the arrows give the positive directions of the gradients and their magnitudes, while the straight lines give the directions of the maximum curvatures and the differences of the maximum and minimum curvatures.

Generally speaking, the directions of the gradients at nearly every station point to the centre of Mt. Mihara, though in minor matters there are several stations where the directions of the gradients do not follow the general tendency above mentioned. The major part of the attracting force that is responsible for the distribution of the gradient-terms, may be due to the presence of an excessive mass under Mt. Mihara in the centre of the island.

It will also be noticed that there are more arrows, and larger ones, in Fig. 1, pointing N or E, than those pointing S or W. To show this tendency more clearly, we shall study the observed results statistically.

Assuming that the effect of the attraction due to the presence of an excessive mass under Mt. Mihara is approximately circular and symmetric around the centre of the mountain, we shall eliminate that effect from the observed values. We divide the whole of Oosima Island into four quadrants by two straight lines, the one passing through the highest point of Mt. Mihara from S to N, and the other perpendicular to it passing through the highest point. These four quadrants denote respectively the NW-, SW-, SE-, and NE-quadrants, the numbers of the stations included in these quadrants being 7, 4, 2, and 5 respectively. We then take the mean value of $\overline{\dfrac{\partial^2 V}{\partial z \partial x}}$ and $\overline{\dfrac{\partial^2 V}{\partial y \partial z}}$ given by

$$\left.\begin{aligned} \overline{\frac{\partial^2 V}{\partial z \partial x}} &= \frac{1}{2}\left\{\sum_{\mathrm{NW+NE}} \frac{\partial^2 V}{\partial z \partial x}\Big/(7+5) + \sum_{\mathrm{SW+SE}} \frac{\partial^2 V}{\partial z \partial x}\Big/(4+2)\right\}, \\ \overline{\frac{\partial^2 V}{\partial y \partial z}} &= \frac{1}{2}\left\{\sum_{\mathrm{NW+SW}} \frac{\partial^2 V}{\partial y \partial z}\Big/(7+4) + \sum_{\mathrm{NE+SE}} \frac{\partial^2 V}{\partial y \partial z}\Big/(5+2)\right\}. \end{aligned}\right\} \qquad (4)$$

These values may give a vector mean value of the gradients, showing the general tendency of the geoid in Oosima Island. In the present case, we get

$$\overline{\frac{\partial^2 V}{\partial z \partial x}} = +20{\cdot}1 \times 10^{-9}, \qquad \overline{\frac{\partial^2 V}{\partial y \partial z}} = +21{\cdot}2 \times 10^{-9},$$

whence

$$\left(\frac{\partial g}{\partial s}\right)_{\max} \simeq 29 \times 10^{-9}, \qquad \alpha = +47^\circ,$$

where α is the azimuth of the positive direction of the gradient as measured from the true north. It will be seen from this result that the gravity value is larger in the N–E part of Oosima than in the S–W part.

5. The gravity value g was observed in July 1938, at three stations in the Island, namely, Motomura, Sasikidi, and Zoo. The method used in the gravity survey is that of Tsuboi,[7] by which the periods of the base and field pendulums are directly compared by wireless communications. (The details of the method will shortly be published in this Bulletin by Dr. C. Tsuboi.) The gravity values were determined with reference to the values of the base-station, our Institute, where g was determined to be 979·802 gal. The results of the gravity observation, that is g, g_0, g_0'', and $g_0''-\gamma_0$, are shown in Table XXII with the positions and heights of the stations. The positions of the stations and the values of g_0 are also shown in Fig. 2. From the foregoing results we find that

Table XXII. Gravity Values in Oosima.

Station	Lat.	Long.	Height	$g-g_{\text{Tokyo}}$	g	g_0	g_0''	$g_0''-\gamma_0$	Mean Error
	° ′	° ′	m	mgal	mgal	mgal	mgal	mgal	mgal
Motomura	34 45·0	130 21·3	57	+46	979848	976867	979861	+152	±0·6
Sasikidi	34 40·9	139 24·8	41	+35	979837	979851	979847	+146	±1·1
Zoo	34 45·5	139 26·2	93	+42	979844	979875	979865	+156	±0·5
Tokyo	——	——	——	+ 2	——	——	——	——	±3·3

the maximum horizontal gradient of g_0, $\left(\frac{\partial g_0}{\partial s}\right)_{\max} \simeq 3 \times 10^{-8}$,

the azimuth of its direction measured from North, $\alpha \simeq +30^\circ$.

These values may turn out to be rather in good agreement with the results of the statistical study of the data of the torsion balance survey.

The value of g was measured in 1915 at Motomura by the members of the Japanese Geodetic Commission. The position of the station where g was observed in 1915 differs slightly from ours, as will be

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[7] C. TSUBOI and T. FUCHIDA, *Zisin*, **9** (1937), 546. (in Japanese).

seen from the following Table.

Table XXIII. Gravity Value observed in 1915.

Station	Lat.	Long.	Height	g	g_0	g_0''	$g_0''-\gamma_0$
	° ′	° ′	m	mgal	mgal	mgal	mgal
Motomura	34 45	139 22	24	979855	979862	979860	+151

The difference in g_0'' between our observation and that made in 1915, however, is only one milligal, which may come within the error of the gravity observation. Unfortunately, however, the ejection of large quantity of lava on the occasion of Mt. Mihara's great eruption occurred before 1915, so that it is not possible to know from a comparison of these two values of g, whether or not the gravity value changes perceptibly accompanying great eruptions of the volcano.

6. Although the topographies surrounding the observing stations are fairly alike, their effects due to the presence of Mt. Mihara may not be small, seeing that it rises to a height of 750 m above sea level. For this reason, it is our intention to study the subterranean structure that is responsible for the distribution of the second derivatives of the gravity potential after completion of the topographic and ellipsoidal corrections, which are now being worked out. This paper merely reports the results of the survey and the correlation between the gravity values and their derivatives. It is hoped to repeat the torsion balance survey as frequently as possible in future, in order to study the relation between the variation in the gravity field and volcanic activity.

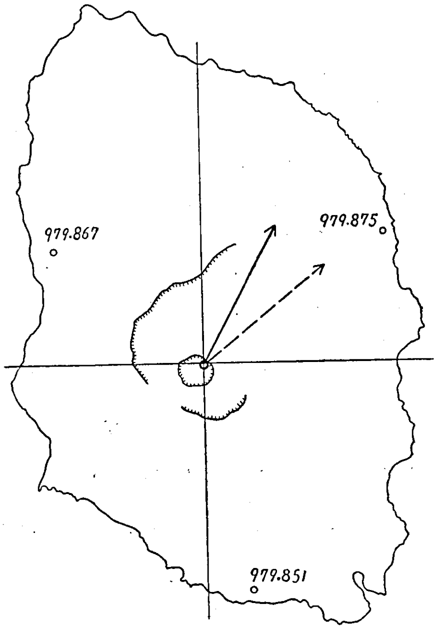

Fig. 5. g_0 and its gradient in Oosima.

In conclusion, the writer wishes to record his obligations to Dr. C. Tsuboi, who kindly allowed him the use of his instrument for gravity observations, besides giving him many valuable hints, to Prof. M. Ishimoto and Dr. R. Takahasi for their encouragement, and to Messers.

R. Takei, A. Zitukawa, and S. Inomata for their assistance in the gravity measurements. His hearty thanks are also due to the Hattori-Hoko-Kai, with the aid of whose grant the present surveys were carried out.

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8. 伊豆大島三原火山の地球物理學的研究 V.

三原山附近の重力偏差測定（第１報）

地震研究所　永田　武

1. 伊豆大島三原山及びその附近の18地點に於いて重力偏差の測定を行つた．使用した器械は地震研究所所有の Askania 製大型重力偏差計 Nr. 120 である．測定結果は第Ｉ表乃至第XX表，及び第１圖に示す如くである．

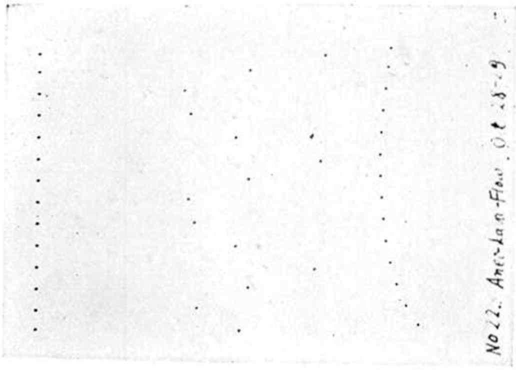
2. この測定の第一の目的は火山活動によつて附近の重力の場がごの程度に變化を示すかを求める爲の第一次測定さいふ事にある．この研究は，將來測定を繰返して，重力偏差の時間的變化を求めた上で行はれなければならない．

3. 重力偏差の場所的分布は三原山下にかなりの過大質量のある事を示してゐるが，その他に北東方向に向つて一様に重力の增す傾向が重疊してゐる様に見える．その大きさは$\dfrac{\partial g}{\partial s}=29\times10^{-9}$であり，方向は北より 47° 東に傾いてゐる．

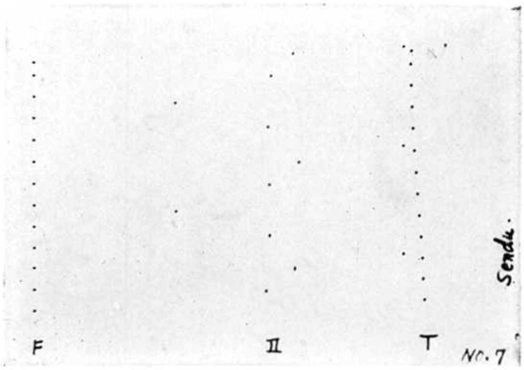
4. 坪井の方法によつて大島內三點に於いて重力を測定し，その結果から$\dfrac{\partial g_0}{\partial s}$を求めて見るさ，大きさも方向も大體上の値に一致する．

5. 重力偏差の分布から，三原山の地下構造が推定される譯であるが，その詳細は第２報に報告する．

之等の研究は，高橋所員及び筆者に與へられた服部報公會の御援助に依つて行はれたものであつて，此處に同會に對して感謝の意を表する．



An'ei Lava Flow.



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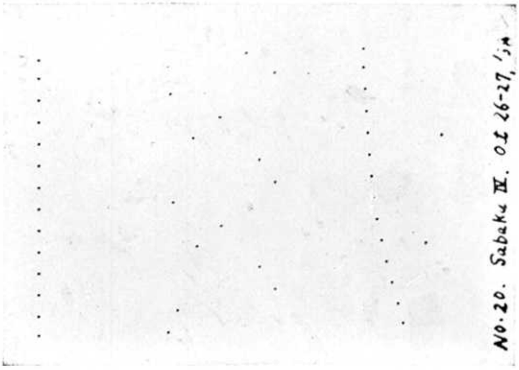
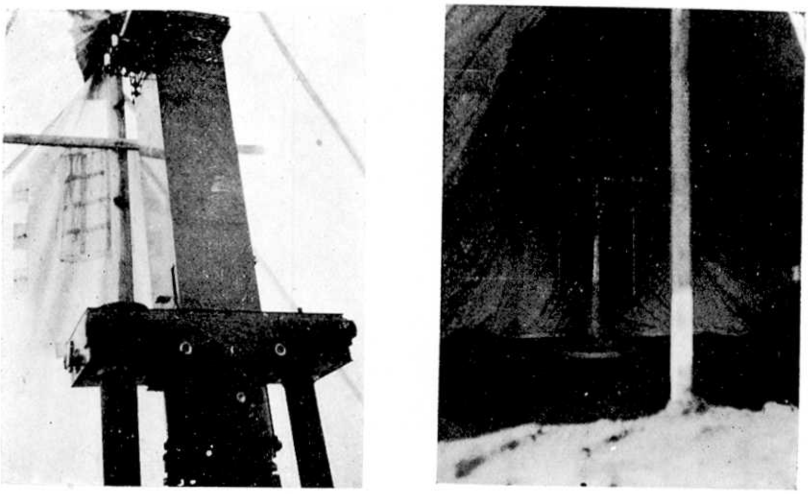


Sabaku IV.
Observed records.

Fig. 2.



The Large Torsion Balance in Tent.

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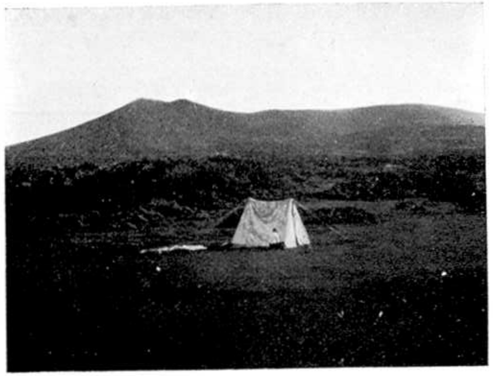
Transportation of the Instrument.

No. 14. Siraisi.

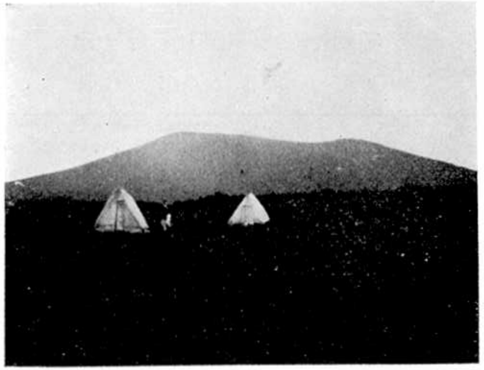
Fig. 3.

No. 13. Sabaku IV.

No. 15. An'ei Lava Flow.



No. 11. Sabaku I.



No. 12. Sabaku III.

Fig. 4.

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