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Observations of Gravity-Gradients Around The Mizusawa International Latitude Observatory.

BY

ISSEI YAMAMOTO.

Tokyo 1926.

OBSERVATIONS OF GRAVITY-GRADIENTS AROUND THE MIZUSAWA INTERNATIONAL LATITUDE OBSERVATORY.

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CONTENTS.

§ 1. Introduction.

Since, in 1899, the International Latitude Observatory was established at Mizusawa, Iwate-Prefecture, the site has become a local center of several geophysical considerations. In 1900 the absolute measurement of gravity was made by Profs. S. Shinjô and R. Ôtani with Repsold's reversible pendulum. Since 1902, regular services of meteorological observations are being made; and moreover, since last year the upper atmospheric currents are being surveyed in night-times regularly and systematically by means of pilot baloons. In 1904–1906 Messrs. Kimura and Nakano made four-group observations of latitude variations and published in Astronomische Nachrichten Bd. 169, Nr. 4040 (1905), which is very significant not only for the latitude itself but also for meteorological and geodetical problems connected with them if any. In 1914–16 the writer made a series of simultaneous observations of latitude variations, quite parallel with the international observations then being carried out; this, being now in print as a number* of memoirs of Coll. of Kyoto Imperial University, has thrown lights upon many problems relating to astronomy and geophysics.

Since 1915, when the writer was staying at Mizusawa for the above said research series of latitude observations, it occurred to Messrs. S. Shinjô, Kimura, A. Tanakadate, H. Nagaoka and M. Hashimoto as well as the writer that the gravity-potential of the Observatory and nearabout should be surveyed with the gravity-variometer of Eötvös. This work, if made, was expected to throw some light even on certain problems connected the writer's astronomical results of the other days, and consequently the actual field works were appointed to be made by him in early summer of 1921. The present report is the result of this work, made under the auspices of the National Geodetic Commitee in the Department of Educaton. The observations were made exclusively by the writer throughout the whole interval, and the transportations of the instruments were made under the supervision of Mr S. Katuoka of the Department of Education.

* Memoirs, Coll. of Science, Kyoto Imp. Univ., Vol. VI, No. 7. (Kyoto, 1923).

§ 2. Instrument and Methods.

The instrument is No. 2051 of Eötvös's Gravity-Variometer, made by the firm Suess and Co., Budapest, belonging to the National Geodetic Commitee, and it is the same which was used by the present writer on the Toné basin,* the Niitu Oil-field† and about the Volcano Asama‡ also about Sakurazima and in Jaluit Atoll by Dr. M. Matuyama. The formulae, the descriptions, and the method of manipulations relating the instrument are all given in No. III* of these Publications.

In the present case of observations about Mizusawa, some misfortunes were experienced in its early part of field work as seen in the table of observed data. But after repeated cleansing and adjustments, the instrument became in good condition, so that generally the 3-azimuth observations have been made very safely. As the possible accuracy was desired rather than quick progression of the work as in the previous case of Niitu Oil-field, the general principle was adopted to spend at least (and its best time) one night for each of the stations throughout the work. Especially on the two selected stations within the yard of the Latitude Observatory, the observations were repeated both in the earliest and the latest parts of the period and checked one another.

All observations were made by the writer himself, not assisted by any person. The transportations of the instrument were always made under the supervision of Mr S. Katuoka as usual in other cases of the writer.

* Report, Imp. Jap. Geod. Comm. No. III. (Tokyo, 1923).
† " " " " " No. V. (Tokyo, 1924).
‡ " " " " " No. VII. (Tokyo, 1926).

§3. Observations.

Table I.

(1) The Office. Sept. 7–8, 1921. Rainy.
岩手縣膽澤郡水澤町大字鹽釜　緯度觀測所本館

Magn. N.: 151° 21′.

Time		Azimuth	Ta	T	n	T′	n′
$5^h 50^m$	P	set free					
6 35		340	21°7	22°6	186.0	22°5	403.4
7 20		100	22.0	22.3	187.2	22.1	416.3
8 10		220	22.0	22.1	185.3	22.0	401.4
9 0		340	21.8	22 0	185.1	21.9	402.3
9 50		100	22.0	22.0	187.7	21.9	416.1
10 55		220	22.2	22.0	184.5	21.9	400.3
11 40		340	22.2	22.1	184.1	22.0	401.1
0 25	A	52	22.2	22.1	183.1	22.0	406.9
1 30		124	22.0	22.1	183.6	22.0	413.7
2 15		196	22.0	22.1	177.7	22.0	399.8
3 0		268	20.5	21.6	193.9	21.4	405.8
4 20		340	19.2	20.5	187.8	20.4	401.9
10 20		52	20.5	20.4	181.6	20.3	406.8
11 10		124	19.6	19.6	184.8	19.5	413.6
11 55		196	20.1	20.0	181.2	19.9	398.9
1 0	P	268	20.5	20.3	193.3	20.1	404.9
1 50		340	19.8	20.2	185.1	20.1	401.0

(2) The Observatory. Sept. 9.–10. Cloudy.
水澤町大字鹽釜　緯度觀測所觀測室

Magn. N.: 137° 46′

2 45	P	set free					
8 35		340	16.2	17.0	113.6	16.9	400.0
9 40		52	16.0	16.4	109.9	16.3	404.6
10 25		124	15.7	16.0	110.7	15.9	407.8
11 15		196	15.3	16.0	110.0	15.8	399.0
0 0	A	268	15.0	15.6	120.0	15.4	401.7
1 0		340	14.5	15.1	112.7	15.0	397.5
1 45		100	14.0	15.0	113.0	14.9	407.3
2 30		220	14.0	14.5	114.0	14.2	396.9
3 15		340	13.7	14.0	112.3	13.9	395.4

(3) Hidaka. Sept. 10–11. Overcast.
水澤町日高小路　日高神社

Magn. N.: 168° 28′

6 15	P	set free					
9 30		220	15.3	16.0	166.1	15.7	443.3
10 40		340	14.8	15 0	177.0	14.9	444.7
11 45		100	13.6	14.2	173.3	14.0	446.5
0 40	A	220	13.3	13.7	165.2	13.3	444.6
1 30		340	13.0	13.1	177.1	13.0	446.0
2 40		100	13.2	12.9	173.6	12.7	449.7
3 50		220	12.3	12.5	164.4	12.3	447.5

(4) Minami-matudo. Sept. 11–12. Clear.
佐倉河村大字下河原小字南松堂　佐倉河尋常高等小學校

Magn. N.: 131° 25′

7 0	P	set free					
8 25		220	16.6	17.9	170.0	17.8	451.35
11 0		220	15.0	15.6	168.4	15.4	454.1
11 50		340	14 2	15.0	173 6	14.9	448.9
0 35	A	100	13.9	14.6	166.9	14 4	460.1
1 25		220	13.5	14.1	168.7	14.0	454.0
2 40		340	13.9	14.0	172.4	14.0	451.4
3 30		100	14.8	14.4	164.9	14 2	463.8
4 40		220	14.9	14.8	167·2	14.7	456.2

(5) Kane-ga-saki. Sept. 12–13. Cloudy.
金ケ崎村本町　金ケ崎尋常高等小學校

Magn. N.: 159° 28′

8 20	P	set free					
11 10		220	—	17.5	169.2	17.4	442.2
0 5	A	340	—	17.4	170.7	17.3	441.0
1 0		100	—	17.6	164.3	17.5	454.6
2 20		220	—	17.9	168.6	17.7	442.6
3 35		340	—	18.0	170.0	17.9	441.1
4 40		100	—	18.0	164.0	17.9	454.0

(6) Hirokoozi. Sept. 13–14. Overcast.
水澤町廣小路　水澤尋常高等小學校

Magn. N.: 180° 47′

9 35	P	set free					
11 10		220	—	19.0	164.1	19.0	444.7
11 55		340	—	18.4	182.9	18.3	438.2
0 50	A	100	—	18.0	163.3	18.0	451.7
1 40		220	—	17.6	163.3	17.5	444.4
2 25		340	—	17.4	182.9	17.2	439.2
4 20		100	—	17.0	162.5	17.0	453.5
5 10		220	—	17.0	162.3	17.0	445.8

(7) Isida. Sept. 14–15. Clear.

水澤町大字石田　芝山分敎場

8 0	P	set free				Magn. N.: 157° 34′	
0 20	A	220	—	12.0	171.0	11.9	443.7
1 5		340	—	11 4	172.0	11.2	440.1
2 15		100	—	11.0	168.0	10.8	446.6
3 15		110	—	11.7	170.5	11.4	451.5
4 0		220	—	11.9	166.9	11.7	445.5
4 50		340	—	12.0	170.6	11.8	441.7
5 35		100	—	11.9	171.6	11.8	448.1
6 20		220	—	11.8	167.8	11.7	443.5

(8) Natuta. Sept. 15–16. Overcast.

南都田村大字本木　南都田尋常高等小學校

8 45		set free				Magn. N.: 176° 3′	
9 35		220	—	17.0	166.1	16.8	441.9
10 20		340	—	16.6	175.9	16.4	444.1
11 5		100	—	16.2	168.8	16.0	442.9
11 50		220	—	16.0	165.1	15.9	441.1
0 35	A	340	—	—	175.9	—	445.0
1 20		100	—	15.2	169.4	15.1	442.0
2 5		220	—	14.2	168.0	14.1	438.4
2 50		340	—	—	177.0	—	442.6
3 10		340	—	13.1	177.0	13.0	442.9
5 50		340	—	11.6	176.4	11.4	445.2

(9) Sasamori. Sept. 16–17. Clear.

小山村大字上笹森

6 45	P	set free				Magn. N.: 140° 17′	
8 5		220	—	15.7	174.0	15.4	432.8
8 55		340	—	14.2	173.3	14.0	435.2
9 45		100	—	13.2	169.0	13.0	446.2
10 30		220	—	12.7	171.5	12.4	435.2
11 15		340	—	12.0	171.9	12.0	436.9
0 35	A	100	—	11.2	168.6	11.0	447.2

(10) Hukuhara. Sept. 17–18. Clear.

水澤町大字福原　福原分敎場

8 10	P	set free				Magn. N.: 161° 44′	
0 50	A	220	—	13.2	164.3	13.0	436.0
1 40		340	—	12.5	174.7	12.3	438.8
2 50		100	—	12.0	165.3	11.9	450.3
3 45		220	—	12.0	163.7	12.0	438.3
5 0		100	—	12.5	166.1	12.3	452.7
5 40		220	—	12.7	—	12.5	438.3

(11) Sedaino. Sept. 19. Rainy.

眞城村大字瀨臺野　瀨臺野分敎場

5 45	P	sect free				Magn. N.: 136° 54′	
6 35		220	—	21.9	168.9	21.8	429.9
7 20		340	—	20.2	172.3	20.1	430.1
8 5		100	—	19.3	166.1	19.1	444.6
8 55		220	—	18.3	167.6	18.2	432 3
10 20		340	—	17.9	170.2	17.7	433.6
11 20		100	—	17.5	163.9	17.3	447.7

(12) Takane. Sept. 20–21. Rainy.

眞城村大字高根　高根分敎場

7 35	P	set free				Magn. N.: 127° 30′	
8 30		220	—	20.2	171.0	20.1	439.9
9 20		340	—	20.0	171.4	20.0	433.3
10 15		100	—	19.9	166.5	19 8	448.0
11 0		220	—	19.8	171.4	19.7	439.5
11 50		340	—	—	171.1	—	433.95
0 40	A	100	—	19.7	166.3	19 6	448.1

(15) The Office. Sept. 21-22. Clody.

						Magn. N.: 152° 32′	
10 55	P	278	—	19.5	177.2	19.3	442 6
11 40		38	—	19.2	161.8	19.1	439.4
0 25	A	158	—	19.0	162.8	18.9	441.6
1 10		278	—	19.0	178.1	18.8	442.6
1 55		38	—	18.9	161.6	18.7	440.0

(14) The Observatory. Sept. 22–23. Rainy.

5 10	P	set free				Magn. N.: 143° 52′	
6 55		220	—	18.6	173.2	18.4	444.8
8 5		340	—	17.8	173.3	17.6	434.4
9 5		100	—	17.2	170.6	17.1	445 8
10 35		220	—	16.9	170.1	16.8	435.9
11 45		340	—	16.7	172.1	16.6	436.0
0 35	A	100	—	16.7	169.3	16.5	446.2
1 55		220	—	16.3	169.5	16.1	435.3

§ 4. The computations.

The final computations of the vectors and their corrections are arranged in the following table. In each table of the individual stations, the first column distinguishes the vector-components, the second the directly observed vectors, the third the corrections due to neighbouring buildings if any, the fourth those due to earth-masses nearby, the fifth also those due to near terrains, and the sixth the corrections due to the geoid ellipsoid. The last column gives the final values of the vectors freed from all systematic corrections just mentioned. The values of these last columns are plotted on the accompanied Plate at the end of this publication.

It is to be remarked that the formulae used here to obtain the vector values in the second column are as follows, the numerical constants of which being derived from determinations of torsional constants of the sensitive wires in the Asama Field as well as in the present Mizusawa Field, (the numerical results of these determinations are given in the report of the Asama Field.)

Formulae for 3-azimuth Observatlons.

$$A = 4.760\{[(n_2-n_0)-(n_3-n_0)]+(1+0.0678)[(n'_2-n'_0)-(n'_3-n'_0)]\}$$
$$B = -8.246\{[(n_2-n_0)+(n_3-n_0)]+(1+0.0678)[(n'_2-n'_0)+(n'_3-n'_0)]\}$$
$$C = 1.450\{[(n_2-n_0)-(n_3-n_0)]-(1+0.0691)[(n'_2-n'_0)-(n'_3-n'_0)]\}$$
$$D = 2.509\{[(n_2-n_0)+(n_3-n_0)]-(1+0.0691)[)n'_2-n'_0)+)n'_3-n'_0)]\}$$

Formulae for 5-azimuth Observations.

$$A = 3.879\{[(n_5-n_1)-(n_2-n_1)]+1.618[(n_3-n_1)-(n_4-n_1)]\}$$
$$B = 2.039\{-2.618[(n_5-n_1)+(n_2-n_1)]+[(n_3-n_1)+(n_4-n_1)]\}$$
$$C = 1.179\{-1.618[(n_5-n_1)-(n_2-n_1)]+[(n_3-n_1)-(n_4-n_1)]\}$$
$$D = 0.620\{-[(n_5-n_1)+(n_2-n_1)]+2.618[(n_3-n_1)+(n_4-n_1)]\}$$

$$A' = 4.137\{[(n'_5-n'_1)-(n'_2-n'_1)]+1.618[(n'_3-n'_1)-(n'_4-n'_1)]\}$$
$$B' = 2.176\{-2.618[(n'_5-n'_1)+(n'_2-n'_1)]+[(n'_3-n'_1)+(n'_4-n'_1)]\}$$
$$C' = 1.259\{-1.618[(n'_5-n'_1)-(n'_2-n'_1)]+[(n'_3-n'_1)-(n'_4-n'_1)]\}$$
$$D' = 0.662\{-[(n'_5-n'_1)+(n'_2-n'_1)]+2.618[(n'_3-n'_1)+(n'_4-n'_1)]\}$$

Table II.

Results of Computations.

(1) The Office. $(\lambda= 141^\circ\, 8'\, 9''.4,\ \varphi=+39^\circ\, 8'\, 7''.2)$

A	91.4	0.3	0.0	0.0	−6.2	85.5
B	−36.7	−0.1	0.0	0.0	0	−36.8
C	20.1	−0.2	0.0	0.0	−8.0	11.9
D	10.5	0.2	0.0	0.0	0	10.7

(2) The Observatory. $(\lambda=141^\circ\, 8'\, 9''.5,\ \varphi=+39^\circ\, 8'\, 3''.3)$

A	57.8	0.0	0.0	0.1	−6.2	51.7
B	− 9.0	0.0	0.0	0.0	0	− 9.0
C	13.6	0.0	0.0	0.1	−8.0	5.7
D	12.7	0.0	0.0	0.0	0	12.7

(3) Hidaka. $(\lambda=141^\circ\, 8'\, 10''.2,\ \varphi=+39^\circ\, 8'\, 22''.1)$

A	64.9	0.0	0.3	−0.1	−6.2	58.9
B	10.4	0.0	−0.5	0.0	0	9.9
C	− 5.0	0.0	−0.2	−0.2	−8.0	−13.4
D	−15.1	0.0	0.1	0.2	0	−14.8

(4) Minami-matudo. $(\lambda=141^\circ\, 7'\, 58''.2,\ \varphi=+39^\circ\, 9'\, 37''.3)$

A	27.5	1.7	0.0	0.0	−6.2	23.0
B	4.0	−0.8	0.0	−3.5	0	− 0.3
C	3.0	0.3	0.0	−0.2	−8.0	− 4.9
D	28.3	−0.1	0.0	0.1	0	28.3

(5) Kane-ga-saki. $(\lambda=141^\circ\, 7'\, 18''.4,\ \varphi=+39^\circ\, 11'\, 22''.6)$

A	35.0	2.6	0.0	0.0	−6.2	31.4
B	−30.1	0.4	0.0	0.5	0	−21.1
C	27.0	0.3	0.0	−0.1	−8.0	19.2
D	7.4	0.0	0.0	0.1	0	7.5

(6) Hiro-koozi. $(\lambda=141^\circ\, 8'\, 29''.9,\ \varphi=+39^\circ\, 8'\, 26''.9)$

A	63.3	−0.1	0.0	0.0	−6.2	57.0
B	0.1	−0.3	0.0	0.0	0	− 0.2
C	32.2	0.0	0.0	−0.1	−8.0	24.1
D	38.5	0.0	0.0	0.1	0	38.6

(7) Isida. $(\lambda=141^\circ\, 7'\, 20''.4,\ \varphi=+39^\circ\, 8'\, 30''.9)$

A	28.7	2.3	0.0	1.0	−6.2	25.8
B	−24.2	−2.3	0.0	−0,8	0	−27.3
C	− 1.5	0.6	0.0	−1.3	−8.0	−10.2
D	11.4	−0.2	0.0	0.8	0	12.0

(8) Natuta. ($\lambda=141° 5' 32''.0$, $\varphi=+39° 8' 11''.6$)

A	61.6	0.0	0.0	−2.8	−6.2	52.6
B	22.1	0.0	0.0	2.0	0	24.1
C	1.5	0.0	0.0	−0.8	−8.0	− 7.3
D	11.5	0.0	0.0	0.2	0	11.7

(9) Sasamori. ($\lambda=141° 7' 19''.1$, $\varphi=+39° 6' 54''.0$)

A	45.1	0.0	0.0	0.0	−6.2	38.9
B	7.2	0.0	0.0	0.0	0	7.2
C	18 8	0.0	0.0	−0.1	−8.0	10.7
D	16.4	0.0	0.0	−0.2	0	16.2

(10) Hukuhara. ($\lambda=141° 7' 38''.4$, $\varphi=+39° 7' 47''.4$)

A	84.2	2.2	0.0	0.0	−6.2	80.4
B	2.3	−0.9	0.0	1.2	0	2.6
C	48.1	−0.1	0.0	−0.1	−8.0	39.9
D	23.1	0.4	0.0	0.1	0	23.6

(11) Sedaino. ($\lambda=141° 9' 54''.9$, $\varphi=+39° 7' 26''.0$)

A	57.3	1.4	0.0	1.8	−6.2	54.3
B	8.7	−0.4	0.0	1.5	0	9.8
C	16.0	0.1	0.0	−0.8	−8.0	7.3
D	26.0	0.0	0.0	−0.1	0	25.9

(12) Takanc. ($\lambda=141° 9' 25''.9$, $\varphi=+39° 5' 39''.0$)

A	48.3	−2.1	0.0	−3.0	−6.2	37.0
B	− 6.5	−1.8	0.0	0.0	0	−8.3
C	10.3	0.1	0.0	−0.6	−8.0	1.8
D	27.8	−0.3	0.0	1.6	0	29.1

(13) The Office.

A	91.6	0.3	0.0	0.0	−6.2	85.7
B	−37.7	−0.1	0.0	0.0	0	−37.8
C	19.0	−0.2	0.0	0.0	−8.0	10.8
D	13.3	0.2	0.0	0.0	0	13.5

(14) The Observatory.

A	52.4	0.0	0.0	0.1	−6.2	46.3
B	0.6	0.0	0.0	0.0	0	0.6
C	13.3	0.0	0.0	0.1	−8.0	5.4
D	16.0	0.0	0.0	0.0	0	16.0

§ 5. Summaries.

Looking at the chart wherein our vectors* are plotted, we can see that there are generally good agreements among the vectors for the whole field. The curvatures are almost parallel to each other, and the maximum curvatures run practically in north-and-south direction. The horizontal gradients are in less agreement; but it is very remarkably certain that all have more or less *eastern* components.

The Mizusawa town stands almost in the centre of a plain field formed probably by the action of the river "Kitakami-gawa", one of the greatest rivers in Japan, between two parallel mountain-ranges of very ancient formation. The present river-bed runs at a distance of about three kilometres east of the town; but, according to geological inspections of the writer, the river seemed more flooded many years ago, and the environments of the present town were probably permanent lakes as seen in the name "Mizu-sawa" (meaning "water-lake".) The southern extreme part of the present town, however, was an exception, and consisted since long time a nice local plateau. On a part of this plateau, stands, at present, the International Latitude Observatory. The level-difference between the present yard of the observatory and the town is about 3 metres.

The centre line of the eastern mountain-range lies at a distance of about 30 km from the observatory, beyond the great river. The formation of this range is palaeozoic and very massive, whose foot almost reaches the east side of the river. The west mountain-range runs at a little farther distance, that is, at about 40 km, which is really a part of the general back-born of the main land of Japan, the nearest distance from the observatory to the foot of this range being about 7 km.

For the two important staions in the Observatory yard, (1) The Office and (2) The Observatory, which are very near to each other, a special Plate II has been prepared. The vector components used here to show the gravity gradients are the arithmetical mean values of the two series of the observation results of the field work made in the beginning and the end of the working interval; let here be given the numerical values:

* In the Plate I, the *mean values* of the vectors from the two series (in the beginning and the end of the working interval) are plotted in each of the both the stations (1) the Office and (2) the Observatory. See further descriptions below.

Table III.

		A	B	C	D
(1) Office.		85.5	−36.8	11.9	10.7
		85.7	−37.8	10.8	13.5
	Mean:	85.6	−37.3	11.35	12.1
(2) Observatory.		51.7	− 9.0	5.7	12.7
		46.3	0.6	5.4	16.0
	Mean:	49.0	− 4.2	5.55	14.35
Difference (1) minus (2):		36.6	−33.1	5.8	−2.25

The differences, (1) minus (2), as given in the above Table are also shown in graphical representations in the plate II.

For the purpose of investigating the actual effects of some anomaly in the atmospheric refracton around the latitude-observing room, especially for the verification of Prof. S. Shinjo's considerations of the "z" term of the latitude variation as an effect of the said refraction anomaly, the writer made a series of Talcott observations for a full interval of two years in 1914–1916. As one of the final results there obtained, he found that there was a *constant* disagreement between the differential latitudes, which was duplicately determined astronomically and geodetically for the distance between the International and the "Research" Observing Rooms. The numerical results are:

Table IV.

Differential Latitudes

Astronomically:	1.″533
Geodetically:	1.474
Difference:	0.059

This difference was attributed by the writer to an effect due to the probable anomaly of the atmospheric refraction according to the above mentioned consideration. But some of the authorities thought it more probable to be due to the "Lotabweichung", relatively, between the two rooms which were really 45.45 metres distant in meridian. In terms of the present gravity gradients, we have:

$$\text{“Lotabweichung”} = \frac{\partial}{\partial x}\left(\frac{\frac{\partial U}{\partial x}}{\frac{\partial U}{\partial z}}\right) = \frac{\frac{\partial^2 U}{\partial x^2}\frac{\partial U}{\partial z} - \frac{\partial U}{\partial x}\frac{\partial^2 U}{\partial x \partial z}}{\left(\frac{\partial U}{\partial z}\right)^2}$$

$$= \frac{1}{g}\left(\frac{\partial^2 U}{\partial x^2}\right) - \frac{\partial U}{\partial x}\frac{\partial^2 U}{\partial x \partial z}.$$

While, the difference of C's in the Table III is, theoretically:

$$\text{Difference of } C = \frac{\partial}{\partial x}\left(\frac{\partial^2 U}{\partial x \partial z}\right)$$

Consequently, in so far as one more relation between the gravity-graduients, for instance:

$$\left(\frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2} + \frac{\partial^2 U}{\partial z^2}\right)$$

can not be obtained by any method independent of our own method, we cannot solve the matter in its numerical form.

The absolute determination of the gravity was made, as mentioned in the Introduction, in 1900, by a band of observers under the auspices of the National Geodetic Committee. Moreover, the relative determinations of gravity were carried out lately by Prof. H. Nagaoka and his party. The provisional results of these all are published in a number of the Verhandlungen der internationalen Erdmessung, from which the following quotations are made here.

Place	year	Gravity			Diff.
		observed	corrected	standard	
Mizusawa	1900	980.174*	980.193	980.089	+0.104
Sendai	1906	980.109	980.119	980.011	+0.108
Ichinohe	1906	980.177	980.185	980.070	+0.115
Mizusawa	1906	980.159†	980.178	980.089	+0.089
Morioka	1906	980.204	980.243	980.139	+0.104
Fukuoka	1906	980.270	980.302	980.190	+0.112
Hachinohe	1906	980.359	980.365	980.212	+0.153
Yusawa	1907	980.139	980.168	980.091	+0.077
Akita	1907	980.186	980.188	980.139	+0.049
Ootate	1907	980.241	980.264	980.190	+0.074
Shinjoo	1907	980.075	980.106	980.055	+0.051
Yamagata	1907	980.024	980.074	980.011	+0.063
Toono	1912	980.172	980.252	980.103	+0.149
Miyako	1912	980.288	980.289	980.134	+0.155
Kesennuma	1912	980.210	980·211	980.068	+0.143

* Absolute detemination. † Relative determination referred to Tokyo.

From the data of this table, we see a horizontal gradient of the gravity, in its eastern component, to be about 0.05 cm/sec² for a distance of 30 kilom., increasing eastward, or in our expression:

$$\frac{\partial g}{\partial y}=\frac{\partial U}{\partial y\,\partial z}=\frac{0.05}{3000000}=+17\times10^{-9}\ \text{c.g.s.}$$

On the other hand, the general mean value of dg/dy for all the present 12 stations gives:

$$\frac{\partial^2 U}{\partial y\,\partial z}=+19.5\times10^{-9}\ \text{c.g.s.}$$

The close agreement between the two values is remarkable.

To Prof. H. Kimura, the Director of the International Latitude Observatory, the writer owes his great obligation for the present work, to which he had much interests and, at the same time, showed deep sympathy and kindheartedness during the work. Prot. S. Shinjo was also a constant adviser to the writer on every point of the programme and field-arrangements to which the latter expresses grateful thanks.

Issei Yamamoto.

Kyoto University Obsevrvatory,
May 27, 1922.

Plate I.

GRAVITY-GRADIENTS AROUND THE MIZUSAWA OBSERVATORY.

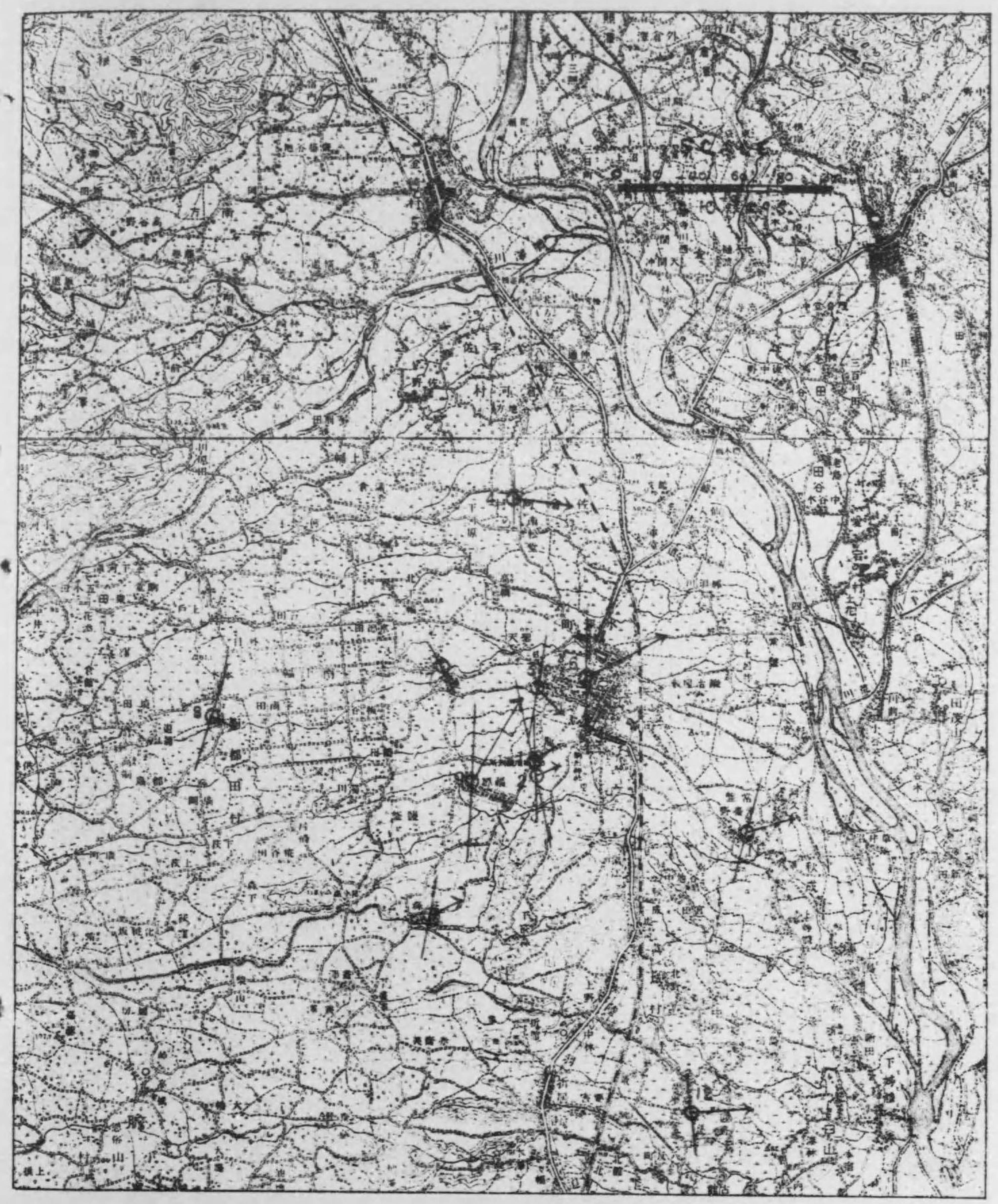


Plate II.

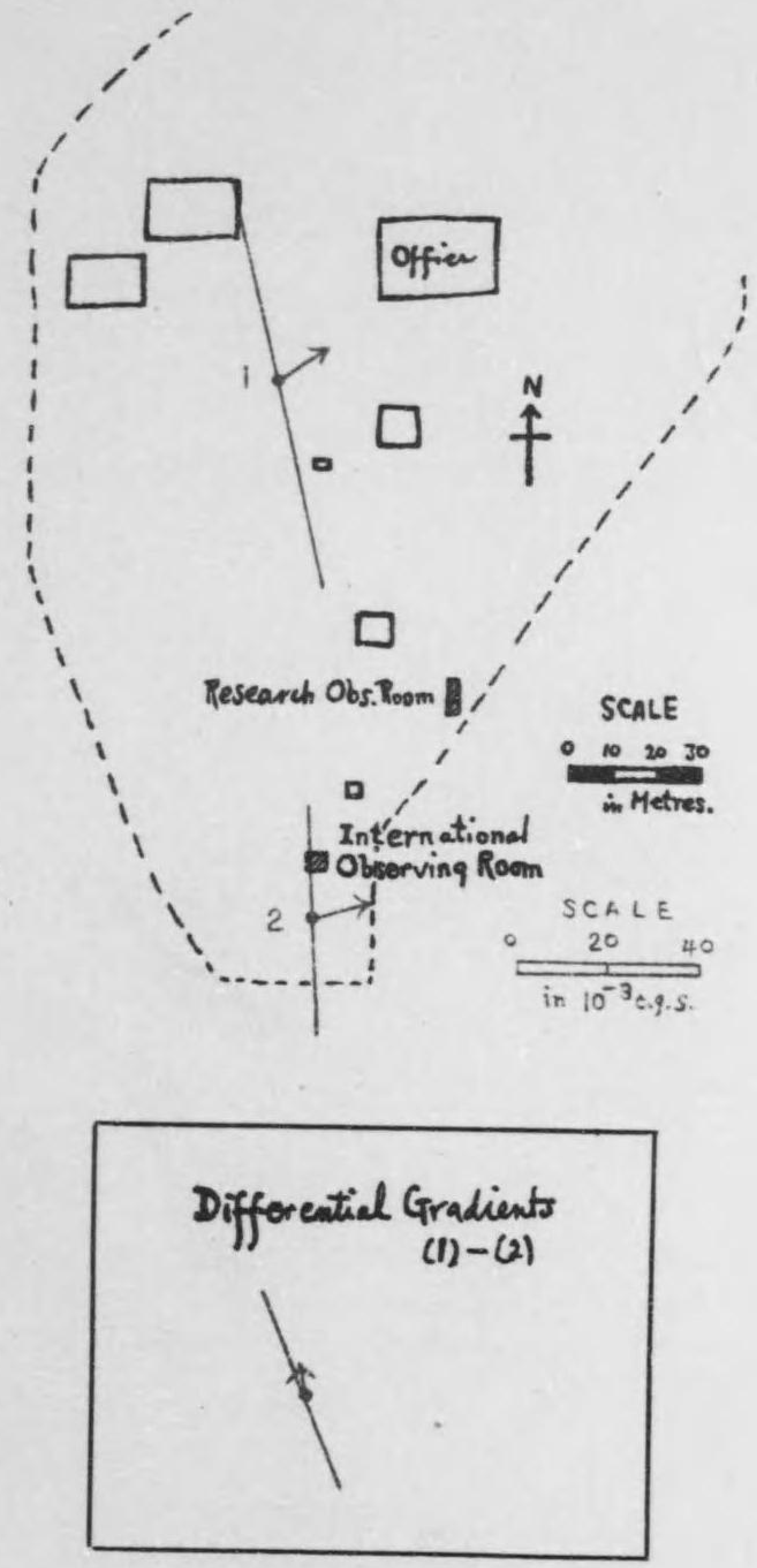
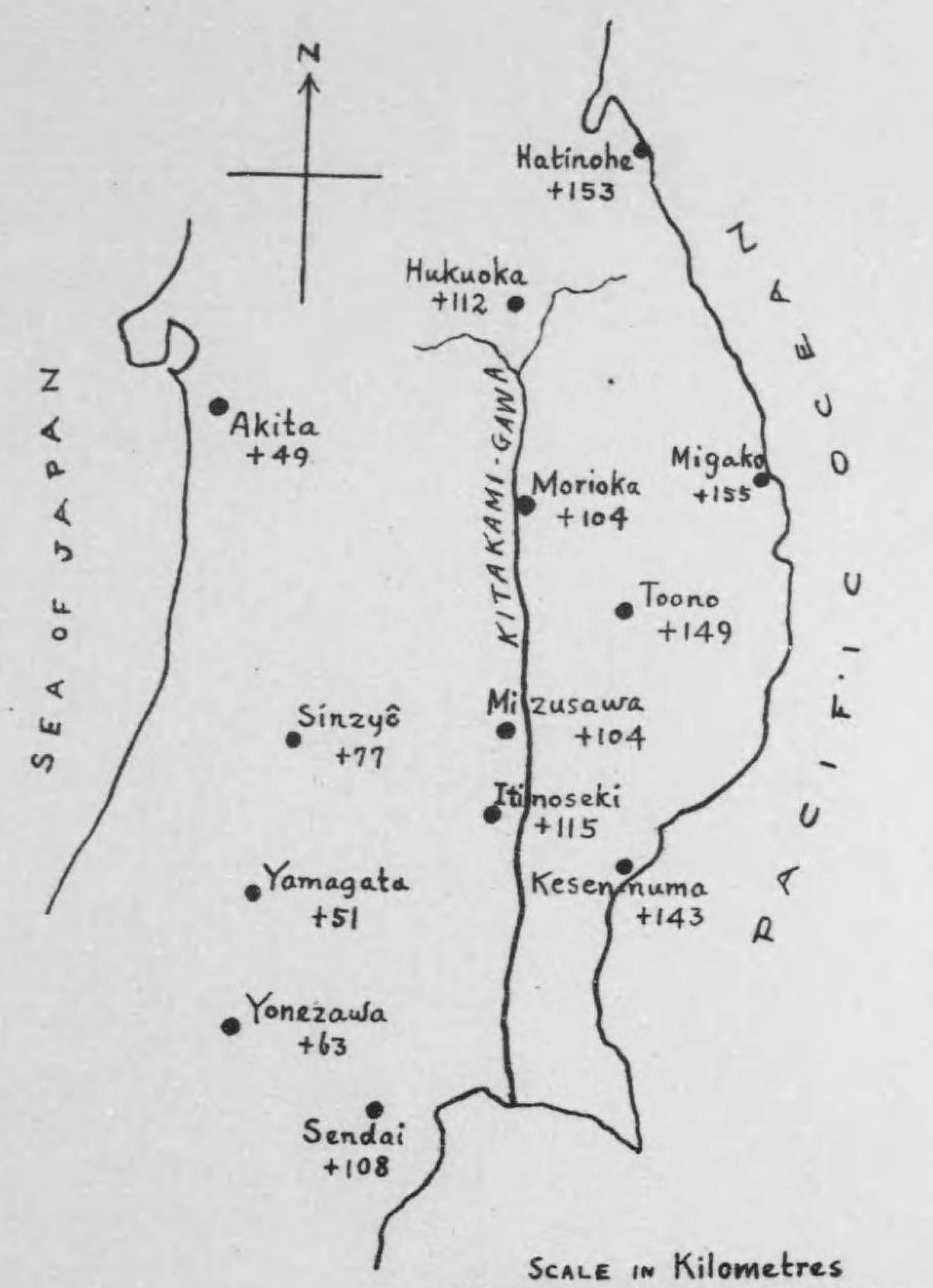

Office
1
N
Research Obs. Room
SCALE
0 10 20 30
in Metres.
International
Observing Room
2
SCALE
0 20 40
in 10^{-3} c.g.s.
Differential Gradients
(1) – (2)

Plate III.

CHART OF DIFFERENCES BETWEEN CORRECTED (g_0) AND STANDARD GRAVITY.



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