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Preliminary Report on a Gravimetric Survey on Towada Caldera, Tōhoku District, Japan

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Towada Caldera is situated in the northern part of the Tōhoku district and contains a trapezoidal caldera lake measuring about 10 km in the longest side.

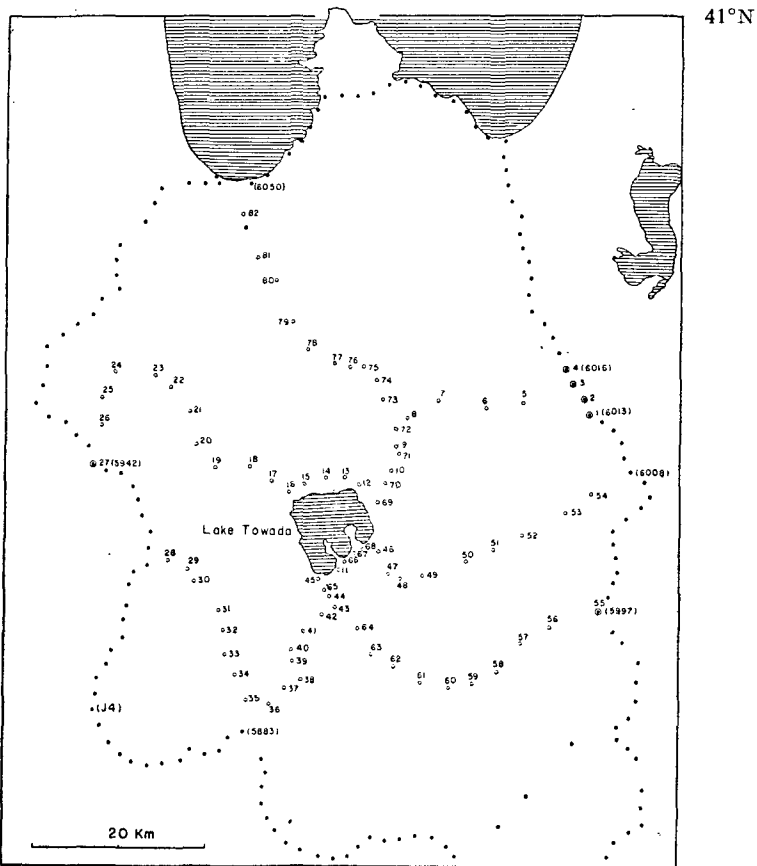


Fig. 1. Distribution of the gravity stations around Towada Caldera. Hollow circles denote the stations of the present survey.

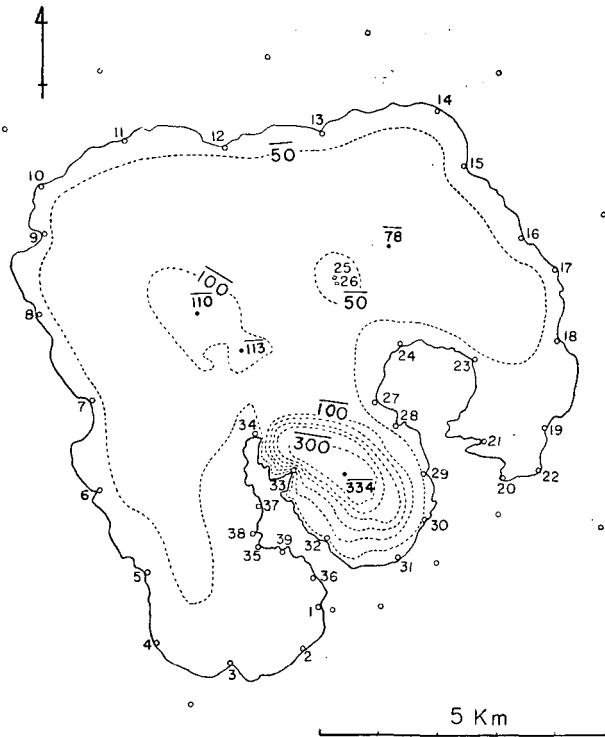


Fig. 2. Distribution of the gravity stations at the shore of Towada caldera lake. Dotted lines denote the depth contours in meters.

On the lake surface, the two peninsulars embrace an elliptical bay which is 334 meters in depth and may correspond to a crater of the last volcanic activities at this caldera. A large amount of pumice flow and fall deposits which were ejected at the time of the caldera formation, is distributed around the caldera, especially in the eastern region.

As a series of gravimetric surveys on the calderas in Japan, the writers carried out the survey on this caldera in August, 1963. In this paper, the gravity values and gravity anomalies observed at each station and the distribution of the Bouguer anomalies are reported as preliminary. Detailed studies on the subterranean structure of the caldera and comparative discussions with other calderas will be postponed to the future papers.

In this district the routes of the gravity survey by the Geographical Survey Institute pass by this caldera at a distance of 20~30 km. Besides

Table I. Gravity values and anomalies observed around Towada Caldera.

Station	ϕ	λ	Height	Normal value	Observed value	Free-air anomaly	Bouguer anomaly
	40°N	140°E	(m)	(mgal) 980,	(mgal) 980,	(mgal)	(mgal)
No. 1 BM 6013	34.7	14.4*	33.36	231.95	289.58	67.9	64.2
2 6014	35.6	14.0*	54.81	232.99	286.73	70.6	64.5
3 6015	36.6	13.1*	65.39	234.77	287.57	73.0	65.7
4 6016	37.5	12.5*	72.24	236.11	286.25	72.4	64.4
5 石瀬橋	35.5	09.3*	68	233.14	285.88	73.7	66.1
6 法量橋独標	35.3	06.0*	97	232.84	288.39	85.5	74.7
7 奥入瀬小学校	37.3	02.0*	164.3	235.81	279.53	86.9	76.1
8 焼山独標	34.5	59.4	208	231.66	272.00	104.5	81.3
9 独標	32.9	58.7	250	229.28	259.99	107.9	79.9
10 雲井の滝独標	31.1	58.6	300	226.60	228.44	94.4	60.9
11 十和田科学博物館	25.5	53.8	405.4	218.29	199.86	106.7	61.4
12 青撫山道	30.0	55.8	691	224.97	143.36	131.6	54.4
13 "	30.1	54.3	832	225.12	119.74	151.4	58.4
14 三角点	30.1	53.1	1011.0	225.12	072.51	159.4	46.5
15 御花部山西方	30.0	51.0	714	224.97	139.08	134.4	54.7
16 滝の沢への分岐点	30.0	49.9	692	224.97	136.44	125.0	47.7
17 温川橋	30.1	48.4	458	225.12	193.90	110.1	59.0
18 独標	30.1	46.5	341	225.12	214.51	94.6	56.5
19 葛川村火の見下	30.1	43.8	274	225.12	225.37	84.8	54.2
20 小国入口	33.3	41.8	185.2	229.87	249.84	77.1	56.4
21 二庄内橋	35.0	41.6	152	232.40	271.08	85.6	68.6
22 東英小学校	36.5	40.1	97	234.62	261.51	56.8	46.0
23 独標	37.3	38.7	102	235.81	252.33	48.0	36.6
24 "	37.5	35.5	40	236.11	255.98	32.2	27.8
25 "	35.9	34.2	36	233.73	260.66	38.0	34.0
26 高畑入口	33.9	34.5	43	230.76	262.54	45.0	40.2
27 BM 5942	33.2	33.6	64.03	229.73	273.33	63.4	56.2
28 たつみ橋	25.5	39.9	242	218.29	230.01	86.4	59.4
29 坂梨峠	25.0	41.4	455	217.55	186.38	109.2	58.4
30 古遼部斂山	24.3	42.0	309	216.51	213.89	92.7	58.2
31 野口独標	20.2	44.0	223	210.42	222.43	80.8	55.9
32 独標	20.1	44.2	192	210.27	236.90	85.9	64.4
33 小坂独標	20.0	44.5	170	210.12	240.75	83.1	64.1
34 独標	17.9	45.2	145	207.00	238.04	75.8	59.6
35 "	16.6	45.3	130	205.08	239.00	74.0	59.5
36 "	16.4	48.1	135	204.78	236.06	72.9	57.9
37 "	17.3	49.2	156	206.11	223.02	65.0	47.6
38 "	17.8	50.2	187	206.85	210.04	60.9	40.0
39 "	18.8	50.0	217	208.34	209.11	67.7	43.5
40 箒畑入口	19.8	50.1	232	209.82	216.51	78.3	52.4
41 独標	20.1	50.8	257	210.27	219.00	88.0	59.3
42 根津塔沢出合	20.2	52.6	303	210.42	218.54	91.6	67.8
43 独標	20.2	53.4	344	210.42	209.84	105.6	67.2
44 笈荷峠南方	23.3	52.9	498	215.02	178.78	117.4	61.8
45 笈荷峠展望台	24.3	52.2	605	216.51	155.76	126.0	58.4

Table I. Continued.

No. 46	高山東麓	26.3	57.1	540	219.47	179.38	126.6	66.2
47	平代田	25.0	57.6	665	217.55	147.85	135.5	61.2
48	五戸・三戸分岐点	24.4	59.2	593	216.66	170.87	137.2	71.0
49	三叉路	24.5	00.3*	495	216.81	201.50	137.1	82.2
50	菅場	25.0	03.5*	324	217.55	231.58	114.0	77.8
51	長漕	26.2	06.6*	217	219.33	251.79	99.4	75.2
52	沢口	27.1	09.2*	157.5	220.66	266.82	94.8	77.2
53	古川代	28.6	12.4*	111	222.88	265.32	76.7	64.3
54	浦田	30.0	14.8*	93	224.97	276.05	79.8	69.4
55	三戸三叉路	20.2	15.0*	47.2	210.42	282.14	86.3	81.0
56	独標	20.1	11.2*	68	210.27	268.90	79.6	72.0
57	田子中学校	20.0	08.9*	97.8	210.12	258.26	78.3	67.4
58	独標	18.2	07.1*	121	207.45	251.51	81.4	67.9
59	道前分岐点	17.4	04.9*	154	206.26	250.18	91.4	74.2
60	独標	17.3	02.7*	205	206.11	243.21	100.4	77.5
61	夏坂独標	17.4	00.2*	232	206.26	236.78	102.1	76.2
62	雷鉢森下	19.9	59.2	519	209.97	175.69	125.9	67.9
63	足洗	20.0	56.6	446	210.12	194.01	121.5	71.7
64	橋の上	20.0	55.5	410	210.12	202.68	119.1	73.3
65	国立公園境界石段	23.3	52.7	494	215.02	178.23	115.7	60.5
66	休屋の寺の入口	25.4	54.5	422	218.14	199.05	111.6	64.0
67	観湖台	25.8	55.1	526	218.73	176.30	119.9	61.1
68	宇樽部	26.8	57.2	411	220.21	206.21	112.8	66.9
69	銚子滝	29.1	57.1	382	220.66	212.34	109.6	66.9
70	十和田道	30.0	57.9	338	224.97	219.72	99.1	61.3
71	石ヶ戸	32.3	59.0	275	228.39	249.54	106.0	75.3
72	黄瀬林道	33.7	59.0	233	230.47	264.22	105.6	79.6
73	葛温泉入口	35.6	57.5	453	233.29	219.50	135.2	75.4
74	仙人橋	36.7	57.0	563	234.92	196.76	135.6	72.7
75	谷地温泉入口	37.7	55.9	737	236.40	165.67	156.7	74.4
76	猿倉温泉入口	37.6	54.9	844	236.25	144.03	168.2	74.0
77	水蓮沼入口	37.7	53.6	957	236.40	116.92	175.8	69.0
78	酸湯橋	38.7	51.3	852	237.89	134.91	160.0	64.8
79	沢の橋	41.1	50.3	411	241.46	165.75	137.2	60.2
80	かやの茶屋	42.3	53.3	509	243.25	215.93	129.8	72.9
81	雲谷四叉路	45.5	52.5	162	248.01	284.65	86.6	68.5
82	大星神社	48.4	51.7	13	252.32	316.33	68.0	66.6

Asterisk denotes 141°E.

the accentuated survey on the caldera, the authors extended the surveying routes radially from the caldera to get general idea of the gravity field in this district.

The survey was made by means of a LaCoste & Romberg Gravimeter and standardized by the gravity value ($g=980.1615$ gal) at the pendulum station at the Mizusawa Latitude Observatory. Residing accuracy of a single observation by the gravimeter is about 0.04 mgal and its drift is less than 0.3 mgal/month. As for the observation points, many bench marks for precise levels

Table II. Gravity values and anomalies observed at the shore of Towada caldera lake.

Station	ϕ	λ	Height (m)	Normal value (mgal) 980,	Observed value (mgal) 980,	Free-air anomaly (mgal)	Bouguer anomaly (mgal)
	40°N	140°E					
No. 1 博物館正面浜	25.3	53.8	401.2	218.04	200.39	106.2	61.4
2 中の平砂浜	24.7	53.2	"	217.10	200.95	107.7	62.8
3 岬	24.8	52.6	401.6	217.25	201.76	108.4	63.6
4 生出棧橋	24.8	51.7	402.5	217.25	201.86	108.8	63.9
5 一夜島	25.5	51.6	401.2	218.29	204.62	110.1	65.3
6 鉛 岬	26.4	51.0	"	219.62	204.35	108.5	63.7
7 大川岱	27.2	50.9	"	220.81	199.77	102.8	58.0
8 銀 山	28.6	50.2	"	222.88	202.91	103.8	59.0
9 岬	28.8	50.3	401.7	223.18	202.42	103.2	58.3
10 滝の沢棧橋	29.3	50.3	401.2	223.93	204.09	104.0	59.2
11 湖 岸	29.7	51.2	"	224.52	207.21	106.5	61.6
12 "	29.7	52.7	"	224.52	211.12	110.4	65.6
13 "	29.8	54.0	"	224.67	214.64	113.8	69.0
14 御鼻部山下	30.1	55.0	"	225.12	210.86	109.6	64.7
15 大豊石	29.5	55.3	"	224.23	206.78	106.4	61.6
16 小豊石	28.9	56.0	"	223.33	208.04	108.5	63.7
17 子の口	28.5	56.5	"	222.74	211.26	112.3	67.5
18 岬	27.9	56.6	"	221.84	213.15	115.1	70.3
19 河 口	27.1	56.4	"	220.66	208.97	112.1	67.3
20 外湖の奥	26.5	55.9	"	219.77	207.23	111.3	66.5
21 御倉山半島岬	26.9	55.6	"	220.36	205.70	109.2	64.3
22 宇樽部湖岸	26.7	56.4	"	220.07	207.18	110.9	66.1
23 御倉山半島	27.7	56.4	"	221.55	202.45	104.7	59.9
24 御倉山半島尖端	27.8	55.5	"	221.69	194.21	96.3	51.5
25 御門石(北)	28.4	54.7	"	222.59	196.37	97.6	52.8
26 御門石(南)	28.4	53.9	"	222.59	196.38	97.6	52.8
27 日暮崎	27.3	53.9	"	220.95	196.78	99.6	54.8
28 鴨 崎	27.1	54.4	"	220.66	201.06	104.2	59.4
29 烏帽子岩	26.6	54.9	401.8	219.92	204.83	108.9	64.0
30 千本松	26.2	54.8	401.7	219.33	206.06	110.7	65.8
31 展望台下	25.5	54.9	401.2	218.29	203.32	108.8	64.0
32 占い場	26.0	54.7	"	219.03	200.38	105.2	60.4
33 千鶴崎	26.6	53.3	401.8	219.92	192.76	96.8	52.0
34 中山崎	26.9	53.4	402.2	220.36	194.22	98.0	53.0
35 六方岩	25.9	52.9	401.7	218.88	200.87	107.0	61.1
36 乙女像浜	25.7	53.0	401.2	218.59	202.59	107.8	63.0
37 六方岩北方	26.3	53.0	"	219.47	198.98	103.3	58.5
38 ぐみ島	26.0	52.9	"	219.03	200.98	105.8	61.0
39 六方岩南方	25.9	53.3	401.7	218.88	201.55	106.6	61.8

and spot heights were occupied and also many temporary stations were set along the shore-line of Lake Towada. Heights of the remaining stations were determined by means of a precise microbarometer of the American Paulin System within an accuracy of about 3 meters at worst. The number of the

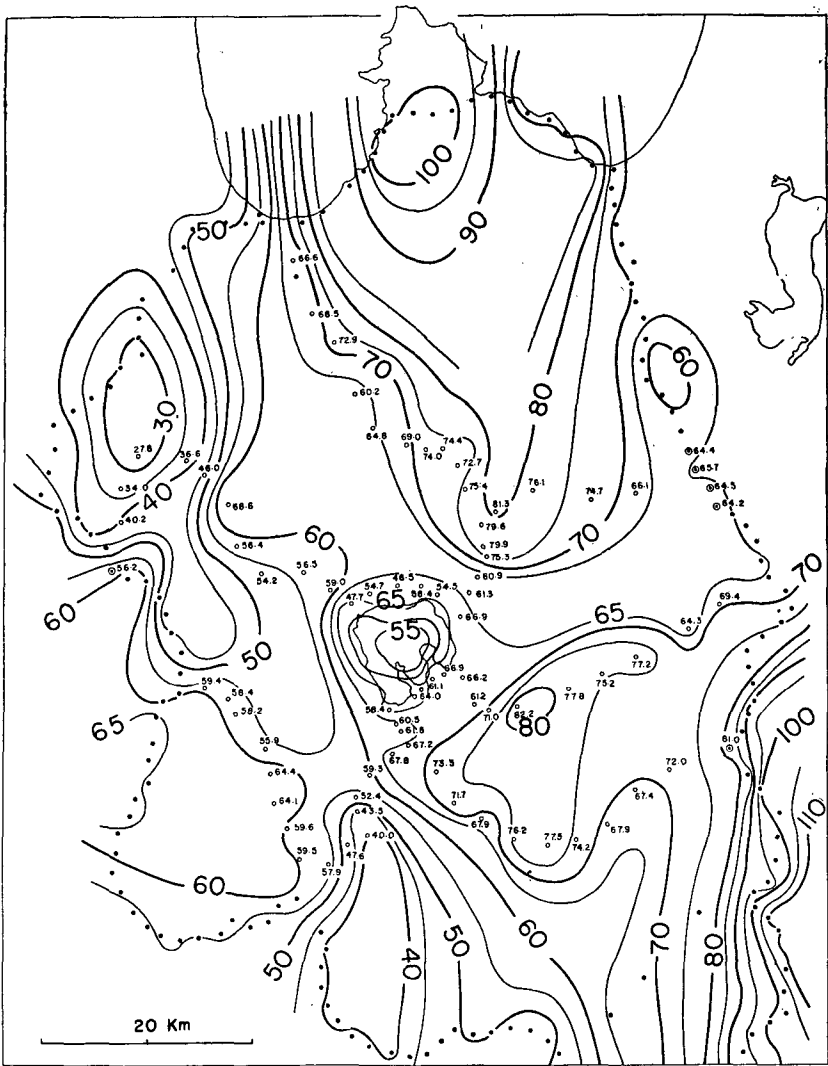


Fig. 3. Distribution of the Bouguer anomalies around Towada Caldera. Unit is *mgal*.

observation points reached 120 and their distribution is shown in Figs. 1 and 2.

To obtain the gravity anomalies, the authors take the density of the earth-crust as 2.67 gr./cc and the vertical gradient of gravity as 0.3086 mgal/meter and neglect the topographic corrections.

The results are listed in Tables I and II where "Observed value" is the

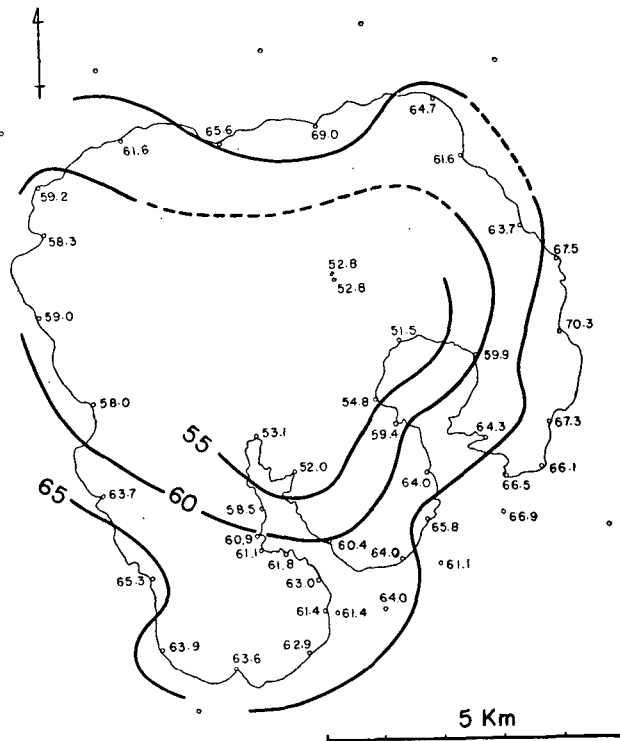


Fig. 4. Distribution of the Bouguer anomalies on and around Towada caldera lake (not corrected for topography). Unit is *mgal*.

gravity value at the height given in column under the designation "Height" and the distribution of the Bouguer anomalies is shown in Figs. 3 and 4. At some stations on the northern and southern rims of the caldera, topographical effects may amount to more than 10 mgal: these effects are taken into consideration when the authors draw the contours of the Bouguer anomaly in Fig. 3. In the figure, the solid circles denote the gravity points measured by the Geographical Survey Institute¹⁾. In Fig. 4, the general tendency of relative gravity anomalies on and around the lake will not be affected seriously by the topographies. In order to avoid the errors due to topographical corrections, the writers present the distribution of the Bouguer anomalies not corrected for the topographies.

For the future, it is necessary to supplement the past and present surveys though there may be many difficulties of access to the spots, height

determination and topographical correction, *etc.*

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Reference

- 1) Geographical Survey Institute: Gravity Survey in Japan (2), II. Gravity Survey in Tōhoku District, Bull. G.S.I., V (1957), 1-94.