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13. *Gravity Surveys on Aso and Kuju Volcanic Region, Kyushu District, Japan.*

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Abstract

Gravity survey at 446 points in an area of about 4300 km^2 over the Aso and Kuju volcanic region occupying the central part of Kyushu Island of Japan was made by use of Worden and LaCoste and Romberg Geodetic Gravimeters from 1965 to 1966.

This survey was carried out as one of the branch projects of "Combined Aeromagnetic-Gravity Studies of Calderas in Japan".

Bouguer gravity anomalies over this area are characterized by
1) a strong negative anomaly on the Aso caldera,
2) a circular negative anomaly over the Kuju volcano group on the north-eastern side of the Aso caldera,
3) positive anomalies on the south-western flank of somma of the Aso caldera and
4) a narrow belt of relatively high gravity running from Ooita to Kumamoto.

The gravity low of the Aso caldera shows characteristic feature of the "low anomaly type caldera" as is pointed out by Yokoyama.

The Kuju volcanic group also shows the similar feature of "low anomaly type caldera", though existence of caldera is not identified from topographical view point. This fact coincides with the geological presumption of buried existence of the Kuju caldera which was once as gigantic as that of the Aso caldera.

On the south-western flank of the somma of the Aso caldera, the oldest formation consists of semi-shist (Sambagawa System) and the outcrop of basalt is also being found from geological surveys. The gravity high which reaches 22 mgal at the center coincides with the distribution of basaltic formation. It reveals, therefore, the high density material such as basaltic or metamorphic rocks.

A narrow belt of relatively high gravity is remarkably observed. The tectonic line which is geologically presumed to run from Ooita

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westward to Kumamoto through the Kyushu Island just coincides with this belt.

1. Introduction

A gravity survey was made from 1965 to 1966 over the Aso and Kuju volcanic region, the central part of Kyushu Island of Japan. This survey was carried out as one of the branch projects of "Combined Aeromagnetic-Gravity Studies of Caldera in Japan" which is participated in by the members of

a) Faculty of Science of the Kyoto University and
b) Earthquake Research Institute of the University of Tokyo.

The volcano Aso has a typical caldera which occupies an area of 379 km^2, with 17 km and 25 km in the EW and NS directions, respectively. There are more than a dozen central cones in the caldera (Kuno 1962). On about 20 km north-east of the Aso caldera, is situated Kuju volcano group consisting of more than ten cones or domes and covering an area of 20 km (EW) $\times$ 15 km (NS) (Kuno, 1962).

On Aso caldera, the gravity survey was previously made by the Earthquake Research Institute of the University of Tokyo (Tsuboi et al, 1954, 1956) along the precise levelling routes set up by the Geographical Survey Institute (G.S.I.) and at the Volcanological Laboratory of Kyoto University in 1954. The observed points in this survey in the Aso caldera were 13 in number. In 1959, another gravity survey was carried out by the G.S.I. along the same route obtaining more or less similar results.

I. Yokoyama (1963a), in discussions of the Bouguer gravity anomalies obtained by these observations, has believed that the Aso caldera belongs to "low anomaly type caldera" such as Kutcharo caldera lake (Yokoyama, 1958) and Aira caldera (Yokoyama, 1961) both belonging to Krakatau type. However, the number of observation points is not sufficient to discuss the precise gravimetric feature of this region especially in connection with the structural interpretation of the volcanic area.

From November 1964 to April 1965, more precise and numerous gravity surveys on the bench marks for precise levelling and triangulation points in the Aso caldera were undertaken (Kubotera and Sumitomo, 1965). In addition to the usual interpretation in terms of subterranean structure of the volcanic regions, what gives a special interest to this particular survey is a possibility to examine secular or local changes in gravity in connection with volcanic activities. From this survey, more detailed distribution of the Bouguer gravity anomalies on the Aso caldera was obtained. One of the conspicuous features of the Bouguer anomalies thus found in the Aso caldera is its rapid decrease toward the interior.

The contours of iso-anomaly are in conformity with the topography of the caldera, its relative value compared with the neighbouring area lowering to −20 mgal at the center of the caldera. The interior of the caldera is marked by a strong negative anomaly from the outer somma, which obviously shows character of the "low anomaly type caldera" justifying Yokoyama's discussion (Yokoyama, 1963a).

The observed results of this survey are also described in this paper by making terrain corrections.

In the present survey, gravity measurement was made at the wide range including the southern part of Aso caldera, somma part of Aso caldera and Kuju volcanic region.

2. Observations and Corrections

1. *Observations*

Two types of gravimeter, Worden Gravimeter No. 127 and LaCoste and Romberg Geodetic Gravimeter G 34 were used, the former for the measurement mainly on the eastern part and the latter on the western part of the observing network, respectively. The discriminations of instruments used are shown by the capital letters K and T respectively, on the top of each station number.

Most of the measurements were made on the bench marks, triangulation points of 3rd or 4th order and spot heights. The elevations are accurately measured on those points. The railway platforms or the spot on the road where heights are known were other favourable observation points. Also supplementarily added in our observation points are the spots where heights are determined from aerophotographs or topographical maps. The gravity values at 446 points in total were measured in an area of 4300 km^2 over the Aso and Kuju volcanic region.

The numbers of our observation points are classified as follows:

	K	T	Total
1) Bench mark (B.M.)	107	36	143
2) Triangulation point (T.P.)	34	25	59
3) Railway station (R.S.)	17	4	21
4) Electric power station or dam	6	1	7
5) Stations on the road where heights are known accurately	26	0	26
6) Spot height (S.H.)	22	29	51
7) Heights was determined from aerophotographs or topographical maps	36	103	139
(Total)	248	198	446

All of the observation points are shown in Fig. 1 and listed in Table 1.

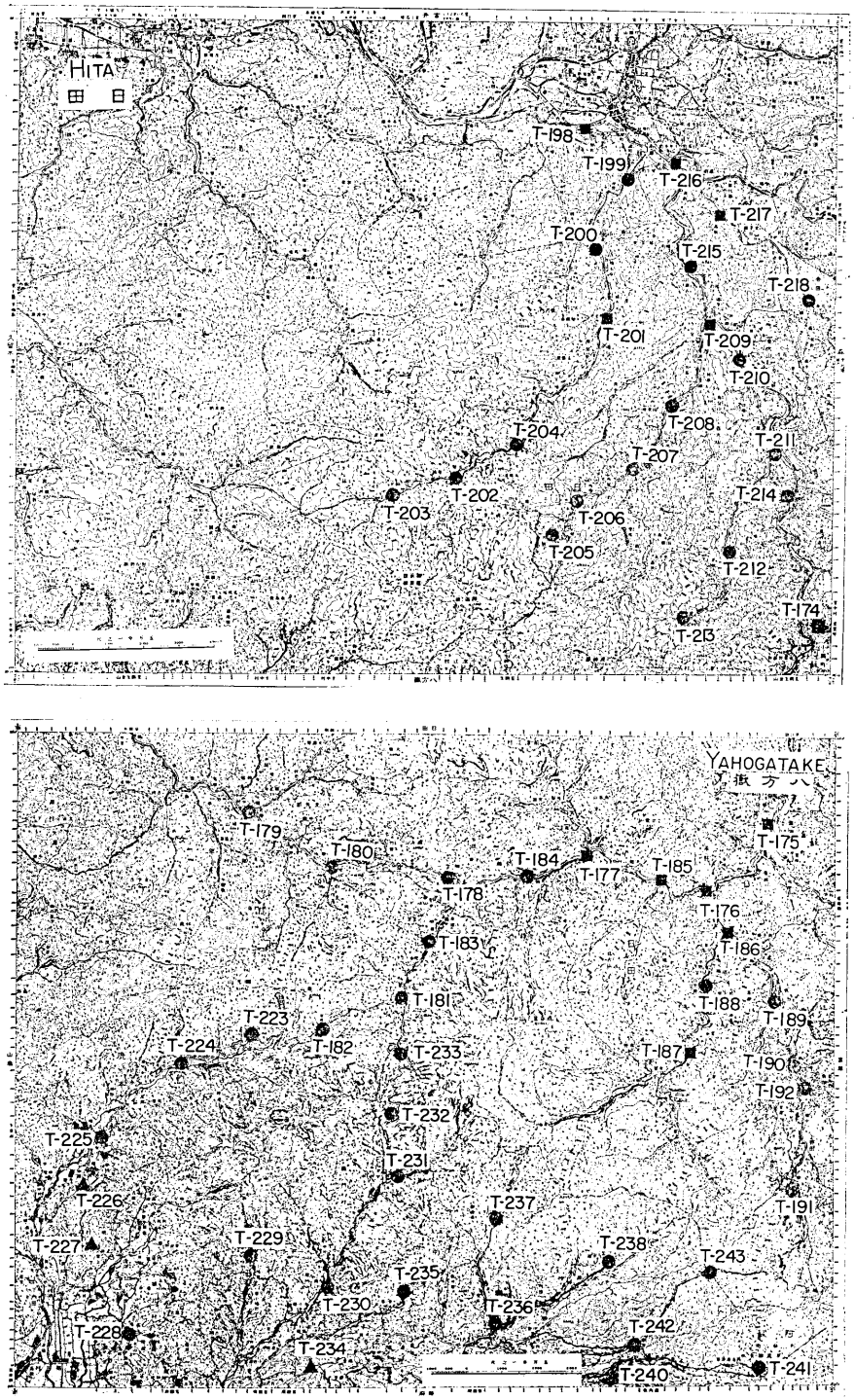

HITA
日田
T-198
T-199
T-216
T-217
T-200
T-215
T-218
T-201
T-209
T-210
T-208
T-204
T-211
T-207
T-214
T-202
T-203
T-206
T-205
T-212
T-174
T-213
YAHOGATAKE
八方ヶ岳
T-179
T-175
T-180
T-184
T-177
T-185
T-178
T-176
T-183
T-186
T-181
T-188
T-189
T-223
T-224
T-182
T-233
T-187
T-190
T-192
T-232
T-225
T-231
T-226
T-237
T-191
T-227
T-229
T-238
T-243
T-235
T-230
T-236
T-228
T-242
T-234
T-241
T-240

Fig. 1-1.

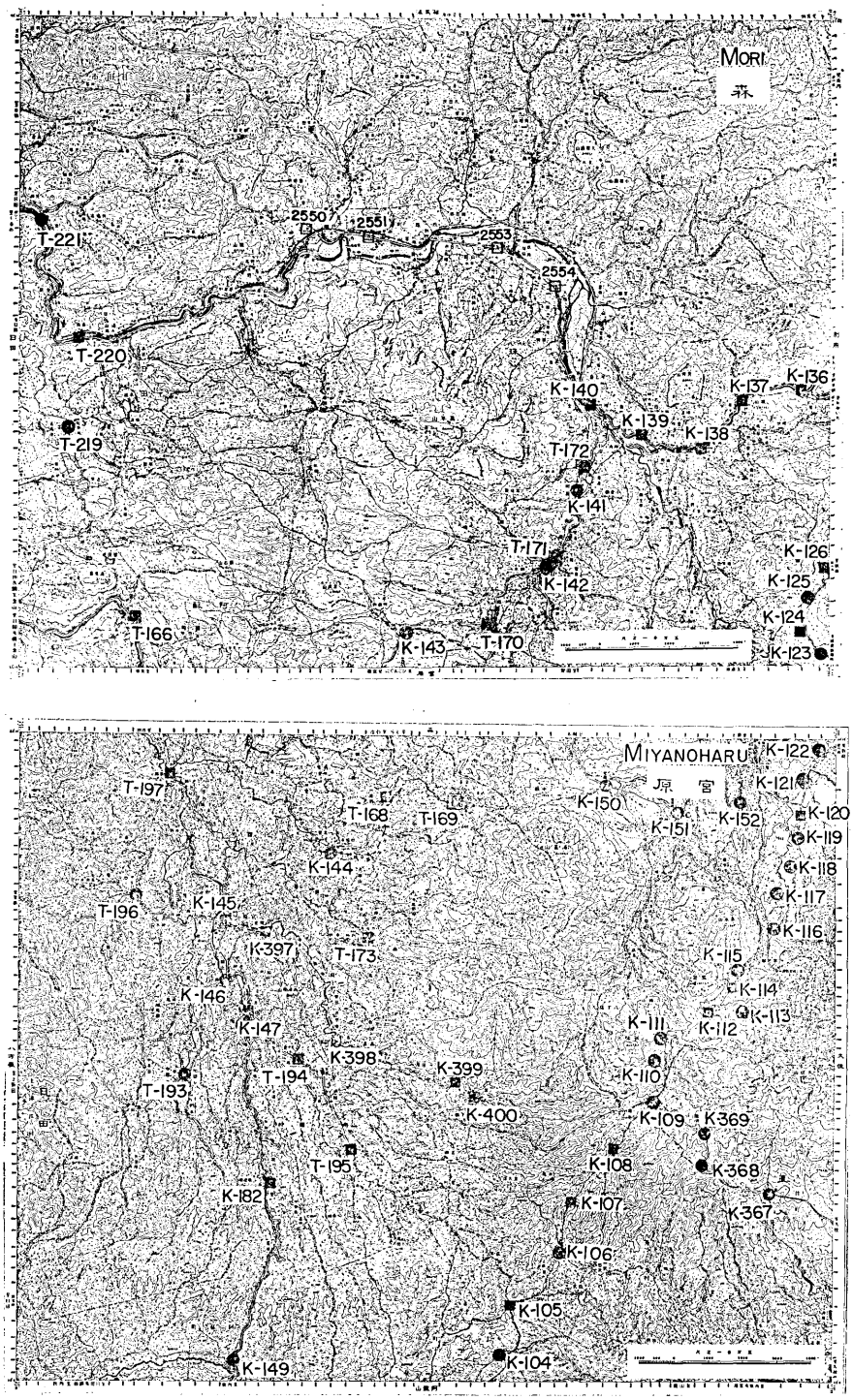
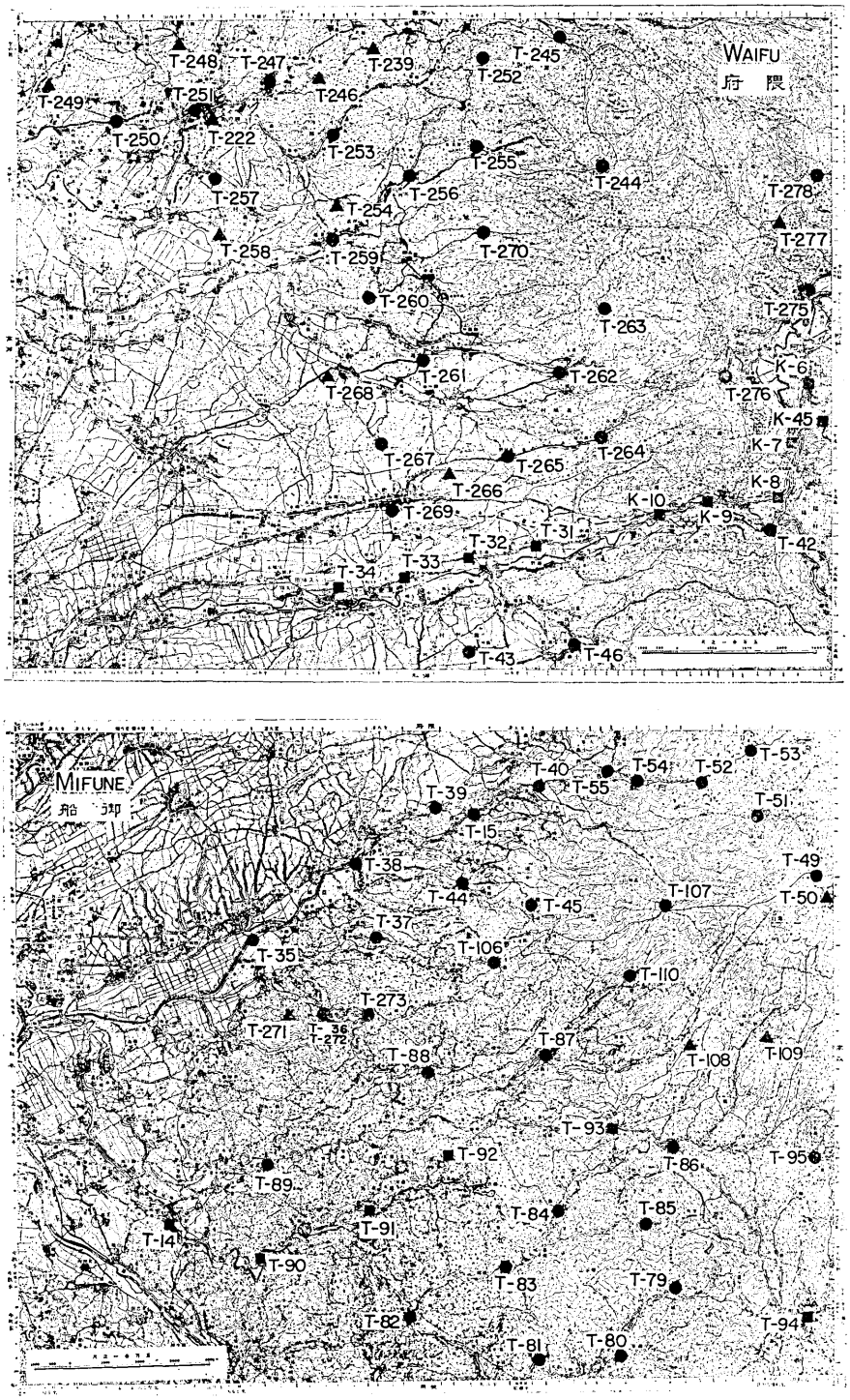

MORI
森
2550
2551
2553
2554
T-221
T-220
T-219
T-166
K-140
K-137
K-136
K-139
K-138
T-172
K-141
T-171
K-142
K-143
T-170
K-126
K-125
K-124
K-123
MIYANOHARU
宮原
K-122
K-121
K-120
K-119
K-118
K-117
K-116
K-115
K-114
K-113
K-112
K-111
K-110
K-109
K-369
K-368
K-367
K-107
K-106
K-105
K-104
K-150
K-151
K-152
T-197
T-168
T-169
K-144
T-196
K-145
K-397
T-173
K-146
K-147
K-398
T-194
T-193
K-399
K-400
T-195
K-182
K-149
K-108

Fig. 1-2.


WAIFU
府 隈
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T-247
T-239
T-245
T-252
T-249
T-251
T-246
T-250
T-222
T-253
T-255
T-244
T-278
T-257
T-256
T-254
T-277
T-258
T-259
T-270
T-260
T-275
T-263
K-6
T-261
T-262
T-268
T-276
K-45
K-7
T-267
T-264
T-265
K-8
T-266
K-10
T-269
K-9
T-31
T-42
T-32
T-33
T-34
T-43
T-46
MIFUNE
船 迎
T-53
T-40
T-54
T-52
T-55
T-39
T-51
T-15
T-49
T-38
T-107
T-50
T-44
T-45
T-37
T-106
T-35
T-110
T-273
T-271
T-36
T-272
T-87
T-108
T-109
T-88
T-93
T-92
T-86
T-95
T-89
T-84
T-85
T-91
T-14
T-90
T-83
T-79
T-82
T-94
T-81
T-80

Fig. 1-3.

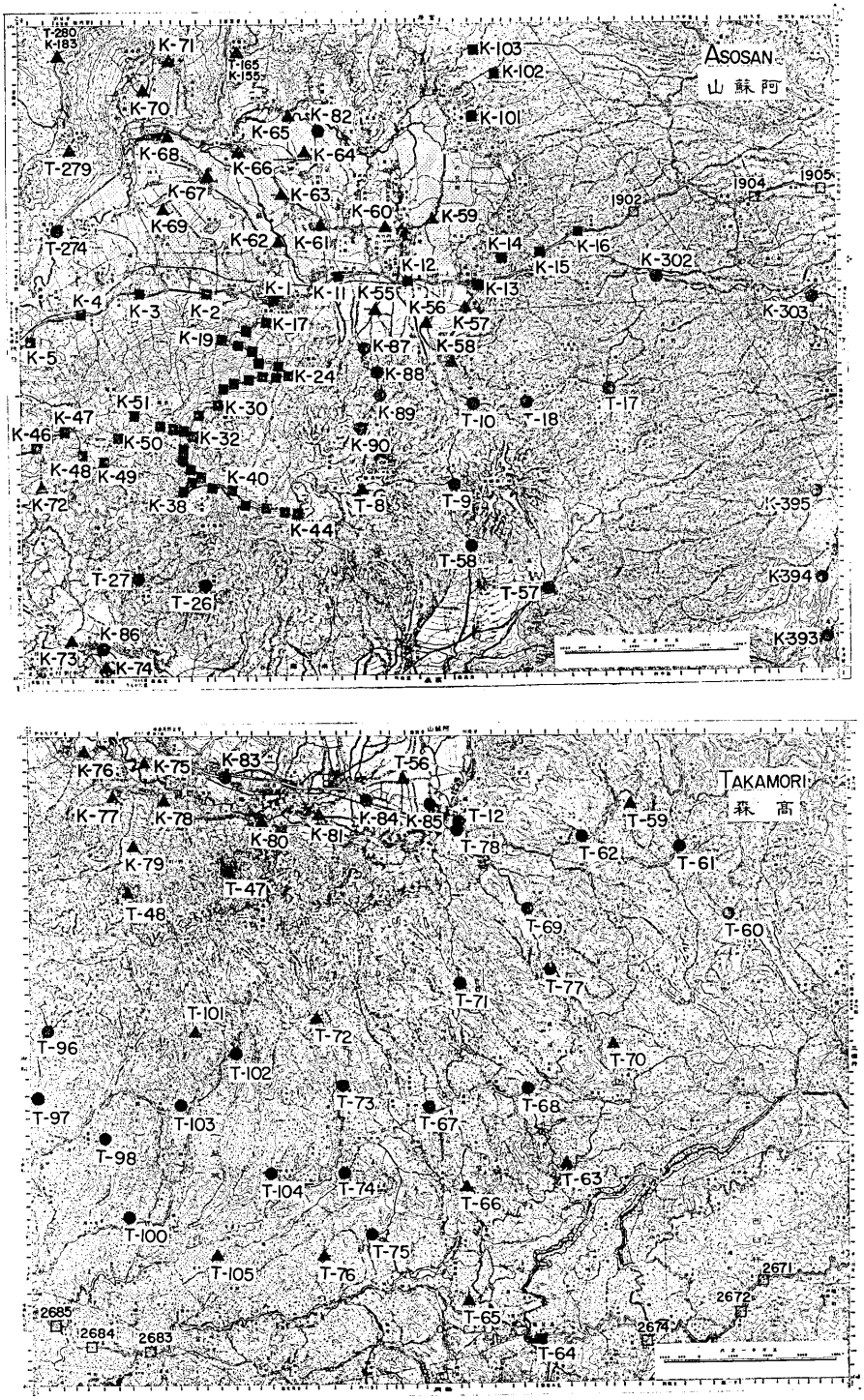

ASOSAN
山 蘇 阿
K-183
T-280
K-71
T-165
K-155
K-103
K-102
K-70
K-82
K-101
K-65
K-68
K-64
T-279
K-66
K-67
K-63
1904
1905
1902
K-60
K-59
K-69
K-62
K-61
T-274
K-14
K-16
K-15
K-302
K-12
K-1
K-11
K-55
K-13
K-4
K-3
K-2
K-56
K-303
K-17
K-57
K-19
K-87
K-58
K-5
K-24
K-88
K-51
K-30
K-89
T-17
K-47
T-10
T-18
K-46
K-50
K-32
K-90
K-48
K-49
K-40
T-9
K-72
K-38
T-8
K-395
K-44
T-58
T-27
K-394
T-57
T-26
K-86
K-393
K-73
K-74
TAKAMORI
蘇 高
K-76
K-75
K-83
T-56
K-77
K-78
K-84
K-85
T-12
T-59
K-80
K-81
T-78
T-62
T-61
K-79
T-47
T-48
T-69
T-60
T-77
T-71
T-101
T-96
T-72
T-70
T-102
T-97
T-73
T-68
T-103
T-67
T-98
T-104
T-74
T-63
T-66
T-100
T-75
T-105
T-76
2671
2672
2685
T-65
2684
2683
2674
T-64

Fig. 1-4.

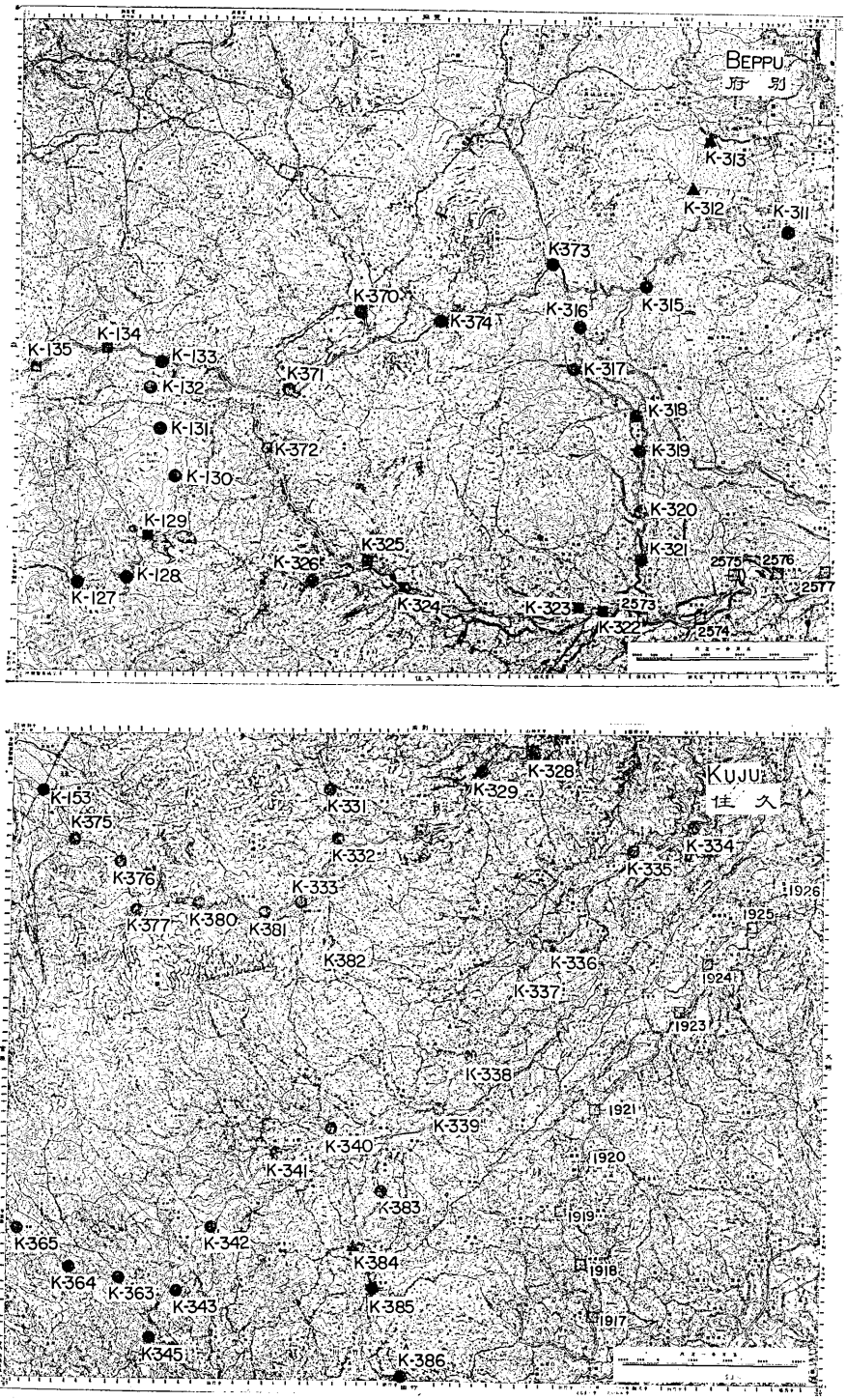

BEPPU
別府
K-313
K-312
K-311
K-373
K-370
K-374
K-316
K-315
K-134
K-135
K-133
K-132
K-371
K-317
K-318
K-131
K-372
K-319
K-130
K-320
K-129
K-325
K-321
K-326
K-128
K-127
K-324
K-323
K-322
2575
2576
2577
2573
2574
KUJUU
佳人
K-153
K-328
K-329
K-331
K-375
K-334
K-332
K-335
K-376
K-333
1926
K-377
K-380
K-381
1925
K-382
K-336
1924
K-337
1923
K-338
1921
K-339
K-340
1920
K-341
K-383
1919
K-365
K-342
K-384
1918
K-364
K-363
K-343
K-385
1917
K-345
K-386

Fig. 1-5.

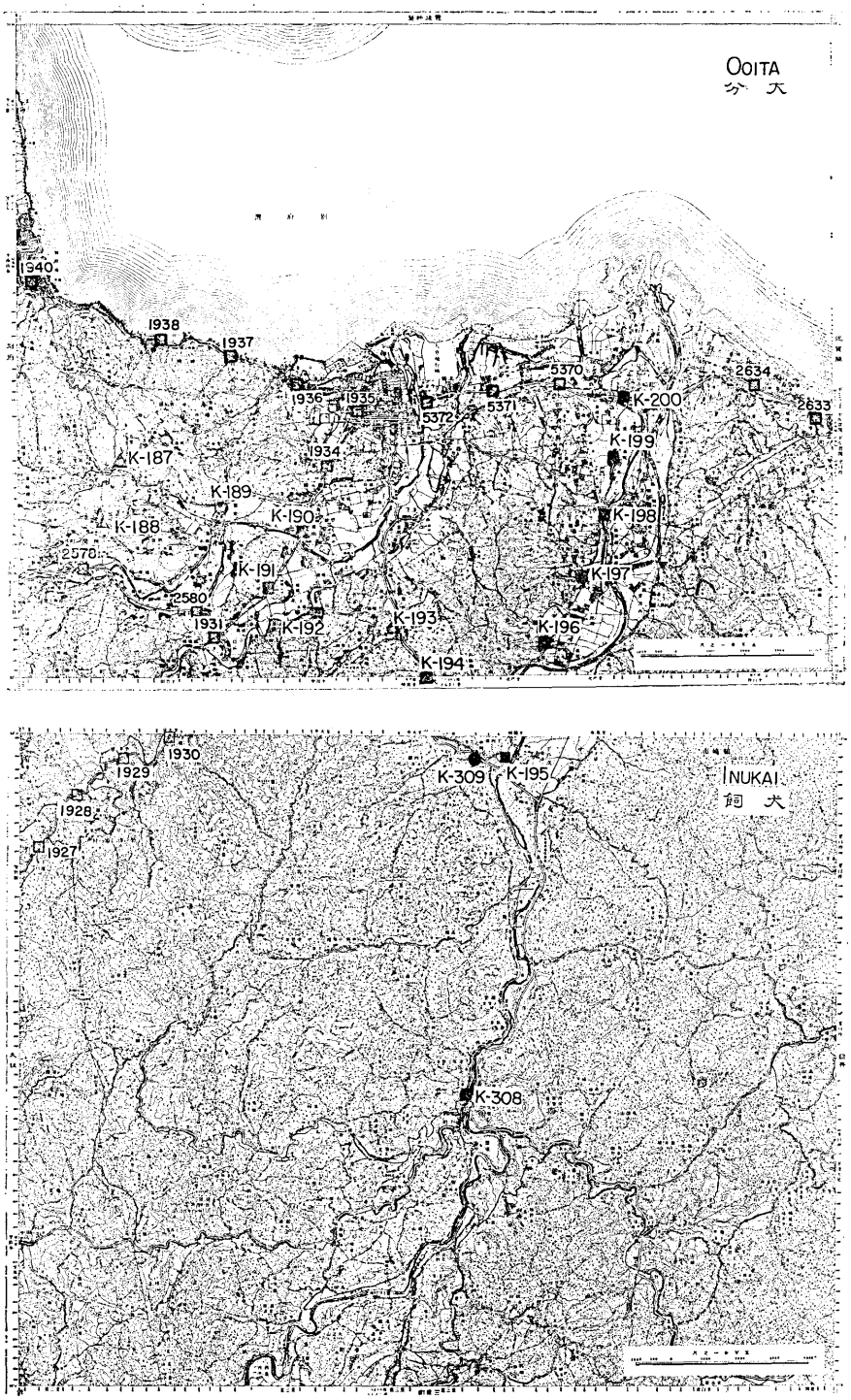
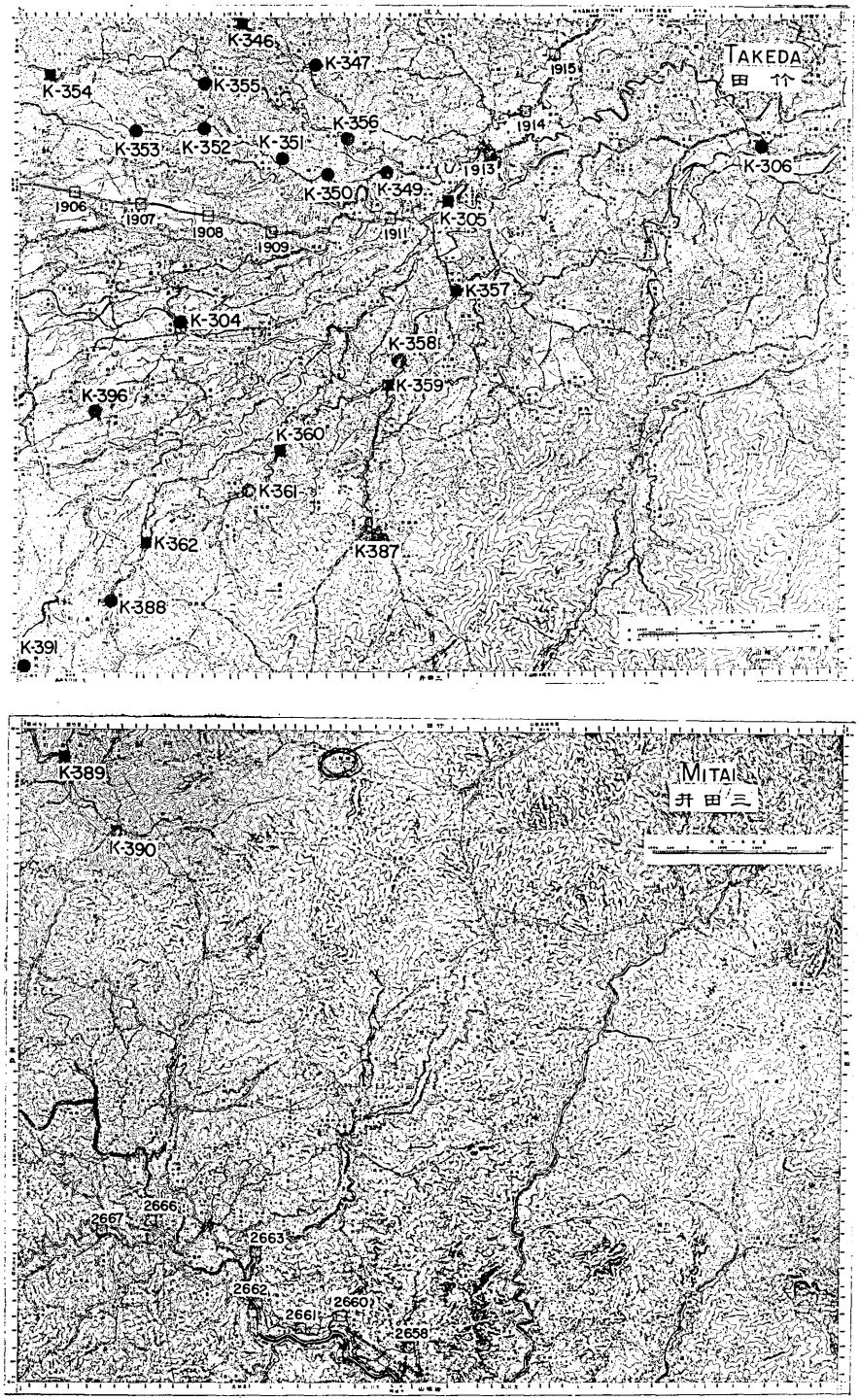

OOITA
大分
1940
1938
1937
1936
1935
1934
5372
5371
5370
2634
2633
K-200
K-199
K-198
K-197
K-196
K-195
K-194
K-193
K-192
K-191
K-190
K-189
K-188
K-187
2570
2580
1931
1930
1929
1928
1927
K-309
K-308
INUKAI
飼犬

Fig. 1-6.


K-346
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K-354
K-355
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K-353
K-352
K-351
K-350
K-349
K-305
K-306
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K-304
K-358
K-359
K-396
K-360
K-361
K-362
K-387
K-388
K-391
1906
1907
1908
1909
1911
1913
1914
1915
TAKEDA
田 竹
K-389
K-390
MITAI
井 田 三
2667
2666
2663
2662
2661
2660
2658

Fig. 1-7.

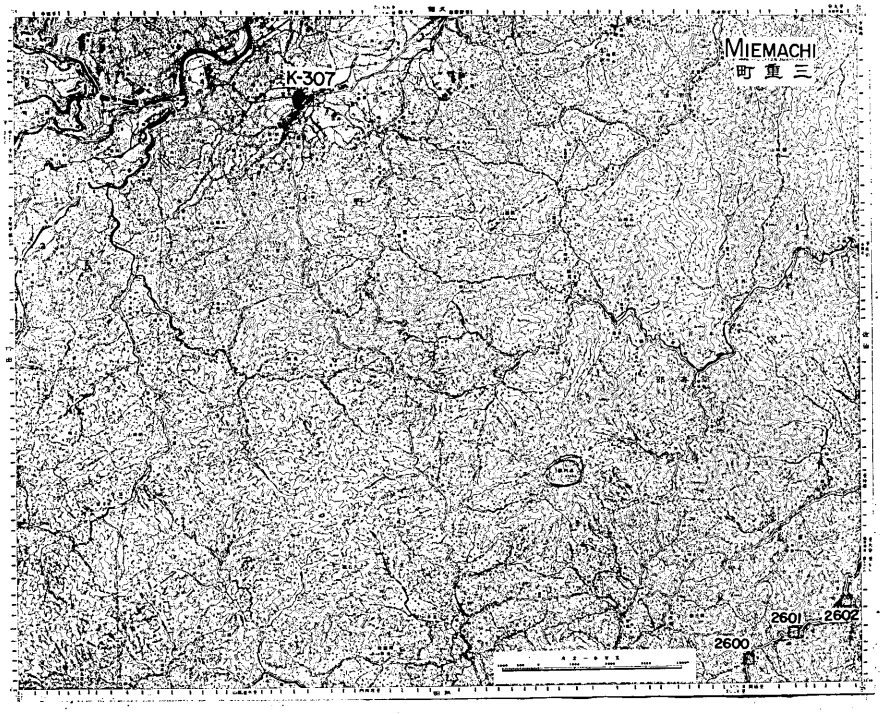

Fig. 1-1~1-8. Distribution of the observation points.

The accuracy of gravity anomaly is strongly controlled by how accurately the heights of the observation points are measured. The heights of the bench marks are very accurately known, so that the elevation corrections are considered to be accurate within 0.01 mgal of errors. The accuracies of elevation at category (2) to (5) in the above Table (p. 217) are estimated to be ± 30 cm, so that the elevation correction is accurate with in error of ± 0.1 mgal. For (6) and (7), however, it has the error of about 1 mgal.

The standard looping technique was used to make the measurement and all the observed gravity values were referred to that determined at the local pendulum station ($\varphi = 34°48.8'$N, $\lambda = 130°43.8'$E, $H = 22.84$ m) in the Kumamoto University in Kumamoto City on the western edge of our measuring station network. The gravity values of the local pendulum station determined by G.S.I. in 1963 (Fuji et al) is

$$g = 979.56555 \text{ gal.}$$

2. *Corrections*

The following corrections were made to the observed gravity values:

a) Free air reduction

Table 1.

No.	Station	φ	λ	Map
K- 1	B.M. 1896 (G.S.I.)	32°55.8′	131°04.8′	ASOSAN (阿蘇山)
K- 2	B.M. 1895 (〃)	32°55.9′	131°03.6′	〃 〃
K- 3	B.M. 1894 (〃)	32°55.9′	131°02.3′	〃 〃
K- 4	B.M. 1893 (〃)	32°55.6′	131°01.3′	〃 〃
K- 5	B.M. 1892 (〃)	32°55.2′	131°00.3′	〃 〃
K- 6	B.M. 1891 (〃)	32°54.4′	130°59.7′	WAIFU (隈府)
K- 7	B.M. 1890 (〃)	32°53.5′	130°59.4′	〃 〃
K- 8	B.M. 1889 (〃)	32°52.6′	130°59.2′	〃 〃
K- 9	B.M. 1888 (〃)	32°52.6′	130°57.9′	〃 〃
K- 10	B.M. 1889 (〃)	32°52.4′	130°57.0′	〃 〃
K- 11	B.M. 1897 (〃)	32°56.2′	131°05.8′	ASOSAN (阿蘇山)
K- 12	B.M. 1898 (〃)	32°56.1′	131°07.2′	〃 〃
K- 13	B.M. 1866 (〃)	32°56.0′	131°08.6′	〃 〃
K- 14	B.M. 1900 (〃)	32°56.4′	131°08.8′	〃 〃
K- 15	B.M. 1900-1(〃)	32°56.5′	131°09.5′	〃 〃
K- 16	B.M. 1901 (〃)	32°56.8′	131°10.2′	〃 〃
K- 17	B.M. No. 1 (Kyoto Univ.)	32°55.5′	131°04.6′	〃 〃
K- 18	B.M. No. 1½ (〃)	32°55.3′	131°04.1′	〃 〃
K- 19	B.M. No. 2 (〃)	32°55.2′	131°03.9′	〃 〃
K- 20	B.M. No. 2½ (〃)	32°55.1′	131°04.0′	〃 〃
K- 21	B.M. No. 3 (〃)	32°55.0′	131°04.2′	〃 〃
K- 22	B.M. No. 3½ (〃)	32°54.9′	131°04.2′	〃 〃
K- 23	B.M. No. 4½ (〃)	32°54.7′	131°04.7′	〃 〃
K- 24	B.M. No. 5 (〃)	32°54.6′	131°05.0′	〃 〃
K- 25	B.M. No. 5½ (〃)	32°54.6′	131°04.7′	〃 〃
K- 26	B.M. No. 6 (〃)	32°54.6′	131°04.4′	〃 〃
K- 27	B.M. No. 6½ (〃)	32°54.6′	131°04.1′	〃 〃
K- 28	B.M. No. 7 (〃)	32°54.4′	131°03.9′	〃 〃
K- 29	B.M. No. 7½ (〃)	32°54.4′	131°03.7′	〃 〃
K- 30	B.M. No. 8 (〃)	32°54.2′	131°03.7′	〃 〃
K- 31	B.M. No. 8½ (〃)	32°54.0′	131°03.3′	〃 〃
K- 32	B.M. No. 9 (〃)	32°53.7′	131°03.1′	〃 〃
K- 33	B.M. No. 9½ (〃)	32°53.5′	131°03.0′	〃 〃
K- 34	B.M. No. 10 (〃)	32°53.4′	131°03.1′	〃 〃
K- 35	B.M. No. 10½ (〃)	32°53.2′	131°03.1′	〃 〃
K- 36	B.M. No. 11 (〃)	32°53.1′	131°03.3′	〃 〃
K- 37	B.M. No. 11½ (〃)	32°53.0′	131°03.1′	〃 〃
K- 38	B.M. No. 12 (〃)	32°52.9′	131°03.0′	〃 〃
K- 39	B.M. No. 12½ (〃)	32°53.0′	131°03.5′	〃 〃
K- 40	B.M. No. 13 (〃)	32°52.9′	131°03.9′	〃 〃
K- 41	B.M. No. 13½ (〃)	32°52.7′	131°04.1′	〃 〃

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Map
K- 42	B.M. No. 14 (Kyoto Univ.)	32°52.6′	131°04.7′	ASOSAN (阿蘇山)
K- 43	B.M. No. 14½(〃)	32°52.6′	131°04.8′	〃 〃
K- 44	B.M. No. 15 (〃)	32°52.5′	131°05.2′	〃 〃
K- 45	B.M. No. 2 (Kumamoto Pref.)	32°53.8′	130°59.9′	WAIFU (隈府)
K- 46	B.M. No. 3 (〃)	32°53.5′	131°00.3′	ASOSAN (阿蘇山)
K- 47	B.M. No. 4 (〃)	32°53.8′	131°00.8′	〃 〃
K- 48	B.M. No. 5 (〃)	32°53.4′	131°01.1′	〃 〃
K- 49	B.M. No. 6 (〃)	32°53.3′	131°01.5′	〃 〃
K- 50	B.M. No. 7 (〃)	32°53.7′	131°01.7′	〃 〃
K- 51	B.M. No. 8 (〃)	32°54.0′	131°02.1′	〃 〃
K- 52	B.M. No. 9 (〃)	32°53.9′	131°02.6′	〃 〃
K- 53	B.M. No. 10 (〃)	32°53.8′	131°02.8′	〃 〃
K- 54	B.M. No. 11 (〃)	32°53.8′	131°03.0′	〃 〃
K- 55	T.P. 北本	32°55.7′	131°06.5′	〃 〃
K- 56	T.P. 南西原 (匹 22)	32°55.5′	131°07.5′	〃 〃
K- 57	T.P. 駄原 (典 14)	32°55.6′	131°08.2′	〃 〃
K- 58	T.P. 牧下 (匹 25)	32°54.8′	131°07.9′	〃 〃
K- 59	T.P. 高田 (典 12)	32°56.9′	131°07.5′	〃 〃
K- 60	T.P. 幡園	32°56.9′	131°06.7′	〃 〃
K- 61	T.P. 役犬原 (匹 11)	32°56.8′	131°05.8′	〃 〃
K- 62	T.P. 北黒川 (匹 12)	32°56.7′	131°05.0′	〃 〃
K- 63	T.P. 今町	32°57.4′	131°04.8′	〃 〃
K- 64	T.P. 新田 (匹 9)	32°57.9′	131°05.4′	〃 〃
K- 65	T.P. 小倉 (匹 8)	32°58.6′	131°05.1′	〃 〃
K- 66	T.P. 黒流 (后 15)	32°58.0′	131°04.2′	〃 〃
K- 67	T.P. 成川 (后 16)	32°57.6′	131°03.6′	〃 〃
K- 68	T.P. 中番出	32°58.3′	131°02.6′	〃 〃
K- 69	T.P. 狩尾 (后 14)	32°57.1′	131°02.7′	〃 〃
K- 70	T.P. 下湯浦 (后 13)	32°59.0′	131°02.4′	〃 〃
K- 71	T.P. 大塚山 (后 8)	32°59.5′	131°03.0′	〃 〃
K- 72	T.P. 黒川 (火山研究所)	32°52.9′	131°00.4′	〃 〃
K- 73	T.P. 岩の上	32°50.5′	131°09.9′	〃 〃
K- 74	T.P. (典 10)	32°50.1′	131°01.5′	〃 〃
K- 75	T.P. 中松	32°49.6′	131°02.1′	TAKAMORI (高森)
K- 76	T.P. 西中原 (典 8)	32°49.8′	131°01.2′	〃 〃
K- 7L	T.P. 松の本 (典 7)	32°49.1′	131°01.7′	〃 〃
K- 78	T.P. 柏木谷 (典 6)	32°49.1′	131°02.6′	〃 〃
K- 79	T.P. 小牧	32°48.3′	131°02.0′	〃 〃
K- 80	T.P. 一の鳥竹 (堂 29)	32°48.7′	131°04.4′	〃 〃
K- 81	T.P. 西中郷 (堂 25)	32°48.8′	131°05.5′	〃 〃
K- 82	S.H. (本村)	32°58.4′	131°05.4′	ASOSAN (阿蘇山)

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Map
K- 83	S.H. (一関)	32°49.1′	131°03.9′	TAKAMORI (高森)
K- 84	S.H. (両併)	32°49.0′	131°06.2′	〃 〃
K- 85	R.S. たかもり駅	32°48.9′	131°07.2′	〃 〃
K- 86	R.S. あそしもだ駅	32°50.4′	131°01.5′	ASOSAN (阿蘇山)
K- 87	No. 129 (一の宮町営道路上)	32°55.1′	131°06.2′	〃 〃
K- 88	No. 178 (〃)	32°54.7′	131°06.5′	〃 〃
K- 89	No. 221 (〃)	32°54.3′	131°06.6′	〃 〃
K- 90	No. 295 (〃)	32°53.8′	131°06.2′	〃 〃
K-101	B.M. (道路公団 別府阿蘇道路上)	32°58.5′	131°08.3′	〃 〃
K-102	B.M. (〃)	32°59.1′	131°08.7′	〃 〃
K-103	No. 2404 (〃)	32°59.6′	131°08.3′	〃 〃
K-104	No. 2304 (〃)	33°00.5′	131°08.8′	MIYANOHARU (宮原)
K-105	B.M. (〃)	33°01.2′	131°08.9′	〃 〃
K-106	No. 2104 (〃)	33°02.0′	131°09.9′	〃 〃
K-107	B.M. (〃)	33°02.8′	131°10.1′	〃 〃
K-108	B.M. (〃)	33°03.6′	131°10.9′	〃 〃
K-109	No. 1822 (〃)	33°04.3′	131°11.6′	〃 〃
K-110	No. 1674 (〃)	33°05.0′	131°11.7′	〃 〃
K-111	No. 1604 (〃)	33°05.3′	131°11.8′	〃 〃
K-112	B.M. (〃)	33°05.7′	131°12.6′	〃 〃
K-113	No. 1404 (〃)	33°05.7′	131°13.3′	〃 〃
K-114	B.M. (〃)	33°06.1′	131°13.0′	〃 〃
K-115	No. 1304 (〃)	33°06.4′	131°13.2′	〃 〃
K-116	No. 1204 (〃)	33°07.0′	131°13.9′	〃 〃
K-117	No. 1154 (〃)	33°07.6′	131°13.8′	〃 〃
K-118	No. 1104 (〃)	33°08.1′	131°14.2′	〃 〃
K-119	No. 1054 (〃)	33°08.4′	131°14.3′	〃 〃
K-120	B.M. (〃)	33°08.8′	131°14.4′	〃 〃
K-121	No. 954 (〃)	33°09.4′	131°14.4′	〃 〃
K-122	No. 904 (〃)	33°09.8′	131°14.7′	〃 〃
K-123	No. 854 (〃)	33°11.3′	131°14.9′	MORI (森)
K-124	B.M. (〃)	33°10.5′	131°14.5′	〃 〃
K-125	No. 754 (〃)	33°11.1′	131°14.6′	〃 〃
K-126	B.M. (〃)	33°11.6′	131°15.0′	〃 〃
K-127	No. 604 (〃)	33°11.4′	131°16.1′	BEPPU (別府)
K-128	No. 504 (〃)	33°11.4′	131°17.0′	〃 〃
K-129	B.M. (〃)	33°12.1′	131°17.4′	〃 〃
K-130	No. 304 (〃)	33°13.0′	131°17.9′	〃 〃
K-131	No. 204 (〃)	33°13.7′	131°17.5′	〃 〃
K-132	No. 104 (〃)	33°14.3′	131°17.3′	〃 〃
K-133	No. 4 (〃)	33°14.7′	131°17.5′	〃 〃

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Map
K-134	B.M. 2562 (G.S.I.)	33°15.0′	131°16.5′	BEPPU (別府)
K-135	B.M. 2561 (〃)	33°14.7′	131°15.3′	〃 〃
K-136	B.M. 2560 (〃)	33°14.3′	131°14.4′	MORI (森)
K-137	B.M. 2559 (〃)	33°14.1′	131°13.3′	〃 〃
K-138	B.M. 2558 (〃)	33°13.4′	131°12.6′	〃 〃
K-139	B.M. 2557 (〃)	33°13.6′	131°11.5′	〃 〃
K-140	B.M. 2556 (〃)	33°14.0′	131°10.6′	〃 〃
K-141	R.S. まちだ駅	33°12.7′	131°10.3′	〃 〃
K-142	R.S. ほうせんじ駅	33°11.5′	131°09.7′	〃 〃
K-143	R.S. あそづる駅	33°10.5′	131°07.1′	〃 〃
K-144	R.S. きたざと駅	33°08.2′	131°05.7′	MIYANOHARU (宮原)
K-145	R.S. ひごおぐに駅	33°07.1′	131°03.8′	〃 〃
K-146	仁瀬	33°06.2′	131°03.7′	〃 〃
K-147	B.M. No. 9 (Kumamoto Pref.)	33°05.7′	131°04.2′	〃 〃
K-149	S.H. (大観望)	33°00.3′	131°03.9′	〃 〃
K-150	地蔵原	33°09.2′	131°10.6′	〃 〃
K-151	豊後渡	33°08.8′	131°12.0′	〃 〃
K-152	筋湯入口	33°09.0′	131°13.2′	〃 〃
K-153	S.H. (千丁無田)	33°09.1′	131°15.4′	KUJU (久住)
K-155	T.P. 大観望	32°59.6′	131°04.0′	ASOSAN (阿蘇山)
K-182	B.M. No. 51 (K.E.P.C.)	33°03.0′	131°04.6′	MIYANOHARU (宮原)
K-183	T.P. 西湯ノ浦	32°59.5′	131°00.7′	ASOSAN (阿蘇山)
K-187	T.P. 越戸 (本 51)	33°13.4′	131°32.0′	OOITA (大分)
K-188	T.P. 古野	33°12.3′	131°31.5′	〃 〃
K-189	R.S. かく駅	33°12.7′	131°33.7′	〃 〃
K-190	B.M. 1933 (G.S.I.)	33°12.2′	131°35.4′	〃 〃
K-191	B.M. 1932 (〃)	33°11.4′	131°34.7′	〃 〃
K-192	B.M. 4337 (〃)	33°11.0′	131°35.4′	〃 〃
K-193	B.M. 4338 (〃)	33°10.7′	131°37.0′	〃 〃
K-194	B.M. 4339 (〃)	33°10.0′	131°37.4′	〃 〃
K-195	B.M. 4340 (〃)	33°09.7′	131°38.9′	INUKAI (犬飼)
K-196	B.M. 4341 (〃)	33°10.4′	131°39.6′	OOITA (大分)
K-197	B.M. 4342 (〃)	33°11.4′	131°40.4′	〃 〃
K-198	B.M. 4343 (〃)	33°12.5′	131°40.8′	〃 〃
K-199	B.M. 4344 (〃)	33°13.3′	130°40.9′	〃 〃
K-100	B.M. 5369 (〃)	33°14.3′	131°41.1′	〃 〃
K-302	R.S. なみの駅	32°56.1′	131°11.6′	ASOSAN (阿蘇山)
K-303	R.S. たきみず駅	32°55.8′	131°14.5′	〃 〃
K-304	R.S. ぶんごおぎ駅	32°55.3′	131°17.9′	TAKEDA (竹田)
K-305	B.M. 1912 (G.S.I.)	32°57.2′	131°22.8′	〃 〃
K-306	R.S. おがた駅	32°58.0′	131°28.5′	〃 〃

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Map
K-307	R.S. みえまち駅	32°58.8′	131°35.0′	MIEMACHI (三重町)
K-308	R.S. いぬかい駅	33°04.5′	131°38.2′	INUKAI (犬飼)
K-309	R.S. なかはんだ駅	33°03.6′	131°38.3′	〃 〃
K-311	Geophysical Research Center Kyoto University	33°16.8′	131°29.1′	BEPPU (別府)
K-312	T.P. 石垣原 (本42)	33°17.6′	131°27.6′	〃 〃
K-313	T.P. 小倉 (本41)	33°18.2′	131°28.0′	〃 〃
K-315	S.H. (鳥居)	33°16.0′	131°26.5′	〃 〃
K-316	城島橋	33°15.4′	131°25.3′	〃 〃
K-317	山口橋	33°14.7′	131°25.2′	〃 〃
K-318	B.M. No. 15 (K.E.P.C.)	33°14.0′	131°26.3′	〃 〃
K-319	柚ノ木	33°13.4′	131°26.4′	〃 〃
K-320	東大津留	33°12.5′	131°26.4′	〃 〃
K-321	大津留橋	33°11.8′	131°26.5′	〃 〃
K-322	B.M. 2572 (G.S.I.)	33°11.0′	131°25.8′	〃 〃
K-323	B.M. No. 7 (K.E.P.C.)	33°11.0′	131°25.4′	〃 〃
K-324	B.M. No. (K.E.P.C.)	33°10.9′	131°23.1′	〃 〃
K-325	B.M. 2568 (G.S.I.)	33°11.7′	131°21.4′	〃 〃
K-326	Hata Electric Powerstation	33°11.4′	131°20.4′	〃 〃
K-328	B.M. No. 19 (K.E.P.C.)	33°09.8′	131°24.6′	Kuju (久住)
K-329	Nobata Electric Powerstation	33°09.5′	131°23.7′	〃 〃
K-331	S.H. (直野内山)	33°09.2′	131°20.9′	〃 〃
K-332	S.H. (井手下)	33°08.4′	131°21.0′	〃 〃
K-333	S.H. (上伊小野)	33°07.4′	131°20.4′	〃 〃
K-334	Serikawa Electric Powerstation	33°08.7′	131°27.6′	〃 〃
K-335	Serikawa Dam	33°08.2′	131°26.5′	〃 〃
K-336	B.M. (Ooita Pref. 下藤目)	33°06.8′	131°24.9′	〃 〃
K-337	大郎堅橋	33°06.4′	131°24.5′	〃 〃
K-338	冬田	33°05.1′	131°23.5′	〃 〃
K-339	Nagayu Dam	33°04.3′	131°23.0′	〃 〃
K-340	石田	33°03.9′	131°21.0′	〃 〃
K-341	仏ノ原	33°03.6′	131°20.0′	〃 〃
K-342	S.H. (小倉)	33°02.4′	131°18.8′	〃 〃
K-343	S.H. (今村)	33°01.4′	131°18.1′	〃 〃
K-345	S.H. (久住)	33°00.6′	131°17.7′	〃 〃
K-346	B.M. No. 24 (K.E.P.C)	32°59.9′	131°19.0′	TAKEDA (竹田)
K-347	S.H. (城原八幡宮)	32°59.2′	131°20.4′	〃 〃
K-349	S.H. (塩付)	32°57.7′	131°21.6′	〃 〃
K-350	S.H. (大畑)	32°57.6′	131°20.5′	〃 〃
K-351	志土地小学校	32°57.8′	131°19.8′	〃 〃

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Map
K-352	S.H. (上畑)	32°58.3′	131°18.3′	TAKEDA (竹田)
K-353	S.H. (久保)	32°58.3′	131°17.1′	〃 〃
K-354	B.M. No. 30 (K.E.P.C.)	32°59.1′	131°15.5′	〃 〃
K-355	S.H. (炭竈)	32°59.0′	131°18.3′	〃 〃
K-356	S.H. (車橋)	32°58.1′	131°20.9′	〃 〃
K-357	B.M. No. 2 (K.E.P.C.)	32°55.8′	131°22.9′	〃 〃
K-358	S.H. (長小野)	32°54.8′	131°21.9′	〃 〃
K-359	B.M. No. 8 (K.E.P.C.)	32°54.4′	131°21.7′	〃 〃
K-360	B.M. No. 9 (K.E.P.C.)	32°53.4′	131°19.8′	〃 〃
K-361	S.H. (田原)	32°52.8′	131°19.2′	〃 〃
K-362	B.M. No. 12 (K.E.P.C.)	32°52.0′	131°17.3′	〃 〃
K-363	小国岐	33°01.6′	131°17.1′	KUJU (久住)
K-364	牧元	33°01.7′	131°16.2′	〃 〃
K-365	九重南登山口	33°02.3′	131°15.2′	〃 〃
K-366	赤川橋	33°02.9′	131°13.8′	MIYANOHARU (宮原)
K-368		33°03.4′	131°12.6′	〃 〃
K-369	岩井川	33°03.9′	131°12.6′	〃 〃
K-370	R.S. ゆふいん駅	33°15.6′	131°21.3′	BEPPU (別府)
K-371	R.S. みなみゆふいん駅	33°14.4′	131°20.0′	〃 〃
K-372	B.M. 2565 (G.S.I.)	33°13.5′	131°19.6′	〃 〃
K-373	猪ノ瀬戸	33°16.4′	131°24.8′	〃 〃
K-374	中ノ原	33°15.4′	131°22.8′	〃 〃
K-375	郡境	33°08.4′	131°16.1′	KUJU (久住)
K-376		33°08.1′	131°17.0′	〃 〃
K-377	黒岳橋	33°07.3′	131°17.4′	〃 〃
K-380	平連橋	33°07.4′	131°18.5′	〃 〃
K-381	栢ノ木	33°07.3′	131°19.7′	〃 〃
K-382		33°06.8′	131°20.9′	〃 〃
K-383	上野	33°03.0′	131°21.9′	〃 〃
K-384	T.P. 山路	33°02.1′	131°21.4′	〃 〃
K-385	新屋敷	33°01.4′	131°21.3′	〃 〃
K-386	辻迫神社	33°00.0′	131°22.3′	〃 〃
K-387	B.M. No. 7 (K.E.P.C.)	32°52.1′	131°21.5′	TAKEDA (竹田)
K-388	S.H. (長野)	32°51.1′	131°16.7′	〃 〃
K-389	B.M. No. 17 (K.E.P.C.)	32°49.6′	131°15.8′	MITAI (三田井)
K-390	B.M. No. 19 (K.E.P.C.)	32°48.4′	131°16.7′	〃 〃
K-391	川上	32°50.1′	131°15.2′	TAKEDA (竹田)
K-393	片山	32°50.5′	131°14.8′	ASOSAN (阿蘇山)
K-394	馬渡	32°51.4′	131°14.7′	〃 〃
K-395	河原	32°52.8′	131°14.6′	〃 〃
K-396	叶野	32°53.9′	131°16.4′	TAKEDA (竹田)

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Map
K-397	B.M. No. 6 (Kumamoto Pref.)	33°07.0′	131°04.5′	MIYANOHARU (宮原)
K-398	B.M. No. 7 (〃)	33°05.3′	131°05.8′	〃 〃
K-399	B.M. No. 59 (K.E.P.C.)	33°04.6′	131°08.0′	〃 〃
K-400	B.M. No. 8 (Kumamoto Pref.)	33°04.5′	131°08.5′	〃 〃
T- 8	T.P. 高岳	32°52.9′	131°06.1′	ASOSAN (阿蘇山)
T- 9	S.H. (日ノ尾峠)	32°52.9′	131°07.7′	〃 〃
T- 10	桜ケ水	32°54.2′	131°08.0′	〃 〃
T- 11	K-85	32°48.9′	131°07.2′	〃 〃
T- 14	B.M. 2700 (G.S.I.)	32°42.5′	130°47.6′	MIFUNE (御船)
T- 15	田中	32°48.8′	130°53.6′	〃 〃
T- 17	遊雀	32°54.4′	131°11.0′	ASOSAN (阿蘇山)
T- 18	箱石峠	32°54.2′	131°09.4′	〃 〃
T- 26	S.H. (御かまど山)	32°51.4′	131°03.6′	〃 〃
T- 27	垂玉	32°51.5′	131°02.3′	〃 〃
T- 30	B.M. 1888 (G.S.I.) K-9	32°52.6′	130°58.0′	WAIFU (隈府)
T- 31	B.M. 1885 (〃)	32°51.9′	130°54.8′	〃 〃
T- 32	B.M. 1884 (〃)	32°51.7′	130°53.6′	〃 〃
T- 33	B.M. 1883 (〃)	32°51.4′	130°52.4′	〃 〃
T- 34	B.M. 1882 (〃)	32°51.2′	130°51.2′	〃 〃
T- 35	S.H.	32°46.8′	130°49.5′	MIFUNE (御船)
T- 36	座女木	32°45.7′	130°50.8′	〃 〃
T- 37	川内田	32°46.8′	130°51.8′	〃 〃
T- 38	津森小学校	32°48.0′	130°51.4′	〃 〃
T- 39	S.H. (田中西)	32°48.9′	130°52.9′	〃 〃
T- 40	S.H. (多々良)	32°49.2′	130°54.7′	〃 〃
T- 42	戸下	32°52.2′	130°59.9′	WAIFU (隈府)
T- 43	S.H. (新所)	32°50.3′	130°55.5′	〃 〃
T- 44	猿帰西	32°47.7′	130°53.3′	MIFUNE (御船)
T- 45	S.H. (権現山)	32°47.4′	130°56.6′	〃 〃
T- 46	S.H. (風当)	32°50.4′	130°55.5′	WAIFU (隈府)
T- 47	T.P. 岩山 (堂 31)	32°48.0′	131°09.9′	TAKAMORI (高森)
T- 48	T.P. 小野 (典 4)	32°47.6′	131°00.0′	〃 〃
T- 49	地蔵峠	32°47.8′	130°59.9′	MIFUNE (御船)
T- 50	T.P. 長谷 (典 3)	32°47.4′	131°01.1′	〃 〃
T- 51	冠ケ岳北峠	32°48.7′	130°58.8′	〃 〃
T- 52	冠ケ岳北西	32°49.2′	130°57.7′	〃 〃
T- 53	S.H. (護王峠)	32°49.7′	130°58.6′	〃 〃
T- 54	出ノ口東三叉路	32°49.2′	130°56.6′	〃 〃
T- 55	出ノ口丁字路	32°49.4′	130°56.0′	〃 〃
T- 56	T.P. 豆塚	32°49.4′	131°07.0′	TAKAMORI (高森)

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Map
T- 57	上色見	32°51.3′	131°09.8′	ASOSAN (阿蘇山)
T- 58	前原北三叉路	32°52.0′	131°08.4′	〃 〃
T- 59	小村	32°48.9′	131°11.2′	TAKAMORI (高森)
T- 60	S.H. (草ヶ部)	32°47.2′	131°13.0′	〃 〃
T- 61	S.H.	32°48.3′	131°12.1′	〃 〃
T- 62	S.H.	32°48.4′	131°10.3′	〃 〃
T- 63	T.P.	32°43.4′	131°10.0′	〃 〃
T- 64	B.M. 2676 (G.S.I.)	32°40.7′	131°09.5′	〃 〃
T- 65	T.P.	32°41.3′	131°08.1′	〃 〃
T- 66		32°43.1′	131°08.1′	〃 〃
T- 67	郷野原	32°44.3′	131°07.5′	〃 〃
T- 68		32°44.5′	131°09.3′	〃 〃
T- 69	梶原	32°47.3′	131°09.3′	〃 〃
T- 70	T·P.	32°45.2′	131°00.8′	〃 〃
T- 71	春山	32°46.2′	131°08.0′	〃 〃
T- 72		32°45.7′	131°05.4′	〃 〃
T- 73	S.H. (川口北)	32°44.6′	131°05.8′	〃 〃
T- 74	井無田	32°43.3′	131°05.9′	〃 〃
T- 75	高月	32°42.3′	131°0..4′	〃 〃
T- 76	T.P.	32°42.0′	131°05.5′	〃 〃
T- 77		32°46.4′	131°09.7′	〃 〃
T- 78	高森	32°48.5′	131°08.0′	〃 〃
T- 79	域山北	32°41.4′	130°57.3′	MIFUNE (御船)
T- 80	瀬峯	32°40.3′	131°56.2′	〃 〃
T- 81	松尾	32°40.3′	131°54.7′	〃 〃
T- 82	S.H. (田畑)	32°41.0′	131°52.3′	〃 〃
T- 83	木鷺野	32°41.8′	131°54.1′	〃 〃
T- 84	木島	32°42.6′	131°55.1′	〃 〃
T- 85		32°42.4′	131°56.7′	〃 〃
T- 86	B.M. 2690 (G.S.I.)	32°43.6′	130°57.2′	〃 〃
T- 87	下鶴	32°45.0′	130°54.9′	〃 〃
T- 88		32°44.8′	130°52.7′	〃 〃
T- 89		32°43.4′	130°49.7′	〃 〃
T- 90	B.M. 2698 (G.S.I.)	32°42.9′	130°49.6′	〃 〃
T- 91	B.M. 2696 (〃)	32°42.6′	130°51.6′	〃 〃
T- 92	B.M. 2694 (〃)	32°43.5′	130°53.0′	〃 〃
T- 93	B.M. 2691 (〃)	32°43.9′	130°56.1′	〃 〃
T- 94	B.M. 2686 (〃)	32°40.9′	130°59.7′	〃 〃
T- 95	造別当	32°43.4′	130°59.9′	〃 〃
T- 96		32°45.5′	131°00.5′	TAKAMORI (高森)
T- 97		32°44.4′	130°00.3′	〃 〃

(to be continued)

Table 1. (continued)

No.	Stotion	φ	λ	Map
T- 98		32°43.8′	131°01.5′	TAKAMORI (高森)
T-100	S.H.	32°42.6′	131°02.0′	〃 〃
T-101		32°45.4′	131°03.2′	〃 〃
T-102		32°45.1′	131°03.9′	〃 〃
T-103	S.H. (稲生野)	32°44.3′	131°02.9′	〃 〃
T-104	S.H. (原尾野)	32°43.3′	131°04.5′	〃 〃
T-105	T.P.	32°42.0′	131°03.6′	〃 〃
T-106	浅ノ藪	32°46.4′	130°53.9′	MIFUNE (御船)
T-107	S.H. (十文字)	32°47.3′	131°57.1′	〃 〃
T-108	T.P.	32°45.1′	131°57.5′	〃 〃
T-109	T.P.	32°45.2′	130°58.9′	〃 〃
T-110	吉無田	32°46.2′	130°56.4′	〃 〃
T-165	K-155	32°59.6′		
T-166	B.M. No. 37 (K.E.P.C.)	33°10.8′	131°02.2′	MORI (森)
T-168	B.M. No. 4 (Kumamoto Pref.)	33°09.1′	131°11.9′	MIYANOHARU (宮原)
T-169	B.M. No. 10 (〃)	33°09.0′	131°13.2′	〃 〃
T-170	B.M. No. 3 (〃)	33°10.7′	131°08.8′	MORI (森)
T-171	B.M. No. 2 (〃)	33°11.6′	131°10.1′	〃 〃
T-172	B.M. No. 1 (〃)	33°13.1′	131°10.6′	〃 〃
T-173	B.M. No. 62 (K.E.P.C.)	33°07.8′	131°11.6′	MIYANOHARU (宮原)
T-174	B.M. No. 36 (〃)	33°10.7′	130°59.8′	HITA (日田)
T-175	B.M. No. 41 (〃)	33°08.6′	130°59.0′	YAHOGATAKE (八方岳)
T-176	B.M. No. 42 (〃)	33°07.6′	130°57.8′	〃 〃
T-177	B.M. No. 45 (〃)	33°08.1′	130°55.6′	〃 〃
T-178	鯛生	33°07.8′	130°53.1′	〃 〃
T-179	矢部	33°08.8′	130°49.3′	〃 〃
T-180	虎伏木橋	33°08.0′	130°51.0′	〃 〃
T-181	柿谷	33°06.0′	130°52.2′	〃 〃
T-182	S.H. (宿ヶ峰尾峠)	33°05.5′	130°50.8′	〃 〃
T-183	市ノ瀬	33°06.8′	130°52.7′	〃 〃
T-184	猪野	33°07.8′	130°54.5′	〃 〃
T-185	B.M. No. 44 (K.E.P.C.)	33°07.8′	130°57.1′	〃 〃
T-186	B.M. No. 46 (〃)	33°06.9′	130°58.2′	〃 〃
T-187	B.M. No. 47 (〃)	33°05.1′	130°57.5′	〃 〃
T-188	生野	33°06.2′	130°57.8′	〃 〃
T-189	姥淵	33°05.9′	130°59.1′	〃 〃
T-190	小川原	33°04.9′	130°59.4′	〃 〃
T-191	上鴇谷	33°03.0′	130°59.4′	〃 〃
T-192		33°04.6′	130°59.7′	〃 〃
T-193		33°04.8′	131°03.2′	MIYANOHARU (宮原)
T-194	B.M. No. 52 (K.E.P.C.)	33°04.9′	130°05.3′	〃 〃

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Mop
T-195	B.M. No. 53 (〃)	33°03.6′	130°06.3′	MIYANOHARU (宮原)
T-196	黒淵	33°07.5′	131°02.4′	〃 〃
T-197	B.M. No. 38 (K.E.P.C.)	33°09.4′	131°03.0′	〃 〃
T-198	B.M. 2540 (G.S.I)	33°18.4′	130°55.5′	HITA (日田)
T-199	琴平町	33°17.6′	130°56.3′	〃 〃
T-200	一戸	33°16.5′	130°55.7′	〃 〃
T-201	B.M. No. 4 (K.E.P.C.)	33°15.6′	130°56.0′	〃 〃
T-202	出野	33°13.0′	130°53.2′	〃 〃
T-203	小畑	33°12.7′	130°52.1′	〃 〃
T-204	上志谷	33°13.5′	130°54.3′	〃 〃
T-205	浦寺	33°12.1′	130°55.0′	〃 〃
T-206		33°12.7′	130°55.5′	〃 〃
T-207	上山	33°13.1′	130°56.5′	〃 〃
T-208		33°14.1′	130°57.1′	〃 〃
T-209	B.M. No. 32 (K.E.P.C.)	33°15.4′	130°57.9′	〃 〃
T-210	中大山	33°14.8′	130°58.4′	〃 〃
T-211	B.M. No. 33 (K.E.P.C.)	33°13.4′	130°59.1′	〃 〃
T-212	上野	33°11.9′	130°58.3′	〃 〃
T-213	曾家	33°10.9′	130°57.4′	〃 〃
T-214	B.M. No. 34 (K.E.P.C.)	33°12.8′	130°59.3′	〃 〃
T-215	S.H. (千張)	33°16.3′	130°57.5′	〃 〃
T-216	B.M. No. 27 (K.E.P.C.)	33°17.9′	130°57.2′	〃 〃
T-217	B.M. No. 31 (〃)	33°17.1′	130°58.0′	〃 〃
T-218	S.H. (合田)	33°15.8′	130°59.7′	〃 〃
T-219	五馬市丁字路	33°13.7′	131°01.1′	MORI (森)
T-220	B.M. No. 6 (K.E.P.C.)	33°15.0′	131°01.3′	〃 〃
T-221	R.S. ぶんごなかがわ駅	33°16.9′	131°00.6′	〃 〃
T-222	T.P. (隈府)	32°58.5′	130°48.8′	WAIFU (隈府)
T-223		33°05.4′	130°49.5′	YAHOGATAKE (八方岳)
T-224	番所	33°05.0′	130°48.2′	〃 〃
T-225	小伏野	33°03.8′	130°46.7′	〃 〃
T-226	T.P.	33°03.1′	130°46.4′	〃 〃
T-227	T.P.	33°02.2′	130°46.6′	〃 〃
T-228	道場	33°00.8′	130°47.3′	〃 〃
T-229	小楠野	33°02.0′	130°49.5′	〃 〃
T-230	虎口	33°01.6′	130°50.9′	〃 〃
T-231	中山	33°03.2′	130°52.1′	〃 〃
T-232	穴川	33°04.2′	130°52.0′	〃 〃
T-233		33°05.1′	130°52.2′	〃 〃
T-234	T.P.	33°00.3′	130°50.6′	〃 〃
T-235	金峯	33°01.5′	130°52.3′	〃 〃

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Map
T-236	立門	33°01.0′	130°54.0′	YAHOGATAKE (八方岳)
T-237	鉾甲	33°02.6′	130°54.0′	〃 〃
T-238	木護	33°01.9′	130°56.0′	〃 〃
T-239	T.P.	32°59.6′	130°51.8′	WAIFU (隈府)
T-240		33°00.1′	130°56.1′	YAHOGATAKE (八方岳)
T-241	深葉	33°00.3′	130°58.8′	〃 〃
T-242	赤岩	33°00.6′	130°56.5′	〃 〃
T-243		33°01.7′	130°57.9′	〃 〃
T-244		32°57.7′	130°55.9′	WAIFU (隈府)
T-245	伊牟田	32°59.7′	130°55.2′	〃 〃
T-246	T.P. (陣床)	32°59.1′	130°50.8′	〃 〃
T-247	Kikunishi Electric Powerstation	32°59.1′	130°49.9′	〃 〃
T-248	T.P.	32°59.6′	130°48.2′	〃 〃
T-249	T.P. (臺)	32°59.0′	130°45.8′	〃 〃
T-250		32°58.5′	130°47.0′	〃 〃
T-251	R.S. わいふ駅 (熊電)	32°58.6′	130°48.5′	〃 〃
T-252	S.H. (平山)	32°59.4′	130°53.8′	〃 〃
T-253	松島	32°58.2′	130°51.1′	〃 〃
T-254	T.P.	32°57.1′	130°51.1′	〃 〃
T-255	旭野牧場	32°58.0′	130°53.7′	〃 〃
T-256	姫井	32°57.6′	130°52.5′	〃 〃
T-257	S.H. (赤星)	32°57.6′	130°48.8′	〃 〃
T-258	T.P. (花房)	32°56.7′	130°49.0′	〃 〃
T-259	S.H. (妻越)	32°56.6′	130°51.1′	〃 〃
T-260	S.H. (片川瀬)	32°55.7′	130°51.7′	〃 〃
T-261	S.H. (片俣)	32°54.7′	130°52.7′	〃 〃
T-262	真木	32°54.5′	130°55.2′	〃 〃
T-263		32°55.5′	130°56.0′	〃 〃
T-264	堀ケ谷	32°53.5′	130°55.7′	〃 〃
T-265	高尾野	32°53.3′	130°53.9′	〃 〃
T-266	T.P.	32°53.0′	130°52.8′	〃 〃
T-267	S.H. (大津・北)	32°53.5′	130°51.6′	〃 〃
T-268	T.P.	32°54.5′	130°50.6′	〃 〃
T-269	R.S. ひごおおづ駅	32°52.4′	130°51.8′	〃 〃
T-270		32°56.7′	130°53.5′	〃 〃
T-271	船野山山頂	32°45.6′	130°50.2′	MIFUNE (御船)
T-272	T-36 座目木	32°45.7′	130°50.8′	
T-273	中野・東	32°45.7′	130°51.6′	〃 〃
T-274	狩尾	32°56.9′	131°00.8′	ASOSAN (阿蘇山)
T-275	S.H. (的石)	32°55.8′	130°59.7′	WAIFU (隈府)
T-276	S.H. (二重峠)	32°54.5′	130°58.2′	〃 〃

(to be continued)

Table 1. (continued)

No.	Station	φ	λ	Map
T-277	T.P. (的石)	32°56.8′	130°59.2′	〃 〃
T-278	S.H. (狩尾・北西)	32°57.6′	131°00.0′	〃 〃
T-279	T.P. (カブト岩)	32°58.1′	131°01.1′	ASOSAN (阿蘇山)
T-270	K-183	32°59.5′	131°00.9′	

K- 1～K-183	Observation were made	November 1964
		April 1965
		August 1965
K-187～K-200	Observation were made	March 1966
K-302～K-400	Observation were made	August 1966
T- ～T-110	Observation were made	August 1965
T-165～T-280	Observation were made	November 1966

B.M.	Bench Mark
T.P.	Triangulation Point
S.H.	Spot Height
R.S.	Railway Station
G.S.I.	Geographical Survey Institute
K.E.P.C.	Kyushu Electric Power Company

b) Terrain correction

c) Bouguer correction

The vertical gradient of gravity: $\delta g/\delta z$ was assumed as 0.3086 mgal/m for corrections (a). For correction (b), simplified method devised by Hagiwara (1968) was applied. The two cases of mean density value $D=2.67$ gr/cm^3 and 2.30 gr/cm^3 respectively, in making corrections (b) and (c) are described. The international formula

$$\gamma_0=978.049(1+0.05288_4\sin^2\varphi-0.000005_9\sin^2 2\varphi)\ ,$$

was adopted for the normal gravity value. The observed gravity values and Bouguer anomalies thus calculated are listed in Table 2.

On the other hand, many bench marks for precise levels belonging to the G.S.I. are distributed in our surveyed area. Some of them are included in the present survey. On the most of bench marks the gravity data obtained by G.S.I. in 1954 are also compatible with the present values if terrain corrections which have been neglected in the published data are made. They were made and the data were also added. The terrain corrections applied to these data on the 63 bench marks are listed in Table 3 together with obtained Bouguer anomalies.

It turned out that available Bouguer anomaly values amount to 509 with the average density of the observation points of one point per 8.5 km^2.

Table 2.

STATION NO.		G.V.	H	F.C.V.	T.C.		B.C.V.		N.V.	B.A.	
					D=2.30	D=2.67	D=2.30	D=2.67		D=2.30	D=2.67
		979. GAL	M	979. GAL	MGAL.	MGAL.	979. GAL	979. GAL	979. GAL	MGAL.	MGAL.
K	1	43954	535.09	60467	1.46	1.70	55457	54651	57271	-18.14	-26.20
K	2	44034	530.18	60395	1.28	1.49	55414	54613	57284	-18.70	-26.71
K	3	44564	520.07	60613	1.10	1.28	55712	54923	57284	-15.72	-23.61
K	4	45627	488.03	60688	1.12	1.30	56096	55358	57244	-11.48	-18.86
K	5	46034	477.08	60757	1.15	1.34	56274	55553	57189	-9.15	-16.36
K	6	46065	469.49	60553	1.18	1.37	56147	55438	57079	-9.32	-16.41
K	7	46249	458.75	60406	2.85	3.31	56270	55605	56955	-6.85	-13.50
K	8	47791	381.32	59558	3.33	3.86	56216	55679	56832	-6.16	-11.53
K	9	49548	295.26	58660	5.53	6.42	56367	55999	56832	-4.65	-8.33
K	10	50967	222.38	57830	4.56	5.29	56142	55871	56805	-6.63	-9.34
K	11	44385	528.30	60688	0.86	1.00	55683	54878	57325	-16.42	-24.47
K	12	44699	536.87	61267	0.91	1.06	56184	55367	57312	-11.28	-19.45
K	13	45225	543.56	61999	2.13	2.47	56974	56165	57299	-3.25	-11.34
K	14	43608	615.13	62591	2.32	2.69	56895	55978	57354	-4.59	-13.76
K	15	41008	748.40	64104	1.06	1.23	56997	55854	57367	-3.70	-15.13
K	16	40706	772.05	64531	0.53	0.61	57144	55955	57409	-2.65	-14.54
K	17	42930	575.01	60675	2.02	2.35	55336	54477	57230	-18.94	-27.53
K	18	42090	608.86	60879	2.31	2.68	55243	54336	57203	-19.60	-28.67
K	19	41663	629.54	61091	2.08	2.42	55232	54290	57189	-19.57	-28.99
K	20	41065	656.80	61334	2.50	2.90	55254	54276	57176	-19.22	-29.00
K	21	40664	673.59	61451	2.62	3.04	55221	54219	57162	-19.41	-29.43
K	22	40243	690.24	61544	2.14	2.48	55106	54070	57148	-20.42	-30.78
K	23	39130	737.75	61897	2.61	3.03	55048	53946	57121	-20.73	-31.75
K	24	38551	762.65	62086	2.64	3.06	55000	53860	57107	-21.07	-32.47
K	25	37785	798.07	62413	2.98	3.46	55020	53831	57107	-20.87	-32.76
K	26	37223	825.87	62709	3.25	3.77	55075	53847	57107	-20.32	-32.60
K	27	36432	859.73	62963	3.80	4.41	55058	53786	57107	-20.49	-33.21
K	28	35892	880.77	63073	3.91	4.54	54976	53673	57080	-21.04	-34.07
K	29	35237	907.94	63256	4.20	4.88	54927	53587	57080	-21.53	-34.93
K	30	34734	932.81	63520	4.20	4.87	54950	53572	57052	-21.01	-34.80
K	31	34316	951.47	63678	4.39	5.10	54948	53544	57025	-20.77	-34.81
K	32	33863	967.55	63722	4.02	4.67	54800	53364	56984	-21.84	-36.20
K	33	33164	1006.10	64212	4.35	5.05	54951	53462	56956	-20.05	-34.94
K	34	32340	1043.50	64542	4.80	5.57	54966	53425	56943	-19.77	-35.18
K	35	31659	1071.00	64710	4.44	5.16	54833	53244	56915	-20.82	-36.71
K	36	30604	1123.40	65272	4.74	5.50	54920	53254	56902	-19.82	-36.48
K	37	30130	1150.25	65627	6.16	7.15	55158	53473	56888	-17.30	-34.15
K	38	29968	1150.81	65482	7.18	8.33	55109	53440	56874	-17.65	-34.34
K	39	30887	1119.02	65420	3.83	4.45	55019	53346	56888	-18.69	-35.42
K	40	31155	1104.70	65246	3.86	4.48	54986	53335	56874	-18.88	-35.39
K	41	30865	1122.63	65509	3.70	4.29	55060	53379	56847	-17.87	-34.68
K	42	29892	1167.28	65914	4.07	4.72	55072	53328	56833	-17.61	-35.05
K	43	29417	1192.30	66211	4.69	5.45	55191	53418	56833	-16.42	-34.15
K	44	28308	1241.98	66635	5.73	6.65	55239	53406	56819	-15.80	-34.13
K	45	45430	485.70	60419	1.14	1.32	55852	55117	56997	-11.45	-18.80
K	46	44140	532.50	60573	1.18	1.37	55559	54753	56957	-13.98	-22.04
K	47	42980	572.80	60657	1.56	1.81	55292	54429	56998	-17.06	-25.69
K	48	41730	626.80	61073	1.79	2.08	55212	54269	56943	-17.31	-26.74
K	49	40780	660.30	61157	2.73	3.17	55067	54087	56929	-18.62	-28.42
K	50	40040	696.40	61531	2.76	3.20	55095	54060	56984	-18.89	-29.24

(to be continued)

Table 2. (continued)

STATION NO.	G.V.	H	F.C.V.	T.C.		B.C.V.		N.V.	B.A.	
				D=2.30	D=2.67	D=2.30	D=2.67		D=2.30	D=2.67
	979. GAL	M	979. GAL	MGAL.	MGAL.	979. GAL	979. GAL	979. GAL	MGAL.	MGAL.
K 51	38620	761.70	62126	2.63	3.05	55048	53910	57025	-19.77	-31.15
K 52	35760	888.10	63167	3.76	4.36	54984	53667	57011	-20.27	-33.44
K 53	34970	925.50	63531	4.49	5.21	55061	53698	56998	-19.37	-33.00
K 54	33960	971.50	63940	4.23	4.91	55001	53563	56998	-19.97	-34.35
K 55	44190	548.40	61114	1.12	1.30	55941	55108	57258	-13.17	-21.50
K 56	44220	574.20	61940	1.20	1.39	56526	55655	57231	-7.05	-15.76
K 57	44840	562.60	62202	1.64	1.90	56944	56098	57244	-3.00	-11.46
K 58	42980	646.40	62928	1.92	2.23	56891	55919	57135	-2.44	-12.16
K 59	45200	507.30	60855	0.88	1.02	56054	55282	57422	-13.68	-21.40
K 60	45020	510.70	60780	0.76	0.88	55934	55155	57422	-14.88	-22.67
K 61	44810	507.20	60462	0.71	0.82	55645	54870	57409	-17.64	-25.39
K 62	44790	502.50	60297	0.76	0.88	55530	54763	57395	-18.65	-26.32
K 63	45000	492.30	60192	0.70	0.81	55518	54766	57491	-19.73	-27.25
K 64	45190	489.30	60290	0.83	0.96	55657	54912	57559	-19.02	-26.47
K 65	44850	523.50	61005	1.11	1.29	56071	55278	57655	-15.84	-23.77
K 66	45560	483.80	60490	0.86	1.00	55914	55178	57573	-16.59	-23.95
K 67	45420	485.20	60393	0.74	0.86	55791	55051	57518	-17.27	-24.67
K 68	45670	479.30	60461	1.03	1.20	55946	55219	57614	-16.68	-23.95
K 69	45710	482.80	60609	0.79	0.92	56036	55300	57450	-14.14	-21.50
K 70	45880	481.20	60730	1.85	2.15	56278	55561	57710	-14.32	-21.49
K 71	44470	555.20	61603	1.48	1.72	56401	55564	57779	-13.78	-22.15
K 72	43220	567.70	60739	1.48	1.72	55416	54560	56874	-14.58	-23.14
K 73	47470	391.60	59555	2.08	2.41	55989	55415	56546	-5.57	-11.31
K 74	47630	370.70	59070	2.32	2.69	55729	55192	56491	-7.62	-12.99
K 75	47270	386.60	59200	2.14	2.49	55689	55124	56422	-7.33	-12.98
K 76	47770	391.10	59839	2.34	2.72	56305	55736	56450	-1.45	-7.14
K 77	47250	425.50	60381	2.95	3.42	56575	55963	56354	2.21	-3.91
K 78	47420	408.10	60014	2.29	2.66	56310	55714	56354	-0.44	-6.40
K 79	44920	532.20	61344	3.21	3.73	56536	55763	56245	2.91	-4.82
K 80	45930	462.00	60187	3.24	3.76	56059	55395	56299	-2.40	-9.04
K 81	45390	481.20	60240	1.69	1.96	55771	55052	56313	-5.42	-12.61
K 82	45510	490.00	60631	1.38	1.60	56047	55310	57628	-15.81	-23.18
K 83	45750	437.00	59236	1.82	2.11	55206	54558	56354	-11.48	-17.96
K 84	44710	503.00	60233	1.26	1.46	55511	54751	56340	-8.29	-15.89
K 85	44470	541.30	61174	1.44	1.67	56102	55286	56326	-2.24	-10.40
K 86	47480	372.30	58969	2.74	3.18	55655	55122	56532	-8.77	-14.10
K 87	42640	619.30	61752	1.47	1.71	55931	54994	57176	-12.45	-21.82
K 88	41160	695.60	62626	1.93	2.24	56116	55068	57121	-10.05	-20.53
K 89	39440	762.30	62965	2.84	3.30	55903	54766	57066	-11.63	-23.00
K 90	36280	895.80	63924	5.83	6.77	55875	54580	56998	-11.23	-24.18
K 101	42014	661.30	62422	2.08	2.41	56256	55265	57642	-13.86	-23.77
K 102	39739	771.10	63535	0.97	1.13	56201	55022	57724	-15.23	-27.02
K 103	39434	785.50	63674	0.63	0.73	56167	54960	57792	-16.25	-28.32
K 104	40856	741.30	63732	0.52	0.60	56640	55499	57916	-12.76	-24.17
K 105	39594	802.20	64350	0.40	0.47	56660	55422	58012	-13.52	-25.90
K 106	39930	788.30	64257	0.56	0.65	56716	55503	58122	-14.06	-26.19
K 107	38497	847.90	64663	0.90	1.05	56582	55282	58232	-16.50	-29.50
K 108	36714	926.50	65306	1.33	1.54	56510	55095	58342	-18.32	-32.47
K 109	34814	1021.40	66334	3.50	4.06	56841	55314	58438	-15.97	-31.24
K 110	31944	1167.00	67958	3.42	3.97	57053	55299	58534	-14.81	-32.35

(to be continued)

Table 2. (continued)

STATION NO.	G.V.	H	F.C.V.	T.C.		B.C.V.		N.V.	B.A.	
				D=2.30	D=2.67	D=2.30	D=2.67		D=2.30	D=2.67
	979. GAL	M	979. GAL	MGAL.	MGAL.	979. GAL	979. GAL	979. GAL	MGAL.	MGAL.
K 111	30777	1218.50	68380	2.93	3.40	56930	55088	58575	-16.45	-34.87
K 112	28103	1333.00	69239	3.98	4.62	56791	54789	58630	-18.39	-38.41
K 113	29412	1255.90	68169	5.07	5.89	56573	54708	58630	-20.57	-39.22
K 114	30746	1199.70	67769	3.61	4.19	56568	54766	58685	-21.17	-39.19
K 115	31948	1140.50	67144	4.03	4.68	56556	54853	58726	-21.70	-38.73
K 116	34143	1021.60	65670	3.39	3.93	56163	54634	58809	-26.46	-41.75
K 117	34729	987.80	65212	2.08	2.42	55901	54404	58891	-29.90	-44.87
K 118	34796	976.00	64915	1.56	1.81	55666	54178	58946	-32.80	-47.68
K 119	35629	917.60	63946	1.21	1.40	55224	53821	59001	-37.77	-51.80
K 120	36488	882.30	63716	0.93	1.08	55306	53953	59056	-37.50	-51.03
K 121	37149	866.60	63892	0.90	1.05	55631	54302	59138	-35.07	-48.36
K 122	36944	888.80	64372	1.16	1.35	55923	54564	59193	-32.70	-46.29
K 123	36519	912.50	64679	2.21	2.57	56106	54727	59400	-32.94	-46.73
K 124	37084	881.80	64296	1.78	2.07	55977	54638	59290	-33.13	-46.52
K 125	37089	887.40	64474	2.26	2.62	56148	54809	59372	-32.24	-45.63
K 126	36745	914.10	64954	1.99	2.31	56344	54959	59441	-30.97	-44.82
K 127	38455	858.50	64948	2.32	2.69	56907	55613	59414	-25.07	-38.01
K 128	37811	906.00	65770	1.74	2.02	57213	55836	59414	-22.01	-35.78
K 129	39421	839.50	65328	1.38	1.60	57376	56096	59510	-21.34	-34.14
K 130	40914	786.30	65179	2.26	2.62	57827	56645	59634	-18.07	-29.89
K 131	40744	803.50	65540	2.53	2.94	58050	56845	59730	-16.80	-28.85
K 132	42412	742.60	65329	1.09	1.27	58282	57148	59813	-15.31	-26.65
K 133	43339	708.40	65200	1.05	1.22	58478	57397	59868	-13.90	-24.71
K 134	45259	623.80	64509	1.40	1.62	58637	57693	59909	-12.72	-22.16
K 135	45779	564.50	63199	2.10	2.44	57970	57128	59868	-18.98	-27.40
K 136	46369	523.20	62515	2.95	3.43	57768	57005	59813	-20.45	-28.08
K 137	47369	467.90	61808	2.35	2.73	57534	56847	59785	-22.51	-29.38
K 138	47159	439.40	60719	2.31	2.68	56715	56071	59689	-29.74	-36.18
K 139	48169	422.40	61204	3.00	3.48	57433	56827	59717	-22.84	-28.90
K 140	49399	390.60	61453	1.72	2.00	57861	57283	59772	-19.11	-24.89
K 141	47589	439.80	61161	2.97	3.45	57220	56586	59593	-23.73	-30.07
K 142	45939	497.10	61279	1.90	2.20	56678	55938	59428	-27.50	-34.90
K 143	42749	669.30	63404	1.05	1.22	57059	56038	59290	-22.31	-32.52
K 144	46399	488.40	61471	1.05	1.22	56869	56129	58974	-21.05	-28.45
K 145	47959	430.30	61238	1.23	1.43	57214	56567	58823	-16.09	-22.56
K 146	47599	450.00	61486	0.83	0.96	57232	56548	58699	-14.67	-21.51
K 147	47029	453.40	61021	1.10	1.28	56762	56077	58630	-18.68	-25.53
K 148	45059	545.00	61878	1.19	1.38	56744	55919	58342	-15.98	-24.23
K 149	38782	865.00	65476	2.22	2.58	57362	56057	57888	-5.26	-18.31
K 150	38879	814.50	64014	1.58	1.83	56323	55085	59111	-27.88	-40.26
K 151	38909	795.60	63461	1.09	1.26	55902	54687	59070	-31.68	-43.83
K 152	37779	828.60	63350	1.02	1.18	55466	54198	59083	-36.17	-48.85
K 153	37159	877.00	64223	0.96	1.12	55868	54524	59097	-32.29	-45.73
K 155	35849	935.90	64731	9.30	10.80	56642	55341	57792	-11.50	-24.51
K 182	43799	607.08	62533	0.54	0.63	56737	55805	58259	-15.22	-24.54
K 183	36295	944.00	65427	2.59	3.01	56589	55167	57778	-11.89	-26.11
K 187	53591	114.96	57139	0.60	0.70	56091	55923	59689	-35.98	-37.66
K 188	54036	113.60	57542	0.35	0.41	56482	56312	59538	-30.56	-32.26
K 189	55840	16.04	56335	0.64	0.74	56244	56230	59593	-33.49	-33.63
K 190	56305	10.63	56633	0.36	0.42	56567	56556	59524	-29.57	-29.68
K 191	56748	24.54	57505	0.50	0.58	57319	57289	59413	-20.94	-21.24

(to be continued)

Table 2. (continued)

STATION NO.	G.V.	H	F.C.V.	T.C.		B.C.V.		N.V.	B.A.	
				D=2.30	D=2.67	D=2.30	D=2.67		D=2.30	D=2.67
	979. GAL	M	979. GAL	MGAL.	MGAL.	979. GAL	979. GAL	979. GAL	MGAL.	MGAL.
K 192	56968	13.12	57373	0.59	0.69	57306	57295	59358	-20.52	-20.63
K 193	56805	27.73	57661	0.40	0.46	57433	57396	59317	-18.84	-19.21
K 194	57155	28.26	58027	0.47	0.54	57801	57765	59221	-14.20	-14.56
K 195	57769	17.10	58297	0.38	0.44	58170	58149	59179	-10.09	-10.30
K 196	57968	26.42	58783	0.24	0.28	58553	58516	59276	-7.23	-7.60
K 197	58521	12.56	58909	0.20	0.23	58807	58791	59414	-6.07	-6.23
K 198	58165	8.39	58424	0.14	0.16	58357	58346	59565	-12.08	-12.19
K 199	57421	4.36	57556	0.10	0.12	57524	57519	59675	-21.51	-21.56
K 200	56923	3.21	57022	0.08	0.09	56999	56995	59813	-28.14	-28.18
K 302	41291	763.92	64866	0.27	0.31	57530	56350	57313	2.17	-9.63
K 303	42856	648.99	62884	0.37	0.43	56667	55666	57272	-6.05	-16.06
K 304	44838	513.28	60678	0.53	0.62	55785	54998	57203	-14.18	-22.05
K 305	51189	258.15	59155	0.84	0.97	56751	56364	57463	-7.12	-10.99
K 306	52979	160.34	57927	0.56	0.65	56438	56198	57573	-11.35	-13.75
K 307	54559	129.03	58541	0.38	0.44	57335	57141	57683	-3.48	-5.42
K 308	57749	33.26	58775	0.52	0.60	58507	58463	58465	0.42	-0.02
K 309	57529	18.21	58091	0.49	0.57	57965	57944	59166	-12.01	-12.22
K 311	56058	75.00	58372	2.31	2.68	57881	57801	60157	-22.76	-23.56
K 312	51182	317.06	60966	3.78	4.39	58289	57858	60268	-19.79	-24.10
K 313	53726	209.34	60186	2.89	3.36	58458	58180	60350	-18.92	-21.70
K 315	45067	590.00	63274	2.51	2.91	57839	56965	60047	-22.08	-30.82
K 316	45737	560.00	63019	2.20	2.55	57842	57009	59965	-21.23	-29.56
K 317	46517	490.00	61638	2.28	2.65	57145	56422	59868	-27.23	-34.46
K 318	49164	348.62	59922	2.01	2.33	56763	56255	59772	-30.09	-35.17
K 319	50117	300.00	59375	2.01	2.33	56685	56252	59689	-30.04	-34.37
K 320	50767	260.00	58791	1.71	1.99	56456	56011	59565	-31.09	-34.84
K 321	51987	150.00	56616	1.90	2.20	55360	55158	59469	-41.09	-43.11
K 322	52144	149.86	56769	1.99	2.31	55523	55323	59358	-38.35	-40.35
K 323	51904	159.05	56812	2.18	2.53	55497	55286	59358	-38.61	-40.72
K 324	50634	245.20	58201	4.55	5.28	56293	55986	59345	-30.52	-33.59
K 325	49054	331.68	59290	3.19	3.70	56412	55949	59455	-30.43	-35.06
K 326	47654	404.78	60145	4.28	4.97	56673	56114	59414	-27.41	-33.00
K 328	51795	230.58	58911	3.28	3.81	57017	56712	59193	-21.76	-24.81
K 329	51208	256.51	59124	4.94	5.74	57146	56828	59152	-20.06	-23.24
K 331	44632	515.00	60525	2.56	2.97	55818	55060	59111	-32.93	-40.51
K 332	44571	548.00	61482	1.76	2.04	56377	55556	59001	-26.24	-34.45
K 333	45094	521.00	61172	2.95	3.42	56446	55685	58864	-24.18	-31.79
K 334	52524	211.00	59035	2.46	2.85	57248	56960	59042	-17.94	-20.82
K 335	50094	338.20	60531	1.24	1.44	57396	56891	58973	-15.77	-20.82
K 336	49289	352.34	60162	1.03	1.20	56870	56340	58781	-19.11	-24.41
K 337	48398	320.00	58273	0.91	1.06	55281	54799	58726	-34.45	-39.27
K 338	45417	470.00	59921	0.69	0.80	55461	54743	58548	-30.87	-38.05
K 339	45946	456.50	60034	0.95	1.10	55729	55037	58438	-27.09	-34.01
K 340	44555	520.00	60602	0.85	0.99	55676	54884	58383	-27.07	-34.99
K 341	42934	584.00	60956	0.92	1.07	55420	54530	58342	-29.22	-38.12
K 342	42503	609.00	61297	0.81	0.94	55509	54578	58177	-26.68	-35.99
K 343	42562	601.00	61109	0.78	0.91	55395	54476	58039	-26.44	-35.63
K 345	44349	561.00	61661	0.66	0.77	56321	55462	57929	-16.08	-24.67
K 346	47861	426.05	61009	0.94	1.09	56997	56351	57833	-8.36	-14.81
K 347	48368	407.00	60928	0.69	0.80	57075	56455	57737	-6.62	-12.82

(to be continued)

Table 2. (continued)

STATION NO.	G.V.	H	F.C.V.	T.C.		B.C.V.		N.V.	B.A.	
				D=2.30	D=2.67	D=2.30	D=2.67		D=2.30	D=2.67
	979. GAL	M	979. GAL	MGAL.	MGAL.	979. GAL	979. GAL	979. GAL	MGAL.	MGAL.
K 349	50669	332.00	60915	0.57	0.66	57772	57266	57532	2.40	-2.66
K 350	49154	383.00	60973	0.59	0.68	57341	56757	57518	-1.77	-7.61
K 351	48402	410.00	61055	0.59	0.68	57162	56536	57546	-3.84	-10.10
K 352	46560	492.00	61743	0.77	0.89	57078	56328	57614	-5.36	-12.86
K 353	44859	548.00	61770	0.61	0.71	56550	55711	57614	-10.64	-19.03
K 354	45495	506.01	61110	0.97	1.13	56331	55563	57724	-13.93	-21.61
K 355	48403	406.00	60932	0.90	1.04	57109	56494	57710	-6.01	-12.16
K 356	50101	309.00	59637	0.84	0.98	56743	56278	57587	-8.44	-13.09
K 357	50935	260.41	58971	1.02	1.18	56563	56176	57272	-7.09	-10.96
K 358	49803	290.00	58752	1.34	1.56	56092	55664	57135	-10.43	-14.71
K 359	49361	303.72	58734	1.59	1.84	55965	55520	57080	-11.15	-15.60
K 360	47245	386.73	59179	1.51	1.75	55603	55028	56943	-13.40	-19.15
K 361	45904	433.00	59266	1.79	2.08	55273	54630	56860	-15.87	-22.30
K 362	42259	606.70	60982	1.13	1.31	55248	54325	56751	-15.03	-24.26
K 363	41955	608.00	60718	0.89	1.03	54947	54019	58067	-31.20	-40.48
K 364	40255	680.00	61240	1.02	1.18	54788	53750	58081	-32.93	-43.31
K 365	38235	780.00	62306	0.86	1.00	54875	53680	58163	-32.88	-44.83
K 367	36517	889.00	63952	2.52	2.93	55637	54299	58245	-26.08	-39.46
K 368	34757	1000.00	65617	1.99	2.31	56179	54661	58314	-21.35	-36.53
K 369	34448	1030.00	66234	2.90	3.37	56598	55048	58383	-17.85	-33.35
K 370	47330	453.57	61327	2.30	2.67	57186	56520	59992	-28.06	-34.72
K 371	47506	456.65	61598	1.46	1.69	57343	56658	59827	-24.84	-31.68
K 372	47916	429.76	61178	2.51	2.91	57287	56661	59703	-24.16	-30.41
K 373	42137	710.00	64048	4.47	5.19	57652	56624	60102	-24.50	-34.78
K 374	44232	580.00	62131	3.46	4.02	56888	56044	59965	-30.77	-39.21
K 375	36810	894.00	64399	1.36	1.58	55919	54555	59001	-30.82	-44.46
K 376	35847	964.00	65596	1.71	1.99	56477	55010	58960	-24.83	-39.50
K 377	36935	873.00	63876	3.74	4.34	55836	54543	58850	-30.14	-43.07
K 380	39641	780.00	63712	3.70	4.29	56564	55415	58864	-23.00	-34.49
K 381	43137	592.00	61406	2.77	3.22	55978	55105	58850	-28.72	-37.45
K 382	43117	620.00	62250	1.46	1.70	56422	55484	58781	-23.59	-32.97
K 383	44769	540.00	61433	0.56	0.65	56285	55457	58259	-19.74	-28.02
K 384	42979	639.70	62720	0.81	0.94	56636	55658	58135	-14.99	-24.77
K 385	45379	580.00	63278	0.79	0.92	57768	56881	58039	-2.71	-11.58
K 386	50509	320.00	60384	1.23	1.43	57424	56947	57847	-4.23	-9.00
K 387	45881	394.19	58046	4.59	5.33	54706	54169	56765	-20.59	-25.96
K 388	39115	738.00	61890	0.84	0.98	54862	53731	56628	-17.66	-28.97
K 389	39444	727.54	61896	0.71	0.83	54956	53840	56422	-14.66	-25.82
K 390	37893	787.30	62189	1.10	1.28	54712	53509	56258	-15.46	-27.49
K 391	40211	680.00	61196	0.99	1.15	54742	53703	56491	-17.49	-27.88
K 393	37970	800.00	62658	0.44	0.51	54992	53759	56545	-15.53	-27.86
K 394	38449	790.00	62828	0.45	0.52	55260	54042	56669	-14.09	-26.27
K 395	40768	710.00	62679	0.35	0.41	55872	54777	56860	-9.88	-20.83
K 396	42167	620.00	61300	0.56	0.65	55381	54429	57011	-16.30	-25.82
K 397	47673	437.07	61161	0.84	0.98	57033	56369	58809	-17.76	-24.40
K 398	45603	515.64	61516	0.99	1.15	56645	55862	58575	-19.30	-27.13
K 399	43173	630.16	62620	1.76	2.04	56723	55774	58479	-17.56	-27.05
K 400	42133	687.10	63337	1.39	1.61	56854	55811	58465	-16.11	-26.54
T 8	19351	1592.40	68492	25.70	29.83	55716	53661	56874	-11.58	-32.13
T 9	35537	982.00	65841	3.52	4.09	56730	55265	56874	-1.44	-16.09

(to be continued)

Table 2. (continued)

STATION NO.	G.V.	H	F.C.V.	T.C.		B.C.V.		N.V.	B.A.	
	979. GAL	M	979. GAL	D=2.30 MGAL.	D=2.67 MGAL.	D=2.30 979. GAL	D=2.67 979. GAL	979. GAL	D=2.30 MGAL.	D=2.67 MGAL.
T 10	42578	714.00	64612	2.46	2.86	57978	56910	57052	9.26	-1.42
T 11	44515	542.00	61241	1.46	1.69	56163	55347	56327	-1.64	-9.80
T 14	56815	17.28	57348	0.79	0.92	57261	57247	55452	18.09	17.95
T 15	52945	175.00	58345	1.46	1.70	56805	56558	56313	4.92	2.45
T 17	40566	809.00	65532	0.50	0.58	57785	56539	57080	7.05	-5.41
T 18	38853	866.00	65578	1.22	1.42	57354	56031	57052	3.02	-10.20
T 26	29083	1153.00	64665	14.27	16.56	54980	53422	56669	-16.89	-32.47
T 27	40836	675.00	61666	4.03	4.68	55565	54583	56683	-11.18	-21.00
T 30	49581	295.34	58695	5.54	6.43	56403	56034	56833	-4.30	-7.99
T 31	53488	127.13	57411	1.52	1.76	56338	56165	56737	-3.99	-5.72
T 32	53971	109.22	57342	1.01	1.17	56390	56237	56710	-3.20	-4.73
T 33	54536	95.01	57468	0.84	0.98	56637	56503	56669	-0.32	-1.66
T 34	55172	79.70	57632	0.59	0.69	56923	56809	56641	2.82	1.68
T 35	56063	7.00	56279	0.69	0.80	56280	56281	56040	2.40	2.41
T 36	53636	161.00	58604	1.40	1.63	57193	56966	55889	13.04	10.77
T 37	54016	208.00	60435	1.21	1.41	58552	58249	56040	25.12	22.09
T 38	55862	46.00	57282	1.49	1.73	56987	56940	56204	7.83	7.36
T 39	53919	119.00	57591	1.32	1.53	56576	56413	56327	2.49	0.86
T 40	50424	282.00	59127	1.46	1.70	56555	56142	56368	1.87	-2.26
T 42	49372	297.00	58537	4.95	5.75	56171	55790	56778	-6.07	-9.88
T 43	52426	179.00	57950	0.78	0.91	56303	56038	56518	-2.15	-4.80
T 44	50127	358.00	61175	1.83	2.12	57907	57382	56163	17.44	12.19
T 45	46481	517.00	62436	1.90	2.21	57644	56873	56122	15.22	7.51
T 46	51553	197.00	57632	2.12	2.46	55946	55674	56532	-5.86	-8.57
T 47	39837	741.06	62706	4.07	4.72	55971	54888	56204	-2.33	-13.16
T 48	39608	768.98	63339	4.67	5.42	56395	55278	56149	2.46	-8.71
T 49	33136	1091.00	66804	6.53	7.58	56943	55357	56176	7.67	-8.19
T 50	29565	1219.98	67214	10.47	12.16	56504	54781	56122	3.82	-13.41
T 51	32453	1116.20	66899	9.07	10.53	57049	55465	56299	7.50	-8.34
T 52	43216	625.00	62503	4.61	5.35	56941	56046	56358	5.73	-3.22
T 53	37710	903.00	65577	5.25	6.09	57399	56083	56436	9.63	-3.53
T 54	46849	464.00	61168	3.71	4.31	57068	56408	56368	7.00	0.40
T 55	49717	318.00	59530	2.96	3.44	56762	56317	56395	3.67	-0.78
T 56	44057	542.40	60795	1.01	1.17	55669	54844	56395	-7.26	-15.51
T 57	42268	672.00	63006	2.40	2.79	56770	55767	56655	1.15	-8.88
T 58	39795	746.00	62817	4.17	4.84	56044	54955	56751	-7.07	-17.96
T 59	38637	791.00	63047	0.96	1.12	55521	54310	56327	-8.06	-20.17
T 60	41489	651.20	61585	0.90	1.05	55400	54405	56094	-6.94	-16.89
T 61	42761	598.00	61215	1.74	2.02	55626	54727	56245	-6.19	-15.18
T 62	42051	654.80	62258	1.10	1.28	56058	55061	56258	-2.00	-11.97
T 63	41913	615.00	60892	0.55	0.64	55020	54076	55575	-5.55	-14.99
T 64	43737	532.56	60172	1.60	1.86	55200	54400	55206	-0.06	-8.06
T 65	41750	616.80	60784	0.72	0.84	54913	53968	55288	-3.75	-13.20
T 66	41385	629.00	60796	0.41	0.48	54776	53807	55534	-7.58	-17.27
T 67	41947	631.00	61420	0.43	0.50	55382	54410	55698	-3.16	-12.88
T 68	41428	635.00	61024	0.33	0.38	54937	53958	55725	-7.88	-17.67
T 69	39008	774.00	62894	0.55	0.64	55490	54299	56108	-6.18	-18.09
T 70	41468	639.90	61215	0.74	0.86	55123	54143	55821	-6.98	-16.78
T 71	40492	704.00	62217	0.54	0.63	55487	54405	55958	-4.71	-15.53
T 72	38608	789.00	62957	0.68	0.79	55421	54209	55889	-4.68	-16.80

(to be continued)

Table 2. (continued)

STATION NO.	G.V. 979. GAL	H M	F.C.V. 979. GAL	T.C. D=2.30 MGAL.	T.C. D=2.67 MGAL.	B.C.V. D=2.30 979. GAL	B.C.V. D=2.67 979. GAL	N.V. 979. GAL	B.A. D=2.30 MGAL.	B.A. D=2.67 MGAL.
T 73	40137	710.00	62048	0.51	0.59	55256	54164	55739	-4.83	-15.75
T 74	42092	632.00	61596	0.39	0.45	55544	54570	55561	-0.17	-9.91
T 75	41975	604.00	60614	0.59	0.69	54853	53926	55424	-5.71	-14.98
T 76	41899	608.30	60671	0.64	0.74	54873	53940	55383	-5.10	-14.43
T 77	40266	708.00	62115	0.52	0.60	55344	54254	55985	-6.41	-17.31
T 78	43322	601.00	61869	2.27	2.64	56304	55409	56272	0.32	-8.63
T 79	47447	481.00	62291	1.54	1.79	57809	57089	55301	25.08	17.88
T 80	49803	304.00	59184	2.94	3.41	56548	56124	55151	13.97	9.73
T 81	50170	283.00	58903	3.55	4.12	56531	56149	55151	13.80	9.98
T 82	50566	327.00	60657	1.21	1.40	57626	57139	55247	23.79	18.92
T 83	49263	396.00	61484	2.93	3.40	57960	57393	55356	26.04	20.37
T 84	50133	332.00	60378	2.49	2.89	57428	56953	55465	19.63	14.88
T 85	44857	614.00	63805	1.40	1.63	58028	57099	55438	25.90	16.61
T 86	47585	459.59	61768	1.20	1.39	57459	56765	55602	18.57	11.63
T 87	49081	383.00	60900	1.49	1.73	57358	56789	55794	15.64	9.95
T 88	50488	311.00	60085	0.88	1.02	57176	56708	55766	14.10	9.42
T 89	54778	112.00	58234	1.19	1.38	57274	57119	55575	16.99	15.44
T 90	56189	42.48	57500	1.71	1.98	57261	57223	55506	17.55	17.17
T 91	53557	167.96	58740	1.24	1.44	57246	57005	55455	17.81	15.40
T 92	51188	291.30	60177	1.31	1.52	57501	57071	55588	19.13	14.83
T 93	47116	485.10	62086	0.73	0.85	57484	56744	55643	18.41	11.01
T 94	46889	449.06	60747	0.84	0.97	56503	55820	55233	12.70	5.87
T 95	44478	572.00	62130	0.65	0.76	56683	55807	55575	11.08	2.32
T 96	40818	714.00	62852	2.20	2.55	56191	55119	55862	3.29	-7.43
T 97	42695	652.00	62816	1.03	1.19	56635	55641	55711	9.24	-0.70
T 98	42488	653.00	62640	0.72	0.84	56419	55418	55629	7.90	-2.11
T 100	43656	590.00	61863	0.56	0.65	56233	55328	55465	7.69	-1.37
T 101	38085	868.40	64884	2.11	2.45	56726	55414	55848	8.78	-4.34
T 102	40473	710.00	62384	1.27	1.48	55669	54589	55807	-1.38	-12.18
T 103	42096	663.00	62556	0.75	0.87	56242	55226	55698	5.44	-4.72
T 104	42309	627.00	61658	0.47	0.55	55663	54699	55561	1.02	-8.62
T 105	42976	584.60	61017	0.59	0.68	55442	54545	55383	0.59	-8.38
T 106	47818	416.00	60656	1.38	1.60	56785	56162	55985	8.00	1.77
T 107	39399	828.00	64951	3.12	3.62	57283	56050	56108	11.75	-0.58
T 108	43421	638.90	63137	1.15	1.34	57096	56124	55807	12.89	3.17
T 109	41877	694.60	63312	1.34	1.56	56753	55698	55821	9.32	-1.23
T 110	44740	578.00	62577	1.76	2.04	57183	56315	55958	12.25	3.57
T 165	35849	935.90	64731	5.45	6.33	56257	54894	57792	-15.35	-28.98
T 166	50639	287.89	59523	4.76	5.53	57225	56856	59331	-21.06	-24.75
T 168	44240	590.45	62461	0.87	1.01	56858	55957	59097	-22.39	-31.40
T 169	42132	694.87	63576	1.27	1.48	57007	55950	59084	-20.77	-31.34
T 170	44619	569.00	62178	10.03	11.64	57698	56977	59317	-16.19	-23.40
T 171	46511	478.55	61279	1.84	2.14	56852	56139	59441	-25.89	-33.02
T 172	47778	429.31	61026	2.05	2.38	57094	56462	59647	-25.53	-31.85
T 173	45554	536.08	62097	1.42	1.65	57073	56265	58919	-18.46	-26.54
T 174	53075	230.33	60183	4.21	4.89	58384	58095	59317	-9.33	-12.22
T 175	51729	308.18	61239	3.45	4.01	58615	58193	59029	-4.14	-8.36
T 176	51708	322.16	61650	3.32	3.85	58877	58431	58891	-0.14	-4.60
T 177	50635	384.00	62485	3.14	3.64	59098	58553	58960	1.38	-4.07
T 178	47410	555.00	64537	1.56	1.81	59345	58509	58919	4.26	-4.10

(to be continued)

Table 2. (continued)

STATION NO.	G.V. 979. GAL	H M	F.C.V. 979. GAL	T.C. D=2.30 MGAL.	T.C. D=2.67 MGAL.	B.C.V. D=2.30 979. GAL	B.C.V. D=2.67 979. GAL	N.V. 979. GAL	B.A. D=2.30 MGAL.	B.A. D=2.67 MGAL.
T 179	52568	350.00	63369	1.91	2.22	60187	59675	59056	11.31	6.19
T 180	50315	429.00	63554	2.39	2.77	59658	59032	58946	7.12	0.86
T 181	46307	594.00	64638	2.44	2.83	59157	58276	58671	4.86	-3.95
T 182	41962	816.00	67144	2.16	2.51	59496	58266	58603	8.93	-3.37
T 183	47685	522.00	63794	2.38	2.76	59001	58230	58781	2.20	-5.51
T 184	49782	433.00	63144	1.87	2.17	59158	58517	58919	2.39	-4.02
T 185	51174	349.89	61972	3.27	3.80	58927	58437	58919	0.08	-4.82
T 186	51426	331.69	61662	3.08	3.58	58774	58309	58795	-0.21	-4.86
T 187	48504	457.51	62623	2.45	2.84	58458	57788	58548	-0.90	-7.60
T 188	50544	359.00	61623	3.26	3.78	58489	57984	58699	-2.10	-7.15
T 189	48880	453.00	62860	1.32	1.53	58626	57945	58658	-0.32	-7.13
T 190	48289	465.00	62639	1.35	1.57	58293	57594	58520	-2.27	-9.26
T 191	45479	579.00	63347	1.36	1.58	57903	57027	58259	-3.56	-12.32
T 192	48313	467.00	62725	1.87	2.17	58411	57717	58479	-0.68	-7.62
T 193	46864	485.00	61831	0.74	0.86	57231	56491	58507	-12.76	-20.16
T 194	46471	463.53	60776	1.21	1.41	56430	55731	58520	-20.90	-27.89
T 195	43868	600.85	62410	0.63	0.73	56683	55761	58342	-16.59	-25.81
T 196	48294	431.00	61595	0.71	0.83	57513	56856	58878	-13.65	-20.22
T 197	50362	328.11	60487	2.27	2.63	57552	57080	59139.	-15.87	-20.59
T 198	57735	83.00	60296	1.09	1.27	59606	59495	60377	-7.71	-8.82
T 199	57523	101.00	60640	1.39	1.61	59805	59671	60268	-4.63	-5.97
T 200	56268	160.00	61206	2.86	3.32	59950	59748	60116	-1.66	-3.68
T 201	54870	209.05	61321	3.76	4.36	59682	59419	59992	-3.10	-5.73
T 202	50489	495.00	65765	3.27	3.80	61322	60607	59634	16.88	9.73
T 203	49393	490.00	64514	3.89	4.51	60181	59484	59593	5.88	-1.09
T 204	51658	380.00	63385	3.89	4.52	60112	59586	59703	4.09	-1.17
T 205	45095	673.00	65864	1.64	1.90	59542	58525	59510	0.32	-9.85
T 206	50824	397.00	63075	2.94	3.41	59543	58975	59593	-0.50	-6.18
T 207	52299	305.00	61711	2.78	3.23	59050	58622	59648	-5.98	-10.26
T 208	54129	214.10	60736	3.95	4.59	59068	58800	59786	-7.18	-9.86
T 209	56353	131.11	60399	2.99	3.47	59434	59279	59965	-5.31	-6.86
T 210	55895	152.00	60586	2.62	3.04	59383	59189	59882	-4.99	-6.93
T 211	54400	185.00	60109	2.89	3.36	58616	58375	59689	-10.73	-13.14
T 212	50570	382.00	62358	2.08	2.41	58885	58326	59483	-5.98	-11.57
T 213	45773	626.00	65091	2.01	2.33	59259	58321	59345	-0.86	-10.24
T 214	53997	200.00	60169	3.08	3.58	58550	58290	59607	-10.57	-13.17
T 215	56821	114.00	60339	2.57	2.98	59497	59362	60089	-5.92	-7.27
T 216	57730	97.45	60737	1.08	1.25	59906	59772	60309	-4.03	-5.37
T 217	55804	184.84	61508	0.73	0.85	59800	59525	60199	-3.99	-6.74
T 218	52730	272.00	61124	0.59	0.68	58561	58149	60020	-14.59	-18.71
T 219	50612	373.00	62123	0.54	0.63	58582	58013	59730	-11.48	-17.17
T 220	54815	186.57	60573	1.93	2.24	58968	58709	59910	-9.42	-12.01
T 221	56315	160.00	61253	1.47	1.71	59858	59634	60171	-3.13	-5.37
T 222	55955	65.00	57961	0.60	0.70	57395	57304	57642	-2.47	-3.38
T 223	47450	511.00	63219	2.28	2.65	58523	57768	58589	-0.66	-8.21
T 224	52669	280.00	61310	3.87	4.49	58998	58626	58534	4.64	0.92
T 225	55401	166.00	60524	1.48	1.72	59072	58839	58369	7.03	4.70
T 226	55017	182.10	60637	0.90	1.04	58971	58703	58273	6.98	4.30
T 227	55266	161.90	60262	0.70	0.81	58772	58532	58149	6.23	3.83
T 228	56863	62.00	58776	0.91	1.06	58270	58189	57957	3.13	2.32

(to be continued)

Table 2. (continued)

STATION NO.	G.V. 979. GAL	H M	F.C.V. 979. GAL	T.C. D=2.30 MGAL.	T.C. D=2.67 MGAL.	B.C.V. D=2.30 979. GAL	B.C.V. D=2.67 979. GAL	N.V. 979. GAL	B.A. D=2.30 MGAL.	B.A. D=2.67 MGAL.
T 229	53245	241.00	60682	1.74	2.02	58534	58188	58122	4.12	0.66
T 230	54719	161.00	59687	2.37	2.75	58373	58161	58067	3.06	0.94
T 231	52646	224.00	59559	3.53	4.10	57753	57463	58287	-5.34	-8.24
T 232	50705	329.00	60858	4.50	5.22	58137	57699	58424	-2.87	-7.25
T 233	44336	667.00	64920	1.55	1.80	58647	57638	58548	0.99	-9.10
T 234	52651	248.40	60317	0.79	0.92	58002	57630	57888	1.14	-2.58
T 235	52167	282.00	60870	2.01	2.33	58353	57948	58053	3.00	-1.05
T 236	51762	293.00	60804	1.47	1.71	58128	57697	57984	1.44	-2.87
T 237	48714	456.00	62786	1.61	1.87	58553	57872	58204	3.49	-3.32
T 238	46701	560.00	63983	1.33	1.54	58718	57872	58108	6.10	-2.36
T 239	52173	256.00	60073	0.85	0.99	57691	57308	57792	-1.01	-4.84
T 240	48738	409.36	61371	3.24	3.76	57750	57167	57861	-1.11	-6.94
T 241	40323	806.00	65196	0.95	1.10	57523	56289	57888	-3.65	-15.99
T 242	45794	576.00	63569	1.06	1.23	58124	57248	57929	1.95	-6.81
T 243	43309	692.00	64664	1.09	1.27	58105	57049	58081	0.24	-10.32
T 244	38660	856.00	65076	3.46	4.02	57173	55902	57532	-3.59	-16.30
T 245	48054	451.00	61972	1.34	1.55	57759	57081	57806	-0.47	-7.25
T 246	53319	199.90	59488	0.84	0.98	57646	57350	57724	-0.78	-3.74
T 247	56144	78.50	58566	0.94	1.09	57904	57797	57724	1.80	0.73
T 248	54209	167.00	59363	0.59	0.68	57812	57562	57792	0.20	-2.30
T 249	55852	73.90	58133	0.31	0.36	57451	57342	57710	-2.59	-3.68
T 250	56420	44.00	57778	0.47	0.54	57400	57340	57642	-2.42	-3.02
T 251	55986	63.50	57946	0.59	0.68	57392	57303	57655	-2.63	-3.52
T 252	49756	403.00	62193	1.35	1.57	58444	57841	57765	6.79	0.76
T 253	55747	79.00	58185	1.07	1.24	57530	57425	57600	-0.70	-1.75
T 254	53460	170.40	58719	0.71	0.82	57147	56894	57450	-3.03	-5.56
T 255	50019	345.00	60666	1.68	1.95	57509	57001	57573	-0.64	-5.72
T 256	54353	145.00	58828	1.37	1.59	57567	57364	57518	0.49	-1.54
T 257	56134	46.00	57554	0.59	0.68	57169	57107	57518	-3.49	-4.11
T 258	54810	114.20	58334	0.39	0.45	57272	57102	57395	-1.23	-2.93
T 259	55306	95.00	58238	0.77	0.89	57399	57264	57381	0.18	-1.17
T 260	53780	172.00	59088	0.65	0.75	57495	57239	57258	2.37	-0.19
T 261	53061	192.00	58986	0.71	0.82	57206	56920	57121	0.85	-2.01
T 262	50485	312.00	60113	1.84	2.14	57291	56837	57094	1.97	-2.57
T 263	47584	431.00	60885	3.35	3.89	57086	56452	57231	-1.65	-7.79
T 264	48964	321.00	58870	1.18	1.37	55895	55416	56957	-10.62	-15.41
T 265	51752	230.00	58850	0.86	1.00	56719	56377	56929	-2.10	-5.52
T 266	52507	196.20	58562	0.64	0.74	56735	56441	56888	-1.53	-4.47
T 267	53759	153.00	58481	0.49	0.57	57055	56826	56957	0.98	-1.31
T 268	54063	164.70	59146	0.45	0.52	57603	57355	57094	5.09	2.61
T 269	54413	115.50	57977	0.58	0.67	56922	56752	56806	1.16	-0.54
T 270	51030	276.00	59547	2.20	2.55	57107	56715	57395	-2.88	-6.80
T 271	50635	308.00	60140	2.80	3.25	57452	57019	55876	15.76	11.43
T 272	53628	170.00	58874	0.81	0.94	57317	57066	55889	14.28	11.77
T 273	51980	240.00	59386	1.32	1.53	57205	56854	55889	13.16	9.65
T 274	46238	490.00	61359	2.25	2.61	56862	56139	57422	-5.60	-12.83
T 275	46304	480.00	61117	2.73	3.17	56764	56064	57272	-5.08	-12.08
T 276	42208	683.00	63285	1.58	1.83	56861	55827	57094	-2.33	-12.67
T 277	35546	968.00	65418	3.75	4.35	56465	55024	57409	-9.44	-23.85
T 278	35732	956.00	65234	3.30	3.83	56351	54922	57518	-11.67	-25.96
T 279	35256	960.60	64900	6.27	7.28	56270	54882	57587	-13.17	-27.05
T 280	36295	944.00	65427	2.59	3.01	56589	55167	57779	-11.90	-26.12

G.V. : Gravity Value
H. : Height
F.C.V. : Free air Corrected Value
T.C. : Terrain Correction
B.C.V. : Bouguer Corrected Value
N.V. : Normal Gravity Value
B.A. : Bouguer Anomaly
D. : Mean Density

Table 3.

		D=2.67		D=2.30		Map
		T.C.	B.A.	T.C.	B.A.	
B.M.	1902	0.40	−12.29	0.34	− 0.80	ASOSAN (阿蘇山)
	1904	0.40	−13.24	0.38	− 2.85	〃 〃
	1905	0.42	−14.49	0.36	− 4.85	〃 〃
	1906	0.53	−16.61	0.46	− 7.61	TAKEDA (竹田)
	1907	0.61	−16.28	0.53	− 8.03	〃 〃
	1908	0.81	−16.90	0.70	− 9.44	〃 〃
	1909	0.67	−15.20	0.58	− 8.95	〃 〃
	1911	0.88	−12.06	0.76	− 7.78	〃 〃
	1913	0.91	− 8.75	0.78	− 5.18	〃 〃
	1914	0.93	− 3.06	0.80	0.34	〃 〃
	1915	0.70	− 2.37	0.60	1.74	〃 〃
	1917	1.32	− 2.80	1.14	1.16	KUJU (久住)
	1918	1.43	− 3.41	1.23	2.40	〃 〃
	1919	1.39	− 8.41	1.20	−2.13	〃 〃
	1920	1.38	−11.29	1.14	−4.00	〃 〃
	1921	0.76	−11.73	0.65	−3.47	〃 〃
	1923	1.55	− 9.89	1.34	−4.56	〃 〃
	1924	1.61	− 8.91	1.39	−4.53	〃 〃
	1925	1.17	− 8.71	1.01	−4.76	〃 〃
	1926	1.64	− 6.06	1.41	−3.20	〃 〃
	1927	1.53	− 5.02	1.32	− 3.29	INUKAI (犬飼)
	1928	1.12	− 8.57	0.96	− 7.03	〃 〃
	1929	1.49	− 8.76	1.28	− 8.23	〃 〃
	1930	1.72	− 7.91	1.48	− 7.67	〃 〃
	1931	1.05	−11.27	0.90	−10.90	OOITA (大分)
	1934	0.31	−38.84	0.27	−38.56	〃 〃
	1935	0.24	−41.62	0.21	−41.59	〃 〃
	1936	0.39	−42.84	0.34	−42.84	〃 〃
	1937	0.75	−42.99	0.65	−43.02	〃 〃
	1938	1.38	−39.41	1.15	−39.57	〃 〃
	1940	2.43	−22.61	2.09	−22.90	〃 〃

(to be continued)

Table 3. (continued)

	D=2.67		D=2.30		Map
	T.C.	B.A.	T.C.	B.A.	
B.M. 5372	0.16	−40.65	0.14	−40.61	OOITA (大分)
5371	0.15	−38.77	0.13	−38.73	〃 〃
5370	0.10	−34.90	0.09	−34.85	〃 〃
2634	0.09	−21.35	0.08	−21.26	〃 〃
2633	0.13	− 6.28	0.11	− 6.25	〃 〃
2580	0.83	−19.85	0.71	−19.60	〃 〃
2578	0.96	−25.62	0.83	−25.16	〃 〃
2577	1.13	−19.19	0.97	−18.31	BEPPU (別府)
2576	1.57	−29.78	1.35	−29.01	〃 〃
2575	1.39	−34.65	1.20	−33.23	〃 〃
2574	1.67	−35.28	1.44	−33.86	〃 〃
2573	2.02	−38.57	1.74	−36.93	〃 〃
2554	1.36	−23.47	1.17	−18.30	MORI (森)
2553	1.25	−16.92	1.08	−11.98	〃 〃
2551	1.49	−15.29	1.28	−10.61	〃 〃
2550	1.55	−12.54	1.34	− 7.91	〃 〃
2600	0.57	−29.67	0.49	−26.35	MIEMACHI (三重町)
2601	1.19	−30.77	1.03	−28.23	〃 〃
2602	1.73	−30.73	1.49	−29.20	〃 〃
2658	4.18	−26.36	3.60	−23.46	MITAI (三田井)
2660	3.39	−23.48	2.92	−19.60	〃 〃
2661	2.43	−23.71	2.09	−19.26	〃 〃
2662	2.93	−23.47	2.52	−19.54	〃 〃
2663	4.08	−20.62	3.51	−17.71	〃 〃
2666	2.12	−20.53	1.83	−15.69	〃 〃
2667	2.48	−17.76	2.14	−12.61	〃 〃
2671	0.87	−10.05	0.75	0.36	TAKAMORI (高森)
2672	2.29	−14.57	1.97	− 6.58	〃 〃
2674	2.27	− 3.81	1.96	3.88	〃 〃
2683	1.57	0.41	1.35	6.76	〃 〃
2684	1.12	0.88	0.96	7.70	〃 〃
2685	0.96	3.30	0.83	10.28	〃 〃

3. Results and Discussions

The iso-anomaly contours of Bouguer anomaly are shown with 5 mgal intervals in Fig. 2 and Fig. 3. They correspond to the cases that $D=2.67$ gr/cm^3 and 2.30 gr/cm^3, respectively.

The Bouguer anomalies over this area are characterized by

a) a strong negative anomaly on the Aso caldera,

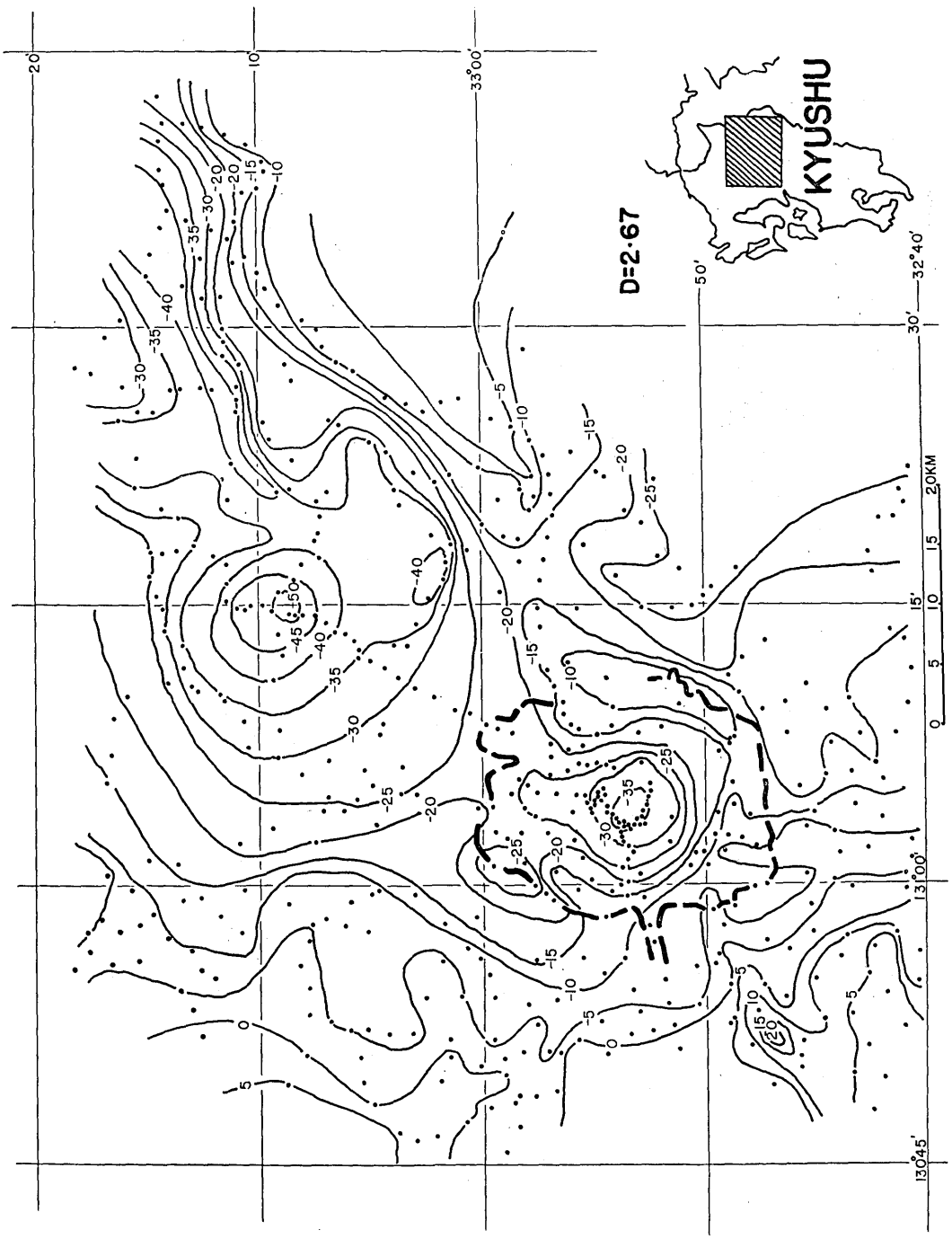

Fig. 2.

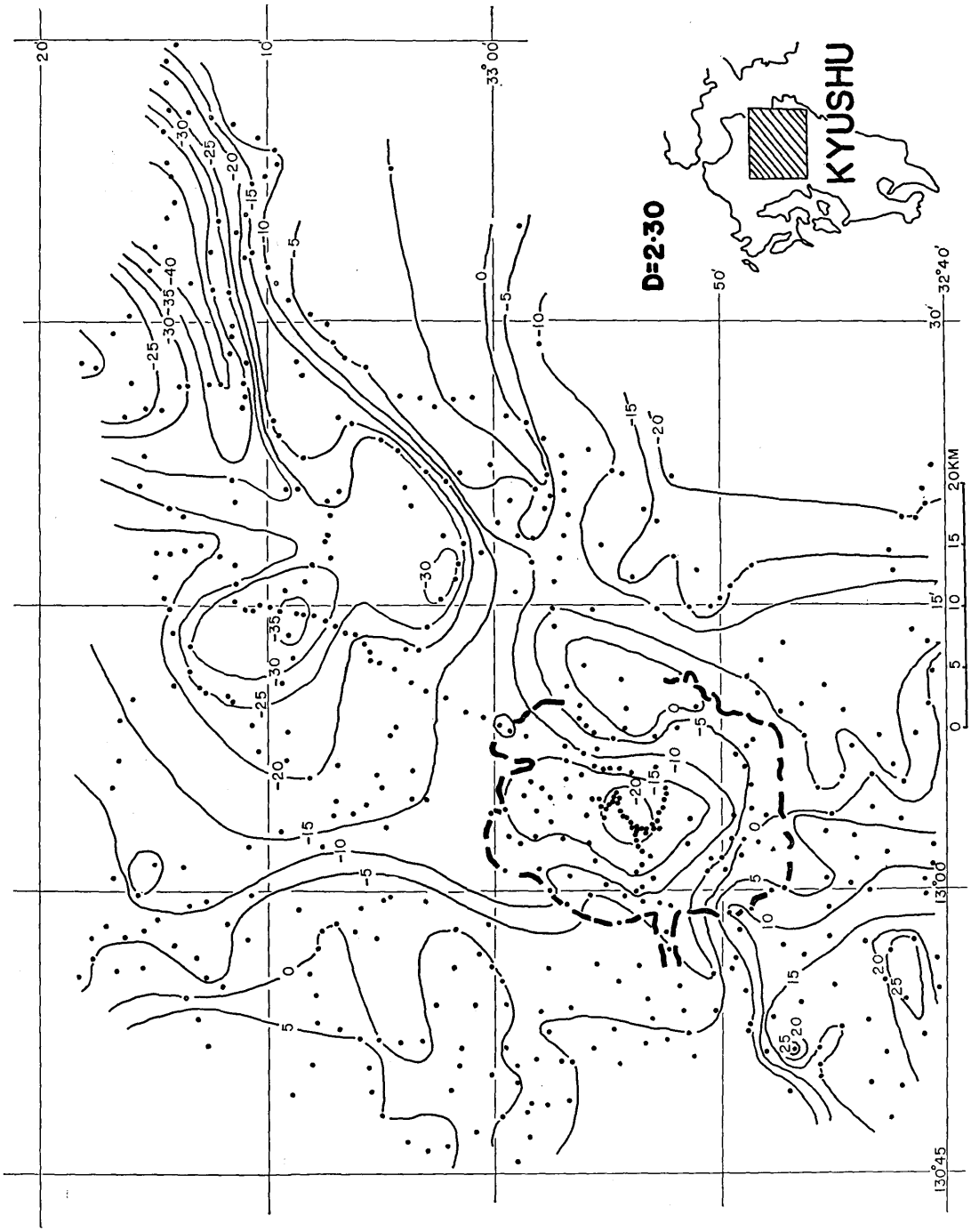

Fig. 2.

b) a circular negative anomaly over the Kuju volcano group on the north eastern side of the Aso caldera,
c) positive anomalies on the south-western flank of somma of the Aso caldera and
d) a narrow belt of relatively high gravity running from Ooita to Kumamoto.

a) *Negative anomaly over the Aso caldera*

A complete picture of negative anomalies spread over the Aso caldera was disclosed by the present survey. The gravity anomaly rapidly lowers toward the interior of the caldera with the maximum gradient 5.4 mgal/km amounting to −20 mgal at the center as compared with the neighbouring area. It exhibits a typical feature of "low anomaly type caldera" supporting Yokoyama's discussions (1963a). The rough sketch of this picture can be inferred also from the previous survey made by two of the present authors (Kubotera and Sumitomo, 1965). The contour lines of Bouguer anomaly over the Aso caldera are in conformity with its topography except at the north-eastern edge where the flank of the caldera gradually merges in the Kuju volcano group. The pattern of Bouguer anomaly over this area suggests that the Aso caldera is structually linked with the Kuju volcano group.

b) *Negative anomaly over the Kuju volcano group*

The negative anomalies extend over the Kuju volcano group occupying an area of about 350 km^2. The contour show concentric circular patterns. The relative values at the center lowers to −26 mgal as compared with surrounding area. The most of the low density deposits in this area are of volcanic origin. The gravity lowering in this district is probably ascribed to the mass defect caused by tremendous volcano tectonic depression.

Gravimetric view thus favours to suppose the "low anomaly type caldera" in this region such as the Aso and Aira though topography does not show it up clearly.

Independent information is available from geology. T. Matumoto (1963) proposed the buried caldera which he named Kuju caldera, formed by gigantic eruptions with a tremendous amount of pumice. From the detailed geological surveys in this area, the Kuju ignimbrite are found surrounding the Kuju volcano group. The geological age of Kuju ignimbrite which is one of the pyroclastic rocks distributed in this area has been estimated to be of the same age with the Aso ignimbrite, namely of Pleistocene. The pyroclastic rocks from Pleistocene are usually supposed to be related to the formation of volcanic calderas. The above proposal of T. Matumoto is mainly based on the distribution of this kind of pyroclastic rocks.

The distribution of Bouguer anomaly seems to confirm his opinion. Therefore, it seems that the gravity low over the Kuju volcano region due mainly to the subterranean structure of Kuju caldera. The center of negative anomaly is seen to be located around Senchomuta, a basin on the northern part of Kuju volcano group which probably coincides with the center of the presumed caldera.

From the above comparative study of the gravity and geology, the buried existence of the Kuju caldera is reasonably supported though the question how this gigantic caldera has disappeared in the following geological history is left unanswered.

T. Matumoto (loc. cit.) proposed that there are many other calderas such as Kusu, Asono and Toyo caldera in the north eastern part of Kyushu Island. The inference is again based on the distributions of ignimbrites of Yabakei, Shonai and Oono, respectively. Geological ages of these calderas natually coincide with the corresponding ignimbrites (Yabakei, Shonai and Oono ignimbrite are of Later Pliocene, Pliocene and Miocene, respectively). However, no conspicuous gravimetric pattern is found over the proposed region. Characteristic feature such as Aso and Kuju caldera, if it exists over the area concerned, could not be overlooked by this survey, taking the accuracy and density of observation points into consideration. It is a marked contrast in that the Krakatau-type calderas belonging to Pleistocene age generally reveal characteristic low gravity anomaly. Although it is questionable whether ignimbrites of any age are related to the formation of calderas, if they are, it might be that an isostatic equilibrium has been achieved for these aged volcanic calderas through the long passage of time. This point, however, is not clear because not many surveys of this kind have been carried out so far.

c) *Positive anomalies on the south-western flank of somma of the Aso caldera*

On the south-western flank of somma of the Aso caldera, there is found a region where the positive gravity anomalies amount to +22 mgal (in case when $D=2.67$ gr/cm^3 is assumed). A detailed geological survey on this area of H. Matsumoto (1963) has disclosed the outcrops of basalt. According to his investigations, the oldest formation in this area consists of semi-schist which is one of the typical metamorphic rocks in Japan belonging to Sanbagawa System. The southern part of this system contact with the Mifune group (Cretaceous Age) by a fault. The serpentines are found to have intruded along the boundary between these formations.

A comparison between gravimetric and geological investigations clearly shows that a center of the gravity high in this region corres-

ponds to the outcrop of the basaltic formation. It is clear, therefore, that the high gravity of the south western flank of somma of the Aso caldera is a reflexion of exceptionally thin deposits for central Kyushu of volcanic material on the base rock with high density such as basaltic and metamorphic formations.

The inferrence is also supported by the magnetic survey which showed anomalous pattern on this region (Blank et al 1966).

d) *Ooita-Kumamoto tectonic line*

A narrow belt of relatively high anomaly which starts from Ooita running west-ward to Kumamoto through the Aso caldera is remarkably observed in the maps of Bouguer anomaly (Fig. 2 and Fig. 3). This narrow belt is connected to above mentioned positive anomalous region. Along this belt, the Tectonic Line from Ooita to Kumamoto has been supposed to run among the geologists. The existence of this line has been demonstrated by our survey.

A peculiar pattern of Bouguer anomaly is along the coast of Beppu Bay on the north-eastern edge of our surveyed area. However, wider observation network is necessary to discuss the gravimetric feature of this area.

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The computation in this study was carried out at the Computer Centre of the University of Tokyo.

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13. 阿蘇及び九重火山地域の重力測定

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阿蘇及び九重火山地域を含む，約4300平方キロメートルの面積における重力測定結果について述べる．この研究は，日米科学協力の一環として行われた研究「日本火山カルデラの航空磁気重力測量」の一部をなすものである．

重力測定を行つた範囲は，国土地理院発行20万分の1地図の「大分」の大部分と「熊本」の東半分であつて，東径130°45′～131°45′ 北緯32°40′～33°15′ であり，測定点は446点である．

測定は，京都大学理学部，東京大学地震研究所が協力して，それぞれ Worden 及び LaCoste and Romberg 型の重力計を用いて実施した．

観測点は，水準点，三角点，独立標高点，鉄道駅，有料道路上等，高度の判明している点を選んだが，このようなものが選べない点上では，航空写真や地形図から高度を決めた．従つて，前者と後者では，重力異常値の精度に1桁以上の差がある．

全点で地形補正を実施し，また，測定地域に分布する，国土地理院の水準点に関して以前の国土地

理院で得たこれら水準点上の重力値についても地形補正を加えた．従つて，この地域の測点密度は平均して8.5平方キロメートルに1点の割となつた．

Bouguer 異常値を算出するに当り，密度を D=2.67 と仮定したものの他，種々の値を選んで求めて，Bouguer異常図を作成したが，大勢においては差がなかつた．本論には，D=2.67 と D=2.30 の場合が図示してある．

Bouguer 異常図で特徴的な地域は，阿蘇カルデラ上の −35 mgal (D=2.67) に達する低重力異常と，九重火山群上より見られる，同心円状の等重力異常線に囲まれた負の異常地区で，その中心では −52 mgal (D=2.67) に達する．更に阿蘇外輪の南西斜面に見出される，22 mgal (D=2.67) に達する，高異常域である．

阿蘇カルデラ上での低重力異常が，「低重力異常型カルデラ」の特性を示すものであることは，1954年の地震研究所及び1959年の国土地理院の水準路線上での重力測定結果から横山が結論しているし，また，1964年～1965年にかけて，著者の二人（久保寺，住友）による，カルデラ内の水準点，三角点上の重力測定でも明らかにされている．この測定結果は今回の測定を継続して行つた関係上，本論の中に測定結果を含めてある．

九重火山群上での低重力異常は，これ迄の坪井らの全国重力測定の結果からは国土地理院の水準路線が走つていない関係上，見出されていなかつたが，今回の測定結果からは，大凡，半径12～13 kmの円形の低重力異常が発見され，重力値は中心に向けて小さくなつている．このような重力異常は，カルデラ上の重力異常と類似しているし，一方地質的にも，松本唯一によつて，九重カルデラの存在が提唱されていることから，九重火山群の千丁無田付近の凹地を中心とする阿蘇カルデラと同等の大きさを持つカルデラの存在が明確になつた．しかし，このカルデラは地形的には，それ程明瞭ではない．

阿蘇南西外輪上での，高異常は，この地区が三波川系の変成岩地帯であつて，玄武岩の露頭が存在し，この露頭と，高異常の中心と一致していること等により，比較的高密度岩石の地層の露出していることと，高異常とが対応しているものと考えられる．また，地磁気の異常もこの地区に現われている．

大分—熊本構造線と言うものが地質学的に考えられているが，比較的高異常のせまい地帯が，阿蘇カルデラを横切つて東西に走つていて，この構造線の実在が重力的に明らかになつた．また，別府湾周辺にも重力異常域が見出されるが，更に測定点密度を増してから結論すべきものと考えられる．

本研究を実施するに当り，地震研究所，力武常次教授に種々御尽力戴いた．ここに厚く謝意を表する次第である．