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CRUSTAL DENSITY STRUCTURE OF THE MIZUHO PLATEAU, EAST ANTARCTICA FROM GRAVITY SURVEY IN 1992

Masaki KANAO[1], Kokichi KAMIYAMA[1] and Kiyoshi ITO[2]

[1]*National Institute of Polar Research,*
9–10, Kaga 1-chome, Itabashi-ku, Tokyo 173
[2]*Research Center for Earthquake Prediction, D.P.R.I.,*
Kyoto University, Gokasho, Uji 611

Abstract: Gravity measurements with a LaCoste & Romberg gravity meter were conducted on the Mizuho Plateau along the traverse routes from Syowa Station (69.0°S, 39.6°E) to Dome-F (77.4°S, 39.6°E) by the 33rd Japanese Antarctic Research Expedition (JARE-33) in 1992. Free-air and simple Bouguer gravity anomalies based on gravity disturbance along the traverse routes were obtained by use of both surface elevation data from GPS positioning and bedrock elevation from radio-echo sounding. A density model of crustal structure between Syowa and Mizuho Stations was derived on the basis of the *P*-wave velocity model from the refraction explosion experiments in 1980 and 1981. The structure of the southern part of Mizuho Station was derived from only gravity anomaly data. The simple Bouguer gravity anomaly was calculated by assuming the layered structure to fit the observed Bouguer anomaly. Increase of the Bouguer anomaly by about -200 mgal from Syowa toward the Dome area indicates crustal thickening of about 40 to 48 km. The resultant Moho depth beneath the Dome area is rather large compared with the averaged ones (40–45 km) over the continental area in East Antarctica.

1. Introduction

Several kinds of geophysical and glaciological surveys were carried out on the Mizuho Plateau, in East Queen Maud Land, East Antarctica, along the traverse routes from Syowa Station (69.0°S, 39.6°E) to Dome Fuji (77.4°S, 39.6°E; hereafter refereed to as Dome-F) over the distance of about 900 km by the 33rd Japanese Antarctic Research Expedition (JARE-33) from September 21 to December 29, 1992 (KAMIYAMA *et al.*, 1994a). The traverse routes surveyed in 1992 are shown in Fig. 1. Capital letters with a number attached show the location of the main observation points along the routes. 'Relay Point' and contours indicate the intermediate camp and the surface elevation, respectively.

The gravity measurements along the traverse routes were conducted by LaCoste & Romberg gravity meter (No., G-515) at about 10 km interval. The number of stations was 78 and the total number of measurements was 84. The main purpose of the measurements was to reveal the bedrock topography under the continental ice-sheet, particularly around Dome-F, by comparing to the bedrock elevation data obtained from radio-echo sounding measured by an oversnow vehicle. The detailed gravity measurement procedure is described by KAMIYAMA *et al.* (1994b). Free-air and simple Bouguer gravity anomalies

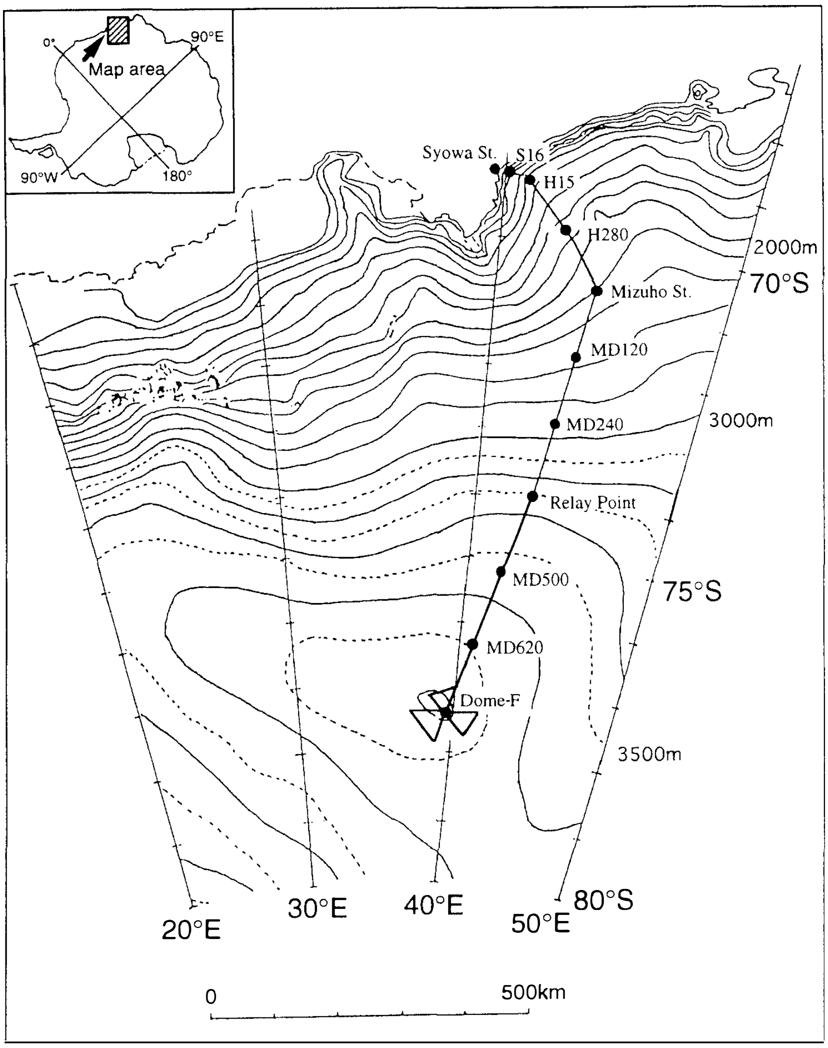

Fig. 1. Map showing the traverse routes studied in this paper, which were carried out by the wintering party of JARE-33. Single capital letter plus number shows the location of the main observation point along the routes. Relay Point indicates the intermediate camp and Dome-F indicates the Dome-Fuji, respectively. Contours indicate the surface elevation.

based on the gravity disturbance along the routes were calculated by using both surface elevation of the continental ice-sheet from GPS relative positioning and bedrock elevation from ground-based radio-echo sounding (MAENO *et al.*, 1994).

Gravimetric surveys on Mizuho Plateau were carried out several times over the last few decades by JAREs since 1961 (YANAI and KAKINUMA, 1971 ; YOSHIDA and YOSHIMURA, 1972 ; ABE, 1975 ; NAGAO and KAMINUMA, 1984). Recently, gravity was measured along the traverse routes over wide areas of the Mizuho Plateau ancillary to glaciological studies (AGETA *et al.*, 1987 ; NISHIO *et al.*, 1988). NAGAO and KAMINUMA (1988) compiled these gravity data on Mizuho Plateau ; NAGAO *et al.* (1991) re-compiled the data and presented the three-dimensional contour maps of gravity anomaly.

Big explosion seismic experiments were conducted in the northern Mizuho Plateau by JARE-20, -21 and -22 (1979–1981) (IKAMI *et al.*, 1984 ; ITO and IKAMI, 1984). The velocity structure of the crust and the upper mantle along the seismic profile between Syowa and Mizuho Stations was revealed in detail by analyzing the travel-time data and by comparing the observed seismograms with the synthetic ones. In addition to these explosion experiments, both gravity measurements and aeromagnetic surveys were carried out along the same line (KAMINUMA and NAGAO, 1984; SHIBUYA *et al*., 1984). An attempt was made to refine the crustal density structure between Syowa and Mizuho stations from the gravity data, in order to fit the *P*-wave velocity structure derived from the explosion experiments (ITO and IKAMI, 1986). Bouguer gravity anomaly was calculated by assuming the density of the layered structure to fit the observed gravity data, using the method of TALWANI *et al*. (1959).

In this paper, the crustal density model was derived, extending over the whole traverse route from Syowa Station to Dome-F by use of the method of ITO and IKAMI (1986), applying the gravity data obtained from the survey in 1992. The simple Bouguer gravity anomaly based on the concept of gravity disturbance was calculated by assuming the layered structure to fit the observed gravity anomaly. Thus, the crustal density section about 900 km inland from the marginal area of the east Antarctic continent was investigated.

2. Calculation of Gravity Anomalies

The reference point of the measurements was taken to be the absolute gravity station (IAGBN-A) of the gravimetric hut at Syowa Station, where the value $g = 982524.244$ mgal had already been obtained (FUJIWARA *et al*., 1993). Gravity anomalies were calculated after correction for the Earth tide and the drift of the gravity meter by the following formula. Free-air anomaly $\varDelta g$ is given by

$$\varDelta g = g - \gamma + 0.3086H + 0.87 - 0.0000965H, \qquad (1)$$

where g and γ are the measured gravity value and the normal gravity defined on the reference ellipsoid 1967 in mgal, respectively. H is the elevation of the gravity station in meters. The latter two terms in the above formula are atmospheric corrections. The simple Bouguer anomaly $\varDelta g'$ was calculated by the formula

$$\varDelta g' = \varDelta g - 2\pi G\rho_1 H, \qquad (2)$$

for an ice free area, where G is the earth gravity constant and ρ_1 is the density of bedrock (assumed 2.60 g/cm^3) and

$$\begin{aligned} \varDelta g' &= \varDelta g - 2\pi G\rho_1 (H - I) - 2\pi G\rho_2 I \qquad (3) \\ &= \varDelta g - 2\pi G\rho_1 H + 2\pi G(\rho_1 - \rho_2) I, \qquad (4) \end{aligned}$$

on the ice sheet, where ρ_2 is the density of ice (assumed 0.90 g/cm^3) and I is the ice sheet thickness in meters. This calculation procedure was the same as that of FUKUDA (1986). The density of bedrock (2.60 g/cm^3) used for calculation of the Bouguer reduction was adopted as that of the lower end of rock samples of a drilling core at Syowa Station. The velocity of these samples was measured by laboratory experiments. Table 1 shows the density, porosity and major mineralogical constituents for the rock samples (after YUKUTAKE and ITO, 1984).

Table 1. Density, porosity and major mineralogical constituents of the sample rocks of the drilling core at Syowa Station (after YUKUTAKE *and* ITO, *1984).*

Symbol of sample	Depht of sample (m)	Bulk density (g/cm^3)	Apparent porosity (%)	Major mineralogical constituents
SP-B	2.1	2.686	0.3	Quartz (rich), feldspar, biotite
SP-C	4.4	2.612	1.0	Quartz (rich), feldspar, biotite
SP-D	9.1	2.822	0.6	Ouartz, feldspar, magnetite, hornblende (rich)
SP-E	14.6	2.775	0.6	Quartz, feldspar (rich), biotite
SP-G	23.8	2.618	0.7	Quartz, feldspar, hornblende
SP-H	29.1	2.668	0.8	Quartz, feldspar, biotite, hornblende
SP-V	2	2.664	1.8	Quartz, feldspar, garnet

The geoid height (the difference between the GPS height and geoid plane) at the astronomical point of Syowa Station was determined to be 22.2 m (KAMINUMA *et al*., 1984 ; SHIBUYA, 1985). Recently, FUKUDA *et al.* (1990) made an accurate estimate of the geoidal undulations around the Japanese Antarctic stations (60°-80°S, 20°-50°E) using both satellite altimeter data and surface gravity data. The elevation above the geoid plane was used to correct the gravity anomaly calculation for each surveyed station. The 'gravity disturbance' is a kind of anomaly reduced to the surface of the normal earth ellipsoid which is the reference surface to estimate the geoid height (SEGAWA, 1984). The elevation in this survey was determined by GPS positioning on the WGS-72 ellipsoid. Gravity anomalies, therefore, were calculated based on the concept of gravity disturbance by use of the elevation from GPS positioning. As for the Bouguer reduction, the 'Bouguer disturbance' based on elevation by use of height measured above the normal ellipsoid was also adopted in this study. Hereafter, we refer to the 'Bouguer disturbance' based on the GPS ellipsoid as the 'Bouguer anomaly' in the following discussion. In practice, there is no confusion in the interpretation of the result obtained from this elevation.

The accuracy of the obtained gravity anomalies is about 3 mgal for the free-air anomaly due to the uncertainty (about 10 m) of the determination of the elevation by GPS positioning. On the other hand, the accumulated error in the determination of Bouguer anomaly is about 10 mgal, which is considered to be the summation of the uncertainty of GPS height determination and the uncertainty of the determination of the bedrock elevation by radio-echo sounding. The maximum estimated error of the determination of bedrock elevation is about 100 m (MAENO *et al*., 1994), which causes the Bouguer anomaly error of about 7 mgal.

Locations of the surveyed stations with surface elevation, obtained free-air and Bouguer gravity anomalies, and bedrock elevation used in this study are listed in Table 2. The obtained gravity anomalies are presented with the ice-sheet and bedrock elevation in Fig. 2. The upper part shows the surface elevations of the ice sheet (broken line) and the bedrock topography (solid line) along the traverse routes. These traces are projected on the 40°E cross section from Syowa Station to the Dome area. The lower part of Fig. 2 shows the free-air and simple Bouguer gravity anomalies, assuming a reduction bedrock density of 2.60 g/cm^3 along the traverse routes projected on the 40°E cross section. The obtained gravity anomalies based on the elevation system by geoid height were reported in

Table 2. Location of surveyed stations, free-air and Bouguer gravity anomalies and the bedrock elevations obtained in this study.

	Station	Latitude (deg.)	Longitude (deg.)	Elevation (m)	Free air (mgal)	Bouguer (mgal)	Bedrock (m)
0	IABBN (A)	−69.008	39.592	21	−17.9	−20.3	21
1	S16 (1)	−69.028	40.052	586	19.2	−21.4	236
2	H24	−69.102	40.830	1080	20.1	−35.6	160
3	H231 (1)	−69.772	42.442	1685	22.7	−36.2	−134
4	H297	−70.003	43.030	1891	59.8	−40.0	321
5	Z33 (1)	−70.268	43.572	2060	47.0	−73.8	519
6	MD60	−71.288	440.77	2405	24.2	−88.2	205
7	MD220	−72.730	43.543	2943	46.4	−117.0	613
8	MD292	−73.372	42.263	3162	48.2	−156.1	1062
9	MD394	−74.270	42.812	3466	56.5	−139.1	766
10	MD432	−74.623	42.532	3513	48.2	−139.8	633
11	MD510 (1)	−75.325	41.922	3628	29.5	−136.5	258
12	MD586	−75.997	41.175	3691	61.4	−190.7	1431
13	MD664	−76.697	40.393	3750	19.5	−168.7	500
14	MD726	−77.257	39.753	3807	27.1	−171.7	617
15	MD738 (1)	−77.363	39.628	3808	26.6	−191.6	888
16	DS22	−77.573	39.367	3793	16.9	−199.6	873
17	DS40	−77.735	39.127	3770	56.5	−204.4	1510
18	DF104	−77.370	37.630	3788	22.7	−176.2	628
19	DS126	−77.368	40.713	3781	34.3	−176.6	801
20	DS140	−77.365	41.310	3771	23.8	−186.7	801
21	DS158	−77.520	41.023	3783	61.5	−210.2	1653
22	DS170	−77.562	40.482	3777	43.7	−217.4	1507
23	MD738 (2)	−77.363	39.627	3808	26.5	−197.4	968
24	DO4	−77.355	39.577	3805	24.8	−216.7	1055
25	DF80	−77.373	39.607	3807	6.8	−219.8	1007
26	DF72	−77.258	39.217	3802	12.8	−218.3	1072
27	DF63	−77.162	38.637	3801	28.1	−200.0	1031
28	DS306	−77.142	38.870	3803	30.7	−201.1	1083
29	DS320	−77.092	39.397	3804	33.8	−196.1	1054
30	DS330	−77.050	39.760	3795	30.8	−222.3	1385
31	MD694	−76.965	40.080	3781	2.9	−191.6	571
32	MD673	−76.773	40.302	3764	18.2	−180.7	643
33	MD660	−76.658	40.437	3752	2.2	−184.8	482
34	MD644	−76.517	40.592	3741	−7.5	−185.4	361
35	MD632	−76.408	40.713	3735	0.4	188.2	515
36	MD620	−76.300	40.832	3720	5.2	−188.2	590
37	MD604	−76.157	40.987	3716	1.2	−172.5	316
38	MD595	−76.073	41.073	3713	26.4	−191.8	942
39	MD584	−75.977	41.202	3686	47.7	−182.5	1126
40	MD568	−75.833	41.358	3680	61.9	−197.5	1540
41	MD551	−75.680	41.528	3663	53.5	−190.4	1332
42	MD534	−75.533	41.697	3645	37.4	−161.1	705
43	MD524	−75.443	41 .788	3641	28.0	−158.7	541
44	MD510 (2)	−75.322	41.930	3628	29.6	−136.3	258

Table 2 (continued).

	Station	Latitude (deg.)	Longitude (deg.)	Elevation (m)	Free air (mgal)	Bouguer (mgal)	Bedrock (m)
45	MD500	−75.232	42.012	3615	22.6	−146.9	315
46	MD488	−75.125	42.095	3596	26.4	−153.9	476
47	MD470	−74.963	42.252	3577	33.0	−161.5	687
48	MD434	−74.638	42.525	3518	42.1	−150.0	688
49	MD418	−74.493	42.635	3509	36.5	−151.7	639
50	MD396	−74.293	42.797	3468	44.7	−146.8	708
51	MD384	−74.187	42.887	3429	51.5	−153.5	919
52	MD364 (R/B)	−74.008	42.997	3348	27.4	−150.0	578
53	MD348	−73.847	43.057	3293	16.1	−154.5	513
54	MD314	−73.560	43.178	3218	19.6	−149.7	538
55	MD300	−73.435	43.235	3198	21.2	−140.1	438
56	MD293	−73.372	43.260	3169	43.0	−163.4	1088
57	MD268	−73.150	43.363	3098	25.2	−127.0	368
58	MD240	−72.902	43.475	2995	51.7	−148.8	1105
59	MD228	−72.793	43.520	2954	36.4	−114.7	434
60	MD207	−72.602	43.593	2898	35.3	−109.6	378
61	MD184	−72.400	43.678	2833	38.4	−98.5	303
62	MD165	−72.227	43.738	2746	26.1	−104.6	266
63	MD142	−72.023	43.823	2669	16.4	−97.1	69
64	MD120	−71.828	43.890	2594	13.6	−98.7	94
65	MD110	−71.737	43.920	2569	17.3	−102.1	209
66	MD92	−71.568	43.972	2488	22.9	−104.5	368
67	MD70	−71.378	44.047	2432	17.8	−86.3	72
68	MD40	−71.110	44.133	2355	30.0	−83.3	245
69	MD32	−71.040	44.155	2346	27.0	−77.4	126
70	MD12	−70.857	44.207	2290	34.4	−73.7	210
71	IM3	−70,753	44.247	2258	30.2	−87.1	358
72	MIZUHO	−70.698	44.332	2245	25.6	−78.9	185
73	Z94	−70.622	44.170	2201	24.1	−86.9	301
74	Z40	−70.320	43.658	2097	38.2	−70.4	327
75	Z33 (2)	−70.268	43.572	2060	43.0	−77.8	519
76	S122	−70.022	43.130	1,916	59.8	−50.7	456
77	H260	−69.877	42.695	1772	35.5	−37.4	12
78	H231 (2)	−69.772	42.442	1685	19.5	−39.5	−134
79	H160	−69.515	41.815	1510	9.1	−50.9	−20
80	H94	−69.277	41.272	1292	17.5	−42.3	101
81	H15	−69.080	40.777	1045	16.1	−31.7	75
82	S16 (2)	−69.028	40.052	586	18.1	−22.6	236
83	IAGBN(NO 1)	−69.008	39.592	21	−17.8	−20.2	21

the JARE Data Report by Kamiyama *et al.* (1994a), and the method for the calculation of anomalies was described in detail by Kamiyama *et al.* (1994b).

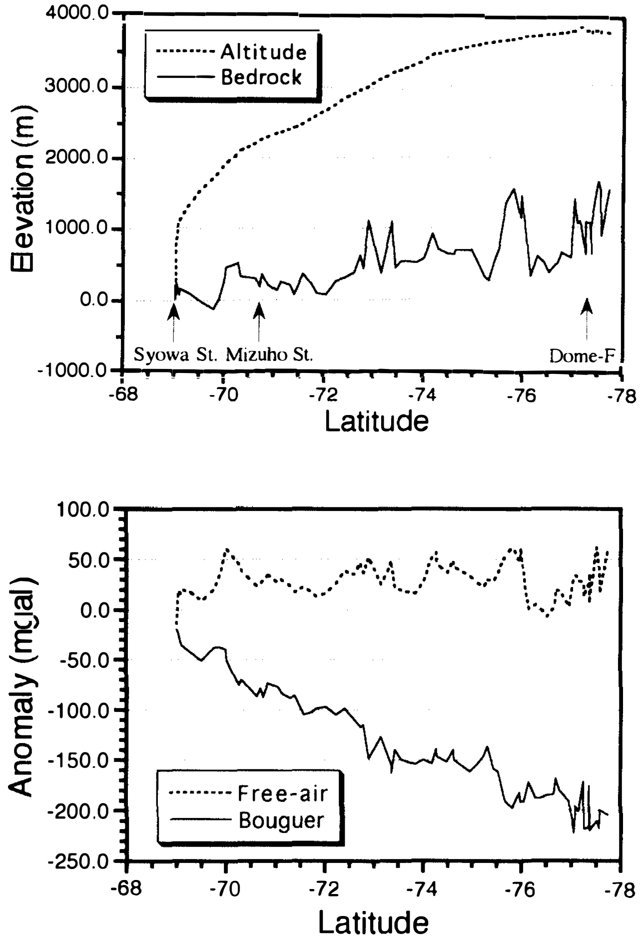

Fig. 2. Upper figure : Surface elevation of the continental ice sheet (altitude : broken line) and bedrock topography (bedrock : solid line) along the traverse routes projected on the 40°E cross section from Syowa Station to Dome-F. Lower figure : Free-air gravity anomaly (broken line) and simple Bouguer gravity anomaly (solid line) along the traverse routes reflected to 40°E cross section.

3. Modeling of the Crustal Structure

In this study, the density model of crustal structure was extended from Mizuho station toward the southern continental area around Dome-F, about 900 km inland from the Prince Olav Coast. The gravity anomaly calculation method was the same as that used by Ito and Ikami (1986). The structure between Syowa and Mizuho stations was modified after the result of Ito and Ikami (1986). The rest of the structure (*i.e.* part south of Mizuho Station) was derived by fitting the calculated gravity anomaly to the observed ones. Bouguer gravity anomaly was calculated by assuming the layered structure as an approximation to n-sided polygons (Talwani *et al.*, 1959) so as to fit the observed Bouguer gravity anomaly.

In the actual gravity anomaly calculation, we assumed a layered density structure with a constant density throughout each layer. The depths of discontinuities were determined on the basis of the P-wave velocity structure (Fig. 3) between Syowa and Mizuho Stations

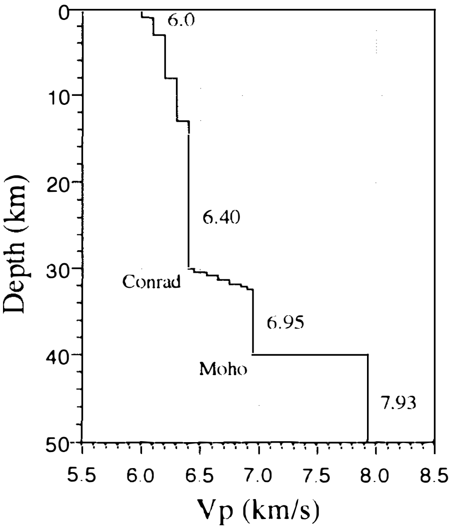

Fig. 3. *Crustal velocity model for P waves on Mizuho Plateau derived from seismic refraction experiments (modified after* IKAMI *et al., 1984). The depths of discontinuities between the upper and lower crust (Conrad), and between the lower crust and upper mantle (Moho) are 33 km and 40 km, respectively.*

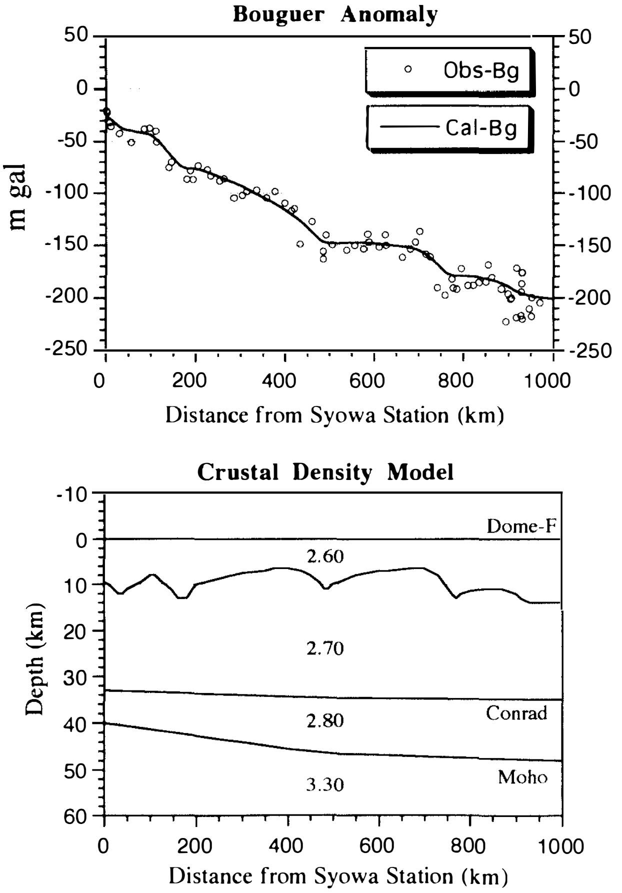

Fig. 4. *Upper figure : Observed Bouguer gravity anomaly from this survey (open circles : Obs-Bg) and calculated gravity anomaly from density model (solid line : Cal-Bg). The horizontal axis indicates the southward distance from Syowa Station. Dome-F is located about 900 km southward. Lower figure : Crustal density model from Syowa Station to Dome-F. The structure between Syowa and Mizuho Stations is derived from the Bouguer gravity anomaly on the basis of the P-wave velocity structure shown in Fig. 5. The rest of the structure is modeled from only gravity data. Numerals show the density of the layer in g/cm^3. The Moho depth beneath the Dome area is 48 km in this model.*

derived from the explosion experiments by IKAMI *et al.* (1984). The depths of discontinuities between upper and lower crust (Conrad), and between the lower crust and upper mantle (Moho) are 33 km and 40 km, respectively. The upper crust has the structure from the surface velocity of 6.0 km/s to the velocity of 6.40 km/s above the Conrad discontinuity. The density model was assumed to have four layers in order to constrain the structure, considering two wavelength variation in the Bouguer anomaly of the short and long period of undulation. Details are described in Section 4. The short-wavelength variation in the Bouguer anomaly was considered to be caused by the undulation of the discontinuity between the first and second layers. The densities of the two layers are 2.60 and 2.70 g/cm^3, respectively. On the other hand, the long-wavelength variation of more than 100 km was considered to be affected by the change in the two deeper discontinuities, the Conrad discontinuity (between the second layer (density$=$2.70 g/cm^3) and the third layer (density$=$2.80 g/cm^3)), and the Moho discontinuity (between the third layer (density$=$2.80 g/cm^3) and the fourth layer (density$=$3.30 g/cm^3)).

After some trial and error to fit the calculated anomaly to the observed one, a final crustal density model was obtained. It is presented in the lower part of Fig. 4. The Moho depth declines slightly from Syowa Station (40 km) toward the Dome-F area (48 km), and the Conrad depth gradually changes from 33 km to 36 km toward the south. The discontinuity in the upper crust varies in depth from 6.5 km to 14 km. The upper part of Fig. 4 shows the observed Bouguer gravity anomaly from the survey (open circles) ; the calculated gravity anomaly from the density model assumed is shown in lower figure (solid line). The horizontal axis is the southward distance from Syowa Station. Dome-F is located at about 900 km.

4. Discussion and Concluding Remarks

4.1. Relationship to bedrock elevation

Bedrock elevation is important in deriving the crustal structure from the gravity data, because a small error of bedrock elevation causes a large error in the gravity anomaly, as mentioned in the previous section. The relationship between free-air gravity anomaly and the bedrock elevation in this survey was pointed out by KAMIYAMA *et al.* (1994b). In this section, the relationship between the bedrock elevation and the simple Bouguer anomaly is discussed. It is useful to adopt a filtering technique in order to divide the gravity anomaly into short and long fluctuation periods. The feasible cut off wavelength was about 100 km (after DAGGETT *et al.*, 1986).

Figure 5 indicates the relationship between the bedrock elevation and the observed simple Bouguer anomaly. The obtained gravity anomaly correlates well ($R=0.8023$) with that of the bedrock elevation from radio-echo soundings. It is also revealed from Figs. 2 and 5 that there is some relationship between these two parameters not only for long but also short wavelengths. In the process of deriving the density model, the short-wavelength variation of Bouguer anomaly was considered to be caused by the change of thickness of the shallow part of the structure such as the depth of the first layer, while the long-wavelength variation of more than 100 km is caused by the change in the density structure in the deeper part of the crust and the upper mantle (*i.e.* the depth change of the Moho and Conrad). Judging from the long-wavelength variation shown in Fig. 5, the Bouguer

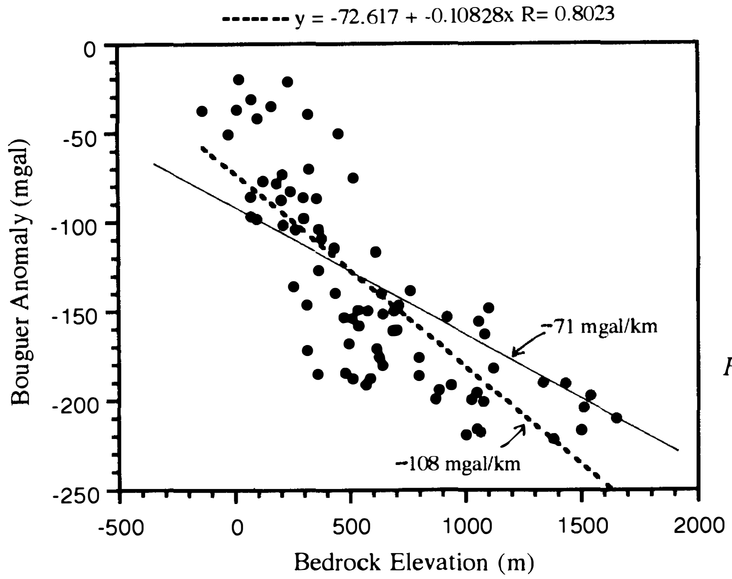

Fig. 5. Relationship between the bedrock elevation and the simple Bouguer anomaly for the reduction density of 2.60 g/cm^3*. The regressive curve is drawn by a broken line.*

anomaly decreases gradually from Syowa Station to reach about −200 mgal beneath the Dome-F area, corresponding to the values of 1000–1500 m bedrock elevation. This inclination of the long-wavelength trend suggests that the assumed rock density (2.60 g/cm^3) for the Bouguer anomaly calculation has lateral heterogeneity along the long traverse routes from Syowa Station to Dome-F. It also suggests that the density discontinuity of the deeper part of the crust gradually changes from Syowa Station to the Dome area, implying that the Moho discontinuity deepens toward Dome area. Under the assumptions mentioned above, the density model was derived as shown in Section 3.

4.2. *Accuracy of Bouguer anomaly*

As already mentioned in Section 2, the accumulated error of Bouguer anomaly was considered to be caused by the summation effect of the uncertainty of the elevation determination and the accuracy of the bedrock elevation by radio-echo sounding. Since the radio-echo soundings are generally accompanied by multiple echoes, the interpretation is not simple. The determination error of bedrock elevation by radio-echo soundings reached 100 m, which causes an error of Bouguer anomaly by about 7 mgal resulting in an error of Moho depth of about 0.3 km. This seems to be the most serious cause of the estimated errors. On the assumption that the actual bedrock elevation is deeper than the observed one, the depth of the Moho will become shallower in order to fit the Bouguer anomaly based on the crustal model.

NAGAO (1984) pointed out the discrepancy between the bedrock elevation determined by radio-echo soundings and the gravity anomaly along the Mizuho routes, and also the problem about the accuracy of bedrock elevation. Recently KUDO and NAGAO (1994) pointed out that the gradient in Fig. 5 contradicts the theoretical one. For the simple case of a layered half space, the gradient is $2\pi G(\rho_1-\rho_2)I$, where G is the gravity constant, and ρ_1 and ρ_2 are the densities of bedrock and ice. When we take $\rho_1=2.60$ and $\rho_2=0.90$ g/cm^3, the gradient is −71 mgal/km. However, the observed gradient is steeper; about −108 mgal/km. To solve this contradiction, KUDO and NAGAO (1994) considered that

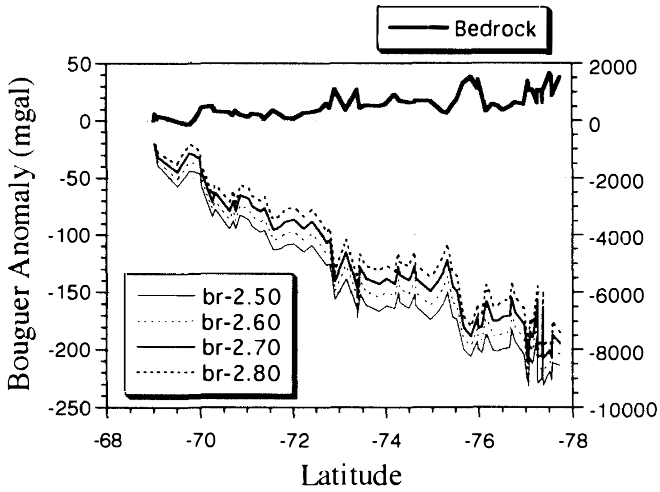

Fig. 6. Observed simple Bouguer anomaly for different reduction density. Each trace from br-2.50 to br-2.80 corresponds to density from 2.50 g/cm^3 to 2.80 g/cm^3. The bedrock elevation is presented by broken line for comparison.

the ice thickness has considerable error. If their thought is correct, the thickness of the ice sheet should be larger than the observed one. There is another possibility to explain shallower bedrock elevation by radio-echo soundings that the existence of the mixture layer of ice and moraine rocks over the bedrock.

As for the assumption of the density for Bouguer anomaly calculation, we adopted the value of 2.60 g/cm^3 as a surface bedrock density (the same as the first layer of the density model). The trial estimation was carried out to vary the reduction density from 2.50 g/cm^3 to 2.80 g/cm^3. Figure 6 shows the Bouguer anomaly for the different reduction density for each trace. The offset of 13 mgal can be derived beneath the Dome area according to the density change by 0.1 g/cm^3. Therefore, the estimated change in Bouguer anomaly is 10 mgal between the assumed value of 2.60 g/cm^3 in this study and the averaged value of the continental crust of 2.67 g/cm^3.

4.3. *Crustal thickness*

Observed Bouguer anomaly is about -200 mgal just beneath the Dome-F area, 900 km inland from the continental margin. By fitting the calculated anomaly to observed ones, the Moho depth was found to increase from 40 km to about 48 km from Syowa Station to Dome-F as seen in Fig. 4. A similar analysis for crustal density structure has been carried out in the Ross ice stream, West Antarctica, by use of seismic refraction/wide-angle reflection and gravity profile (MUNSON and BENTLEY, 1992). From their result, the crustal thickness is about 15 km in the area. NAGAO and KAMINUMA (1984) showed the difference of the Moho depth by about 4 km between Yamato Mountain area and Lützow-Holm Bay region from analysis of the Bouguer anomaly. The mean thickness of the Moho was reviewed to be about 40–45 km in East Antarctica and 30 km in West Antarctica including the results of seismic explosion experiments (BENTLY, 1983 ; KADMINA *et al.*, 1983). The thickness of the crust from gravity data was summarized by GROUSHINSKY and SAZHINA (1982). The Moho becomes deeper from the continental margin to 600–700 km inland along the latitude of 76°S in East Antarctica.

Comparing our result with that by the JARE South Pole Traverse party from Syowa Station to the South Pole in 1968 (YANAI and KAKINUMA, 1971), the thickening of the crust toward the Dome-F area was nearly the same in both cases. Although the Moho depth was almost constant at 75°S, around 46-47 km depth from their result, the bedrock elevation could not be obtained accurately, particularly the inland area, during that South Pole traverse. The advantage of the result in this study is that the continuous bedrock topography profiles were obtained with high resolution by the precise ground-based radio-echo sounding. Therefore, the results for the Bouguer anomaly and the obtained crustal structure are more accurate than those of 1968. The result for the Moho depth beneath the Dome-F area seems to be rather deep compared to the other result mentioned above in the marginal region of East Antarctica.

In order to obtain the gravity anomaly map more accurately over a wide area, surveys at many stations are needed on Mizuho Plateau by use of seismic refraction and reflection experiments, magnetic surveys and, in particular, precise radio-echo sounding, both ground-based and airborne. Recent progress of ice-core drilling technology will make it possible to measure the actual depth of the ice sheet and to investigate the actual condition between the bedrock and ice-sheet on the Antarctic Continent. The contradiction of bedrock elevation (ice thickness) has great importance for the evaluation of crustal structure, and should be discussed and solved by cooperation between glaciology and geophysics.

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