IV. GRAVITY MEASUREMENT

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In the present cruise, gravity measurement was carried out by the method of surface ship gravity meter, Air-Sea Gravity Meter of La Coste and Romberg Co. with a measurement accuracy of 1 mgal. The gravity was measured along the geophysical traverse of Japan-Hawaii, Hawaii-surveyed area, surveyed area-Japan, besides the tracks closely arranged in the surveyed area of the Eastern Pacific Basin. The surveyed lines are tabulated in Table IV-1.

Procedure

The gravity values in the measurements were connected with the gravity value on land at Chiba Port. That is to say, based upon the previously known values of gravity at three leveling points of 3832, 3833 and 3835, measured by the Geographical Survey Institute, we measured the gravity at these leveling points by the Worden Land Gravity Meter Model 3 of land use again and also that in the neighbourhood of the Hakurei-Maru Pier of Chiba Port, and then the absolute value of the gravity, 979,777.20 mgal at this point was decided (Table IV-2).

In each track, gravity measurements were made every 30 minutes. During seismic surveying, the ship's speed was about 12 kt, so distance interval of each measurement points was about 6n.m. On the other hand, during the navigation without seismic surveying, the ship's speed was about 15 kt, and each measurement was made every about 7.5n.m. The gravity values during course changes and speed changes of the ship and during the following 15 min. were unsteady and so they were excluded from the data processing. The time constant of the high-cut filter of the gravity meter output was 3 min.

Table IV-1   List of length of the survey lines for gravity measurement.

Designation of the survey line	Length (n.m.) of the survey line	Approximate direction
Chiba → Honolulu	3,403	W → E
Honolulu → survey area[1]	752	NE → SW
survey area → Hilo	883	SW → NE
Honolulu → survey area[2]	792	NE → SW
survey area	2,780	—
survey area → Chiba	2,320	ESE → WNW

Note: 1—track of east side
2—track of west side

Table IV-2   The gravity measurement at the neighbourhood of the Hakurei-Maru in Chiba port with Worden Land Gravity Meter (measured in 1974).

Measurement point	Height	Gravity value
level 3832	6.93 m	979,788.47 mgal
level 3833	9.29	979,782.12
level 3835	2.10	979,777.06
dock site in Chiba port	3.04	979,777.20

BOUGUER
ANOMALY

FREE AIR
ANOMALY

TOPOGRAPHY

P5

P4

P3

P2

P1

246 d

245 d

244 d

NE ⟶ SW

FREE AIR (MGAL)100
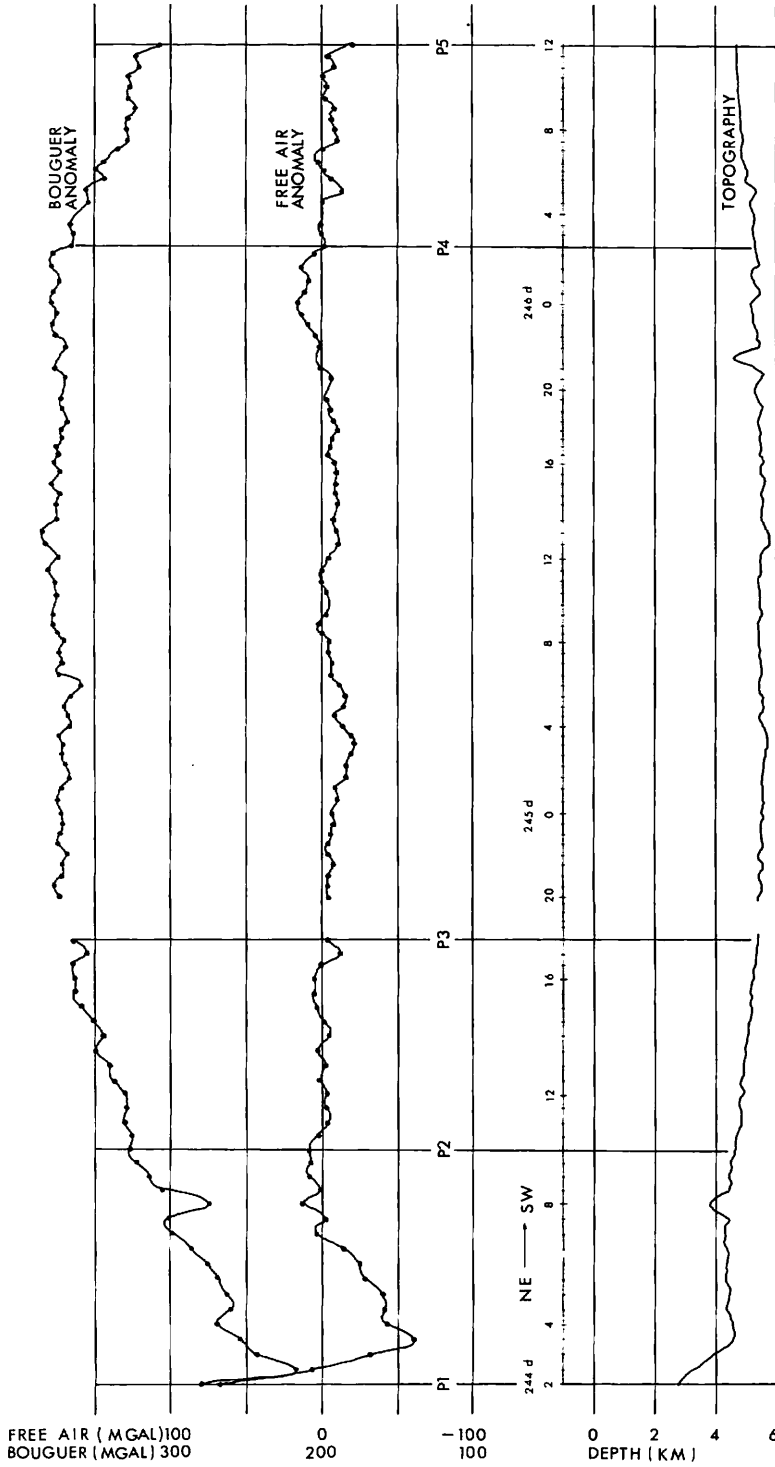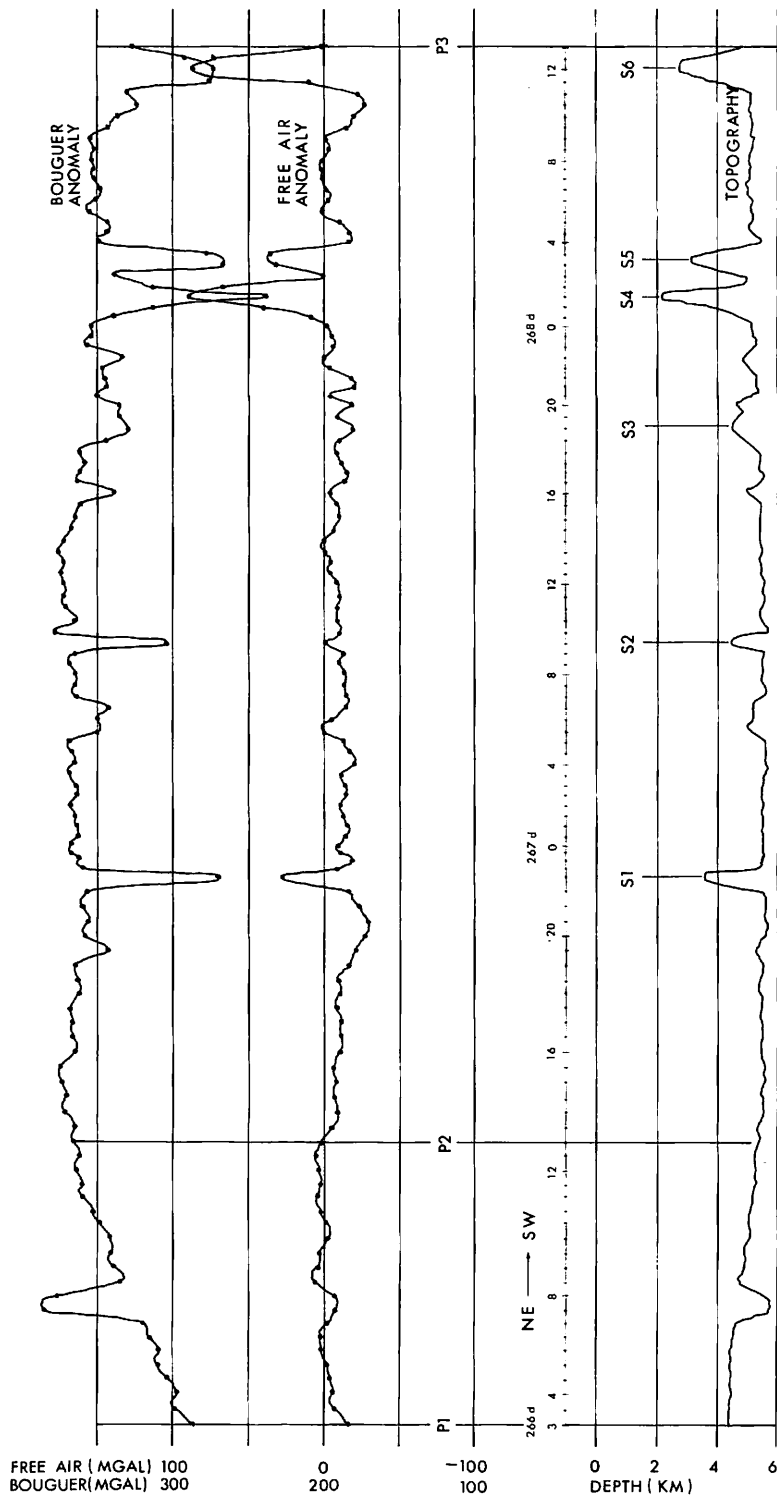BOUGUER (MGAL) 300

0
200

−100
100

0
2
4
6
DEPTH (KM)

Fig. IV-1   Free air and Bouguer gravity anomaly profile from south-west of Oahu Island to the surveyed area (track of east side).
P1 = 21°00′N, 158°04′W south-west about 60 km of Oahu Island   P2 = 19°12′N, 159°14′W
P3 = 17°34′N, 160°16′W   P4 = 12°18′N, 163°52′W   P5 = 10°49′N, 164°55′W

Fig. IV-2 Free air and Bouguer gravity anomaly profile from south-west of Oahu Island to the surveyed area (track of west side).
P1 = 20°01'N, 159°00'W south-west about 200 km of Oahu Island   P2 = 18°01'N, 160°49'W   P3 = 10°15'N, 167°18'W
from S1 to S6: seamount
S6: seamount of north side of the survey area 10°26'N, 167°10'W

Based on the results of measurements, free air anomaly and Bouguer anomaly were calculated, and composite profiles with topography were prepared for every track in the surveyed area and its adjacents. For calculation of the latitude correction for free air anomaly, the International Gravity Formula was applied, and the Bouguer anomaly was computed under the assumption of the water density of 1.03 gr/cm^3 and rock density of 2.67 gr/cm^3.

Results

Gravity measurements of Oahu Island—surveyed area

Two profiles were obtained. They are the tracks of east side and west side between Oahu Island to the surveyed area, respectively (see Fig. I-4), and they are apart about 90 km on average.

Gravity measurements from 244 day to 246 day. The result is shown in Fig. IV-1. The profile represents that of the east side cited above, and the starting point, P1 is located at about 60 km south-south-west of Oahu Island, the total distance to the end point, P5, measuring about 690n.m. Free air anomaly shows +70 mgal at P1, but
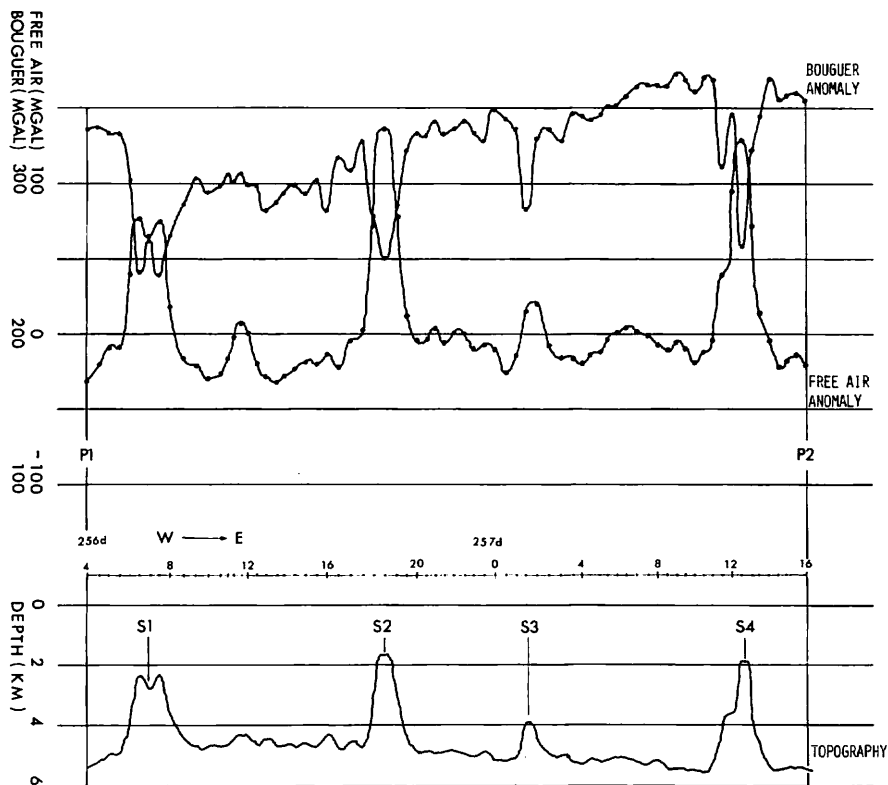

Fig. IV-3   Free air and Bouguer gravity anomaly profile from the surveyed area to south of Clarion Fracture Zone.
P1 = 10°01′N, 166°53′W
P2 = 11°54′N, 160°19′W south about 110 km of Clarion Fracture Zone
from S1 to S2: seamount
S1: seamount of north-west side of the surveyed area 10°15′N, 166°10′W

abrupty decreases to −60 mgal towards offshore. On the other hand, it increases again to about 0 mgal southwesterly, and the value from the adjacents of P2 to P5 is rather constant, slightly varying in the range from +20 to −20 mgal. The Bouguer anomaly remarkably increases at a rate of 0.42 mgal/km from near P1 to P2, and 0.21 mgal/km from P2 to P3. The water depth from P2 to P3 becomes deeper from 4,600 m to 5,300 m as the Bouguer anomaly increases. This corresponds to the gradient of the Bouguer correction of 0.25 mgal/km, and it is concluded that the Bouguer anomaly variation from P2 to P3 is dependent upon topography.

Gravity measurements from 266 day to 268 day. The result is shown in Fig. IV-2. The track is measured about 740n.m. of the total distance from the starting point, P1 which is located at about 200 km south-west of Oahu Island to the end point, P3, northern extremity of surveyed area. This track crosses six seamounts which are shown as the symbols of S1-S6 in the figure. Above the seamounts S4 and S6, free air anomaly was calculated to about +90 mgal, which is 20–30 mgal lower than the adjacent basins, and also the Bouguer anomaly is 100 mgal lower than the same ones.
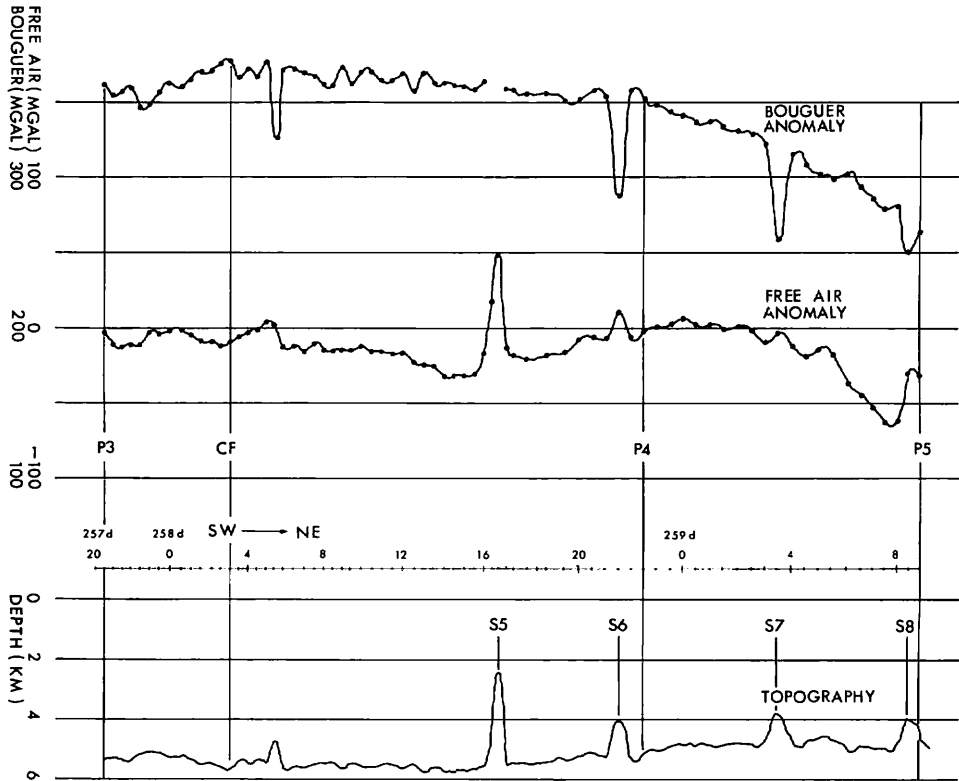

Fig. IV-4 Free air and Bouguer gravity anomaly profile from south of Clarion Fracture Zone to Hawaii Island.
P3 = 12°27'N, 159°44'W south about 80 km of Clarion Fracture Zone
P4 = 16°34'N, 156°55'W
P5 = 18°37'N, 155°31'W south about 40 km of Hawaii Island
from S5 to S8: seamount
CF: Clarion Fracture Zone

Gravity measurements of surveyed area-Hawaii Island

The track runs the Clarion Fracture Zone. The gravity profile is shown in Fig. IV-3 (southern segment) and Fig. IV-4 (northern segment). The southern segment includes four seamounts (S1-S4). Above the seamounts S1 and S4, the free air anomaly is +140 mgal and Bouguer anomaly shows generally low values. In the northern segment, the Bouguer anomaly only slightly varies from +350 mgal to +380 mgal. The variation of free air anomaly is from 0 mgal to −30 mgal and the anomaly strikingly decreases to −60 mgal at the foot of Hawaii Island.

Gravity measurements in the surveyed area

Figs. IV-5–9 show gravity profiles of some tracks in the surveyed area. Based upon the whole profiles obtained, the contour maps of the free air anomaly (Fig. IV-10) and the Bouguer anomaly (Fig. IV-11) were prepared through the area.

The free air anomaly is generally low in the basin of the south-west part and its value is 10 mgal lower than the other part of the basin. The low anomaly areas of the free air gravity exist in the vicinity of St. 132, St. 139 and St. 142 (see Fig. I-5). The free air anomaly is −40 mgal at St. 132, −30 mgal at St. 139 and −20 mgal at St. 142. On the other hand, the Bouguer anomaly is generally high in the southwestern part of the basin and the value is about 20 mgal higher than the other areas, although in certain areas of St. 139 and St. 142 above cited the Bouguer anomaly also shows lower value.
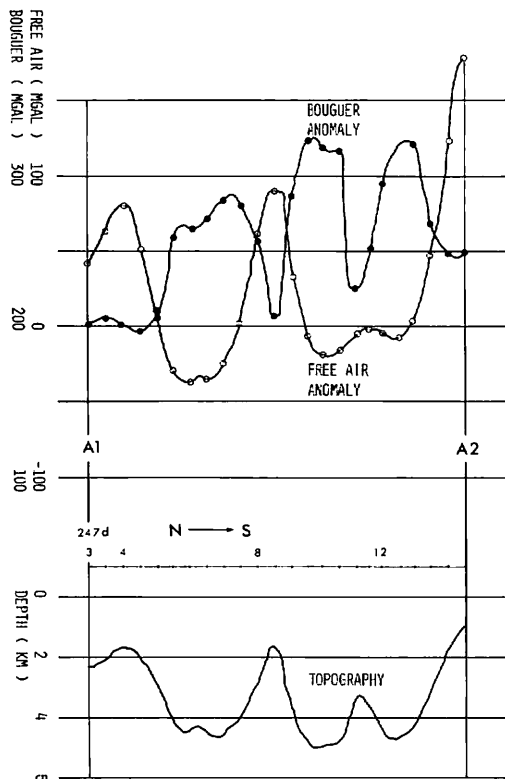

Fig. IV-5   Free air and Bouguer gravity anomaly at seamount of north-west part in the surveyed area.
A1 = 09°52′N, 164°43′W A2 = 08°36′N, 164°21′W
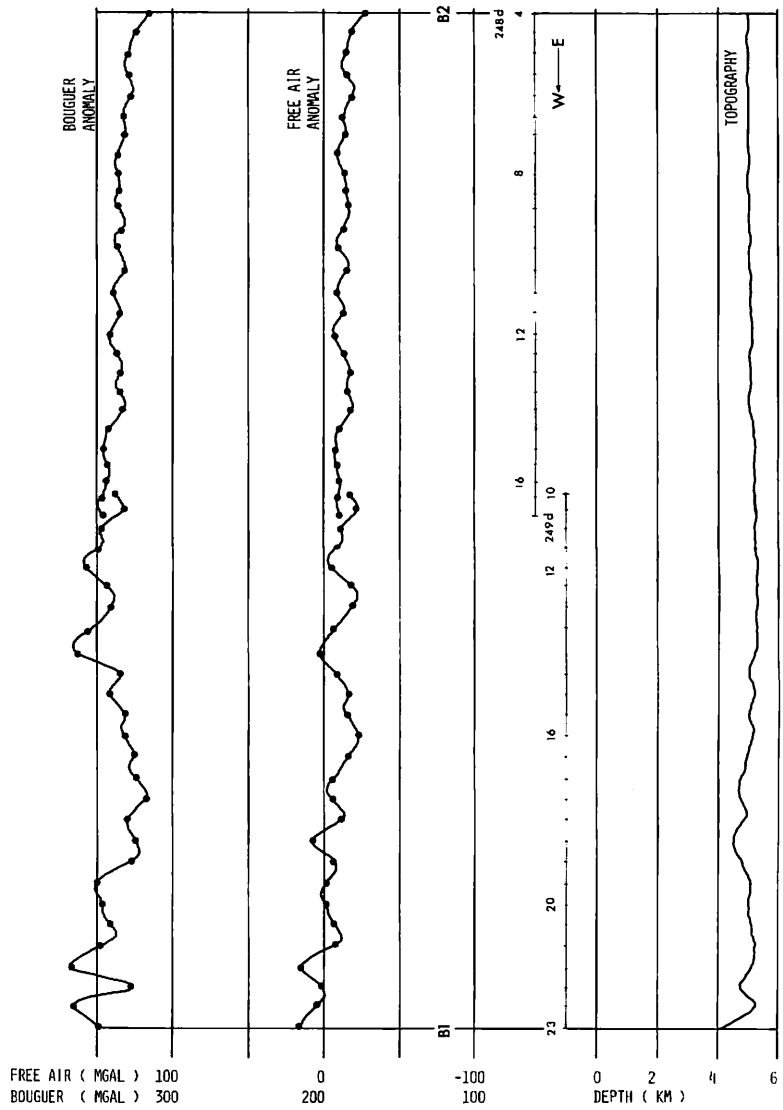
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Fig. IV-6 Free air and Bouguer gravity anomaly along 08°N line.
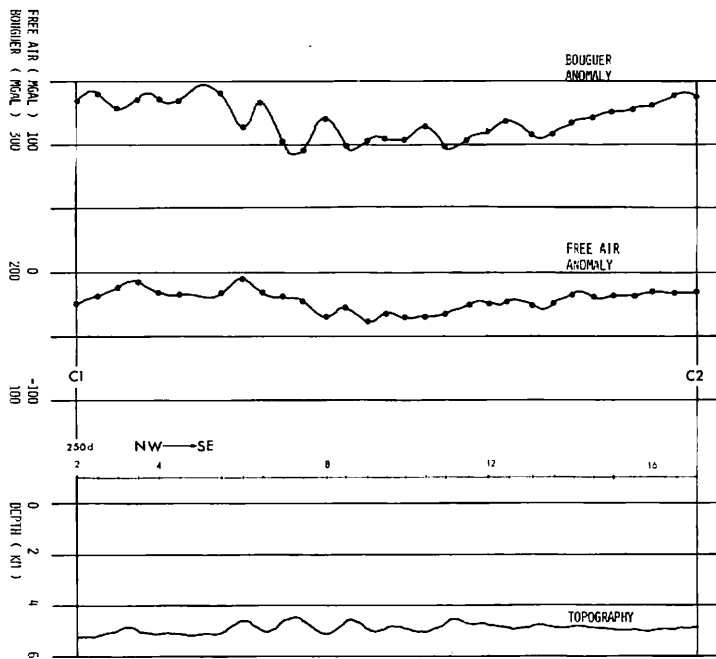B1 = 08°19'N, 164°58'W   B2 = 08°00'N, 167°07'W

Fig. IV-7   Free air and Bouguer gravity anomaly from St. 141 to St. 117.
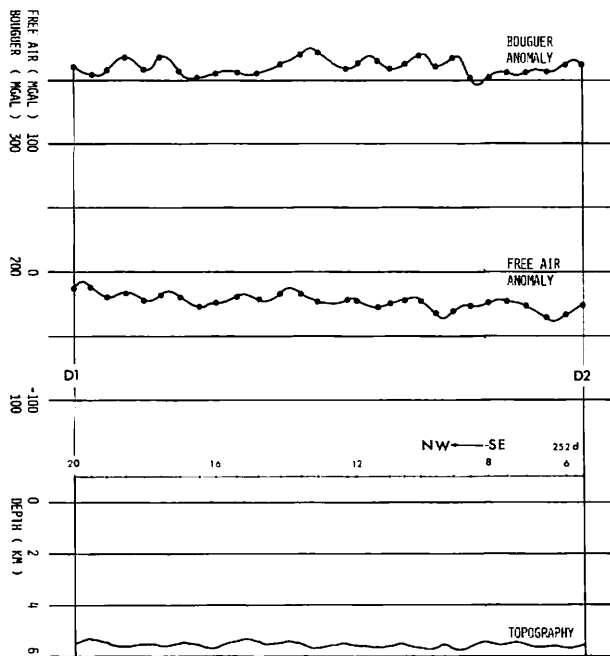C1 = 08°19′N, 168°58′W C2 = 05°55′N, 166°55′W

Fig. IV-8   Free air and Bouguer gravity anomaly from St. 141 to St. 138.
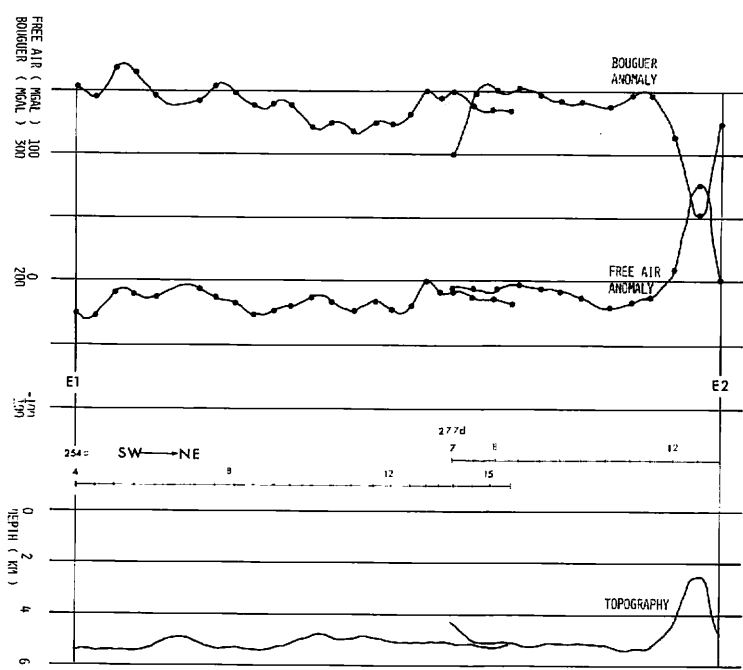D1 = 06°06′N, 168°59′W D2 = 08°09′N, 170°27′W

Fig. IV-9   Free air and Bouguer gravity anomaly from St. 140 to St. 144.
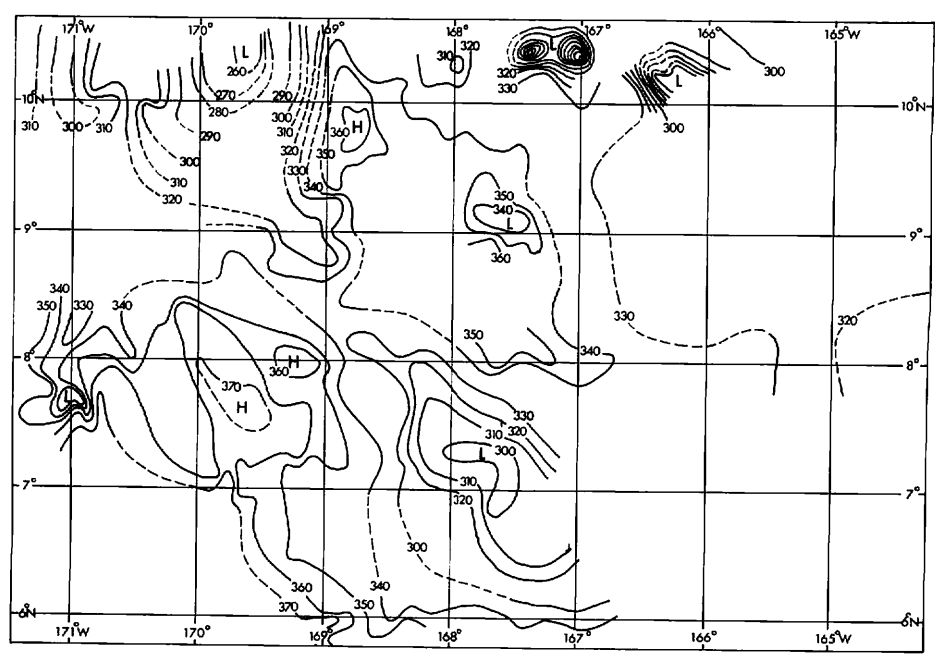E1 = 08°12'N, 170°20'W E2 = 10°19'N, 167°51'W

Fig. IV-10   Free air gravity anomaly contour map in the surveyed area.
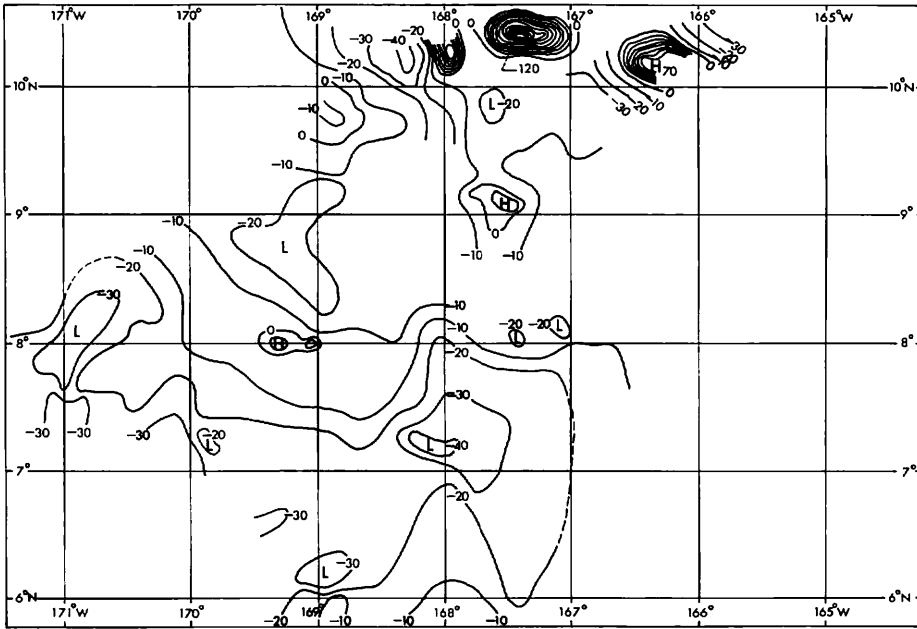Contour interval is 10 mgal.

Fig. IV-11   Bouguer gravity anomaly contour map in the surveyed area.
Contour interval is 10 mgal.