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Compilation of shipborne magnetic and gravity data images crustal structure of Prydz Bay (East Antarctica)

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Abstract

A magnetic anomaly map and a free air anomaly map of Prydz Bay, of the adjacent slope and over the continental rise area (63°S-69.5°S, 69°E-81°E) were compiled using Russian, Australian, Japanese and other available data (more than 20000 km in total length). Adjustment of different data sets was performed before gridding and making contour maps. Crossover differences of the magnetic data were significantly reduced by removing data segments with short-period time variations, by applying time variation corrections of Mawson Station to Australian and Japanese data, and by giving a constant bias to each trackline. Crossover differences of the gravity data were also substantially reduced by applying a constant bias to each cruise/leg. According to the compiled gravity data, in the western part of Prydz Bay the continent ocean boundary is inferred to be situated around the shelf edge at the seaward end of Prydz Channel, while it is in the continental rise in the eastern part. The gravity data also suggest the presence of sediments in the Prydz Bay basin reaching a thickness of about 8 km and overlying a «granitic» layer; the Moho beneath the basin is located at a depth of about 22 km. According to the magnetic data, highly-magnetized rocks occur at shallow depths northwest of the Prydz Bay basin and other parts of Prydz Bay.

Key words *Prydz Bay – shipborne data – magnetic anomalies – gravity anomalies – two-dimensional modelling*

1. Introduction

Prydz Bay lies at the oceanward end of the Lambert Graben, which extends 700 km or more landward in East Antarctica (fig. 1). The graben is now occupied by Lambert Glacier and Amery Ice Shelf, the largest glacier system flowing from East Antarctic Ice Sheet.

Like other Antarctic continental shelves, Prydz Bay has a deep inner shelf (600-800 m near the Amery Ice Shelf) and shallow outer shelf banks (less than 200 m deep), *i.e.* the Four Ladies Bank in the eastern part and the Fram Bank in the western part (fig. 1). Prydz Channel crosses the western part of the outer shelf between both banks longitudinally with a large sedimentary fan on the continental slope (O'Brien, 1994).

Marine geophysical surveys of Prydz Bay have been conducted by Australian, Russian and Japanese cruises (Stagg, 1985; Shelestov and Alyavdin, 1987; Mizukoshi *et al.*, 1988). Gravity and magnetic data as well as MCS seismic data were collected during these survey cruises.

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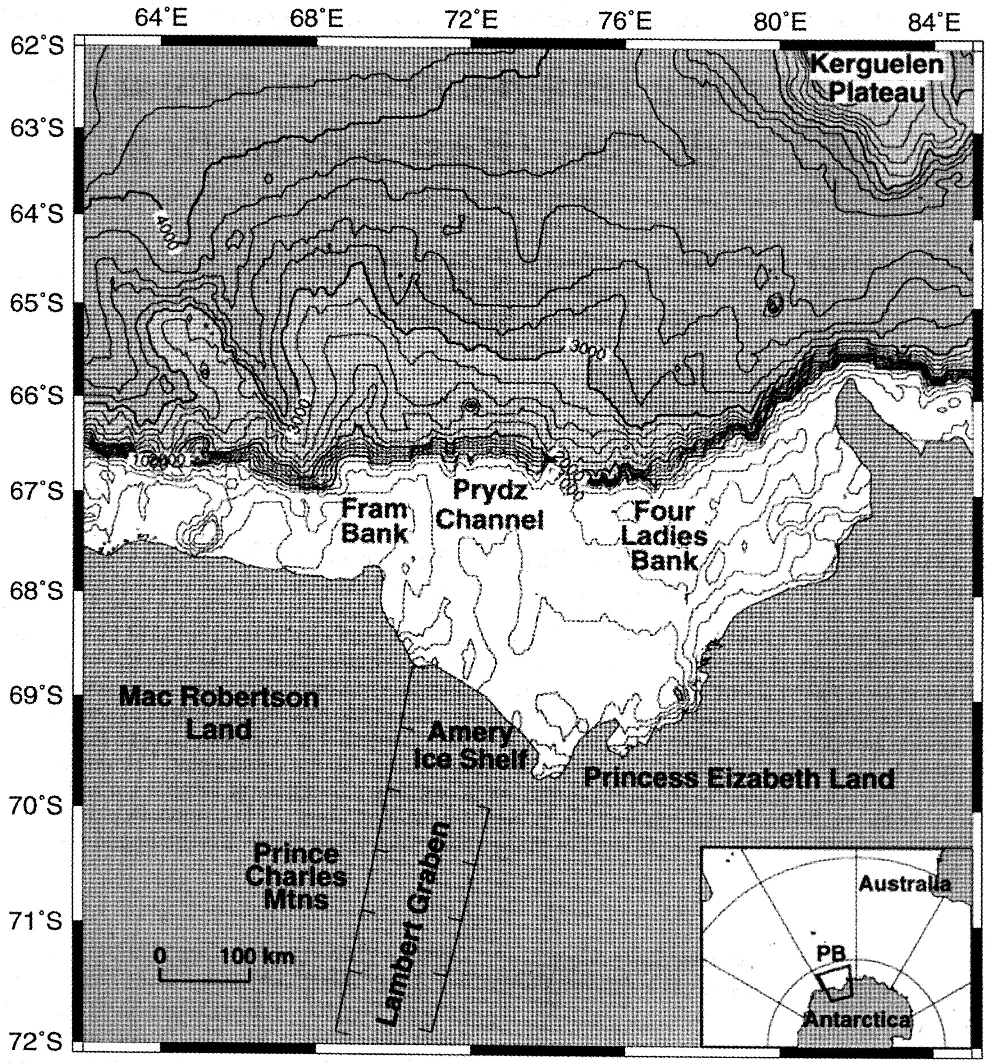

Fig. 1. Bathymetry of Prydz Bay and adjacent continental slope and rise area obtained from ETOPO5 digital gridded data (National Geophysical Data Center, 1988). Contours are at 200 m interval. PB (Prydz Bay) in the inset shows the location of the study area in East Antarctica.

Seismic stratigraphy and ODP Leg 119 results revealed that seven acoustic units can be recognized in Prydz Bay, and that more than 5 km of sediments fill the NE-trending Prydz Bay basin beneath the inner shelf (Stagg, 1985; Cooper *et al.*, 1991). Stagg (1985) interpreted the Prydz Bay basin and the Lambert Graben as a failed rift arm of a triple junction in the initial breakup phase of Gondwana in the Early Cretaceous.

Magnetic and gravity maps are tools to study crustal structure and tectonics of the Prydz Bay region. We have compiled a magnetic anomaly map and a free air gravity anomaly map using all available data including those collected from the Russian, Australian and Japanese surveys.

2. Magnetic data processing

Shipborne magnetic data collected in the continental shelf of Prydz Bay and adjacent slope and rise area (62°S-69.5°S, 65°E-85°E) were compiled (fig. 2). Magnetic surveys were conducted during Russian (or former Soviet Union) Antarctic Expedition cruises SAE-31, 32, 33, 39 and 40 (total length of 14900.8 km), during Australian Antarctic Expedition cruises ND-32, ND-33 and ND-34 (8611.6 km), and during JNOC (Japan National Oil Corporation) TH-84 and TH-89 cruises (6319.5 km). Total length of original magnetic data collected in this area is 34875.8 km including other additional available data from research cruises, *i.e.* Eltanin Leg 47, INMD05MV and ODP Leg 119 (table I).

Magnetic anomalies were calculated by subtracting DGRF-IGRF reference fields of the corresponding periods (IAGA Division V, Working Group 8, 1995) from the observed total force values. Russian data had been already corrected for time variations. Corrections for time variations were applied to Australian and Japanese data using observatory data. No corrections for time variations was applied to the other research cruise data.

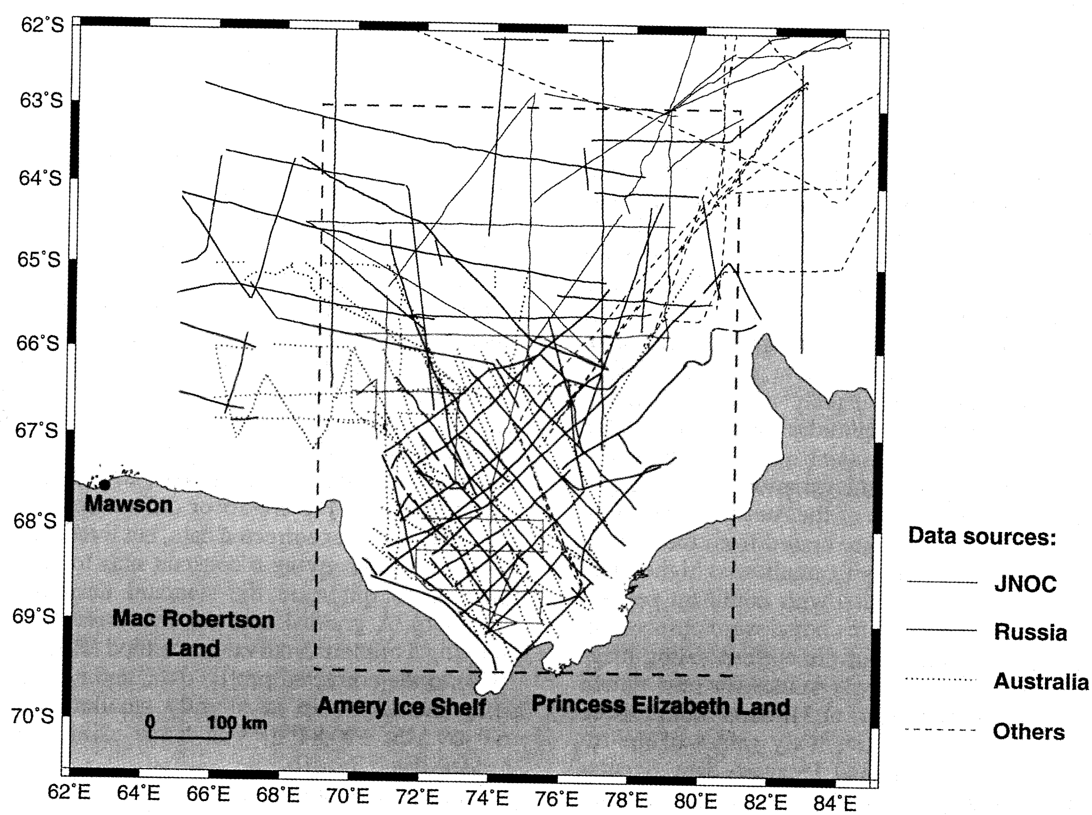

Fig. 2. Tracklines of JNOC, Russian, Australian and other cruises, where magnetic data were collected. The heavy dashed line shows the compiled area.

Table I. Magnetic profile data of Prydz Bay area (62°S-69.5°S, 65°E-85°E).

	Survey year	Original (km)	Edited (km)	E/O (%)	No. of lines	No. of C-O's	Mean and SD of C-O differences (nT)
TH84	1984-1985	4504.5	4026.1	89.4	18	101	+ 0.43 ± 56.2
TH89	1989-1990	1815.0	714.9	39.4	10	31	+ 130.00 ± 83.8
ND32	1980	1395.6	1279.4	91.7	11	45	− 113.29 ± 57.2
ND33	1981	622.1	229.6	36.9	4	6	− 90.56 ± 59.0
ND34	1982	6593.9	3913.1	59.3	33	176	− 80.39 ± 62.1
SAE31	1986	940.7	785.5	83.5	20	50	− 54.19 ± 98.1
SAE32	1987	3129.5	3091.0	98.8	16	152	+ 71.11 ± 50.5
SAE33	1988	4514.5	4089.3	90.6	33	123	+ 46.57 ± 57.4
SAE39	1994	2932.8	1629.8	55.6	10	27	+ 77.78 ± 43.4
SAE40	1995	3383.3	3383.3	100.0	9	79	+ 45.88 ± 46.0
ELT47	1971	1665.9	954.5	57.3	7	11	− 390.54 ± 64.9
INMD05MV	1978	739.1	0.0	0.0			
ODP119	1988	2638.9	1151.0	43.6	4	23	+ 20.03 ± 93.4
Total		34875.8	25247.6	72.4	175	412 (× 2)	0.00 ± 40.8

Mawson Station, which is located about 500 km apart westward from the centre of the compiled area, is the nearest observatory which furnishes magnetograms and hourly (or one-minute) value data (fig. 2). Time variations of the survey data, particularly their short period components, were compared with magnetograms of Mawson Station relative to the same periods. Similar time variations are usually recognized in the survey data, but amplitudes and shapes of the variations are not the same as the magnetogram data. Short-period time variations were not corrected for. Segments of the Australian and Japanese survey data were erased from the compilation, if variations with amplitudes higher than about 100 nT and also with dominant periods shorter than about three hours were observed in Z or H components of the corresponding magnetogram. Then, hourly values (or one-minute values for TH89 data) of Mawson Station were subtracted from the anomaly values of the remaining Australian and Japanese data. Secular mean value of the total force was steadily decreasing in this area during 1980 to 1990. The bases of the hourly (or one-minute) values were set to be 50300, 50200, 50150, 49900 and 49700 nT for ND-32 (1980), ND-33 (1981), ND-34 (1982), TH-84 (1984-1985) and TH-89 (1989-1990) cruises, respectively.

Crossover analysis with a constant bias to each trackline of all the remaining Australian and Japanese survey data as well as Russian and other ones, was done several times and bad data segments, where large crossover differences were found, were further erased each time. Profile data of 25247.6 km long (or 72.4% of the original data) along 175 tracklines remained after removing bad data segments (table I). The standard deviation of 412 crossover differences was 136.1 nT for the uncorrected data, but it reduced to 40.8 nT after giving a constant bias to each trackline to minimize the standard deviation (fig. 3a,b). A gridded data set was created by applying a minimum curvature method (Briggs, 1974) to the corrected profile data, and a magnetic anomaly map of slightly smaller area (63°-69.5°S, 69°-81°E) was made using this gridded data (fig. 10).

Hourly value (or one-minute value) data of Mawson Station clearly show the differences of magnetic activity levels. Time variations with amplitudes of 500 nT or more are observed in

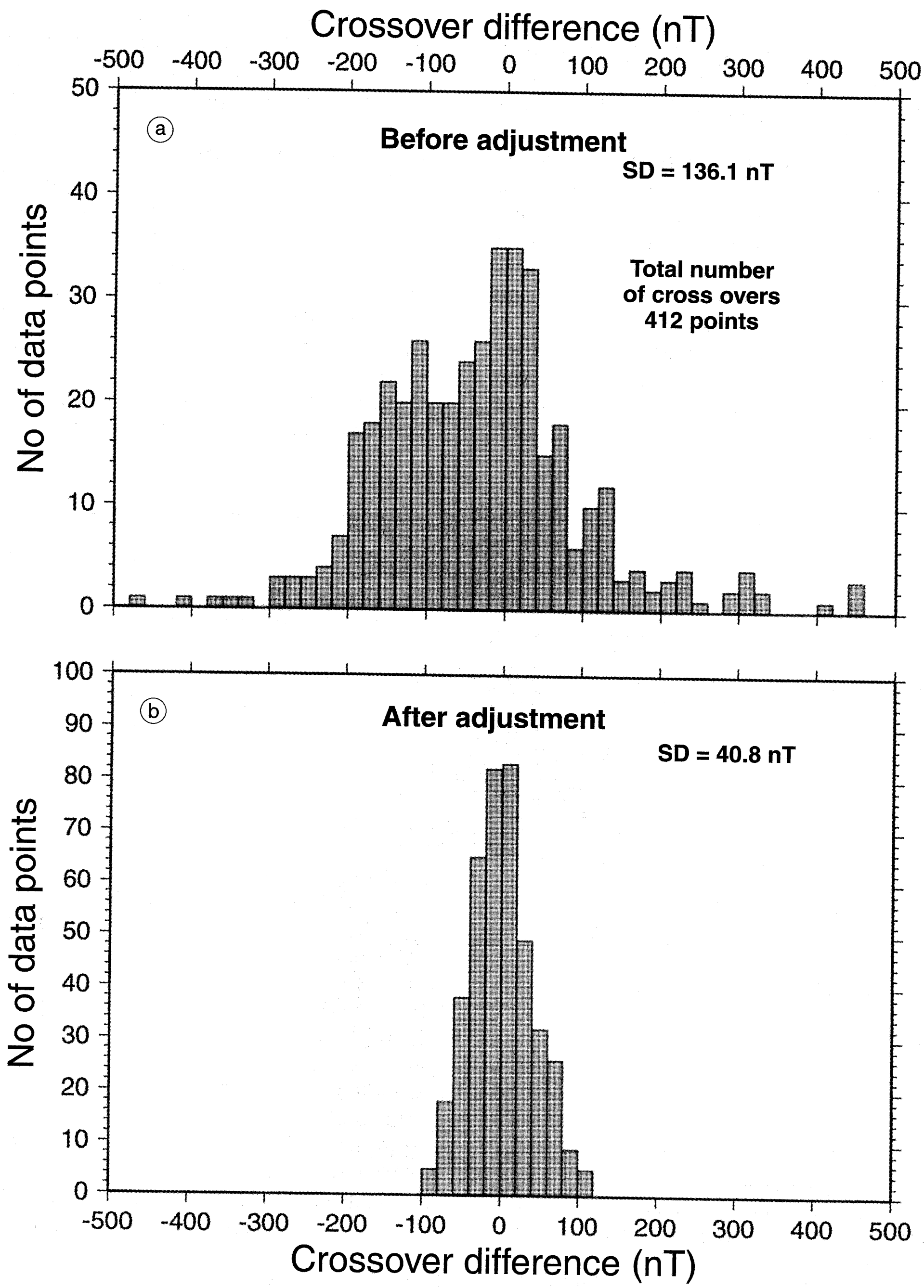

Fig. 3a,b. Histograms of crossover differences of magnetic anomaly data. a) Original data; b) data corrected for time variation using Mawson Station data and after adjustment by giving a constant bias to each line to minimize the differences.

1982 and 1990, while they are relatively calm (generally with amplitude of 100 nT or less) in 1985. Survey cruises ND-34 and TH-89 were conducted in the former periods (in 1982 and in 1989-1990, respectively), while TH-84 was conducted in 1984-1985. Table I clearly shows dependence of rate of the remaining data (E/O) on magnetic activity level. Almost 90% of data collected during relatively calm TH84 cruise remained after editing, while only 39 and 59% of the original data remained for TH89 and ND34 cruises, respectively.

Figure 4 shows the distribution of crossover differences in order of time in each cruise, and Table I gives the mean and standard deviation of crossover differences for each cruise. Here, each crossover difference was calculated after the other crossing line was corrected by the estimated bias for that line used in the actual profile data correction. Crossover differences for Russian data, especially, for SAE-32, 39 and 40 cruises show small variations. We could expect similar small variations for Australian and Japanese data, if time variations were corrected successfully. As an example, crossover errors of TH84 cruise show relatively small change almost comparable to the Russian data, while those of TH89 cruise, which was conducted during a high-activity period, show a greater variation even after deletion of more than 60% of original data. It is obvious that Japanese and Australian data show generally greater varia-

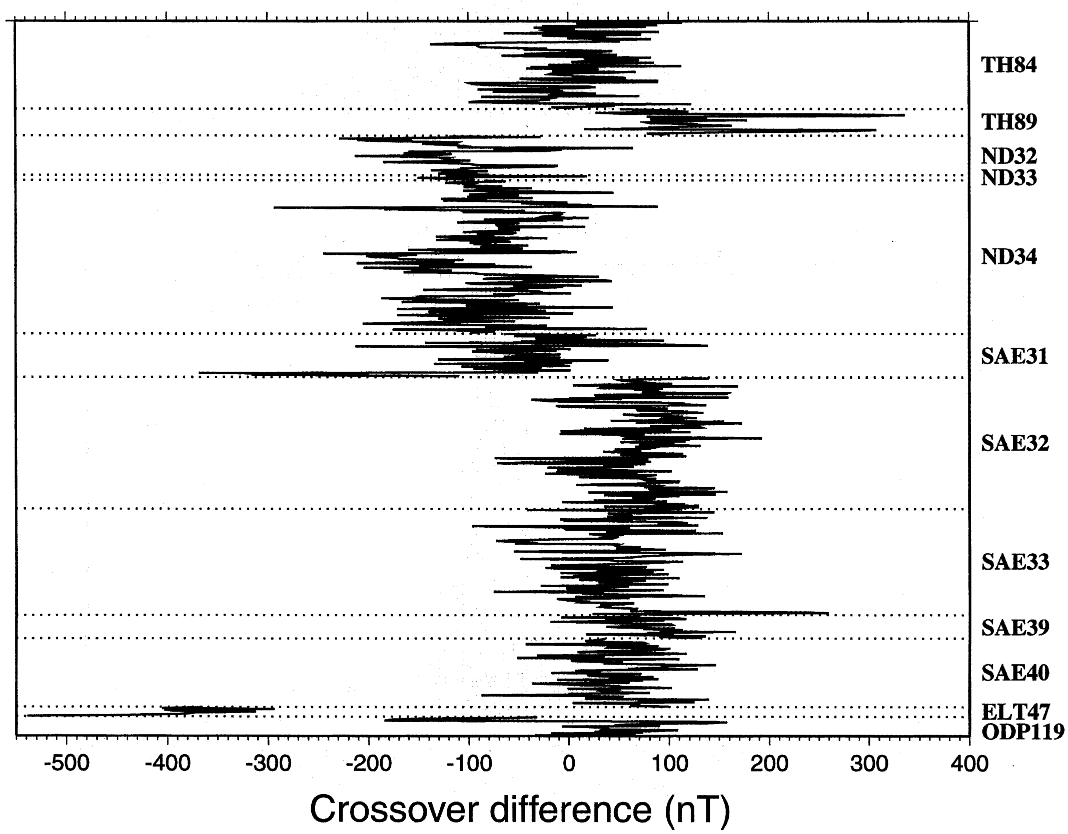

Fig. 4. Distribution of crossover differences in order of time in each cruise. Each crossover difference was calculated after the other crossing line was corrected by the final bias given to that line.

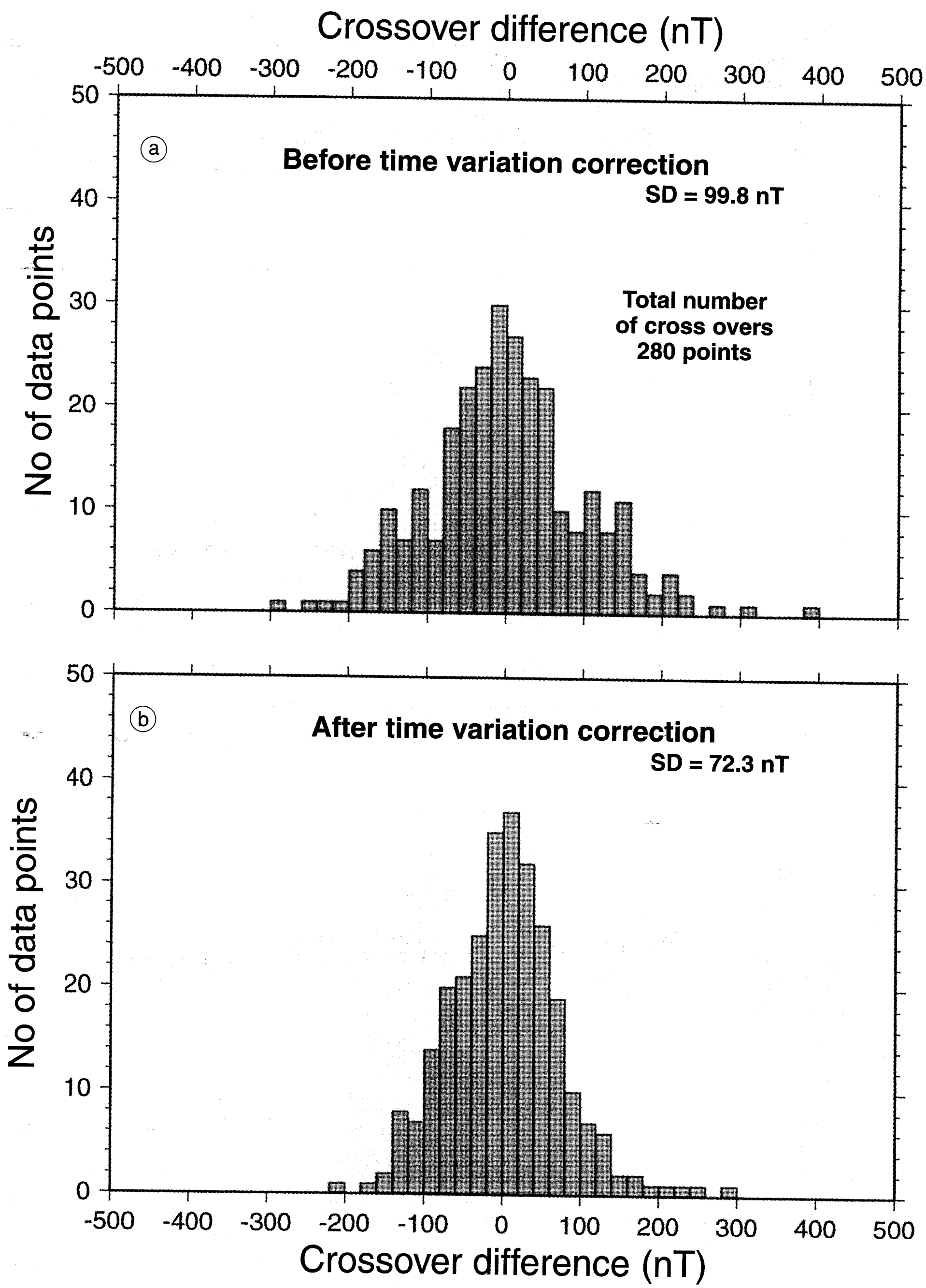

Fig. 5a,b. Histograms of crossover differences of Australian and Japanese magnetic data with a constant bias given to each cruise to minimize the differences. a) Before time variation correction using Mawson Station data; b) after the correction.

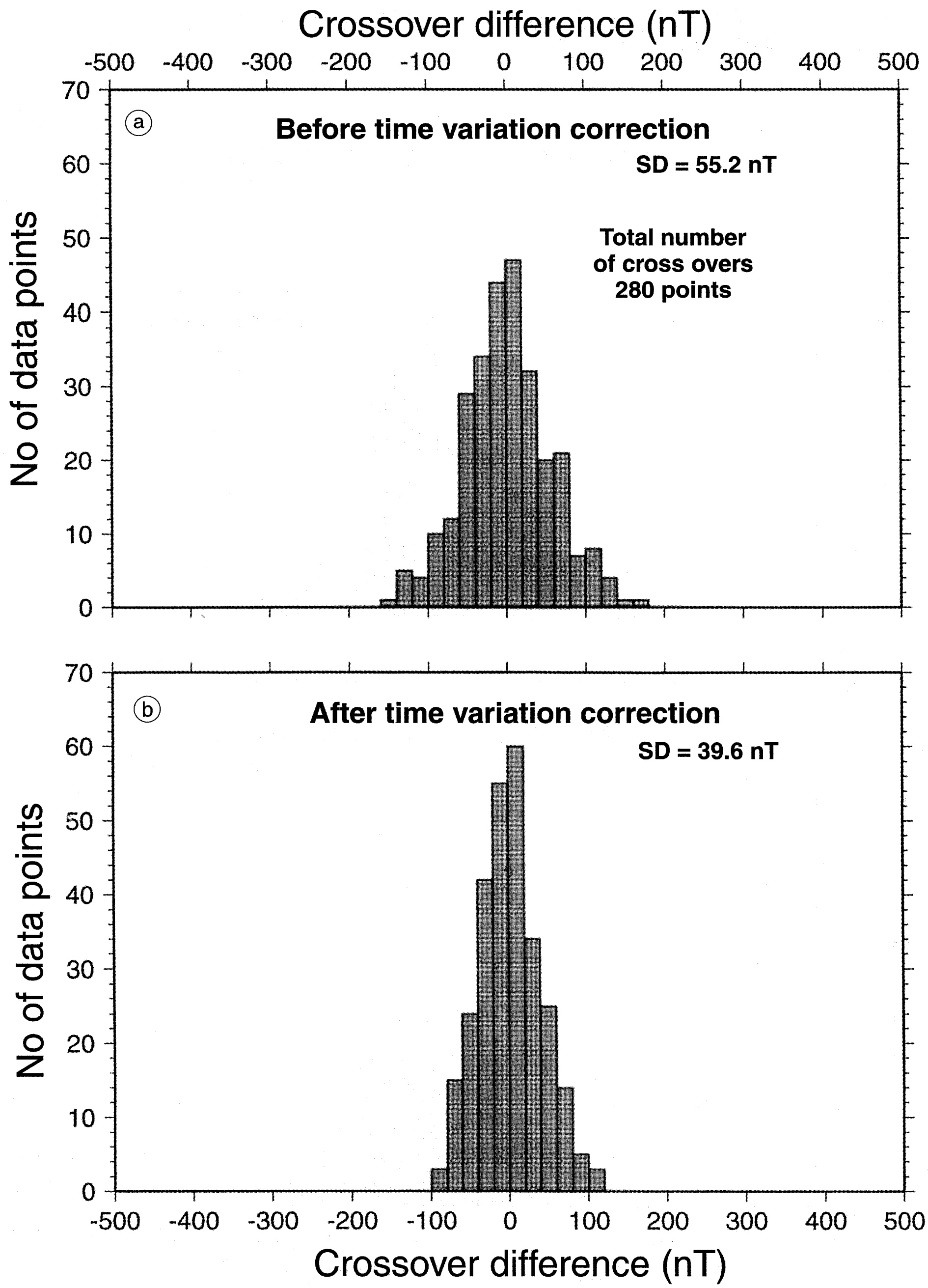

Fig. 6a,b. Histograms of crossover differences of Australian and Japanese magnetic data with a constant bias given to each line to minimize the differences. a) Before time variation correction using Mawson Station data; b) after the correction.

tions of crossover differences than Russian data. This suggests that the effect of the time variations was not fully corrected by Mawson Station data.

If the time variation of the survey data and Mawson Station data were almost the same, after the time variation correction, it should be enough to give only one constant bias for each cruise to minimize the crossover differences. Figure 5a,b shows histograms of the Japanese and Australian crossover differences with only one constant bias given to each cruise. The standard deviation decreases from 99.8 nT to 72.3 nT after time variation correction using hourly (or one-minute) value data at Mawson Station. When a constant bias is given to each line, this situation becomes much more improved (fig. 6a,b). The standard deviation decreases from 55.2 nT to 39.6 nT after time variation correction. Among other things, this means that the standard deviation for the case of one constant bias given to each line and without time variation correction is smaller than that for the case of one constant bias given to each cruise and with time variation correction using Mawson Station data. This suggests that the time variation effects can be corrected more effectively by giving one constant bias to each line, since each line has a time duration of a few hours to one day. Nevertheless, Mawson Station data have some effects to improve the data. We can conclude that it is the best choice to apply time variation correction using Mawson Station data as well as a constant bias to each line to minimize the crossover differences.

3. Gravity data processing

Shipborne gravity data of the same area were compiled (fig. 7). Gravity data were collected during Russian cruises SAE-31, 32, 33 and 36 (total length of 8328.0 km), and during JNOC TH84 and TH89 cruises (7841.0 km). Data obtained from other research cruises ELT47, JARE-29, 30, 32 and 33 (5779.2 km) were also utilized. Profile data of 21 948.2 km in total length were used in this compilation (table II).

The free air anomaly values of the original JNOC data had been calculated using the 1967 gravity formula, while those of the Russian data had been calculated using the 1930 gravity formula. Both of the JNOC and the Russian data were recalculated using the 1980 gravity formula. No recalculation was done for the other data. Large crossover differences still remained after this recalculation: the standard deviation of 357 crossover differences was 14.44 mGal (fig. 8a,b). It drastically reduced to 1.77 mGal after giving a constant bias to each cruise or leg (fig. 8a,b and table II). Just like the magnetic data, a gridded data set was created using these profile data, and a free air anomaly map of the same area (63°-69.5°S, 69°-81°E) was made using this gridded data set (fig. 9).

Table II gives a mean and standard deviation of crossover differences for each cruise/leg. Just like table I for the magnetic data, each crossover difference was calculated after the other crossing line was corrected by the estimated bias for that cruise/leg used in the actual profile data correction. There are rather large discrepancies of gravity values among different cruises. What is the possible cause of them? We suspect errors in the scale factors and/or drift corrections of the sea gravimeters.

A LaCoste-Romberg sea gravimeter S-63 and a straight-line gravimeter SL-2 were used during TH84 and TH89 cruises, respectively. All the gravity readings during these cruises were tied to known absolute gravity values at the port of Fremantle, Australia. There is a difference of about 3 Gal in absolute gravity values between the port and the Prydz Bay area. This means that, as an example, an error of 0.2% of the scale factor of a gravimeter, which may be probable, leads to a change of 6 mGal from true gravity values.

A NIPR-ORI sea gravimeter (Segawa *et al.*, 1988) was used during JARE-29 to 33 cruises. Table II shows that, although large crossover mean differences occur for JARE 29 and 30 cruises, their standard deviations are comparable to those for other cruises. The large mean differences are probably due to imperfect drift corrections applied to the data.

We have no detailed information on Russian gravimeters. Yet, large crossover differences occur among Russian cruises. Errors in drift corrections or scale factors may also exist for Russian gravimeters.

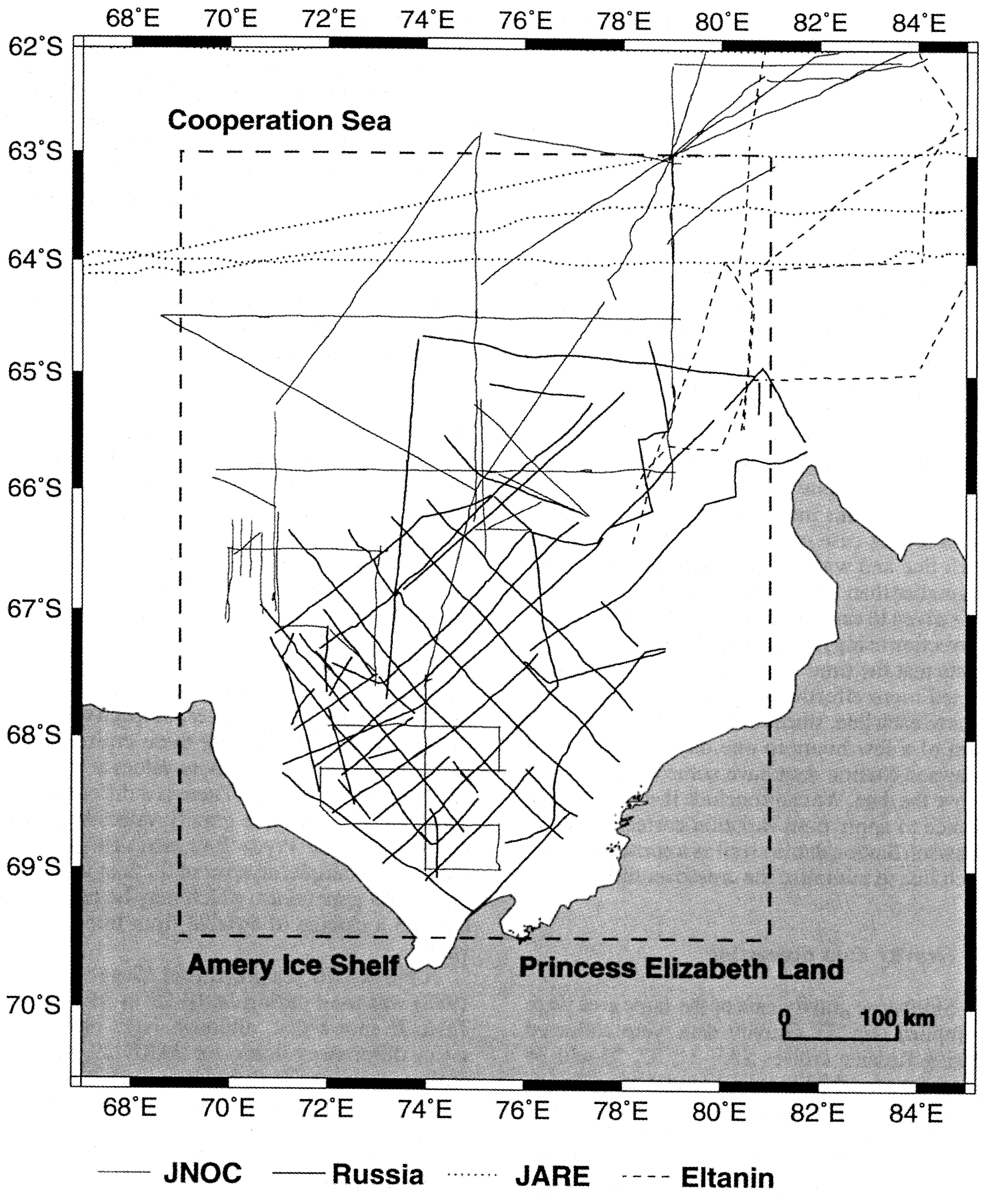

Fig. 7. Tracklines of JNOC, Russian, JARE and Eltanin cruises, where gravity data were collected. The heavy dashed line shows the compiled area.

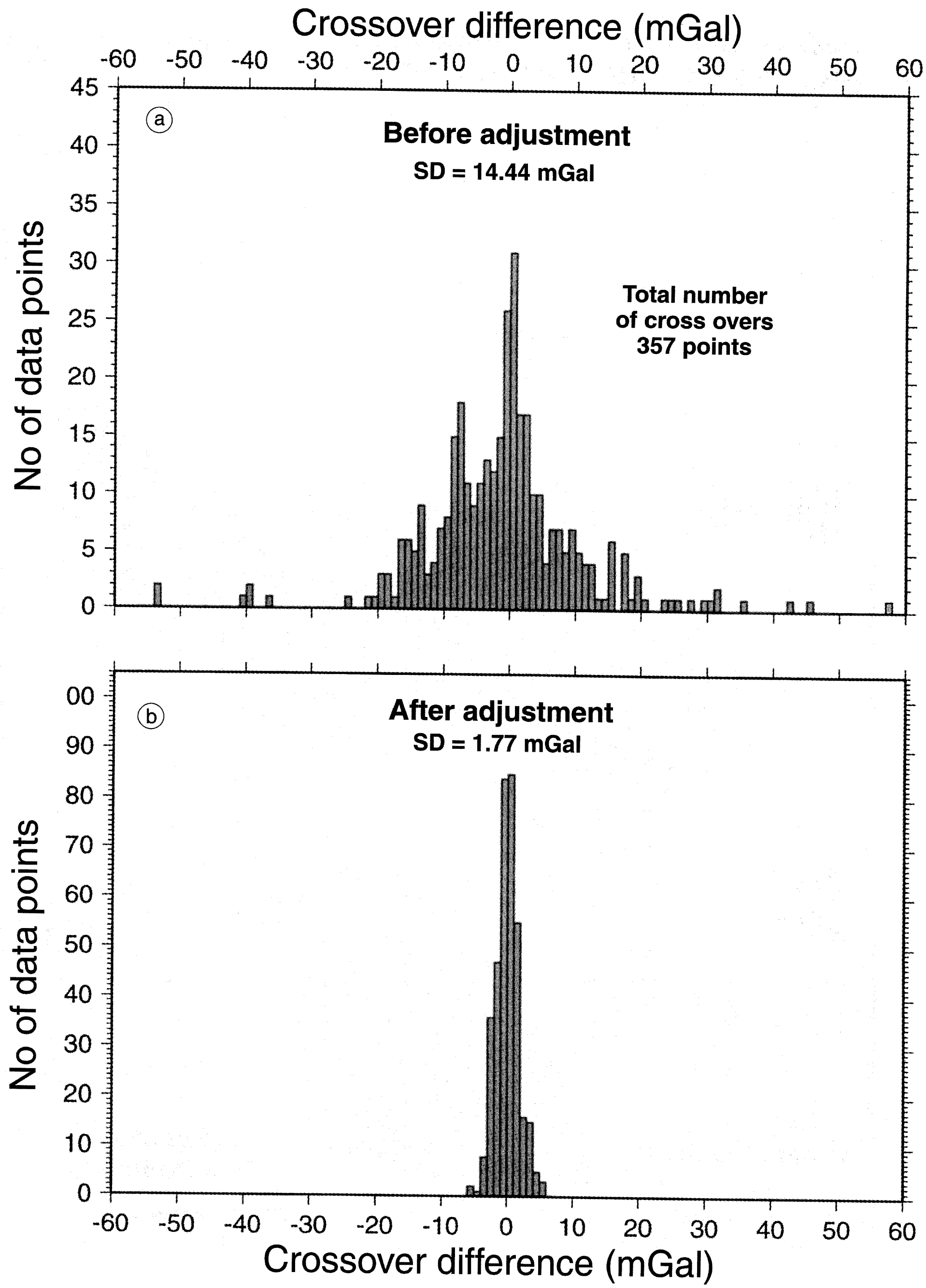

Fig. 8a,b. Histograms of crossover differences of gravity anomaly data. a) Original data; b) data after adjustment by giving a constant bias to each cruise/leg to minimize the differences.

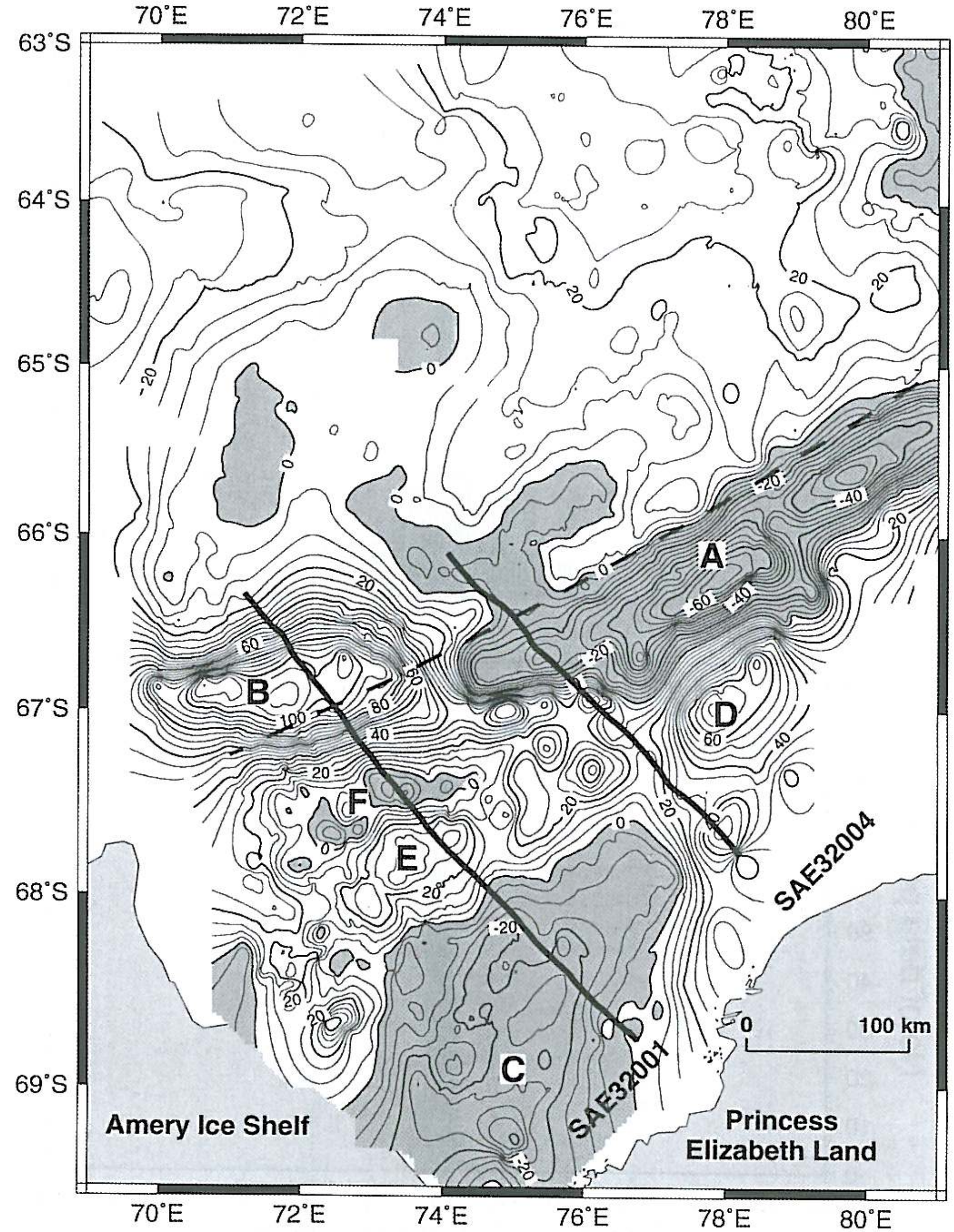

Fig. 9. Free air gravity anomaly map of Prydz Bay. Contours are at 5 mGal interval. Negative values are shaded. The two tracklines SAE32001 and 32004, where two dimensional models of profile data were made, are also shown. Dashed line indicates approximate location of the continent ocean boundary inferred from gravity data. Labels A to F show the negative and positive anomalies discussed in the text.

Table II. Gravity data of Prydz Bay area (62°S-69.5°S, 65°E-85°E).

	Survey year	Length (km)	No. of lines	No. of C-O's	Mean and SD of C-O differences (mGal)
TH84a	1984	2328.9	8	47	– 5. 84 ± 2.32
TH84b	1985	3483.3	24	113	– 0.76 ± 2.09
TH89a	1989	615.1	7	28	– 8.80 ± 1.90
TH89b	1990	1413.7	16	97	– 9.10 ± 1.25
SAE31a	1986	1079.9	12	81	– 0.88 ± 1.80
SAE31b	1986	224.9	5	12	– 2.93 ± 1.74
SAE32a	1987	1299.9	5	50	+ 7.80 ± 1.63
SAE32b	1987	1938.7	9	84	+ 4.63 ± 1.64
SAE33a	1988	1743.9	8	48	+ 7.69 ± 1.51
SAE33b	1988	470.4	2	22	+ 0.60 ± 1.48
SAE36	1991	1570.3	13	59	– 10.58 ± 1.57
ELT47	1971	1810.8	11	35	+ 13.43 ± 2.24
JARE29	1988	992.7	1	12	+ 53.78 ± 1.90
JARE30	1989	1008.3	1	12	– 31.93 ± 1.90
JARE32	1991	954.3	1	2	– 2.19 ± 4.53
JARE33	1992	1013.1	1	12	– 2.73 ± 1.61
Total		21948.2	124	357(× 2)	0.00 ± 1.77

4. Compiled maps

4.1. *Free air anomaly map*

In the eastern part of the map, a negative free air anomaly belt (A in fig. 9) extends in an ENE direction in the continental slope and rise area seaward of the Four Ladies Bank with a minimum of –75 mGal at (66.2°S, 78°E). This may correspond to extended thin continental crust in this area as shown in the following two-dimensional modelling. This negative belt suddenly ends at about (67°S, 74°E). Further westward, a positive anomaly belt extending almost in an E-W direction with a maximum greater than 110 mGal (B in fig. 9) occurs over the shelf edge at the seaward end of Prydz Channel, where channel fan sediments with thickness of 1 s TWT or more are observed by seismic surveys (Leitchenkov *et al.*, 1994). Continental rise area in the northern part of the map is characterised by long wavelength anomalies of – 10 to 30 mGal.

The most prominent feature in the free air anomaly map of the Prydz Bay shelf area is a broad NE-trending negative anomaly belt in the inner shelf (C in fig. 9). This negative anomaly belt corresponds to Prydz Bay basin, a graben structure of the basement which lies at the ocean-ward end of the Lambert Graben south of the area (Cooper *et al.*, 1991). Seismic surveys revealed that the graben is filled with at least 5 km of late Paleozoic to Cenozoic sediments (Stagg, 1985). Stagg (1985) also suggested that the Prydz Bay basin is structurally separate from the Lambert Graben. We have no gravity data on land or on the Amery Ice Shelf, but it seems that this negative anomaly belt ends near the coast southward, and does not continue straight to the Amery Ice Shelf and Lambert Glacier (Wellman and Tingey, 1976). The graben is bounded by positive anomalies in its eastern and northwestern sides. A positive anomaly greater than 60 mGal (D in fig. 9) occurs on the Four Ladies Bank of the outer shelf northeast of the graben, where the water depth also becomes shallower than 200 m. In the northwest of the graben, a positive anomaly belt with varying amplitude of 15 to 45 mGal (E in fig. 9) extends in an ENE direction, and appears to continue to the positive anomaly D on the Four Ladies Bank. The positive anomaly belt E is separated from the positive anomaly belt B over the Prydz Channel sedimentary fan by a negative anomaly belt between them (F in fig. 9).

4.2. *Magnetic anomaly map*

The most prominent features in the magnetic anomaly map (fig. 10) are positive anomalies distributed roughly along both of the free air positive and negative anomaly belts northwest of the Prydz Bay basin (E and F). These anomalies are characterized by short wavelengths (20-40 km) and suggest existence of igneous rocks in shallow parts of this area. In the Prydz Bay basin (C) southwest of areas F and E, the magnetic anomalies are characterized with longer wavelength and smaller amplitude. However, further southeastward of the basin near the coast of Princess Elizabeth Land, where the basement is exposed according to seismic data (Stagg, 1985), existence of metamorphic (or igneous) rocks in shallow parts are also suggested by short-wavelength anomalies similar to the areas F and E. A round-shaped positive anomaly with a corresponding gravity high occurs at about (68.9°S, 74°E) in the graben, which suggests an intrusive basement high in this area.

Although the trackline spacing is not short enough (about 40-50 km) in the eastern part of the Prydz Bay including the Four Ladies Bank (fig. 2), no significant anomalies of short wavelength are likely to occur there. Existing profile data show magnetic anomalies of long wavelength character. As shown in later, one example is the profile along line SAE32004 (fig. 12a-c), which passes the southwestern side of the Four Ladies Bank. A long-wavelength and large-amplitude positive anomaly, probably due to deeper igneous (or metamorphic) rocks is observed roughly corresponding to the free air positive anomaly D over the Four Ladies Bank.

The compiled magnetic anomaly map may not be accurate in the continental rise area, because the data coverage is less dense there than in the shelf area. Additional short-wavelength anomalies may occur where no tracklines exist. High-amplitude magnetic anomalies are observed in the northeastern part and also in the western end of the map area, which suggests existence of seafloor spreading anomalies. However, no lineated anomalies have been identified so far.

5. Two-dimensional models

We made two-dimensional models for two profiles: SAE32001 and SAE32004 (the tracklines are shown in figs. 9 and 10). Seismic stratigraphy of Prydz Bay revealed five acoustic units of late Paleozoic to Cenozoic ages and the basement composed of Precambrian metamorphic rocks and Mesozoic intrusive rocks (Stagg, 1985; Cooper *et al.*, 1991). As the density model, however, we made a simplification that below sea water with a density of 1.03 g/cm^3, there are only two layers: sediments and the «basement». We refer to the density estimate from deep seismic sounding results in the south of Prydz Bay (Kurinin and Grikurov, 1982, Fedorov *et al.*, 1982), but we adopt a lower mean density of 2.3 g/cm^3 for sediments, taking into account that young low-density sediments are also included in Prydz Bay. According to Fedorov *et al.* (1982), there are two layers in deeper part of the crust: «granitic» layer and «basaltic» layer. The estimated density of the «granitic» layer is 2.8 g/cm^3 beneath and west of Lambert Glacier south of Prydz Bay, while it is 2.9 g/cm^3 east of the glacier. In the southeastern side of Prydz Bay near coast of Princess Elizabeth Land the «basement» with a density of 2.7 g/cm^3 lies above the «granitic» layer with a density of 2.9 g/cm^3, while the «basement» is equivalent to the «granitic» layer with an estimated density of 2.8 g/cm^3 beneath the seaward side of the shelf including most of Prydz Bay basin. The «basaltic» layer and upper mantle are assumed to have densities of 3.1 g/cm^3 and 3.3 g/cm^3, respectively. The bathymetric data collected simultaneously with the gravity measurements were used to define sea bottom topography, and the deeper

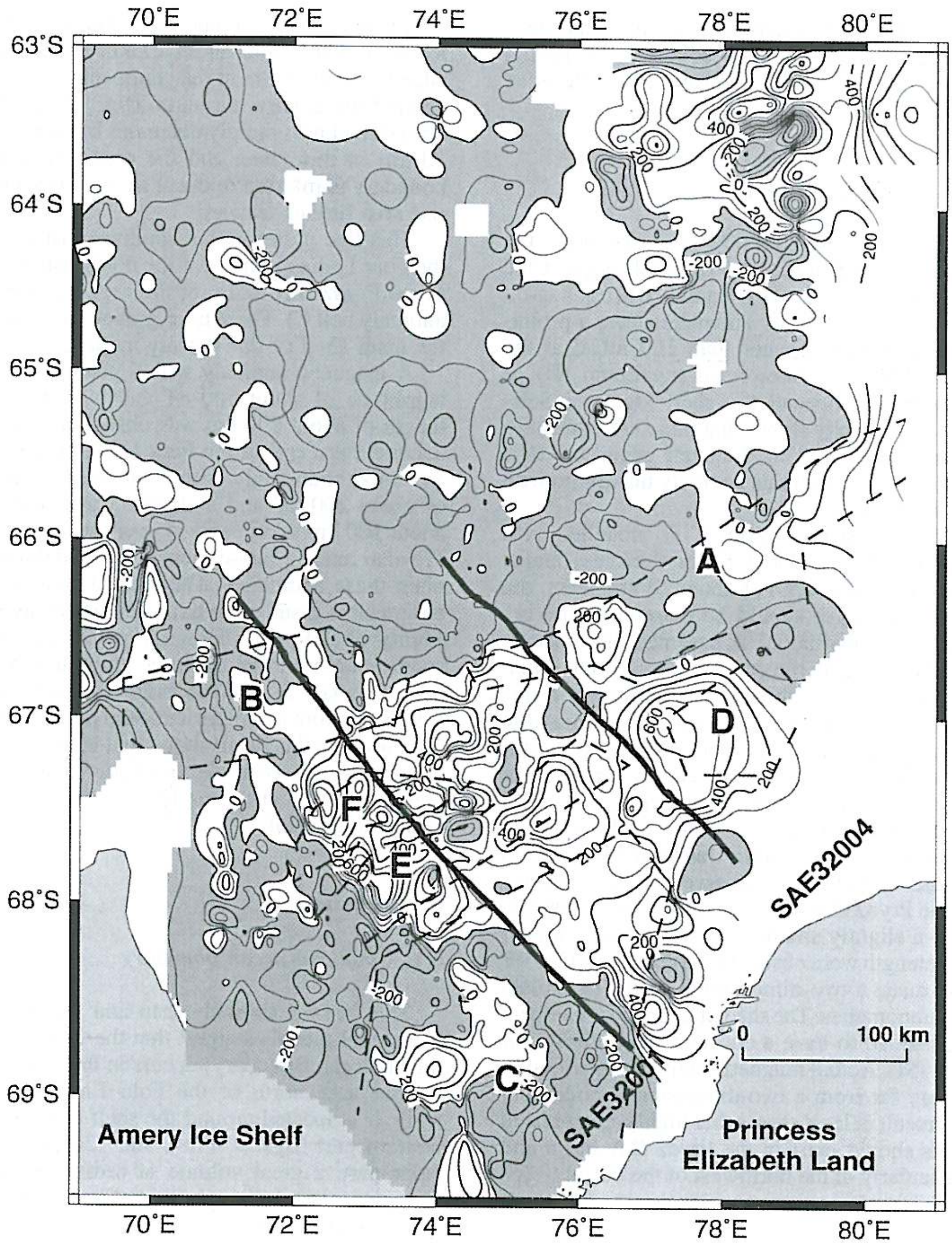

Fig. 10. Magnetic anomaly map of Prydz Bay. Contours are at 100 nT interval. Negative values are shaded. The two tracklines SAE32001 and 32004, where two dimensional models of profile data were made, are also shown. Labels A to F with the surrounding dashed lines indicate areas of the free air anomalies discussed in the text.

structures were determined based on the deep seismic sounding results south of the profile lines (Kurinin and Grikurov, 1982, Fedorov *et al.*, 1982).

5.1. *Prydz Bay basin line*

This line (SAE32001) crosses both the Prydz Bay basin (C) and the shelf edge at the seaward end of Prydz Channel (B) (fig. 11a-c). The observed free air anomalies have a prominent maximum greater than 100 mGal at the shelf edge. We interpreted maximum (B) as oceanic crust beneath this shelf edge area. Seismic stratigraphy shows that there are thick low-density sediments at the shelf edge, and it is difficult to explain this anomaly maximum with a thicker crust.

The Prydz Bay basin (C) is modelled by a sediment fill of about 8 km thickness and a shallow Moho depth of about 22 km. Here, the «granitic» layer should be extremely thin according to this model. A basement high occurs corresponding to the gravity anomaly maximum (E) northwest of the graben, and beyond this gravity maximum the basement becomes a little deeper and almost flat (F), and further northwestward the basement gradually deepens toward the shelf edge, slope and rise area.

Magnetic anomalies with a peak to trough amplitude of about 200 nT and with wavelength of about 30 km were observed in the northwest of the Prydz Bay basin (E and F) and anomalies with a slightly smaller amplitude and a longer wavelength were observed over the basin (C). We also made a two-dimensional model to explain these anomalies. The shaded area in the basement is assumed to have a constant susceptibility of 0.03 (SI). Actual magnetic anomaly distribution is very far from a two-dimensional model, but this result at least shows that highly-magnetized rocks should exist in the Prydz Bay basin and particularly in the northwest of the basin.

5.2. *Four Ladies Bank Line*

This line (SAE32004) crosses the western end of the negative gravity anomaly belt at the continental slope (A). The Moho becomes shallower seaward from about 27 km at the shelf edge to about 16 km at the continental rise area beyond the gravity minimum (fig. 12a-c). The crustal thickness rapidly decreases by more than 10 km in this zone, and the continent ocean boundary is inferred to occur in the continental rise area further seaward.

This line passes in the southwestern end of the Four Ladies Bank near the northeastern end of the Prydz Bay basin (or the negative free air anomaly belt C). There is no graben structure in the inner shelf of this density model.

A magnetic anomaly with a peak to trough amplitude of about 500 nT and with a wavelength of about 200 km was observed near the southwestern end of the Four Ladies Bank (D) and another anomaly with a smaller amplitude of about 200 nT and a shorter wavelength of about 100 km was observed over the slope (A). We also made a two-dimensional model to explain these anomalies. The shaded area in the basement is assumed to have a constant susceptibility of 0.04 (SI). This line passes near the southwestern end of the large amplitude magnetic anomaly D, and the anomaly distribution is very far from a two-dimensional model in this area also, but this result shows that large body of highly-magnetized rocks (probably igneous or metamorphic rocks) should exist beneath the Four Ladies Bank.

6. Discussion

6.1. *Continent ocean boundary*

The free air anomaly map and the two-dimensional models suggest that the COB (Continent Ocean Boundary) occurs in the continental rise area north of the Four Ladies Bank, while it is located around the shelf edge in the western part (figs. 9, 11a-c and 12a-c). In the latter part, a great volume of sediments have been transported through Prydz Channel by the Lambert Glacier and fan sediments have deposited at the shelf edge and slope. Seismic stratigraphy revealed at least three events of shelf edge progradation, and original paleo shelf edge was inferred to occur 30 to 60 km landward (Leit-

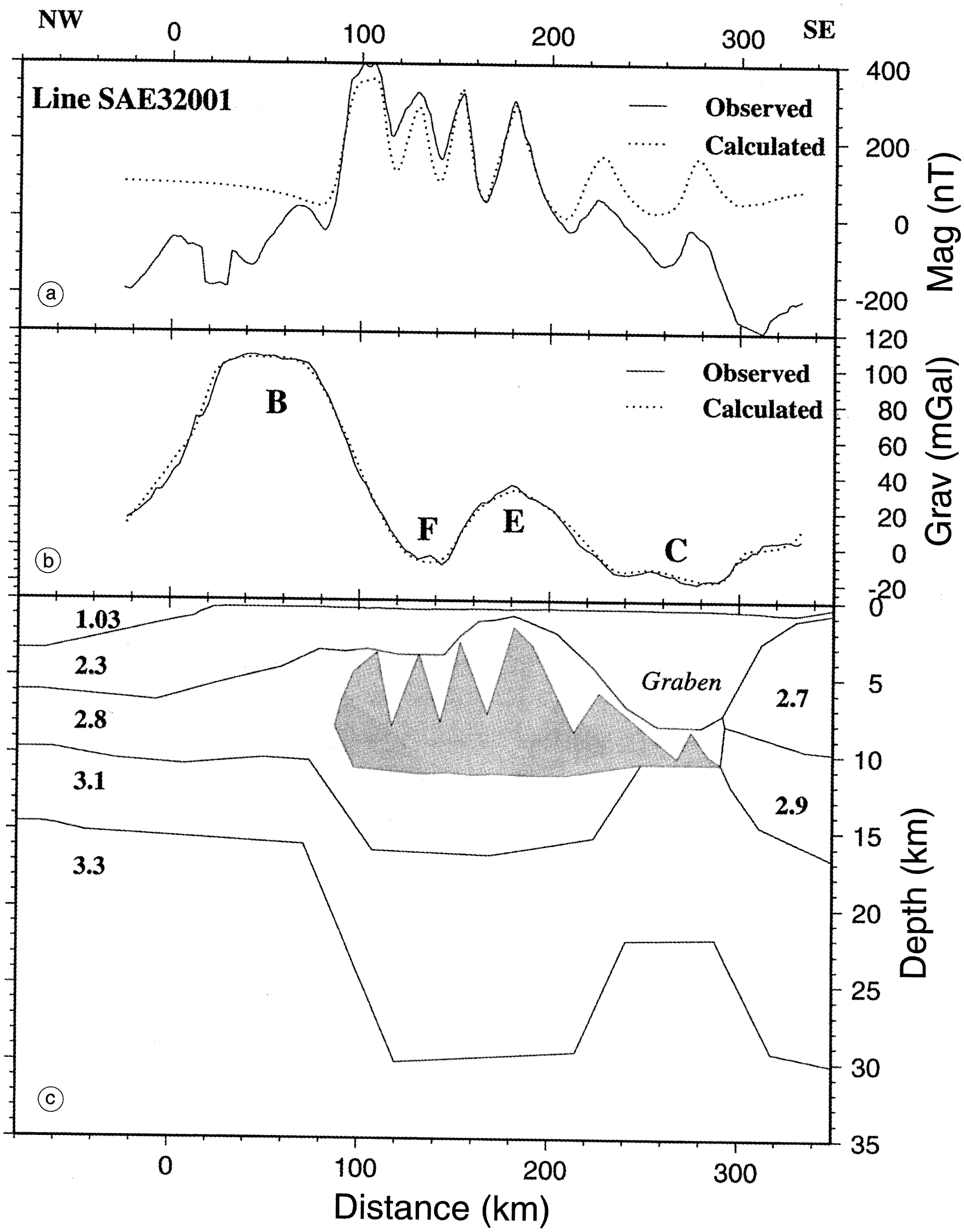

Fig. 11a-c. Gravity and magnetic anomaly profiles of Line SAE32001. a) Observed and calculated magnetic profiles; b) observed and calculated gravity profiles; c) crustal structure with assumed densities in g/cm^3 inferred from two dimensional modelling of the data. Shaded area in the 2.8 g/cm^3 layer is assumed to have a constant susceptibility of 0.03 (SI).

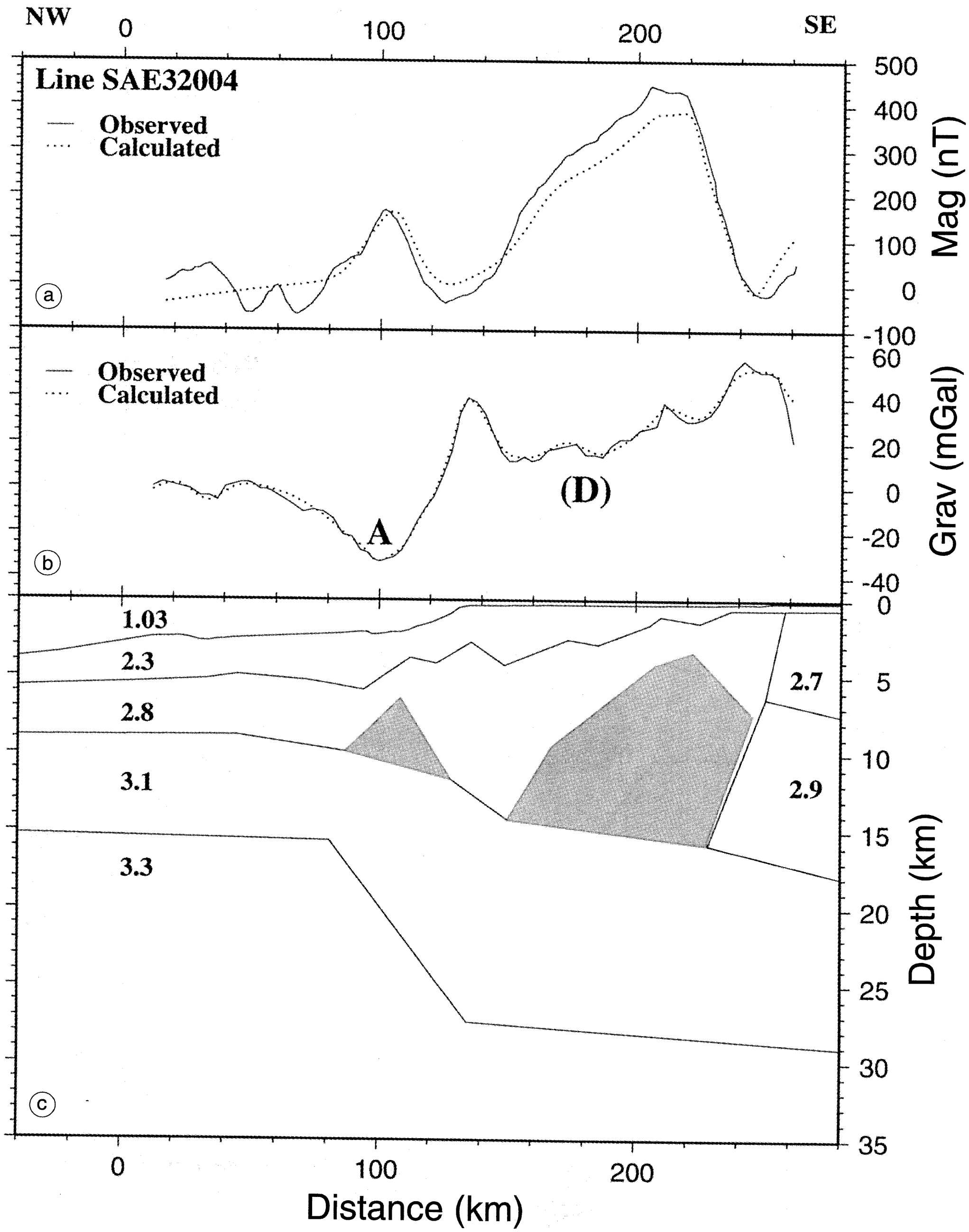

Fig. 12a-c. Gravity and magnetic anomaly profiles of Line SAE32004. a) Observed and calculated magnetic profiles; b) observed and calculated gravity profiles; c) crustal structure with assumed densities in g/cm^3 inferred from two dimensional modelling of the data. Shaded area in the 2.8 g/cm^3 layer is assumed to have a constant susceptibility of 0.04 (SI).

chenkov *et al.*, 1994). This coincides at least qualitatively with a landward shift of the COB in this area. A free air maximum greater than 100 mGal at the shelf edge, where thick low-density sediments (at least 1 s TWT of young Prydz Channel fan sediments and probably much more older sediments below) have deposited, almost excludes other possibilities than the existence of a thin crust there, either an oceanic crust or an anomalously thinned continental crust with a thickness comparable to an oceanic crust.

The negative gravity anomaly belt (A) in the slope and rise area in the eastern part of the map suddenly ends at about 74°E. However, we can consider alternatively that this negative belt continues beyond a narrow positive anomaly further west-southwestward to a smaller-amplitude negative anomaly belt in the outer shelf (F). The two belts continue almost in a straight line in an ENE direction. Further landward, ENE-trending positive anomaly belts (D and E) parallel the negative anomalies. These paired negative and positive anomalies probably correspond to a transition zone, where crustal thickness rapidly decreases oceanward. We suggest that the COB in this area runs in an ENE direction as shown in fig. 9, and that the original shelf edge including the western part of Prydz Bay ran also in an ENE direction landward of the COB.

6.2. *Highly-magnetized rocks*

The magnetic anomaly map suggests the occurrence of highly-magnetized rocks in a wide area of Prydz Bay. In the area of positive free air anomaly belt E with magnetic anomalies of short wavelength, the acoustic basement, which probably corresponds to the magnetic source body, lies less than 1 s TWT below the seafloor (Stagg, 1985). According to the two dimensional modelling along the two lines SAE32001 and 32004, the source bodies have magnetic susceptibilities of 0.03-0.04 (SI), which suggests mafic igneous composition.

No magnetic susceptibilitiy data are available for rocks collected from near onshore regions. A wide range of K/Ar ages from 500 to 50 Ma were obtained for mafic igneous rocks from the Prince Charles Mountains (Sheraton, 1983). Among others, the Early Cretaceous age (110 Ma) was obtained for alnöite sills from Radok Lake in the Prince Charles Mountains near the western margin of the Lambert Graben. This approximately corresponds to the breakup of India and Antarctica (Johnson *et al.*, 1976). Unfortunately, the basement has not been drilled in the offshore Prydz Bay area. Cooper *et al.* (1991) suggested that the breakup was associated with emplacement of strongly magnetic rocks such as observed in the northwest of the Prydz Bay basin (E). We also suggest that most probable source bodies of the magnetic anomalies in the Prydz Bay area are mafic igneous rocks that intruded at the time of breakup, and that the breakup was associated with wide igneous activity over the Prydz Bay area.

Free air anomaly data suggest that the Prydz Bay basin is separate from the Lambert Graben. We have no data in the boundary area and it is difficult to discuss the relations between the two graben structures. Both were probably made almost simultaneously as a failed rift system during the breakup phase of Gondwana.

7. Conclusions

A magnetic anomaly map and a free air anomaly map of Prydz Bay and adjacent slope and rise area were compiled using Russian, Australian, Japanese and other available data. Mawson Station data were used to correct magnetic time variations of Austalian and Japanese survey data. However, because of the long distance (about 500 km) of the station from the survey area, time variations of these data could not be removed sufficiently. Crossover differences of the magnetic data could be reduced only by removing data segments with short-period time variations and by giving a constant bias to each trackline. Crossover differences of the gravity data were substantially reduced by applying a constant bias to each cruise/leg.

From free air gravity maximum at the shelf edge in the western part of Prydz Bay, we infer that the continent ocean boundary is situated around the shelf edge, where thick sediments, transported by Lambert Glacier northward through Prydz Channel, have deposited. The gravity profile crossing the Prydz Bay basin SAE32001 reveals a thick sediment infill in the basin of about 8 km overlying a thin «granitic» layer; the Moho beneath the graben is shallow (about 22 km deep).

According to the magnetic data, highly-magnetized rocks, probably Mesozoic intrusive rocks related to breakup of Gondwana, occur in a shallow part of the northwest of the Prydz Bay basin and other parts of Prydz Bay.

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