Technical procedures for aeromagnetic surveys in Antarctica during the Italian expeditions (1988-1992)

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Abstract

For most of Antarctica, the geophysical data now available are those of aeromagnetic surveys performed there from 1950 to 1960. Until 1984, the inaccurate positioning and insufficient monitoring of geomagnetic time variations allowed the investigation of the geomagnetic residual field only along profiles. The *Ganovex IV* aeromagnetic survey, performed by BGR-USGS over the Ross Sea and the Northern Victoria Land, and the geophysical investigations of BAS on the Southern Antarctic peninsula and the Ronne ice shelf region corresponds to the recent advancement of these techniques in Antarctica. The first experiments of aeromagnetic measurements, during the Italian expeditions in Antarctica were made during the 1988-1989 field season. Some geomagnetic helicopter borne profiles were accomplished with a Proton Precession Magnetometer (PPM) in the Terra Nova Bay-Gerlache Inlet area. In the 1989-1990 *ItaliAntartide* expedition some profiles were flown over the suture between the Wilson and Bower terranes, in Northern Victoria Land. During the 1991-1992 expedition, in cooperation with researchers of BGR (Bundesanstalt fur Geowissenschaften und Rohstoffe) of Hannover, the GITARA I (German ITalian Aeromagnetic Research Antarctica) program, as part of the LIRA (Litospheric Investigation in the Ross Sea Area) project, was carried out. The investigated area lies between the latitudes 74°18′ S and 75°18′ S and the longitudes 160°30′ E and 164°30′E and it corresponds to a portion of the North Victoria Land, located between the Eisenhower Range and the Drygalski Ice Tongue. The survey was made with a Cesium vapour magnetometer. The positioning system was of the «Range-Range» type, it consisted of three transmitters (beacons), installed inside the investigated area and located with GPS measurements. The line spacing was 4.4 km, with tie lines every 22 km. The survey covered an area of 6500 km^2. Four PPM base stations for the determination of the time variation corrections were installed. The aeromagnetic anomalies will allow the comparison with the ground geomagnetic surveys performed during the previous Antarctic expeditions, also in connection with the aeromagnetic maps of *Ganovex IV*, located at the northern and eastern boundaries of the GITARA area.

Key words *aeromagnetism – crustal-field – magnetic-maps – Antarctica*

1. Introduction

Regional ground magnetic surveys in Antarctica involve several different problems from similar surveys made in other continents. These problems have to be considered in the planning of the field work and in the data evaluation.

First of all topographic references are available only over deglaciated areas which generally correspond to the areas near the coastline. Furthermore the logistic support needed to carry out these surveys is generally available on the coast, where the Bases are located. Also the geological mapping, which constrains the data interpretation, is possible only in the coastal areas where most outcrops are present. For these reasons ground surveys become very time consuming and effectiveless when the survey area is located far from the coast and from where the logistic support is available.

Airborne surveys allow a large amount of data to be collected in a short period, in the range of operation of the aircraft. In Antarctica, where the survey is flown over ice-covered areas and for the most part no topographic maps are available, the choice of the positioning and navigation systems is particularly important. The navigation system gives the coordinates of the aircraft in real time supplying the pilot with the information needed to follow the planned flight path. In the past, the possibility of using the Global Positioning System (GPS) in Antarctica was limited by the number of satellite orbits at high latitudes. Recently, new orbiting satellites favoured the use of the GPS in Antarctica that became of common use and allows the positioning of the aircraft with an accuracy of some meters or less (Whillans *et al.*, 1990).

Aeromagnetic surveys are commonly performed, by fixed wing aircraft. However some Canadian and US companies have developed techniques and instrumentation for helicopter borne surveys. These techniques have been adopted in Antarctica for the versatility of the helicopters which have a very broad band of operation and can be used under hard work conditions.

The safety and range of operation of airborne surveys depend on the quantity and quality of the logistic support available. The Standing Committee on Antarctic Logistics and Operations of the Council of Managers of National Antarctic Programs has requested all countries having bases in Antarctica, to specify the availability of support to the aircrafts. Useful indications are supplied by the «PAIS» (Primary Air Information Station) and the «Ground Facilities» (SCALOP, 1990). The above mentioned information for Italy il listed in table I.

2. Historical background

Behrendt *et al.* (1991) examined the data of aeromagnetic surveys made in Antarctica from the 1950s to date. At first they considered the surveys with widely spaced flight lines and the oversnow traverses, of mainly regional character; then the aeromagnetic survey by BGR-USGS on the Ross Sea and the Northern Victoria Land; and lately the recent geophysical surveys made by BAS on the Antarctic peninsula and the Ronne ice shelf (Johnson *et al.*, 1991). A summary of the major aeromagnetic surveys in Antarctica (1958-1988) is given in table II.

During the three Austral summers, from 1958 to 1961, 13 000 km of aeromagnetic profiles, between the 85°W meridian and the Wilkes station (66°15′S, 110°31′E), were flown. The survey was performed by the University of Wisconsin, in cooperation with US-ARP (U.S. Antarctic Research Program) of the NSF (National Science Foundation), by means of a DC3 of the U.S. Navy and an P2V (Neptune). The DC3 was equipped with a PPM Varian having a towed bird with a 30 m wire, while the Neptune had the sensor mounted on the fuselage. The height of the aircraft during the survey was determined by means of an aneroid altimeter, coupled to a radio altimeter, with an accuracy of 200 m. The flight altitude ranged between 500 and 1000 m from the surface and the accuracy of the positioning was 50 km. The Varian magnetometer, with a flight speed of 280 km/h, sampling rate of 0.7 s corresponding to a ground resolution of 50 m. No correction for the time variations of the geomagnetic field was made.

About 48 000 km of aeromagnetic profiles were flown in Antarctica by Gjelsvik and Wanous from November 1963 to January 1964. The total geomagnetic intensity F was determined by two PPM systems, with Elsec-Wisconsin digital recording systems, on board a DC3 of the U.S. Navy. The flights were based on McMurdo and Byrd stations. The height of flight, between 500 and 1000 m over the surface of the ice, was measured with aneroid and radio altimeters. The correction for the daily variation was made with reference to

Table I. Descriptions of some items from AFIM.

COUNTRY	Italy
PAIS	Terra Nova Bay station INMARSAT 008721150175 (TBAY)
GROUND FACILITIES:	
– Facility	Terra Nova Bay Helipad
– Location	Northern Foothills 74°41′42″; 164°07′23″ 200 yards N from center of station
– Elevation	52 feet a.s.l.
– Monthly mean of the daily maximum temperature for the warmest month	0 degrees Celsius
– Magnetic variation to the nearest degree	137 mean value on period November 14, December 1, 1990
– Operational dates and hours of the facility, local time zone	From November 5 to February 20, all hours. Local time is UTC + 12. However, official time is UTC + 13
– Postal address	Italian Antarctic Expedition, c/o Union Maritime Ltd, Norwich Quay, Box 3, Lyttleton, New Zealand
– Obstacles in approach and takeoff areas and declared distances for each direction of each runway/skiway, *i.e.*	500 yards W of helipad rising terrain, 300 feet; 750 yards SW of the helipad rising terrain, 500 feet
– Surface suitable to be used as a helipad or skiway	Station: Terra Nova Bay
– Facility	Tethys Bay Airfield Northern Foothills
– Location	74°41′42″S 164°03′00″E 2000 yards NW from center of station
– Elevation	Sea level

the Scott Base, South Pole, Halley and Byrd Stations magnetic data. About 28 000 km of traverse were flown over the TAM roughly, on a band of 450 km width, perpendicular to the strike of the chain. Moreover, about 20 000 km were flown east of the Byrd station, over the northern side of the Pensacola Mountains, Berkner Island, Filchner Ice Shelf and Ellsworth Mountains. These data, together with those of 27 000 aeromagnetic profilings by researchers of Wisconsin University from 1958 to 1961 (Behrendt and Wold, 1963; Ostenso and Thiel, 1964), and profiles over 13 000 km, collected during the Project Magnet (U.S. Navy Oceanographic Office) were worked out to elaborate the first map of occurrence of magnetic anomalies (Behrendt, 1964b).

The first helicopter borne aeromagnetic survey was carried out by the US during the Antarctic campaigns 1971-1972 and 1972-1973, over most of the topographic 1:250 000 maps of the Ross Island and of the Taylor Glacier. The total geomagnetic field intensity F was measured by a PPM Varian M-50 instrument. The sampling interval, during the 1971-1972 season and most of the 1972-1973 season was of 3 s, corresponding to a ground spacing of about 150 m. Afterwards, because of technical difficulties, a sampling interval of 10 s was adopted, corresponding to a ground resolution of 500 m. The bird was dragged by a 60 m

Table II. Summary of the previous aeromagnetic surveys in Antarctica.

	Western Antarctica
1958-1961	Marie Byrd Land (Ostenso and Thiel, 1964)
1960-1961	Ellsworth Land (Behrendt and Wold, 1963)
1963-1964	Antarctic Peninsula, Filchner Ice Shelf, Berkner Island, Pensacola Mountains, Ellsworth Land, Marie Byrd Land (Behrendt, 1964b)
1974-1975	Marie Byrd Land (Rose, 1978), (Jankowski, 1981)
1977-1979	Ellsworth Land, Marie Byrd Land (Jankowski, 1981) (Jankowski *et al.*, 1983)
1978	Dufek Intrusion (TAM-West Antarctica), (Behrendt *et al.*, 1980, 1981, 1991)
1986-1987	Palmer Land, Ellsworth Land (Jones and Maslanyj, 1990)
	Eastern Antarctica
1958-1961	Wilkes Land (Ostenso and Thiel, 1964)
1960-1961	Ross Sea Area (Behrendt, 1964a)
1963-1964	Ross Sea Area (Cooper and Yuan, 1987)
1963-1964	Ross Ice Shelf and TAM (Behrendt, 1964a,b)
1971-1974	Ross Island – McMurdo Sound – Dry Valleys (Pedersen *et al.*, 1981)
1980	Lutzow-Holm Bay – Mizuho Plateau – Shirase Gl. (Shibuya and Tanaka,1983)
1984-1985	North Victoria Land – Western Ross Sea (*Ganovex IV* + USGS) (Damaske, 1989)
1988	Lower Rennick Glacier (*Ganovex V*) (Damaske, 1990)

long wire during the 1971-1972 campaign, and of 46 during the 1972-1973 campaign. The survey was flown with a helicopter of the U.S. Navy and Coast Guard. During both campaigns the lines were flown with a 2 km spacing. The average speed was 150 km/h with, when possible, a surface clearance of 300 m. Where the topography was irregular, the survey altitude increased to about 600 m over narrow and deep valleys and it decreased to about 100 m over steep cliffs.

The helicopters were equipped with a radar altimeter, to determine the height over the surface. The determination of the horizontal position of the helicopter depended mainly on visual control, as related to the known topography. For this purpose, a 1:25 000 map was utilised, on which the positions of the flights were marked. Therefore, the best accuracy was that of the flights over the Ross Island and over the Dry valleys, where the topographic references were most abundant. In these areas, the positioning error was less than 500 m. Over the McMurdo Sound, the location of the flight lines was possible only at the end of the flight, in proximity of the coast of Ross Island and Victoria Land. The most inaccurate navigation, with errors reaching 1 km, was obtained on the Ross Ice Shelf (Pederson *et al.*, 1981).

During 1978, with the inertial navigation able to reach a better accuracy of positioning, the aeromagnetic technique was coupled to those of radio ice sounding (Behrendt et al, 1980,1981; Jankowsky *et al.*, 1983; Drewry, 1980), in the survey of a part of the Western Antarctic rift. The excessively spaced flight lines and the lack of knowledge of geomagnetic time variations did not allow the compilation of anomaly maps, and the data were interpreted only along profiles.

During the *Ganovex IV* German expedition (1984-1985), a 4.4 km × 22 km spaced aeromagnetic survey was flown with a «Dornier 228» fixed wing aircraft, over Northern Victoria Land and the South-Western Ross Sea. The survey comprised an area of nearly 250 000 km^2, extending from the ice covered Polar Plateau through a central section of the Transantarctic Mountains (TAM) into the Western Ross Sea, from Coulman Island in the north to Ross Island in the south (fig. 1). Details on the planning, realization and interpretation of the survey are described in Damaske *et al.* (1989) and Bosum *et al.* (1989).

Further aeromagnetic surveys were carried out during *Ganovex V* and *Ganovex VI* expeditions (1988-1989 and 1990-1991). These surveys were performed partly in the Ross Ice Shelf area, near Ross Island, and in the Rennick Glacier area northernmost portion of Victoria Land (Damaske, 1990). The former was flown with a Dornier 228 aircraft; in the latter the aeromagnetic equipment was installed in an «Ecureil AS 350» helicopter.

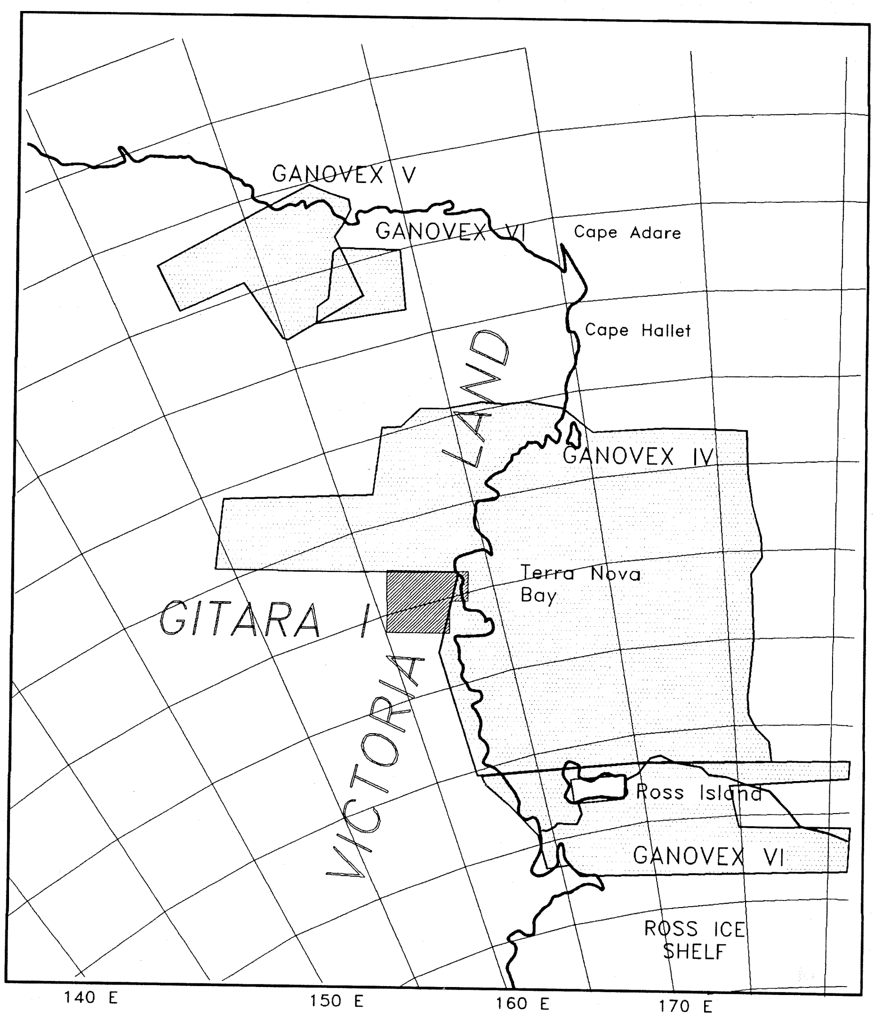

Fig. 1. The GITARA I survey in the frame of the Ross Sea area.

3. Previous aeromagnetic flights during the ItaliAntartide 1988-1989 – 1989-1990 expeditions

Within the frame of the Earth Sciences Group geophysical research in Antarctica, the first measurements of the geomagnetic field from an aircraft were carried out during the *ItaliAntartide 1988-1989* expedition, to ascertain the feasibility of this type of measurements by a helicopter lacking specific adaptation.

During January 1989, the «geomagnetism and gravimetry» team, to which some authors of this work belong, carried out two profiles over the areas of the Gerlache Inlet-Campbell Glacier Tongue and the Northern Foothills. The first flight, at a constant height of 1000 feet over the ground topography, moved from the Terra Nova Bay station toward Shield Nunatak; then along the direction Shield Nunatak-Markham Island; and finally toward the Markham Island-Terra Nova Bay station. A PPM Littlemore Elsec type 595 magnetometer, transportable by helicopter, already used for the aeromagnetic survey of the Valle d'Aosta in Northern Italy (Armando *et al.*, 1986) was used; the flight parameters were the following: a 35 knots speed, a towed bird with a 25 m long wire and a sampling rate of 10 s. The «Terra Nova Bay» Italian Geomagnetic Observatory, was taken as reference for correction of time variations.

In the austral summer 1989-1990 (*ItaliAntartide V* expedition), an aeromagnetic survey was carried out in the area of contact among the Wilson Terrane, Dessent Unit and the Bowers Terrane (North Victoria Land, Antarctica). Magnetic data were acquired along twelve profiles executed with a helicopter borne magnetometer. The measurements benefitted logistic support of a tent camp (Marinella Camp), at No Ridge (167°00′ E-73°29′ S). The aim of this survey was to check if the major suture of the North Victoria Land has a magnetic signature.

A PPM magnetometer Scintrex MP3 with a resolution 0.1 nT was used. The sensor was installed in a «bird» with a wire 30 m long. The sampling rate along these profiles was 2-3 s, corresponding to a distance on the ground of 40-80 m depending on flight speed. As no telemetric systems were available, positioning was performed simply by means of visual control on a topographic map (the U.S. Geological Survey maps, 1/250 000 were used). The chance of controlling the quality of such positioning was supplied by the northernmost profiles; on these profiles the presence of the Pleiades volcanites supply very impulsive magnetic anomalies, with characteristic shapes. The data were corrected for the daily variation of the magnetic field, as recorded at the «Terra Nova Bay» Italian Geomagnetic Observatory (Bozzo et al., 1993).

4. The «GITARA I» aeromagnetic survey

During the 1991-1992 *ItaliAntartide* expedition, the first campaign GITARA I – German ITalian Aeromagnetic Research in Antarctica – was carried out by a team of researchers belonging to «Dipartimento Scienze della Terra» of Genoa University, «Istituto Nazionale di Geofisica» of Rome and of «BGR» (Bundesanstalt für Geowissenschaften und Rohstoffe) of Hannover, as part of the LIRA project (Lithospheric Investigation in the Ross Sea Area).

4.1. *The magnetometer*

In general, the magnetometer used for the survey did not show any malfunctioning. However it is useful to recall some essential features that an airborne magnetometer should provide: 1) high resolution (usually 0.01 nT); 2) high sampling rate to provide a sufficient ground resolution; 3) availability of both analog and digital outputs; 4) general strength of the equipment that has to be used during long period, under hard work conditions.

For the GITARA I survey, a Scintrex Cesium vapour magnetometer with a sampling rate of 1 s was adopted.

The equipment is formed essentially by two parts: the console and the sensor. In the console an oscilloscope probe allows the operator to check the signal strength received from the sensor. The sensor is installed in a towed bird with a 30 m cable.

4.2. *Survey overview*

The survey area is comprised in latitudes 74°18′ S and 75°18′ S and longitudes 164°30′ E and 164°30′ E (fig. 1). The survey covered the area between the Ross Sea and the Polar Plateau (88 km far from the coast), between the Campbell and the Drygalski ice tongues. Originally the plan was to cover an area over the Plateau up to 154 km far from the coast, but the extremely bad weather conditions caused a reduction of the survey. An area of 6582 km^2 was covered with a line spacing of 4.4 km and a tie lines spacing of 22 km. The total length of flight lines was 2084 km. The survey was performed in 26 h 29 min of flight.

The magnetic values were sampled at 1 s intervals corresponding to a ground resolution of 40 to 50 m depending on the flight speed. The data were stored digitally on a laptop computer used as an acquisition system.

The flight altitude was kept constant to a 9500 ft barometric. It should be noted that the true flight altitude was somewhat lower than the one indicated on the barometric altimeter of the helicopter. This is due to the non-standard atmospheric conditions in Antarctica. During *Ganovex VI* German expedition, a comparison between readings of the helicopter altimeter with elevations known from GPS measurements were carried out. This comparison showed that for the 9000 ft level the true altitude was about 500 ft less than the indicated barometric reading (Damaske, 1990).

4.3. *Positioning and navigation*

The Trident IV system was used for navigation on the helicopter and to provide the positioning of the flight lines at every data point. This system is an advanced version of Trident III, used during the *Ganovex IV* survey. The Trident IV was already tested during the *Ganovex V* and *VI* expeditions for the surveys on the Ross Ice Shelf, south of McMurdo Sound, and in the Rennick Area. Details on the system are described in Bachem *et al.* (1989) and Damaske *et al.* (1990).

The system is based on an interrogator, installed on the helicopter, which receives coded signals from ground transmitters called «beacons». The signals are converted into distances (ranges) and the information is transferred to the board computer. The distances are used by the board computer to determine the helicopter position within the beacon network. The transmitting range of the beacons is approximately 300 km, when not shadowed by any topographic relief. Obviously, to obtain absolute position of the helicopter, it is necessary to know the exact location of the beacons. The absolute position of the beacons was thus computed using a GPS receiver with an accuracy of 10 m.

For the GITARA survey, three beacons were installed, on the highest peaks of the area, to avoid shadowing effects mentioned above. The beacons were installed on Mt. Nansen (NAN), Mt. Larsen (LAR) and Mt. Joyce (JOY) (fig. 2). The best configuration for the beacon network is that in which the transmitters are placed outside the area to be surveyed. Due to the topographic features of the area, such a configuration was not possible and the three beacons were placed almost on the same line. In this case the computation of the position becomes very critical, especially when the helicopter is very close to the line connecting the beacons. Furthermore, for most of the survey, the Mt. Larsen beacon was not operating for unknown reasons. The positioning, with only two beacons, has two different possible solutions, one for each side of the connecting line between them. For these reasons the operator has to introduce one pair of coordinates (X, Y) to initialise the system.

5. Survey data processing

The data processing was performed through several steps as shown in fig. 3. After a preliminary check during the survey, the first step

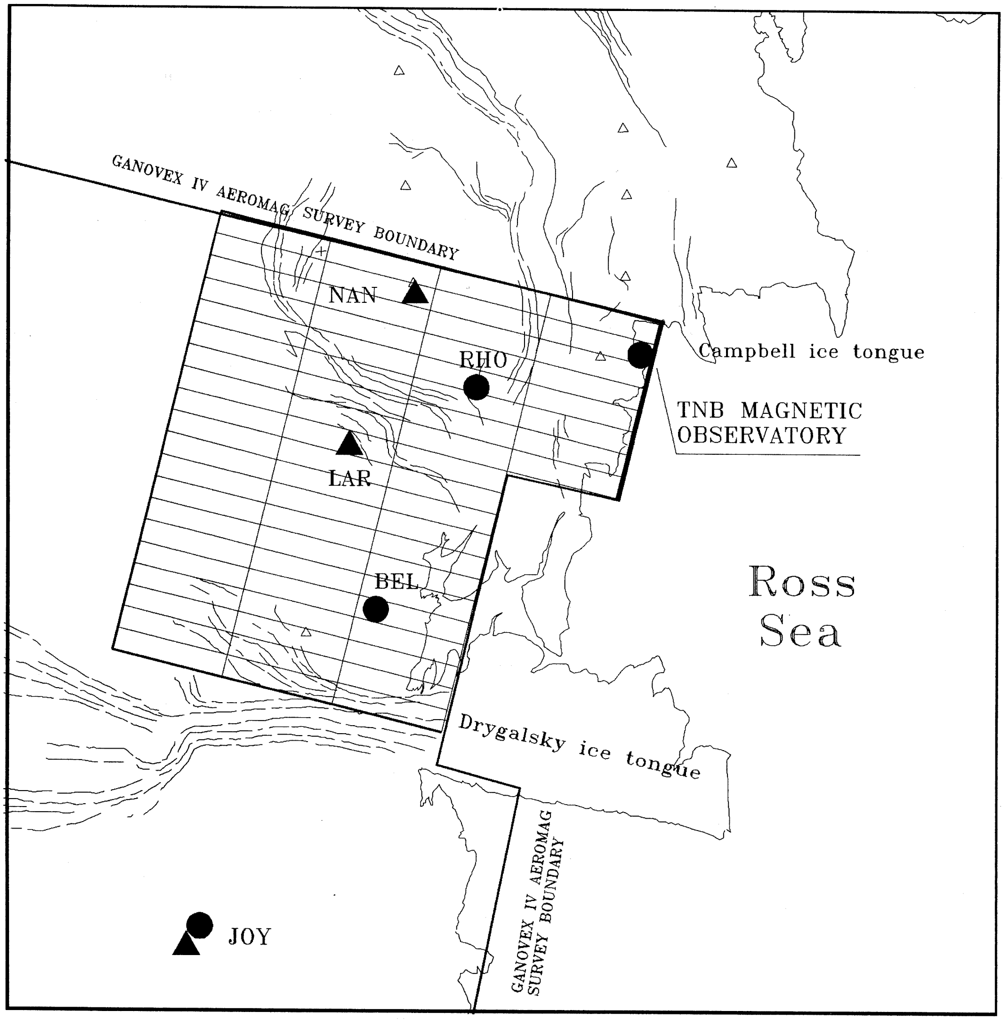

Fig. 2. Positioning of the GITARA I flight lines, beacons (full triangle), magnetic base stations and tents camp (BEL) (full dot).

consisted in the reconstruction of the flight lines positioning. Even in a crude and small-scale representation most errors affecting the positioning were recognised as: 1) small individual peaks; 2) a wrong («returning») path of the flight lines after passing through the connecting line between two beacons. The latter problem (2) occurred several times as all profile flights were carried out after the third installed beacon was out of function.

To account for these errors a set of software routines was developed. Wrong coordinates were set to «invalid» and the position was then calculated interpolating linearly between «valid» X, Y pairs, assuming a constant speed of the helicopter.

5.1. *Suppression of time variations*

To monitor the geomagnetic activity during the survey some base stations were installed.

As the main reference station a Scintrex MP3 PPM magnetometer near the «Terra Nova Bay» Geomagnetic Observatory was used. This base station recorded data with a sampling interval of 1 min. Geometric G856a PPMs were set up at two other locations, respectively Mt. Joyce (JOY) and at Rhodes Heads (RHO) (fig. 2).

As known from previous experience the same time variations are different in amplitude and phase for stations being a long distance apart. Indeed it has been shown that base station data are critical, to be used for time variation correction, if the distance exceeds 100 km (Maslanyj and Damaske, 1986). However, base station data are still a worthy instrument to diminish the effect of long period variations, by reducing the survey data with a filtered set of base station data. In this way the long term trends in the survey data can be removed while the short variations will be removed making use of the tie lines. For these reasons the tie lines were planned at relatively closed spacing. The profile to tie line rate is usually 10 to 1, while in polar regions a rate of 5 to 1 is mostly adopted.

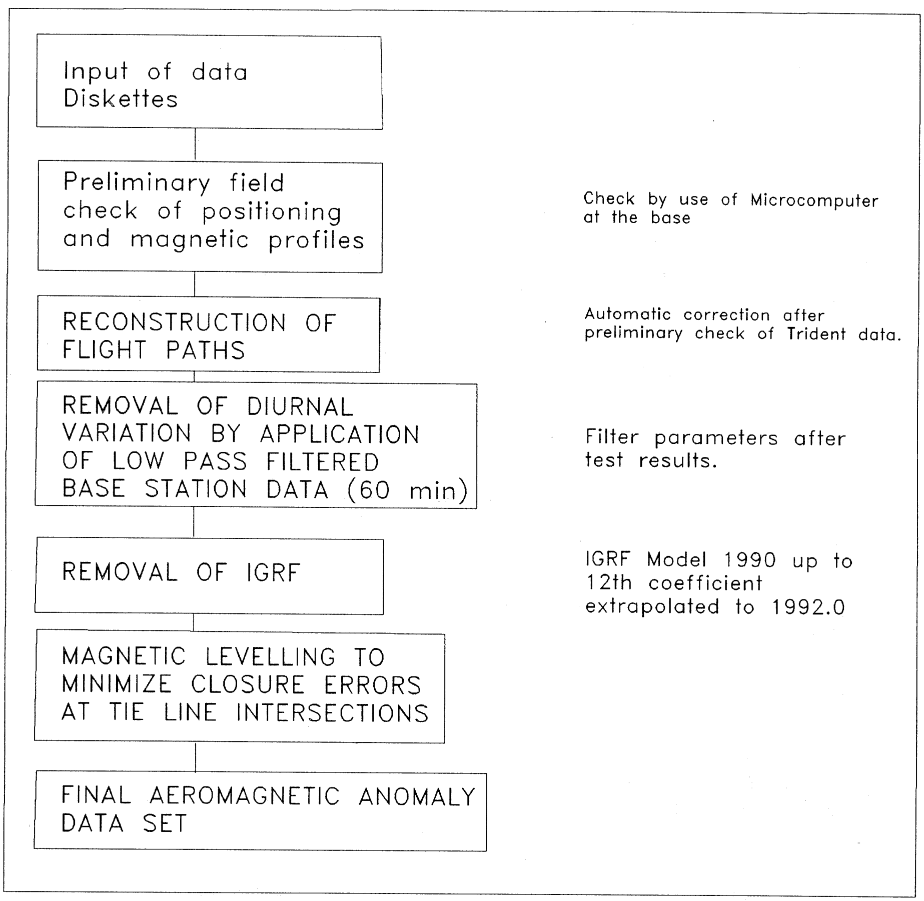

Fig. 3. Block diagram of the data processing steps.

For the GITARA I survey all data from the three base stations were filtered with a 60 min low pass filter which proved to be sufficient to remove the high frequency discrepancies between the stations. The use of a higher frequency filter showed unacceptable differences between the base stations.

The reduction of the magnetic field values was carried out, according to the following:

F(corrected) = *F*(observed) + [*F*(filtered values) – *F*(mean value at base)]

using:

F(mean value at TNB) = 64659 nT
F(mean value at JOY) = 66254 nT
F(mean value at RHO) = 64818 nT

The mean value at every station was computed as the average magnetic field over the entire period of the survey.

5.2. *Removal of IGRF*

As reference field the International Geomagnetic Reference Field (IGRF, 1990) was adopted. The IGRF value was computed at each latitude-longitude coordinate of the flight path. For calculating the IGRF at each point the spherical harmonic coefficients up to the grade 12 were used, for the year 1990 and extrapolated to 1992.0. The IGRF values were

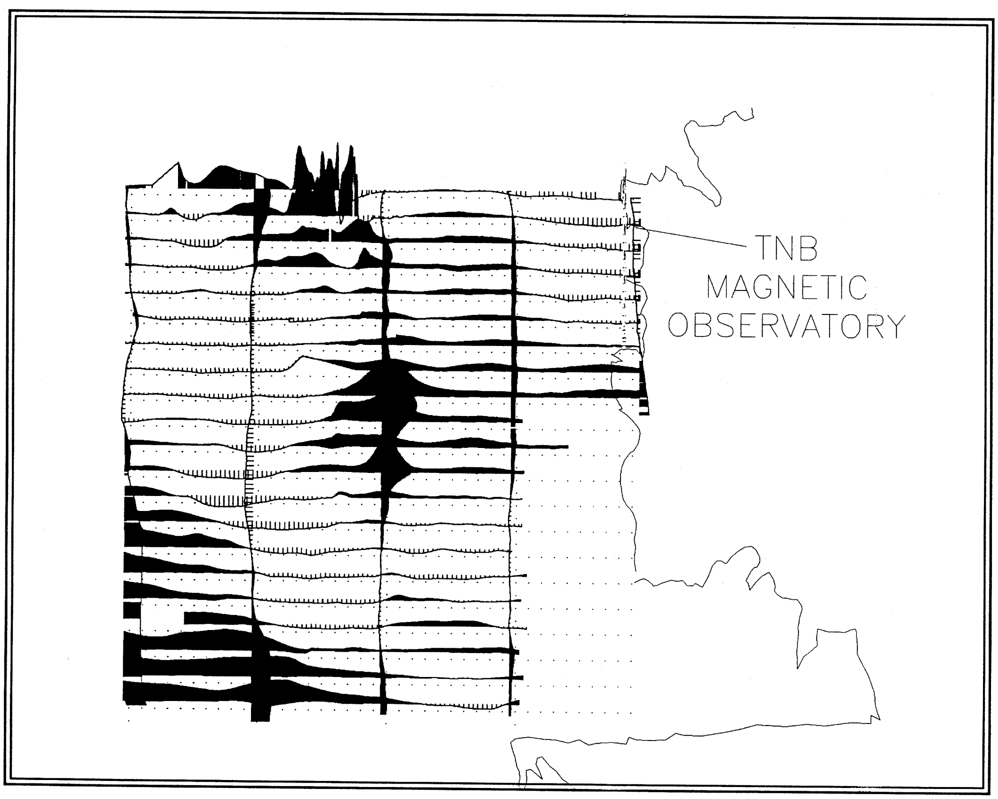

Fig. 4. Shaded aeromagnetic profiles of GITARA I after magnetic levelling (scale 1:1 000 000).

calculated for a height of 2700 m (corresponding to a flight altitude of 9000 ft).

5.3. *Magnetic levelling*

The magnetic levelling consists of minimizing the closure errors at the intersection points between profile lines and tie lines. After removing the long term trends from the data set by making use of the filtered base station data, discrepancies at line intersections still exist.

The first step is to calculate the spatial coordinates of the intersections between profile lines (*PR*) and tie lines (*TI*). Then the magnetic measurements on both profile and tie lines are extracted. The final data set produced by this process is a matrix of the form:

$$(PR, TI, X, Y, GPR, GTI)\ i, j$$

where:

PR = profile line;
TI = tie line;
X, *Y* = the coordinates of the intersection point of *PR* and *TI*;
GPR = the aeromagnetic total field value on the profile line;
GTI = the aeromagnetic total field value on the tie line;
i = an index ranging from 1 to GPR (number of profile line);
j = an index ranging from 1 to GTI (number of tie lines).

This primary data set is used by an iterative process to apply a first order levelling correction and a higher order levelling as follows:

1) first order (linear) correction: a constant value, calculated on the basis of the statistical mean of its closure errors, is applied equally to each and every data point along a line. All profile and tie lines are adjusted individually in this way. The process is repeated iteratively until the amount of readjustment falls below a specified minimum (1/100th gamma);

2) higher order levelling corrections («slopes» and /or «tilts»): this correction can be applied after the first step reveals any second or third order residual which remain, and that effects are not masked by the high amplitude first order discrepancies;

3) the final process is to interpolate adjustment values for every data point on the lines between the intersection points.

When this process is complete, the magnetic data (fig. 4) are ready for gridding and contouring and any other technique of digital enhancement.

6. Discussion

The planning and execution of aeromagnetic surveys in Antarctica shows different aspects from similar surveys made at mid latitudes. Primarily the magnetic activity at high latitudes makes it more complicated to remove time variations, and several magnetic base stations are needed; positioning requirements are also particularly stringent. Furthermore the logistic implications predominate over scientific needs. For instance, the line spacing that normally is chosen on the basis of the sensor-source distance, is here the result of a compromise with logistic requirements.

Even if the data processing steps are more time consuming than usual, it is possible to achieve a good precision in the magnetic anomaly data. The computation of the GITARA I magnetic anomaly map is now underway, and will contribute to solve some questions that still exist in the interpretation of the structure of the Ross Sea region. Although this area includes some of the most intensively studied regions of the continent, important long-standing problems remain to be solved (Tessensohn, 1989). Now further geophysical plans are evaluated in the frame of the LIRA project (Litospheric Investigations in the Ross Sea Area). From this standpoint the main target, to be tackled in the next few years, is to complete the aeromagnetic coverage of the TAM. In this respect, during the 1992-1993 season the GITARA program (Gitara II) was extended southward and the data are currently being processed.

The main goal of the geophysical and geological investigations in this sector of Antarctica is to contribute data on three major aspects of Antarctic geology:

– the relationship of these areas to Australia, Tasmania, and New Zealand;
– the tectonics of the mobile belts at the fringe of the East Antarctic Craton;
– the Ross Sea and its development in connection with recent plate tectonics.

This will contribute to the knowledge of the Antarctic lithosphere in a key area for the understanding of global tectonics.

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