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22. An Aeromagnetic Survey over the Northwestern Ross Ice Shelf and the McMurdo Sound Area

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INTRODUCTION

As part of the expedition GANOVEX VI 1990/91, the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), the Alfred Wegener Institute for Polar and Marine Research (AWI), and the United States Geological Survey (USGS) carried out an airborne magnetic survey over the northwestern Ross Ice Shelf and McMurdo Sound between Ross Island, the Transantarctic Mountains, and Minna Bluff.

The area planned for the aeromagnetic survey connects directly with the GANOVEX IV survey area (BGR & USGS 1987, BACHEM et al. 1989a) which terminated along an approximately east-west line at about the latitude of Cape Bird. The GANOVEX IV survey covered the Victoria Land Basin - which is the westernmost of the three north/south striking basins in the Ross Sea - from its northern end in the Terra Nova Bay region to its known southern end at Ross Island. A possible southern extension of the Victoria Land Basin and its central graben structure (the Terror Rift as found from seismic surveys (COOPER et al. 1987) and what has been referred to as Victoria Graben in the aeromagnetic interpretation of the GANOVEX IV data (BOSUM et al. 1989) was one of the major targets for this survey.

The survey was laid out in the form of blocks. A 135 km wide transect from the Transantarctic Mountains to about 175° W formed the focal block of the survey (Fig. 1) in which all major scientific objectives could be covered. Other survey blocks were planned to the south of this. During the course of the survey it turned out that in the time available no further area could be covered. Indeed, the unfavourable weather conditions made it impossible to complete even the above described main section fully.

In detail, the lay-out of the survey area was closely following that of the GANOVEX IV survey to assure compatibility and direct continuation between the two data sets.

The line spacing was chosen again to 4.4 km with a tie-line separation of 22 km. The survey altitude of 2,000 ft (610 m) corresponds to that of the Ross Sea section of the GANOVEX IV survey to which this survey area is directly adjacent. The profile lines were aligned approximately E-W, the tie-lines N-S.

As part of the survey area is covered by the maps of the USGS Antarctica Reconnaissance Series 1 : 250,000 the Lambert conformal conic projection used for these maps was also used for the preparation of a flight line grid.

INSTRUMENTATION

As measuring platforms two Dornier 228-100 ski-equipped aircraft were prepared with a magnetometer, a special navigation system, and a data acquisition system. Both aircraft are owned by the AWI and maintained by the Deutsche Forschungsanstalt für Luft- und Raumfahrt (DLR).

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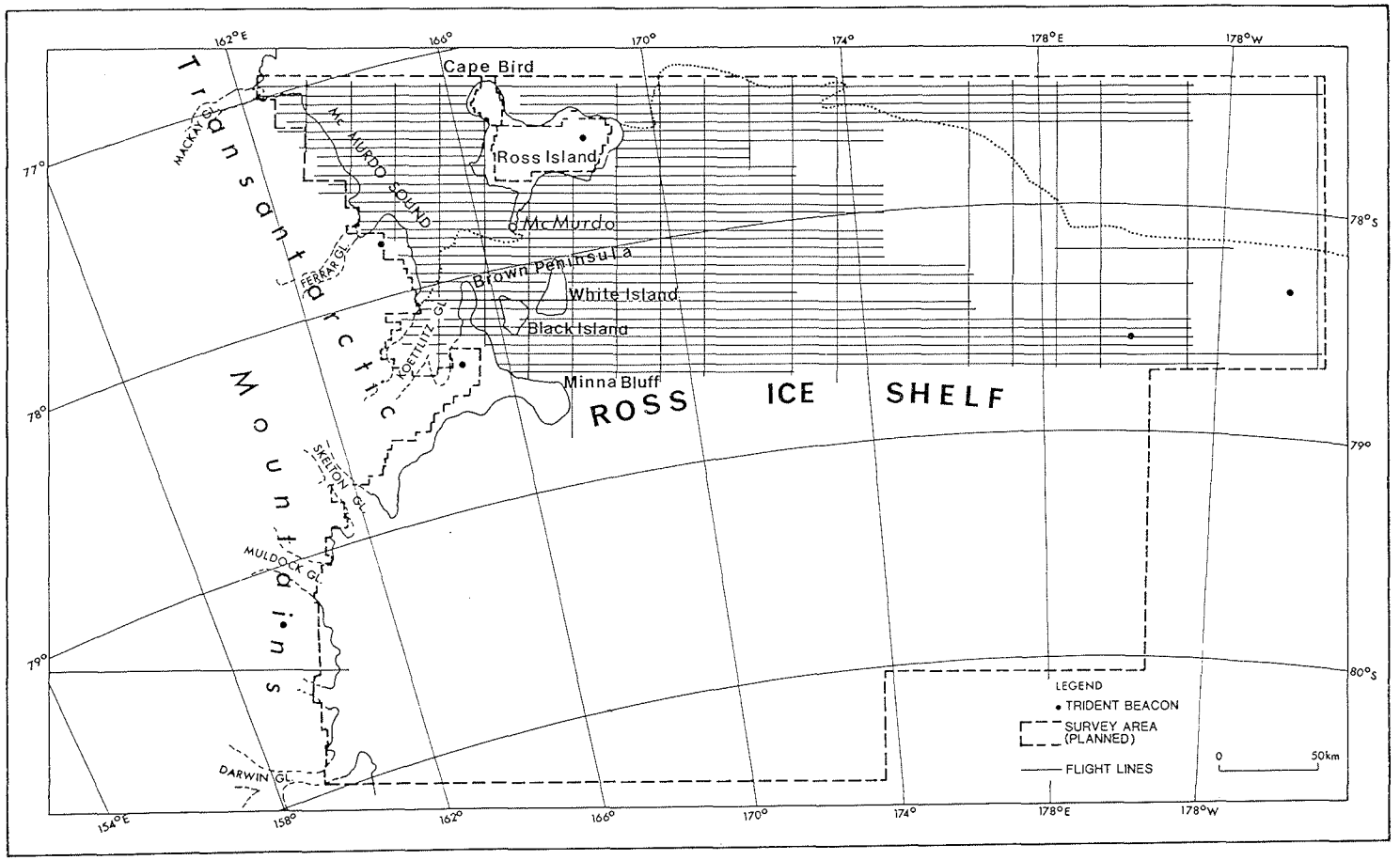

Fig. 1: Overview of the planned survey area and the lines flown over the Ross Ice Shelf and McMurdo Sound. Dots mark the positions of the Trident navigation transmitters. The thick line is the profile section presented in Figure 3.

Abb. 1: Übersicht über das geplante Meßnetz über dem Ross-Schelfeis und dem McMurdo-Sund sowie die tatsächlich geflogenen Linien. Punkte markieren die Position der Trident Navigationssender. Die dicke Linie bezeichnet das Profil von Abbildung 3.

For measuring the total intensity of the magnetic field a proton precession magnetometer of the type Geometrics G813 was installed in the *Polar 2* aircraft. For the *Polar 4* aircraft an optically pumped Helium vapour cell magnetometer of the type Geometrics G833 was base of measurement.

Both aircraft are equipped with an inertial navigation system (INS) type Honeywell Lasernav from which data are read into the data acquisition system. As, however, the INS navigation is insufficient for the desired accuracy of the positioning of the flight lines the Trident IV navigation system has been additionally installed. This is a radiolocation system using a frequency of 1.2 GHz for the distance measurement between the moving platform and the fixed transmitter stations on ground. If at least two stations are received the position of the platform can be calculated to an accuracy of the same order as the locations of the ground transmitter are known. More details can be found in BACHEM et al. (1989b).

The basis of the data acquisition system is presented in Figure 2. In-flight control of the data was possible via a screen and a printout. After returning from survey flights the data were copied and controlled blockwise to restore bad data sequences. The copies were used for editing and pre-processing magnetic profiles using Terra-Tools software to get an overview about first results in the field.

Geomagnetic activity was monitored with a base station type Geometrics G856 set up near Willie Field air strip. In general, the level of geomagnetic activity during this season was higher than in the previous years as was expected from the known fact that geomagnetic activity is always trailing behind the solar cycle which passed its maximum in 1989/90. The daily pattern of magnetic activity in this region (DAMASKE 1989), however, remained unchanged: the less disturbed interval was found to start in the early afternoon hours lasting to about after midnight local time. Only during this period survey flights were carried out.

THE SURVEY

The scientific equipment and all personnel except the flight crews were brought from Christchurch, New Zealand to McMurdo Station, Antarctica on board of a Hercules C141 aircraft. Upon arrival all equipment was tested in the Thiel Earth Science Laboratory at McMurdo and the Trident ground transmitters were installed. Locations of the ground transmitters are included in Fig. 1.

The two Dornier aircraft *(Polar 2* and *Polar 4)*, left Germany on October 8, 1990 reaching Punta Arenas eight days later. They proceeded to the Antarctic Peninsula on October 26. Bad weather at Rothera and Halley Bay caused a delay of nearly one month. They finally arrived at McMurdo on November 26. Due to this late arrival

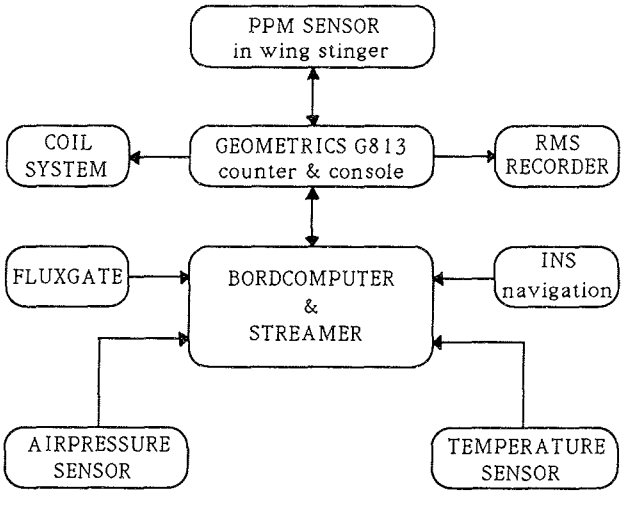

Fig. 2: Data acquisition structogram.

Abb. 2: Flußdiagramm für die Datengewinnung.

all planned sections of the survey beyond the primary target area had to be skipped concentrating work on only this area.

The first survey flight of *Polar 2* took place on December 5. After a week of reasonable good weather conditions some flights over the Ross Ice Shelf area and the full McMurdo Sound grid was completed. After that the constantly unfavourable weather conditions over the eastern section of the Ross Ice shelf grid prevented any more flights to this area. Toward the end of the already extended stay at McMurdo work concentrated on the near Ross Island sections. The last survey flight took place on December 22. Until then the Polar 2 had covered an area of about 36,800 km^2. The 12,700 km of profile- and tie-lines (see Fig. 1) were flown during 70.5 hours of flying time (47.5 hours on line) on 19 flights.

PRELIMINARY DATA PROCESSING AND FIRST RESULTS

The data set used for preliminary data processing has been extracted from the raw flight data with a sampling rate of 1 Hz. It has been checked for spikes and bad data sequences. The data were corrected for the daily magnetic field variations using base station data recorded at Willie Field, McMurdo. Correction for the earth's magnetic field was done by reducing the data using the IGRF model 1985.0.

An example of a line section (thick section of a flight line in Fig. 1) with the total field data reduced in the above described way is given in Figure 3. The reduced total magnetic field shows smooth, slowly rising values in the beginning of the profile section, then turning into a steep positive slope followed by a sequence of field variations of about 5 km wavelength. The wavelength decreases whilst the amplitude increases up to 300 nT near the end of the flight line.

The lower part of Figure 3 shows the barometric flight altitude and the surface contour. It can be clearly seen that the uncorrected flight altitude of 655 m is quite constant, while the surface contour (the difference between radar and barometric altitude) shows a distinct topography that correlates with the pattern of the reduced field values. The flight line starts at the western side of McMurdo Sound (Koettlitz Glacier), the following rise in the surface contour can be identified with Brown Peninsula, then the northern parts of Black Island and White Island before reaching the Ross Ice Shelf.

To show that the high amplitude, short wavelength variations of the reduced total field are mainly due to near-surface rocks a mean terrain clearance (see HANSEN & MIYASAKI 1984) was calculated and plotted against the total field upward continued to a constant height level of 1000 m. The dominating amplitudes above White Island are reduced to about a fifth of the original value. In contrast, the long magnetic wavelength variations as over McMurdo Sound including Brown Peninsula and Black Island remain nearly unchanged thus pointing to deep and broad magnetic sources.

All data discussed so far refer to INS navigation. The top part of Figure 3 shows the geographic INS heading. In the very beginning of the line directional errors are considerably high as common in airborne surveys; deviations of about 20° from the survey heading of 110° are observed. The corrections are performed by adjusting the autopilot according to the Trident navigation indicator on the cockpit monitor. During the flight the necessary corrections in heading are getting smaller. For further processing it is indispensable to compute a dynamic compensation to correct the heading errors and to base the data on Trident navigation whenever possible.

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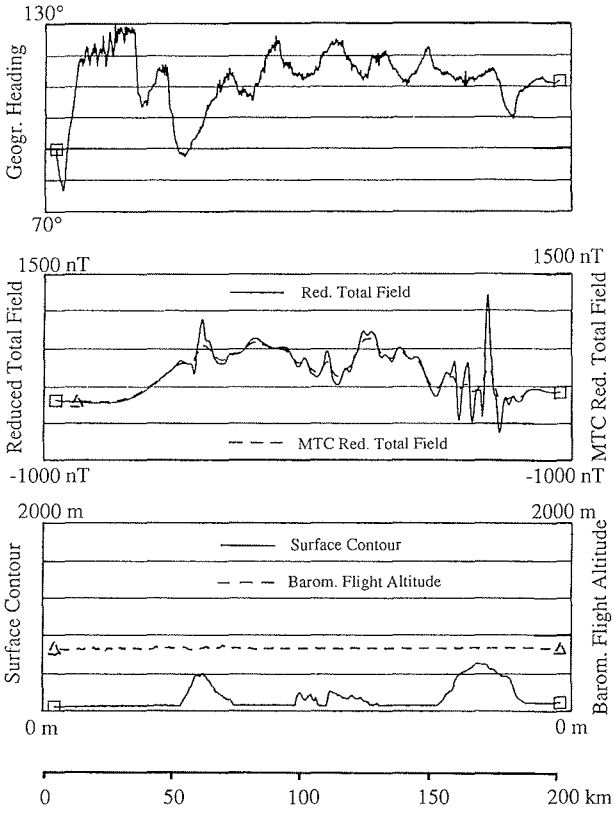

Fig. 3: Section of an aeromagnetic profile over McMurdo Sound, Brown Peninsula, Black and White Islands (for locations see Fig. 1). Aircraft heading (upper part), reduced total magnetic field (middle), and barometric altitude and surface contour (bottom).

Abb. 3: Profilabschnitt geflogen über McMurdo-Sund, Brown-Halbinsel, Black Island und White Island (vgl. Abb. 1). Oben: Richtung der Flugzeugachse, Mitte: reduziertes magnetisches Totalfeld, unten: barometrische Höhe und Oberflächenkontur.

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