Project AEROMAG-92: a new high resolution aeromagnetic survey of the Lersletten area, central West Greenland (68°15′ to 68°55′N, 50°25′ to 53°35′W)

Leif Thorning

Open File Series 93/2

February 1993

GRØNLANDS GEOLOGISKE UNDERSØGELSE
Ujarassiortut Kalaallit Nunaanni Misissuisoqarfiat
GEOLOGICAL SURVEY OF GREENLAND

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LIST OF CONTENTS

ABSTRACT

A new high resolution aeromagnetic survey has been flown over Lersletten, central West Greenland. The survey comprises 10 062 line kilometres covering approximately 8 425 km^2. Line spacing is 1 km, with 5 km between tie-lines and the altitude fixed at approximately 500 metres. The data have been acquired, compiled and interpreted by Geoterrex Ltd, and in this report a qualitative discussion relates the data to the Nagssugtoqidian geology of the area. It is also demonstrated that later geological events can be seen in the data, e.g. possible deep-seated intrusions and reversely magnetised dykes and sills. Copies of the original maps of flight lines, total field anomalies, calculated vertical derivative anomalies and interpreted features, as well as the digital data are available from GGU.

1. INTRODUCTION

This report presents a new high resolution aeromagnetic survey comprising 10 062 line kilometres over the area of Lersletten, central West Greenland acquired in **project AEROMAG-92**. The survey has been carried out by Geoterrex Ltd (Geoterrex) under a contract with the Geological Survey of Greenland (GGU). The data were also compiled and interpreted by Geoterrex, who delivered the results in November 1992. GGU now holds all rights to the data. This report relies to a considerable extend on the final report from Geoterrex, with some additional comments on the interpretation, and its publication signals the release of both the maps and the digital data to the general public. The main objective of this report is to provide a sufficient background for readers to decide on possible further use of the maps or the digital data. These can be purchased separately at modest prices in accordance with standard conditions for the purchase of GGU digital data.

South of the survey area earlier aeromagnetic surveys (Thorning, 1982) cover most of the region down to Sukkertoppen Iskappen. With the addition of the data presented here an aeromagnetic regional coverage now exists over this interesting part of the Precambrian shield of West Greenland. These data are also available in digital form from GGU.

The project has been financed by the Mineral Resource Administration, Ministry of Energy, Nunaoil A/S, and GGU.

2. PROJECT HISTORY

The project was initiated in late May 1992, at which time the design and initial planning of the survey was worked out by the author. The contract with Geoterrex was signed in Copenhagen on the 2nd of June, and the field operations were started the 22nd of June, 1992, and concluded the 5th of July, 1992. Immediately thereafter Geoterrex Ltd commenced the compilation and interpretation of the data in their Ottawa office. The final versions of the magnetic anomaly maps, profile plots, digital data, and interpreted maps were delivered to GGU and accepted late November, 1992. This report concludes project AEROMAG-92, but further work on the interpretation of the data will be undertaken by GGU.

3. PROJECT OBJECTIVES

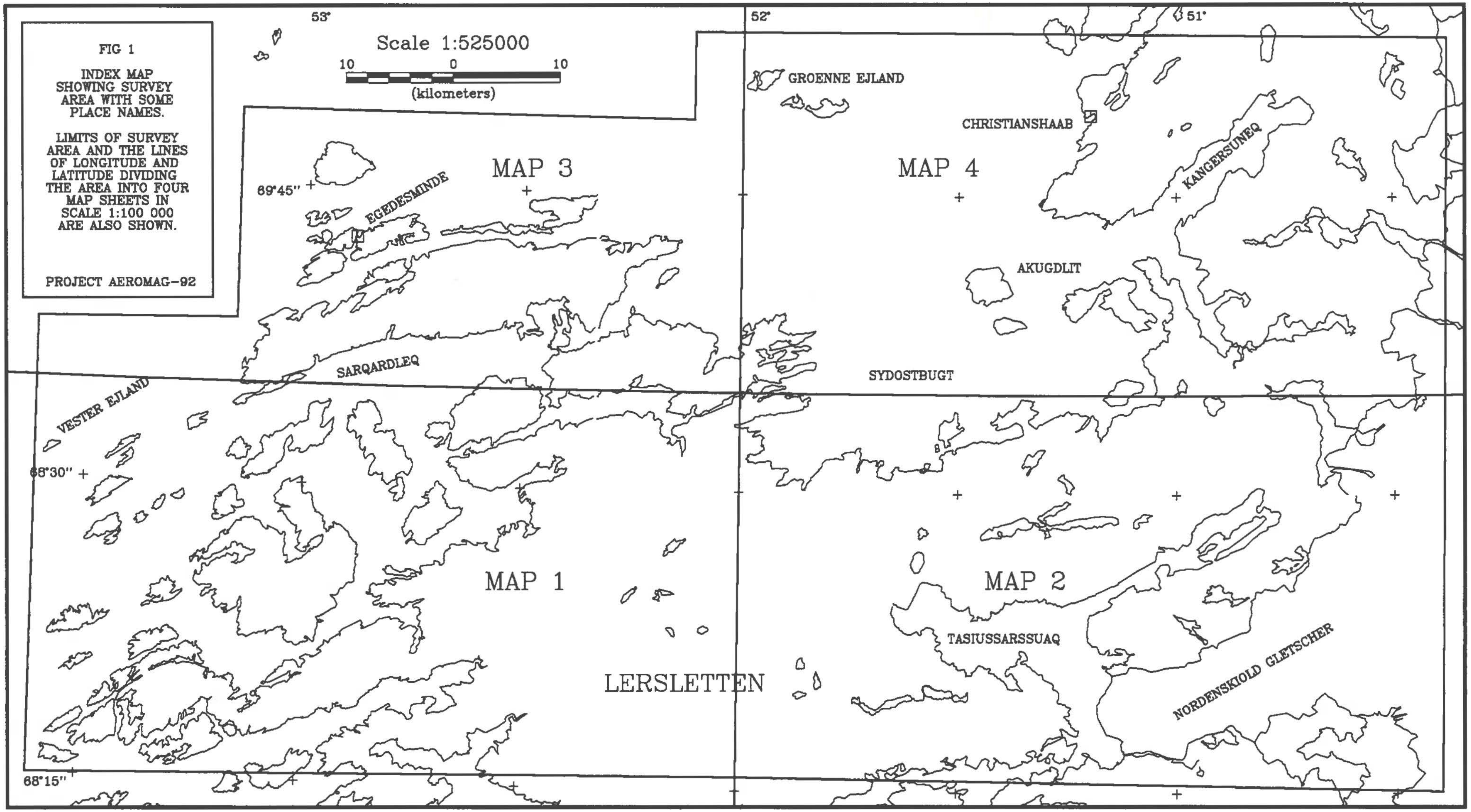
The main objective of the project is to procure good quality high resolution aeromagnetic data from an important part of the Precambrian shield in central West Greenland, and to make the data generally available to the public as soon as possible. The details of the geology of the area are only partly known and understood, and a regional aeromagnetic survey of this type will provide a better basis for regional geological mapping and understanding and at the same time serve as a suitable base for subsequent more detailed investigations carried out by GGU or companies holding exploration licences in the area. It is hoped that the data will be a help for any such activity, and therefore this report is published prior to a thorough treatment of the data by GGU, in the hope that this will encourage others to take an interest in the area.

4. ACQUISITION, COMPILATION AND PRESENTATION OF DATA

The following sections give a brief account of the main phases in the production of the data. The aeromagnetic survey has been carried out according to normal industry standards, and most of the steps in the processing will be familiar to anyone used to working with aeromagnetic surveys. Further information can be found in the final report from Geoterrex by Schacht (1992). The survey area is shown in Fig. 1.

Fig. 1 *(Opposite page)*: Index map for project AEROMAG-92 survey area showing place names, limits of the aeromagnetic survey and the latitude and longitude dividing the area into four 1:100 000 map sheets.

THE GEOLOGICAL SURVEY OF GREENLAND (GGU)



4.1 Survey specifications

The survey was flown with north–south lines spaced 1 km apart, and with 5 km between the east–west tie-lines covering an area of approximately 8 425 km^2. Altogether 131 north–south lines and 15 tie-lines were measured, most of them in one piece, only a few has because of reflights been measured in segments, which were then in the order of half lines. Altitude was fixed at approximately 500 m, with slightly draped flying in the easternmost part of the survey area, where the topography rises up to that height. Reflights were made if the spacing exceeded more than ± 200 m for 5 km or more.

Diurnal conditions were deemed acceptable when there was no departure of more than 10 nT from one minute long chords (the approximate time to fly 5 km, the distance between two tie-lines). The base magnetometer used for the evaluation was placed in Jakobshavn (Ilulissat), see Fig. 6, less than 50 km north of the northern limit of the survey area.

Before the actual production flights started, a series of operations were carried out to evaluate the magnetic compensation of the aircraft. On the 21st of June the figure of merit was determined to 1.6 nT, with an average noise envelope for the manoeuvres of 0.13 nT. A lag test was also carried out, and taken into account in the processing. The heading differences averaged 0.5 nT.

4.2 Instrumentation

The Geoterrex aircraft (CGGTA) used for the survey was a Cesna Titan 404 especially equipped for aeromagnetic surveying operating at 150 knots corresponding to approximately 77 m/sec. Navigation was by GPS (Global Positioning System - Sercel NR103) and Doppler radar (DECCA 9305A), and the flight path was recorded on video. Altitudes were measured by radar (TRT AHV 6) and barometric altimeter (Rosemount 1241). The magnetometer was a single cell Scintrex cesium vapour magnetometer with a stinger mounted sensor, having a sensitivity of 0.01 nT, and a sampling rate of 0.125 sec. The general noise envelope during operation was kept below 0.2 nT. The magnetic compensation of the aircraft was carried out automatically using a Sonotek AADC compensator (18 terms). All data were recorded digitally (Geoterrex MADACS system) and displayed in analogue form (RMS-GR33).

The base station monitor in Jakobshavn (Ilulissat) consisted of a single cell cesium vapour magnetometer with sensitivity 0.01 nT and sampling rate 1 sec. and included a Sercel 10 channel GPS receiver. A Picodas digital acquisition system recorded the information together with the time, daily synchronised with the aircraft system.

4.3 Acquisition of data

The base of operation was the airport at Jakobshavn (Ilulissat) just north of the survey area. The weather was reasonably good for the period of operation, but diurnal conditions were somewhat disturbed during the daytime. Consequently, many of the flights were carried out at night, when diurnal variation was at a minimum.

4.4 Processing of data

The compilation of the data was carried out by Geoterrex at their offices in Ottawa. This is a brief summary of the processing, more details can be found in the final Geoterrex report (Schacht, 1992).

The flight path was checked by video images against existing topographic maps, and the average speed of the aircraft along the flight path was calculated as a check for errors. All recorded digital data went through a general editing based on fourth difference values, removing any defects in the digital data. Any cultural disturbances was removed from the ground station magnetic data, and a noise filter was applied to remove anomalies up to 2.5 seconds wavelength, 4.5 seconds for a few noisy lines. The correlation of events in the base station data and the airborne magnetic data was checked and a cross-correlation technique comparing both wavelength and amplitude was used in order to subtract the diurnal data from the airborne data, when the correlation was sufficiently good.

The radar altimeter data and the barometric altimeter data was filtered in the frequency domain to remove wavelengths up to 160 metres and 360 metres respectively. The filtered barometric altitude was used to apply an altitude correction to the magnetic data using a similar cross-correlation technique as for the diurnal correction. This process reduced any short period variations (500 to 2500 metres) in the magnetic data due to variation in altitude. The IGRF 1990 was subtracted using 1992.5 as the date and the ambient altitude.

The residual magnetic anomaly data thus corrected for diurnal variation, altitude variation, and for the Earth's main field, were used for an along the line calculation of the vertical gradient by a first order vertical derivative operator in the frequency domain combined with a low-pass filter to suppress high frequencies amplified by the derivative operator. The low-pass filter removed all wavelengths less than 250 meters and left wavelengths over 500 meters untouched.

In preparation for the gridding and contouring of the data the magnetic data were levelled by use of intersection differences, which were analysed in order to calculate smoothly varying adjustments along both lines and tie-lines so as to produce the same field values at the intersections. The magnetic levelling was subsequently checked by careful examination of grids and contours, and any errors were corrected in the line data, which were then re-gridded.

The gridding of the finally corrected total field magnetic data was performed by use of the method by Akima (1970) in a modified version by Geoterrex with a grid interval of 250 metres (2.5 millimetres on a 1 : 100 000 map). The basic contour interval for the total field anomaly map was 5 nT.

The vertical derivative anomaly maps were created from the total field grid by applying an operator in the frequency domain, and at the same time and also in the frequency domain, a low pass filter (complete removal of wave-lengths below approximately 400 m, wavelength above 800 m not touched) was applied to remove unwanted high frequency noise produced by the vertical derivative operator. Basic contour interval for these maps were 5 nT/km.

4.5 Presentation of profiles and maps

The data resulting from the AEROMAG-92 project are available as digital data for further use (see section 8), but they are also presented in analog form as profiles and maps. Apart from all the field material delivered to GGU, the following plots were produced and delivered by Geoterrex:

Profiles: All profiles have been plotted on separate sheets at a true horizontal scale of 1 : 100 000 and with traces showing the nine parameters listed below:

(1) Total magnetic field without any corrections at 5 nT/cm,
(2) Total magnetic field after filtering, altitude correction, diurnal correction and levelling at 5 nt/cm,
(3) The same as 2, but at a vertical scale of 25 nT/cm,
(4) Total field depths calculated automatically with different symbols for different models of prism, stepped contact and horizontal thin plate at a vertical scale of 100 m/cm,
(5) Similar depths derived from vertical gradient data at 100 m/cm,
(6) Calculated vertical gradient based on (2), at a vertical scale of 25 nT/km/cm,
(7) Barometric altimeter data at 50 m/cm,
(8) Diurnal variation at 5 nT/cm,
(9) The terrain trace produced by subtracting the radar altimeter data from the barometric altimeter data, at scale 50 m/cm.

Maps: The survey area was divided into four parts in order to present the results at scale 1 : 100 000. For each of the map types mentioned below four maps corresponding to the four quadrants of the survey area were produced by Geoterrex (see Fig 1) on stable transparency. These will be used for reproduction in connection with sale of the maps, see section 8:

(1) Flight path map showing position of lines and fiducial numbers,
(2) Total field contour map (basic contour interval 5 nT) with flight lines superimposed,
(3) Vertical gradient contour map (basic contour interval 5 nT/km) with flight lines superimposed,
(4) Interpretation map showing a combination of qualitative and quantitative interpretation performed by Geoterrex.

On the following four pages are shown cuts from a flight line map (Fig. 2), a contour map of total field anomalies (Fig. 3), a contour map of calculated vertical derivative anomalies (Fig. 4), and an interpretation map (Fig. 5). The maps in these illustrations cover the same area, and the scale of the maps as they appear is true 1 : 100 000 as for the original maps. The cuts are taken from map 1 (see Fig. 1), the SE quadrant of the survey area.

5. INTERPRETATION BY GEOTERREX

As a part of the contract Geoterrex carried out an interpretation of the magnetic data involving both quantitative calculations and qualitative evaluations, and compiled this into four 1 : 100 000 maps covering the four quadrants of the survey area. In this report only a brief summary of the methods used will be given, and a part of one map shown (Fig. 5) to illustrate the type of results that have been obtained. In the following sections of the report the interpretation of Geoterrex will be related to the geology of the area and some additional comments will be given.

The qualitative interpretation performed by Geoterrex relies on the study of shape, size, strike and density of the magnetic anomalies as seen on both maps and profiles, and it has to be considered somewhat subjective, as is the case for all methods of this type. Outlines of magnetic sources have been identified by magnetic contours and can be taken to represent definite changes in lithology or structure. The boundaries may be faults, especially the linear ones, but this can

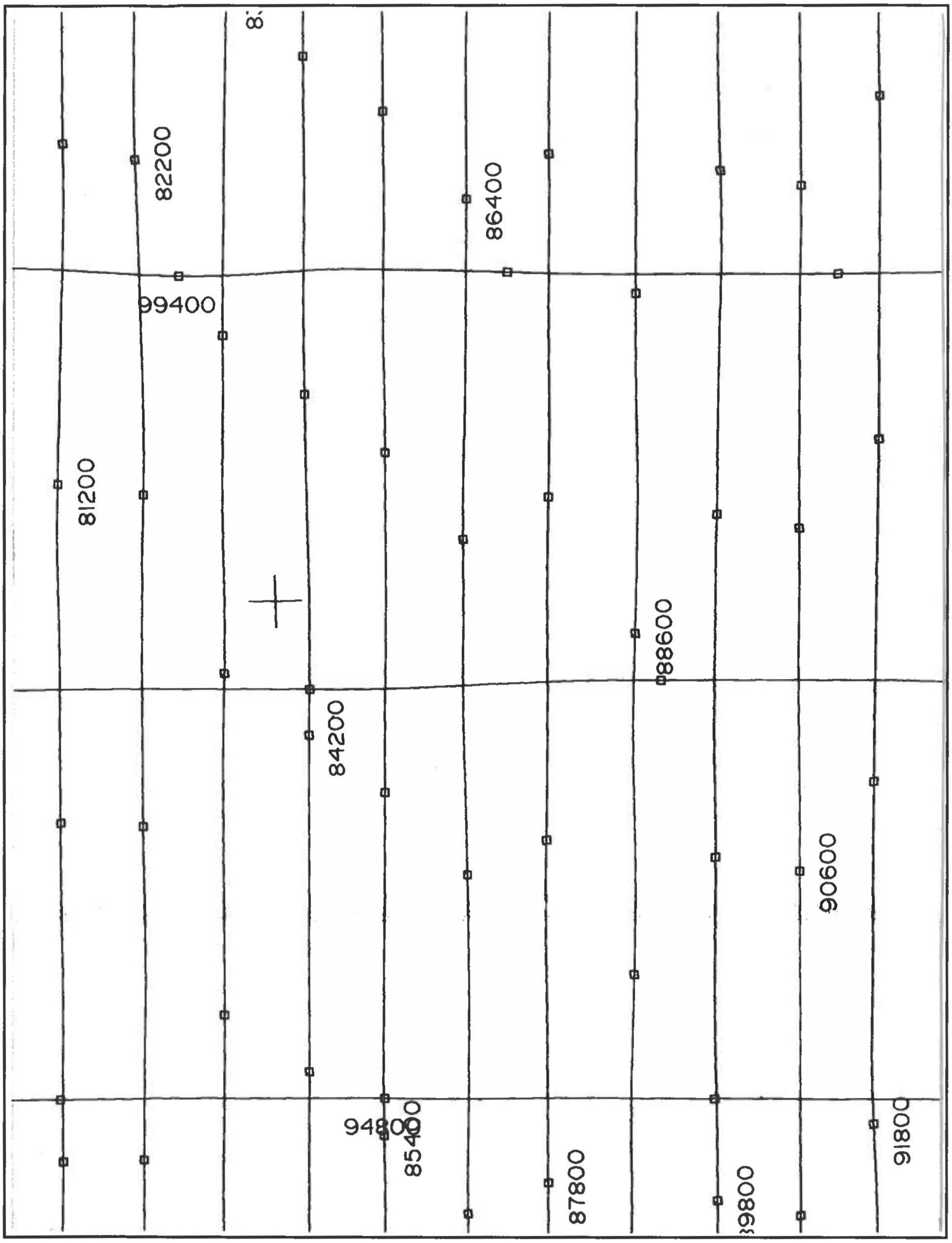


Fig. 2: A cut from the 1 : 100 000 flight line map produced by Geoterrex, showing the position of flight lines and selected fiducial numbers which refer to the profile plots. On the original maps are also shown line number and the direction of flight.

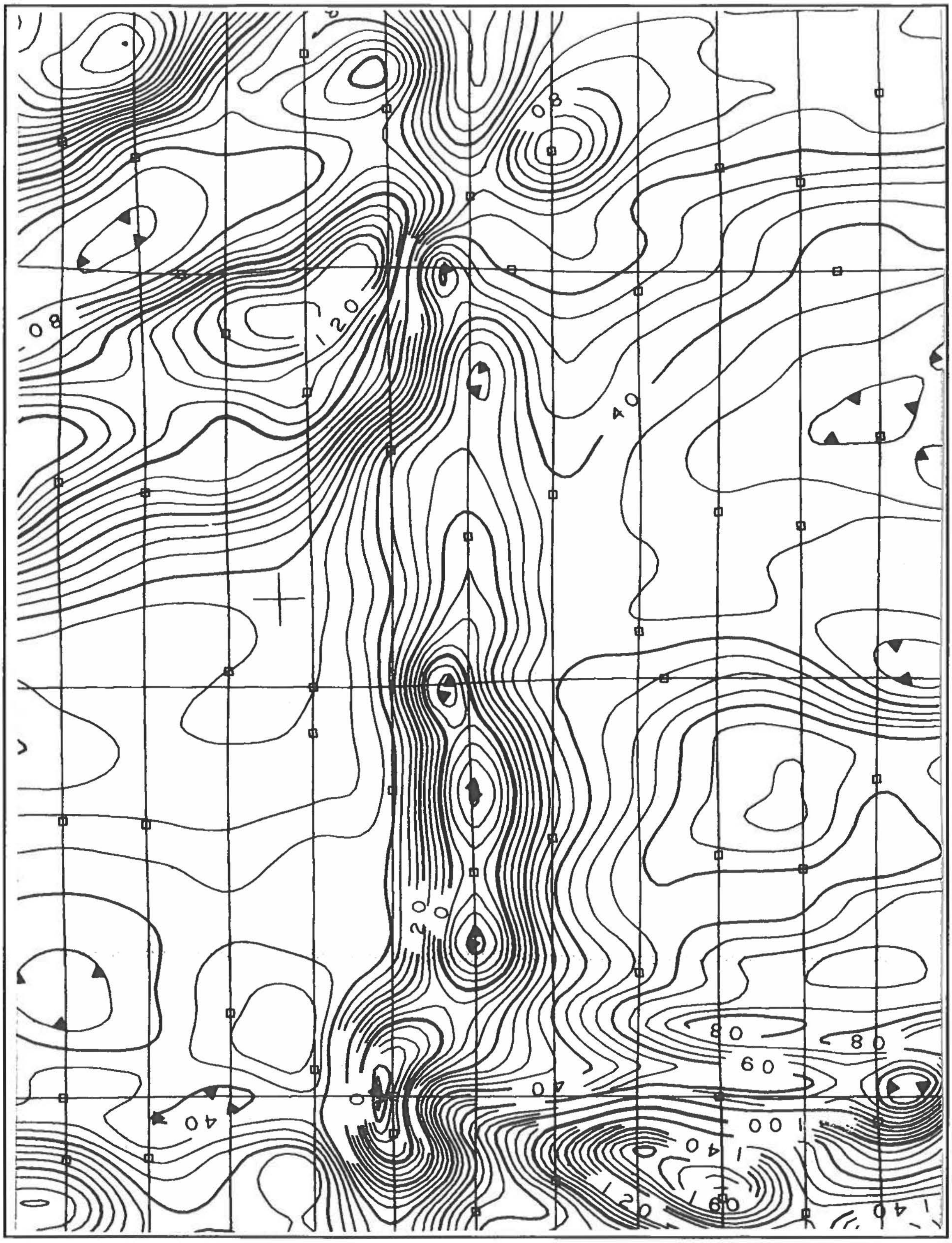


Fig. 3: A cut of the 1 : 100 000 contour map of magnetic total field anomalies produced by Geoterrex. Basic contour interval is 5 nT. Flight lines and fiducials also shown.

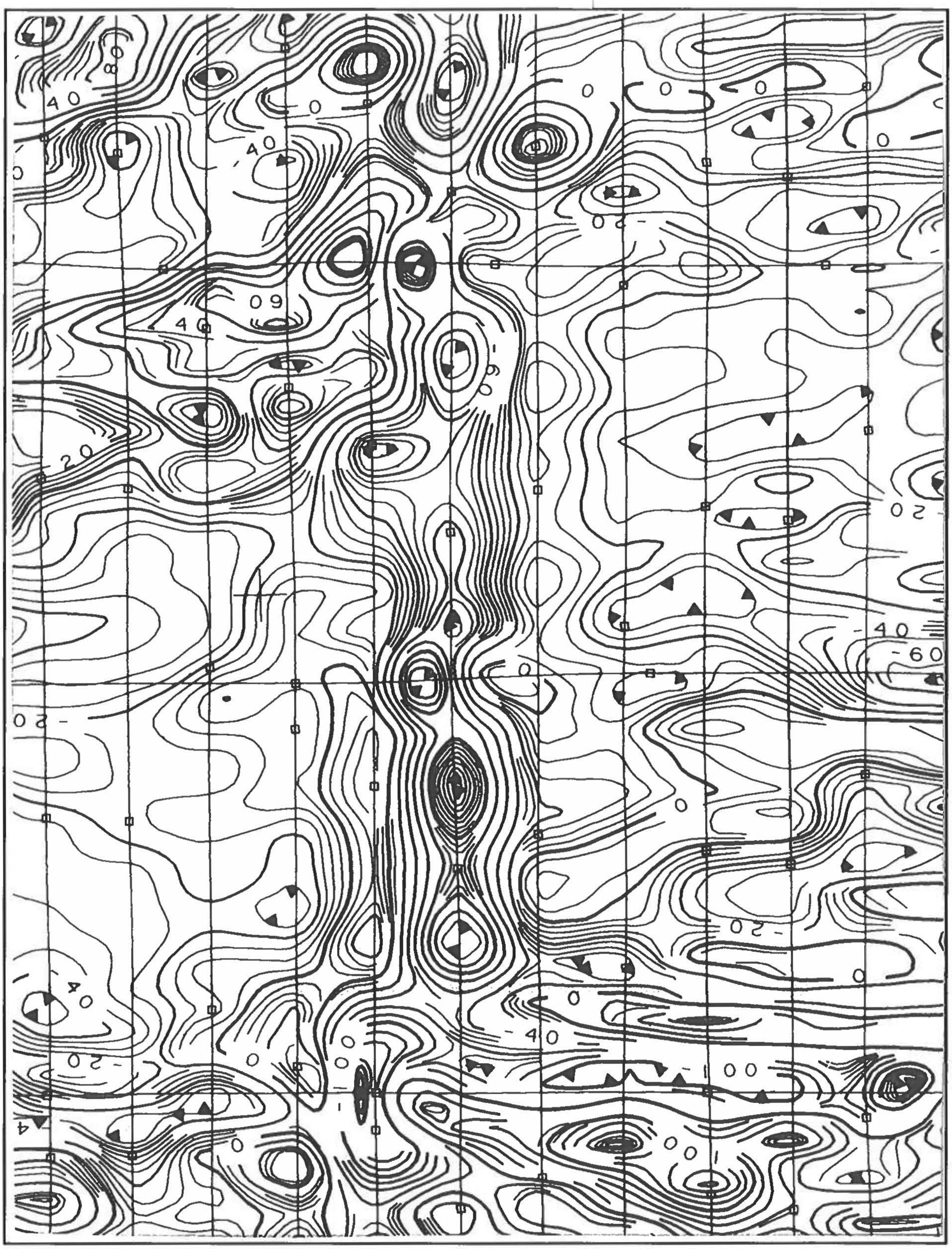


Fig. 4: A cut of the 1 : 100 000 contour map of calculated vertical derivative produced by Geoterrex. Basic contour internal is 5 nT/km. Flight lines and fiducials also shown.

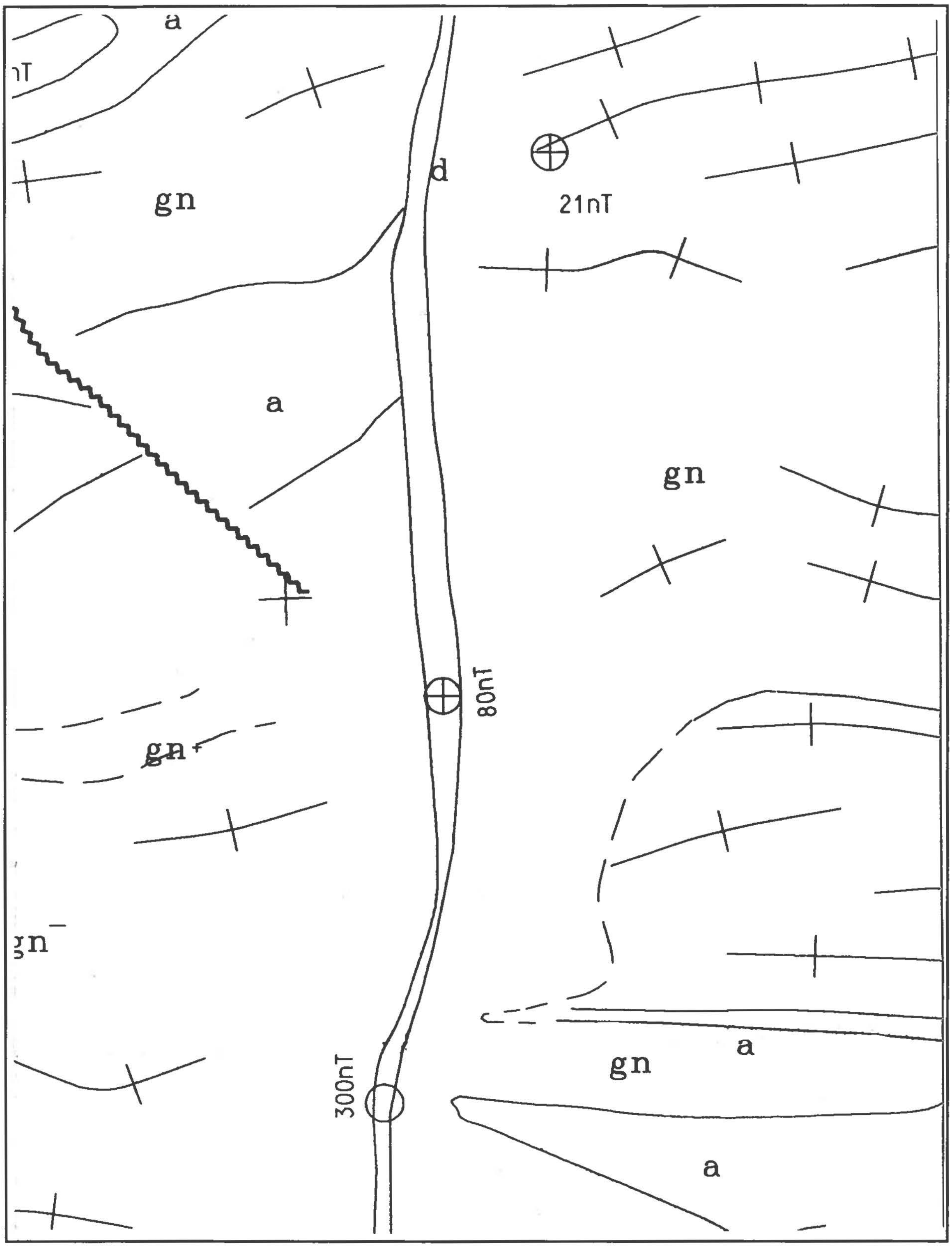


Fig. 5: A cut of the 1 : 100 000 interpretation map produced by Geoterrex showing examples of features; a = amphibolites, d = dolerite, gn = gneiss, solid or stipled lines = lithological boundary, lines with crossing short line = magnetic axis, thick zig-zag line = fault, circle = model for calculation is a prism, circle with plus sign = prism of great vertical extent, 21 nT = calculated apparent magnetisation.

seldom be said with certainty. Some faults have been located by anomaly offsets, terminations and changes in strike of anomalies, level shifts in the magnetic field or changes in magnetic character. Magnetic axis symbols have been used in areas where source interference makes outlines unreliable, and have been omitted, where low terrain clearance results in undersampling of the magnetic anomalies and where therefore the apparent strike of anomalies may become unreliable.

The quantitative interpretation has been focused on the determination of the depth to magnetic bodies and of their dimensions and magnetic properties. Geoterrex has used two methods, a graphical analysis ("the I.T.I. method") and a computer based automatic analysis ("Naudy filtering"). Both methods were used on the line data.

The method for automatic depth analysis is developed from that of Naudy (1971). The method can be applied to both total field data and vertical derivative data. It is based on a comparison of measured anomalies with theoretical ones, and it produces a measure of how good the fit is for each anomaly. In practise the method automatically produces a number of estimated depths and magnetisation contrasts for various models, and this information must then be carefully considered by the interpreter in order to choose the geologically relevant information.

The graphical analysis (I.T.I. stands for 'inflection tangent intersection') uses charts of certain characteristic properties of the anomalies from which depth, dimensions, and location of the upper surface of the anomalous body can be determined. These are not affected by any ambient remanent magnetisation, but the calculated magnetisation contrast and dip of a body may be so.

Both methods use several of the following different models: a horizontal thin plate, a horizontal thick plate, a dyke, a prism, and a step. A number of assumptions have been made: the causative bodies are two dimensional, the tops of bodies are horizontal and the sides parallel, the profile is perpendicular to the strike of the body, and the body is uniformly magnetised. When real conditions deviate from this corrections have been applied where possible.

The interpretation maps thus contain the synthesis of the interpretation by the methods briefly mentioned here, as seen by Geoterrex. A complete summary of these results cannot be given here, but a few general points can be mentioned and in the next section some of the information will be used in the discussion.

In general, most of the anomalies reveal sources near the Precambrian surface. With a few exceptions most sources can best be described as prism or boundary type models of considerable to great vertical extent, in agrement with the generally steeply dipping geology. Schacht (1992) has interpreted near-surface geology in terms of gneisses, generally producing banded linear anomalies of intermediate amplitude, amphibolites producing both banded and amorphous shaped anomalies of intermediate to very high amplitude, and sometimes difficult to distinguish from the most magnetic of the gneisses, basic agmatite, usually occurring within the gneiss and difficult to distinguish from the amphibolites, producing round or amorphous shaped anomalies of intermediate to high amplitude, mica schist generally producing banded linear zones with very little magnetic response and difficult to distinguish from weakly magnetised gneiss, and granite producing zones of low magnetic activity. A classification corresponding to these rock types is used on the interpretation maps, with some of the rock types further divided into three subdivisions based on the relative levels of apparent magnetisation. The maps also show numerous faultlike structures, dolerite dykes and sills, some of which are probably reversely magnetised, and a few indications of deeper sources and structures. As Schacht (1992) points out, the identification of rock types may be erroneous in some cases, which is not surprising considering the reconnaissance nature of the project, but the units identified can probably be taken as bodies of rock with rather homogeneous magnetic properties, and if identified by field work at one location can be extrapolated with confidence following the magnetic anomaly maps.

6. DISCUSSION

6.1 General geology

The geology of the survey area is not known in great detail because field work in the area has been limited. The first investigations by Noe-Nygaard & Ramberg (1961) were reconnaissance work along the coastal areas. Henderson (1969) mapped the area at scale 1 : 250 000 by photogeological methods and a few subsequent field checks, and Escher (1971) compiled the information available at that time on a 1 : 500 000 geological map. Since then most of the activities in the area can best be characterised as scattered observations in connection with regional reconnaissance and geochemical surveying, the latest reported in Steenfelt *et al.* (1992). The region just to the south around the fjords of Arfersiorfik and Nordre Strømfjord, where a major linear shear belt has been described (Sørensen, 1983), have received more attention and is better known.

The survey area of project AEROMAG-92 is situated within the Nagssugtoqidian mobile belt of the Precambrian Laurentian shield (Escher *et al.,* 1976; Korstgaard *et al.,* 1969; see Fig 6). The southern limit of this belt lies approximate 200 km to the south around Søndre Strømfjord, where it borders the Archaean basement. The northern limit is approximately 100 km to the north near Atâ Sund, see Fig. 6, bordering the Rinkian mobile belt. The rocks of the Nagssugtoqidian belt consist mainly of Archaean basement (gneisses and supracrustal sequences) reworked during the Proterozoic *c.* 1850 Ma ago, but there are also volcanic and plutonic rocks of Proterozoic juvenile origin, as well as Proterozoic metasediments. The generation of most of these rocks is usually related to an assumed collision between two Archaean continental blocks *c.* 1850 Ma with a possible position of the suture south of the survey area (Kalsbeek *et al.,* 1987; Bridgwater *et al.,* 1990).

The tectonic structure of the Nagssugtoqidian in general is characterised by strong ENE linear trends, at places developed into shear belts with very strong shearing and sinistral displacement, in the case of the Nordre Strømfjord shear

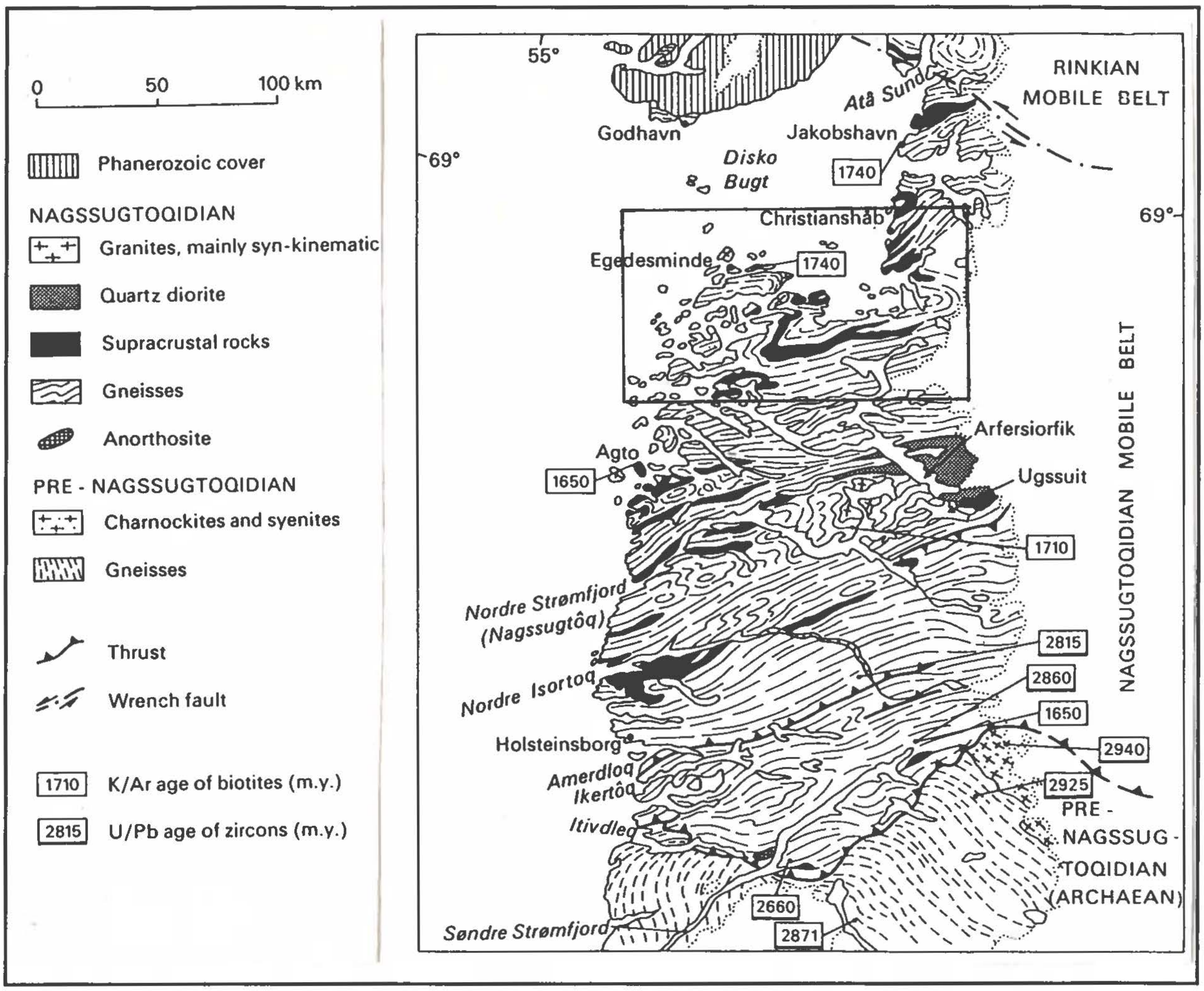


Fig. 6: From Watt & Escher (1976) ed.: Sketch map of some main divisions and features of the Nagssugtoqidian mobile belt. The survey area is indicated.

belt estimated to be 115 km (Sørensen, 1983), with regions of less deformation between, but the actual extent of Archaean and Proterosoic deformation north of the Nordre Strømfjord shear belt is not well known. Similarly, the lithologies of the area are not mapped in detail, especially where they are overlain by Quaternary deposits, e.g. Lersletten itself.

The exposed surface rocks of the entire survey area is generally believed to be metamorphosed in amphibolite facies.

6.2 A known mineralisation in the area

Prospecting work by Kryolitselskabet Øresund A/S identified massive to semi-massive sulphide horizons in a supracrustal sequence at Lersletten (Nielsen 1976). The supracrustal rocks comprise schists, amphibolites, and subordinate marble layers. The sulphide mineralisation is dominated by iron-sulphides with minor amounts of chalcopyrite and sphalerite. Molybdenite and arsenopyrite have been reported as accessory minerals.

The mineralisation is estimated to have a resource of 12 million tons of sulphides with grades up to 0.5% Cu and about 2% Zn, and it is classified as a sedimentary stratiform deposit. Steenfelt *et al.* (1992) give some additional information on the geochemical response of the mineralisation.

6.3 The aeromagnetic data in general

It has not been possible to include all 16 maps in this report. In order to give the reader an impression of the aeromagnetic data two maps at scale 1:525 000, have been made using the total field and vertical derivative gridded values delivered by Geoterrex. Fig 7 (total field) and Fig 8 (vertical derivative) show these anomaly maps as colour anomaly maps (blue=lows, purple=highs) with shaded relief superimposed (light from NNE). They have been prepared by a regridding of the Geoterrex grids with a new grid cell size of 500 m using the method of minimum total curvature in a version (RANGRID) implemented as a part of the Geosoft Ltd suite of computer programs for the presentation and analysis of potential field data. Taking the scale and filtered state of the grid data into account the two maps present a fair reproduction of the original maps although they lack some of the detail. The total field anomaly map contains the full dynamic range of the data showing both shallow and deeper lithologies and structures. The vertical derivative map emphasises near surface structures, but looses information related to deeper structures. The shaded relief on both maps also tends to emphasise near surface structures.

However, both maps still show well defined magnetic anomalies of considerable detail. The line spacing appears to have been adequate for the magnetic pattern except in the northeastern part of the survey area, where the rising topography decreases the distance to the magnetic sources and the linear anomalies therefore tend to break up into isolated anomalies with closed contours. From the profile plots it can be seen that there is more detail available in the data along flight lines, not represented in the contour maps. No signs of serious diurnal noise can be seen on the original maps or the versions presented here. In summary the aeromagnetic survey meets customary expectations to quality and comprises a valuable new set of data to utilise for both regional and more local work. The data are probably not detailed enough to use in grid form over small mineral occurrences, but the flight lines crossing such locations may well be suitable for modelling in many cases.

It should be noted that the survey has been flown at a fixed altitude of approximately 500 m, with draped flying, occasionally a little higher, over the eastern part of the area. Consequently, the topography has influenced the appearance of the magnetic anomalies sometimes giving rise to different anomalies over presumably similar rock types at varying distances below the aircraft. This does not seriously affect the trend of anomalies, except in the NE part of the survey, but it has to be taken into account when comparing amplitude and wavelength of the anomalies.

6.4 The aeromagnetic data and the geology

In this section some of the features visible on the map of Figs. 7 and 8 will be briefly described. A final description will have to await the detailed examination of the new aeromagnetic data followed by modelling, and therefore

Fig. 7 *(Opposite page)*: Total magnetic field anomaly map in colour. The scale is 1 : 525 000 corresponding to Fig. 1. Blue = lows, purple = highs. Shaded relief version of same data superimposed, light source at NNE. Grid cell size is 500 metres. A simple topography (coast lines, lakes, ice limit) is underlayed the anomaly map.

Fig. 8 *(Following page)*: Corresponding map based on the calculated vertical derivative data.

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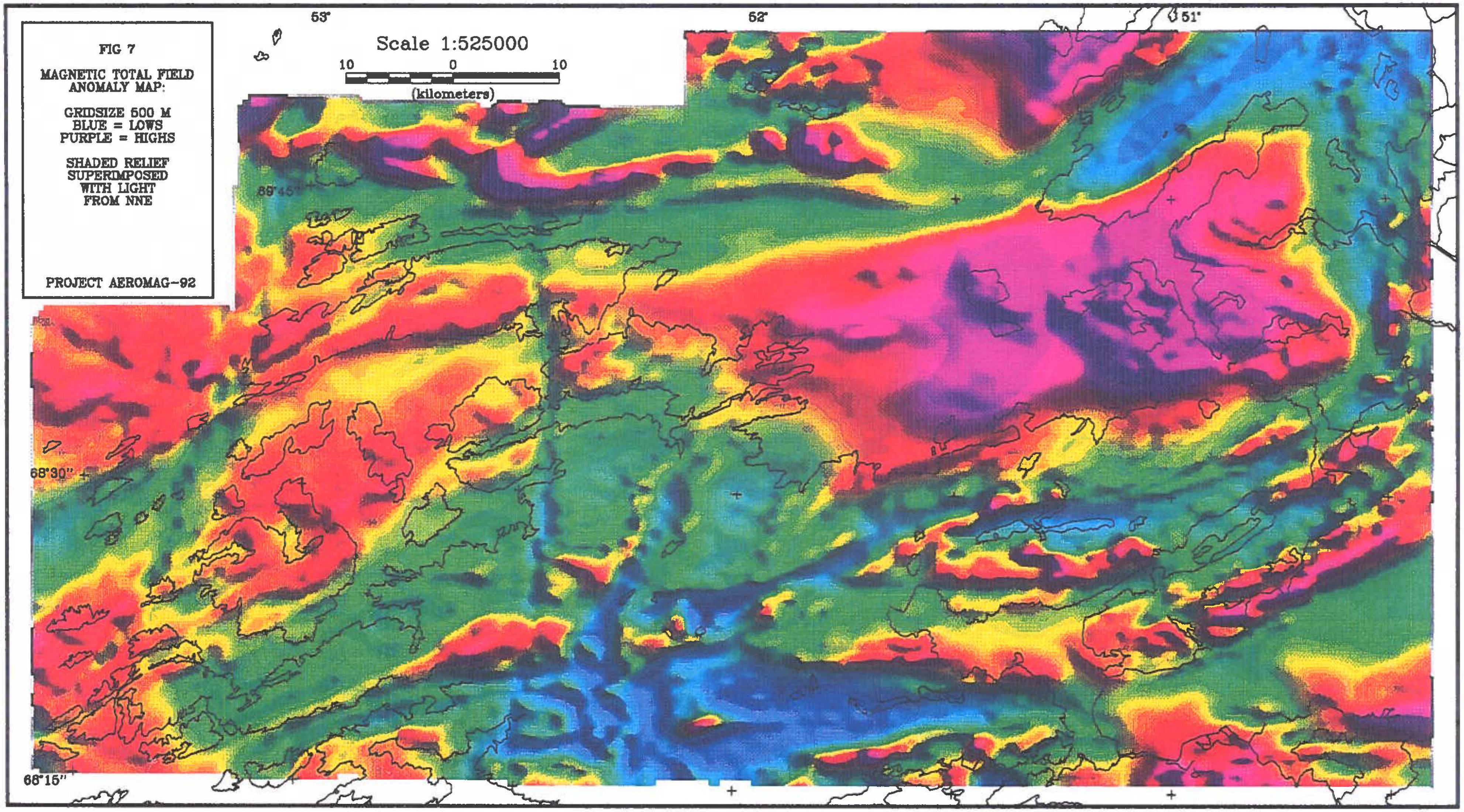

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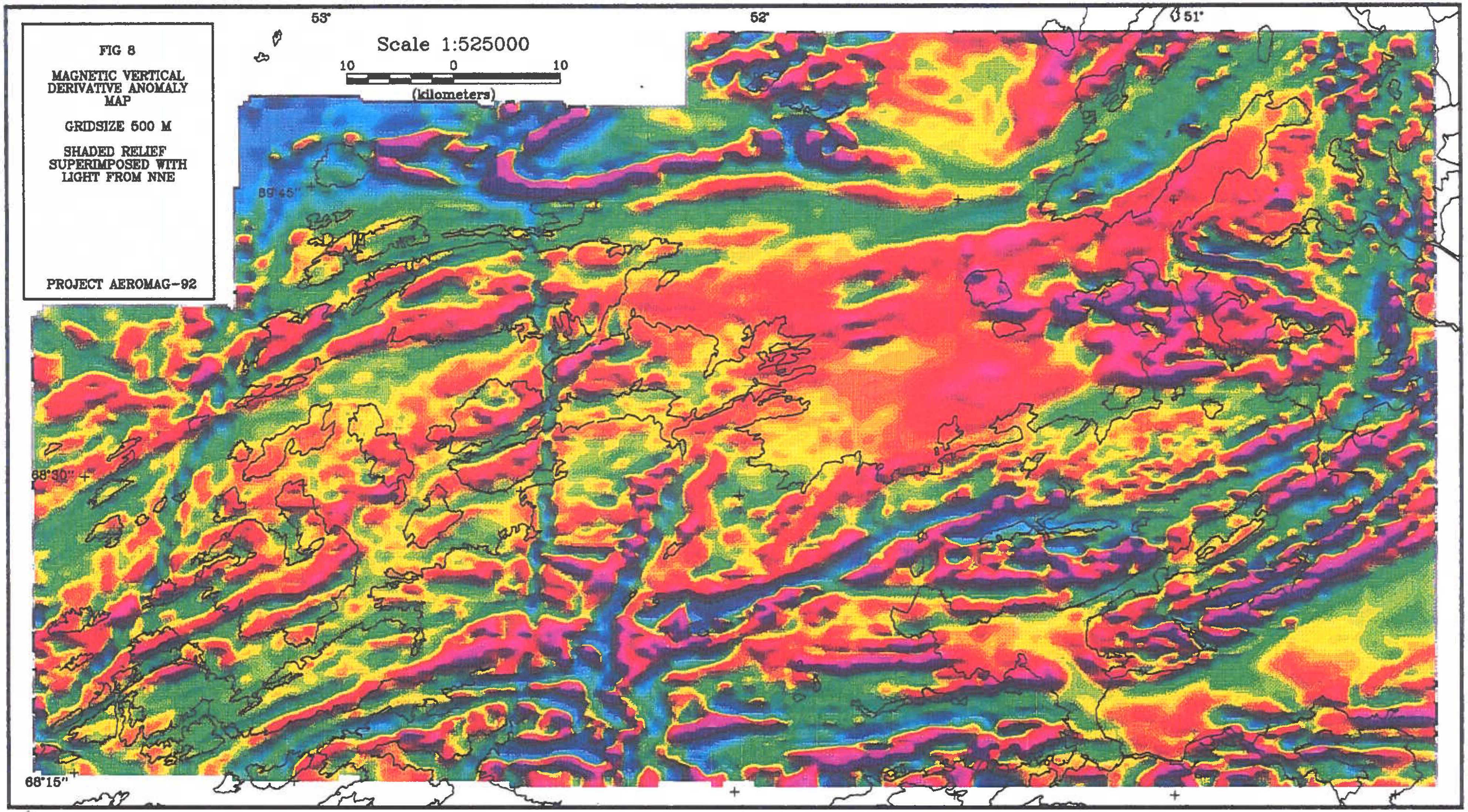

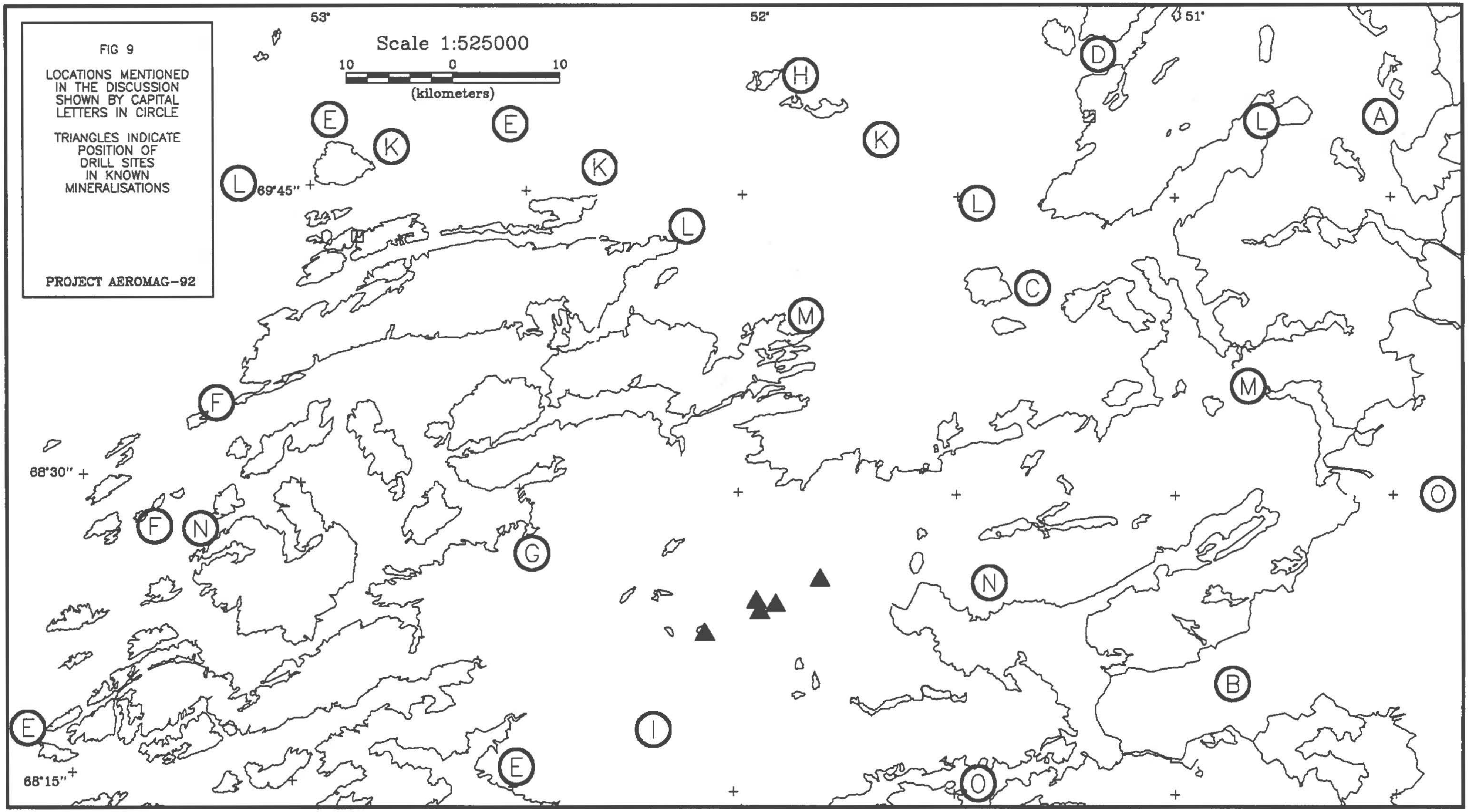
FIG 9
LOCATIONS MENTIONED IN THE DISCUSSION SHOWN BY CAPITAL LETTERS IN CIRCLE
TRIANGLES INDICATE POSITION OF DRILL SITES IN KNOWN MINERALISATIONS
PROJECT AEROMAG-92
Scale 1:525000
10
0
10
(kilometers)
53°
52°
51°
69°45''
68°30''
68°15''
D
H
E
K
E
K
K
L
A
L
L
L
C
M
M
F
O
F
N
G
N
B
E
I
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O

the following should be taken as suggestions for working hypothesis rather than proven facts. Capital letters in brackets refer to the locations indicated by the similar capital letters on a location map in Fig. 9.

The general impression from both maps confirms the assumed Nagssugtoqidian structural style of the area. There is a clear banding of anomalies over almost the entire area with a general strike WSW–ENE, although the trend seems to be more E–W in the central part of the map and in other areas may reflect structures related to folding rather than shearing. This corresponds to similar trends in the magnetic anomalies further south over the Nagssugtoqidian mobile belt (Thorning, 1984). In the northeastern part of the survey area (**A**) the trend breaks down, due to effects in connection with the limited distance to the magnetic sources in this topographically higher area. According to Schacht (1992) most of the calculated depths to magnetic sources over the entire survey area, with only a few exceptions (see later) place the sources at or very near the Precambrian surface. The banding originates from both the gneisses and the supracrustals, and at places it has been emphasised by similar trends in the topography.

Variation in topography alone cannot explain the anomaly pattern. One case to illustrate this is the magnetic low below Nordenskiöld Gletscher (**B**). At a first glance it looks as if this could be explained solely by topography, but actually this would demand that the bottom of the glacier be situated several hundreds of metres below sea level (Schacht, 1992). A more likely explanation is that the lithology underlying the glacier is different from the rocks to the north and south of it, and that this in fact is at least partly responsible for the location of the glacier.

The northeastern quadrant of the survey area is dominated by a large anomaly of considerable amplitude (**C**), here named <u>the Akugdlit magnetic high</u> after the island of that name in Sydostbugt (see Fig. 1). Schacht (1992) esti-

Fig. 9 *(preceding page)*: Locality map corresponding to Figs. 7 & 8 showing position of features discussed in the text (circled capital letters) and drill sites of mineralisation (triangles).

mates depths of 700 to 1300 metres below sea level along its boundaries and at certain places within it using a magnetic/lithologic boundary model with a vertical extent of at least 1000 metres. The variations in depths, and the shape of the Akugdlit magnetic high indicate that there may be more than one body, maybe at different depths, or that one original body has been broken up by later faulting. The shape as such seem in part to be fault controlled, certainly along the northern boundary (see later). Just north of Christianshåb (**D**) lies what appears to be the southern limit of a high of similar amplitude, but unknown areal extent, and here depths of 700 to 800 metres below sea level have been obtained by Schacht (1992). It is impossible to say whether this is a separate body or part of the body to the south displaced by faulting. The most likely explanation is that the relatively deep seated sources of the magnetic highs are intrusives. There are similar cases just south of the survey area at the head of the fjord of Arfersiorfik (see Fig. 6) where an exposed quartz diorite intrusion is displayed by a significant anomaly (Thorning, 1984). To the ENE of this and following the Nagssugtoqidian trend under the Inland Ice lie other magnetic highs thought to be similar intrusions. However, alternative explanations, e.g. transition to granulite facies at depth (Thorning, 1984) will also have to be considered.

The conspicuous linear anomalies (**E** at survey boundaries) cutting N–S or SSW–NNE across the Nagssugtoqidian trend are probably caused by reversely magnetised dolerite dykes. Reversely magnetised basalts of Tertiary age are common in the Disko Bugt area, and presumably the dykes may also be of Tertiary age. Escher (1971) indicates parts of one of these dykes situated almost along longitude 52°30'W, and the aeromagnetic data show this to be continuous from the southern to the northern boundary of the survey area although the northernmost part cannot readily be seen on the maps of Figs. 7 and 8. The other dykes visible in the aeromagnetic data further to the east are mostly under water, but have similar dimensions. At places along these dykes there appear to be breaks in the anomalies that may be indicative of faulting involving both sinistral (e.g. **F**) and dextral (e.g. **G**) movements of the blocks involved, or alternatively differential vertical movement of blocks between faults, depending on whether or not the dykes are emplaced in an exactly vertical position. Around Grønne Ejland (**H**), where dolerites are exposed, the aeromagnetic field (Fig. 7) shows similar negative anomalies indicating that these are also reversely magnetised. According to Schacht (1992) the geophysical models that best fit the latter anomalies are all of limited depth extent, indicating that the dolorites here may occur in the form of volcanic extrusions or sills rather than dykes.

Another striking feature is the very low apparent magnetisation related to the mica schists at e.g. the central part of the survey area (**I**). Schacht (1992) found no geophysical indications for reverse magnetisation of these bodies and concludes that if this is correct then their virtually non-magnetic nature may be indicative of a unique argillaceous metasediment.

Offshore the islands around Egedesminde (**K**) the anomaly maps show another linear, maybe folded (?) structure the sources of which exhibits exceptionally high apparent magnetisation, and appears to represent amphibolites of a type different from those further south and onshore. The trend is also different, and the linearity is less well developed, especially towards the East. It seems reasonable to assume that these rocks have a different origin, maybe post or late orogenic (Schacht 1992) or maybe are related to an entirely different environment.

On the interpreted map of Schacht (1992) there are numerous possible faults with many different strike directions, strongly indicating general and widespread block faulting in the area, especially because the horizontal displacement for many of the faults seems to be very limited. Some major lineaments that may be fault or fault zones are visible even at the scale of the maps in Figs. 7 and 8. One of the most well defined lineament, probably a fault zone (**L**), cuts from near Egedesminde, between Grønne Ejland and Akugdlit, and on to the head of the fjord Kangersuneq. It limits the Akugdlit magnetic high to the north, the Nagssuqtoqidian trends to the south seem to terminate against it, and the magnetic texture is different both to the north and south. This may be a major crustal feature of considerable importance having a bearing on the formation of Disko Bugt itself. Further to the south, with a little more southernly trend, but also definitely at odds with the Nagssugtoqidian trend, there appears to be two other less developed, but still significant lineaments of unknown nature (**M** and **N**). The southernmost of these cuts the dolerite dykes at the above mentioned localities (**G**, **F**). Finally, at the north side of the Nordenskiöld Gletscher (**O**) there is an example of a typical Nagssugtoqidian linear trend nearly parallel with the trend of the Nordre Strømfjord Fracture zone a little to the south of the survey area, see Fig. 6.

Five drill sites of the sulphide mineralisation mentioned above have been plotted (triangles) on Fig. 9. The mineralisation seems to be related to a regional structure of considerable extent near the southern border of the Akugdlit magnetic high. Steenfelt *et al.* (1992) demonstrate the presence of geochemical indicators of hydrothermal activity and relate this to known granite intrusions in the area. A relationship to the tentatively proposed intrusive source of the magnetic anomaly may be considered as an alternative explanation to be investigated.

7. CONCLUSIONS

A new high resolution aeromagnetic data set of good quality has been produced. The data are immediately available to the public and should be of considerable value in connection with any type of further work in the area. Based on the work of Geoterrex and the subsequent evaluation by the author some preliminary conclusions can be drawn at this time:

(1) Many features in the aeromagnetic data can be related to the typical Nagssugtoqidian tectonic style.

(2) There are indications of widespread block faulting as well as the existence of fault structures (?) of crustal importance. One such fault forming the southern boundary of Disko Bugt may separate the onshore Nagssugtoqidian geology from an offshore geology of a different type.

(3) The gneisses and supracrustals in the area have been mapped in considerable detail with the aid of the aeromagnetic data. Subsequent evaluation and confirmation of the classification in terms of actual rock types will be necessary.

(4) Most anomalies in the area have sources at or near the Precambrian surface. An notable exception is the Akugdlit magnetic high which, following a speculative line of reasoning, may be attributed to a deep-seated intrusion with the upper surface 700-1300 m below sea level.

(5) Known mineralisations fall on regional trends clearly defined in the aeromagnetic data, and it can be speculated that they may bear some relationship with the possible intrusion mentioned above.

(6) Reversely magnetised dolerite dykes, guessed to be of Tertiary age, have been shown to cross the survey area from south to north. Dolerite sills have been indicated near Grønne Ejland.

Further analysis and modelling of the new aeromagnetic data are clearly warranted and will be undertaken at GGU as soon as possible.

8. AEROMAG-92 PRODUCTS AVAILABLE FROM GGU

A number of products have been delivered to GGU by Geoterrex subsequent to the conclusion of project AEROMAG-92. They comprise the original field material including analog records, video tapes, logs etc, as well as items produced during the processing (see section 4.5). All of this is archived and can be inspected at GGU by arrangement. In order to facilitate the further use of the data the following three items can be purchased from GGU:

(1): A package of paper or stable base copies of all 16 original Geoterrex maps in scale 1:100 000 (flight path, total field anomalies, calculated vertical derivative anomalies, and interpretation) together with a copy on micro-fiche of the final Geoterrex report

(Price approximately 6 500 or 9 100 DKK depending on material used for the maps).

(2): A package consisting of the final Geoterrex report (micro-fiche) together with a copy on magnetic tape of the digital data (flight line data and grids) as delivered by Geoterrex. Purchase of this item is subject to certain conditions, see Appendix (Price approximately 2 300 DKK).

(3): A combination of (1) and (2) including maps, digital data and one copy of the final Geoterrex report (Price approximately 8 700 or 11 300 DKK).

The three packages will be produced on demand by a subcontractor in Copenhagen, so please allow up to 3 weeks of production time from the receipt of the purchase order at GGU. Prices are modest and designed to cover only the price of reproduction. This may vary slightly with time and ambient price levels, but are presently estimated to be approximately those given in brackets above. These prices are exclusive of VAT. Orders will be accepted by fax or letter to GGU, and are payable in Danish kroners (DKK) only.

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Figs. 2, 3, 4, and 5 are all reproduced directly from the maps prepared by Geoterrex. Figs. 1, 7, 8, and 9, have been produced by the author using Geosoft Ltd software and plotted on a HP DeskJet 550C printer. The data have been transferred from Geoterrex Ltd archive format to GGU's own format by Kjeld

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APPENDIX:
CONDITIONS FOR PURCHASE AND USE OF GGU DIGITAL DATA

Anyone interested in further use or purchase of the digital data from project AEROMAG-92 will be required to accept the standard terms for the purchase and use of digital data as laid out in the enclosed sample copy of the standard form. In some cases modifications or amendments to the conditions of purchase can be negotiated.

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