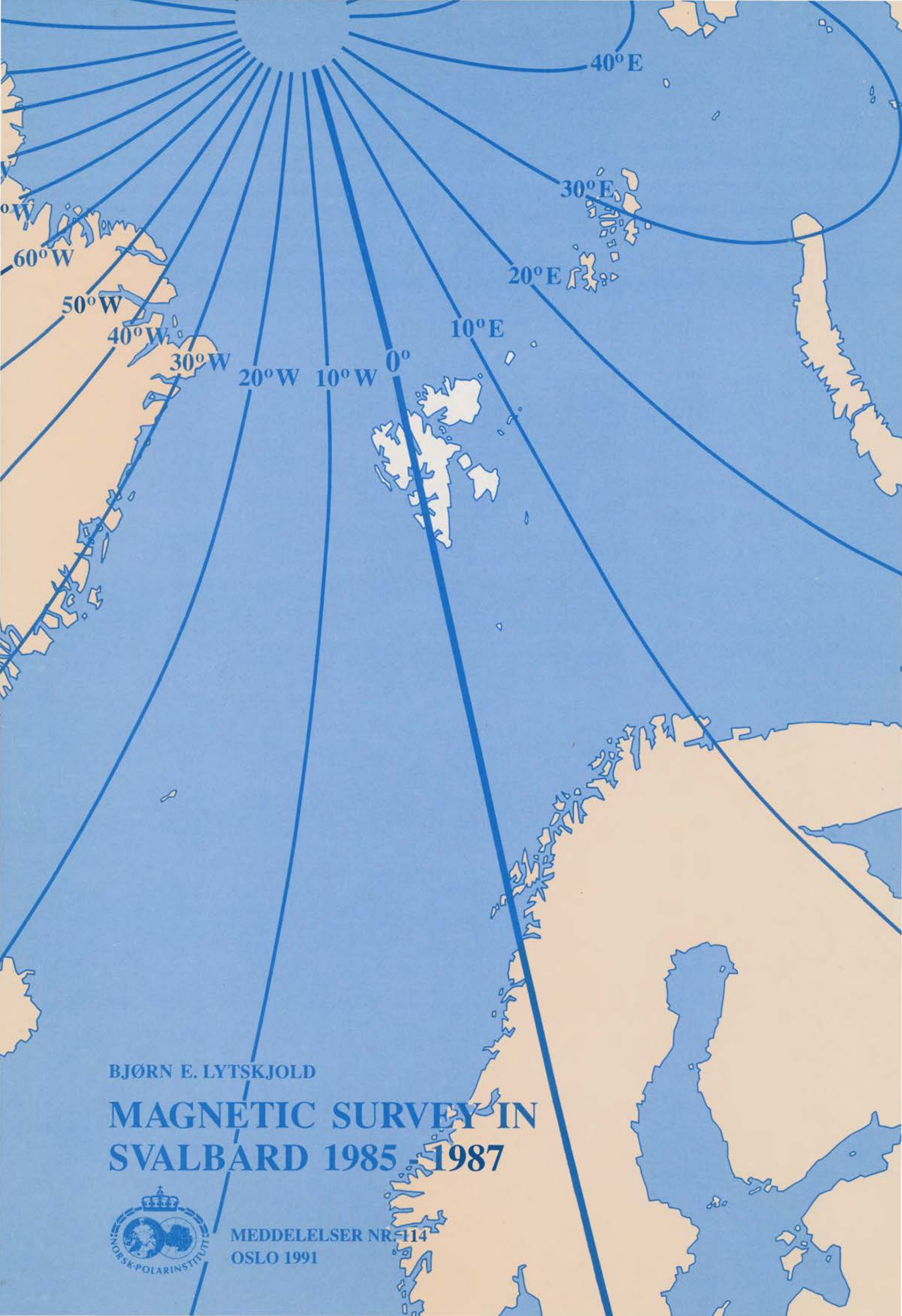

BJØRN E. LYTSKJOLD

MAGNETIC SURVEY IN SVALBARD 1985 - 1987

NORSK POLARINSTITUTT
MEDDELELSER NR. 114
OSLO 1991

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Topographer

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ISBN 82-90307-88-8
Printed May 1991

CONTENTS

1. INTRODUCTION

This report presents the result of a geomagnetic survey in Svalbard that took place during the summers of 1985, 1986 and 1987. The field survey was carried out by Norsk Polarinstitutt (NP) - the Norwegian Polar Research Institute - as parts of the Institute's annual Svalbard Expeditions. Topographer Sigurd Helle and the author were responsible for the field measurements in 1985 and topographer Knut Svendsen and the author in 1986. The author finished the field work in 1987.

A magnetic map covering Svalbard was published in 1957 by Kaare Z. Lundquist, at that time hydrographer at NP. He collected available observations made in the area - the oldest made by Willem Barents in 1596 - and supplied it with own measurements from 1952 and 1953. With these observations he compiled a map that presented the magnetic declination in Svalbard for the epoch 1930 (NP, skrifter nr. 110). Systematic corrections for magnetic storms were not possible in his work. He corrected, however, all observations with a characteristic daily variation and a calculated secular variation. In 1957 and 1958 Lundquist continued the magnetic measurements to compile better isomagnetic maps. The purpose was to improve the mapping of the declination, which was highly needed when publishing sea charts and topographical maps.

Considering the inhomogenity of his material, a systematic survey was clearly needed.

The purposes for mapping the geomagnetic field were:

1. Determination of the declination for use on the main map series covering Svalbard.
2. Determination of the field intensity in Svalbard for scientific purposes.

It was decided to compile isoline maps of the geomagnetic components D, F, H and Z in the scale of 1:1 200 000 to meet the purposes.

2. GEOMAGNETISM IN GENERAL

The earth's magnetic field has two internal sources:

- The earth's interior, in particular the core, being responsible for the major part of the field.
- Magnetic minerals in the earth's crust creating regional and local anomalies.

In addition there is one external source:

- In the upper atmosphere and magnetosphere currents cause temporary disturbances in the field. A secondary effect of these currents is induced current in the ground. Thereby the observed effects of atmospheric currents also depend on the conductivity of the ground.

The geomagnetic field is described by these components:

F = The geomagnetic field's total intensity.
H = The geomagnetic field's horizontal component.
Z = The geomagnetic field's vertical component.

Measuring unit for F, H and Z is nT.

D = Geomagnetic declination,
positive values represent easterly declination,
negative values represent westerly declination.

I = Geomagnetic inclination.

Measuring unit for D and I is degree.

The field originating from the earth's interior is changing slowly and irregularly. Typical time scales are years and longer. This variation, called secular variation, reflects prosesses of the interior of the earth and is consequently a source of information of these. The aim of a magnetic survey is to map this field.

The anomalies due to the magnetic characteristics of the crust are of permanent nature, changing only in geological time scales. Such anomalies are of value to geologists.

The external field is basically of solar origin. The particles of the solar wind interact with the earth's magnetic field resulting in complicated current patterns in the upper athmosphere. The magnetic fields set up by these currents are of value to the science of the upper athmosphere. From a magnetic survey point of view, however, they are regarded as disturbances. The time scale ranges from fractions of a second to weeks. There are regular components in these disturbances e.g. daily variations due to solar heating of the athmosphere. The major parts, however, have the form of so called magnetic storms. These are global phenomena, but their apperance varies strongly with the latitude. Especially the polar regions have large and very irregular disturbances.

Deviations of several hundred nT in F and a few degrees for D are quite common. The average field for days not affected by magnetic storms is usually a good approximation to the internal field. Such quiet days are scarce in the auroral zone and the polar cap regions. Observations over at least several months are needed to obtain a quiet field value. In the polar regions we encounter the additional problem that the quiet field is contaminated by the interplanetary magnetic field. This is due to the fact that the field lines in the region are open into the interplanetary space. The sector structure of solar wind is in this way seen in the ground field as variations of several tens of nT (Friis-Christensen 1971, Albrigtsen et. al. 1981).

The internal field is assumed to coincide with the mean field of quiet days. Point measurements made during a field survey will most of the time be affected by external disturbances. Theoretically a solution is to wait for magnetically quiet conditions, but such are unpleasantly infrequent in the Arctic. Therefore this method is hopeless from a practical point of view. Measurnments have to be done whenever the surveyor visits a field station and all readings are treated as if they are affected by disturbances.

Recorded data from a nearby running observatory will enable us to correct the readings and find the quiet mean values.

3. FAVOURABLE CONDITIONS

To avoid severe magnetic storms, the field work had to be done when solar wind was supposed to be at a minimum. 1985, 1986 and 1987 were supposed to be good years. A diagram of the sun spot activity is shown in figure 1.

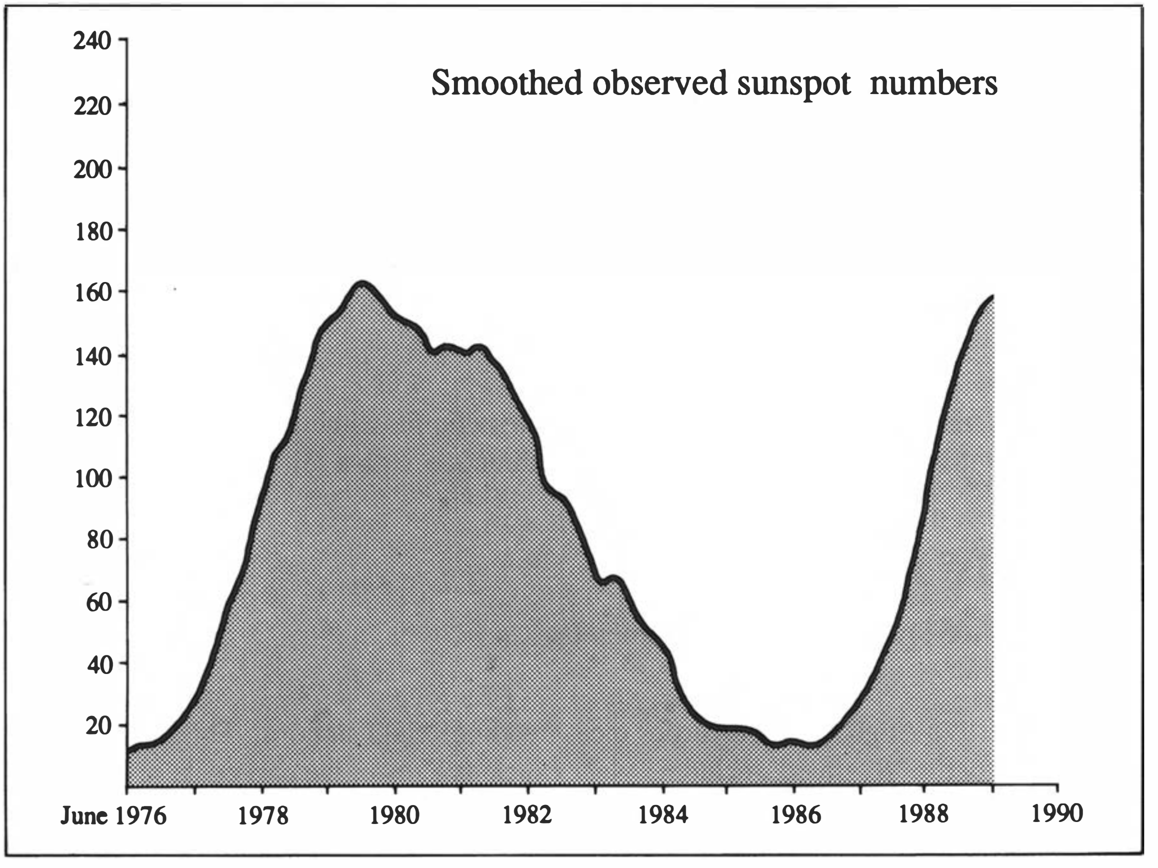

Fig. 1: Smoothed observed sunspot number

4. THE MAGNETIC OBSERVATORIES IN SVALBARD

When the survey took place, two magnetic observatories were operating:

Bjørnøya	(since 1952) at 74°30' N 19°02' E
Ny-Ålesund	(since 1966) at 78°55' N 11°57' E

Both are run by Nordlysobservatoriet (The Auroral Observatory, University of Tromsø).

The Polish Academy of Science is operating an observatory in Hornsund (77°00'N 15°36'E). Data from this site would be very valuable for this survey. Unfortunately we were not able to obtain the relevant information.

5. INSTRUMENTS

The surveyors mainly relied on instruments belonging to NP, in addition some were borrowed from Statens Kartverk (Norwegian Mapping Authority) and the University of Oslo. In all the parties disposed:

- 2 Andersen & Sørensen Quartz Horizontal-Force Magnetometers (QHM)
- 2 Elsec 770 Proton Magnetometers
- 2 Wild T2 Theodolites
- 2 Clocks, GMT syncronized
- 1 Wild GAK1 Gyro Theodolite (available in 1985 and 1986)

5.1 The Quartz Horizontal-Force Magnetometers

The QHM is primarily intended for determination of the horizontal component H of the magnetic field, but also usable for determination of the declination D. Both instruments were calibrated before and after each season at Danish Meteorological Institute to check their constants. No significant changes were noted.

5.2 The Proton Magnetometers

The proton magnetometer measures the total magnetic field intensity F. It is a scalar measurement independent of the field vectors direction with a resolution of 1 nT.

6. FIELD WORK

The survey took place during three summer seasons:

1985:
From July 19 to August 28 two parties measured in 59 field stations. This cruise visited the eastern part of Svalbard, including places such as Hopen, the east coast of Spitsbergen, islands in Hinlopenstretet, Tusenøyane, Edgeøya, Barentsøya, Nordaustlandet, Kong Karls Land, Kvitøya and Sjuøyane. On the northern coast of Spitsbergen surveying was carried out on Mosselhalvøya, Gråhuken and Reinsdyrflya.

1986:
During this summer two field parties measured in 53 stations in Spitsbergen. From July 18 to August 21 one party based in Longyearbyen worked mainly in an area between 77^0N and 79^0N. From August 14 to 21 a party based in Ny-Ålesund worked mainly north of 79^0N and west of Wijdefjorden.

1987:
One party worked on Spitsbergen from July 18 to August 22 visiting 20 stations. Most of these were new points while some were "trouble makers" from 1985 and 1986. The party was mainly stationed in Longyearbyen.

6.1 Selections of Stations

The selection of magnetic field stations followed these directions:

- The network of stations should be as homogeneous as possible, characteristic distance between the stations set to 30-50 km.

- In cases stations used by K. Z. Lundquist could be identified, these were preferred.

- Geological maps were checked when new stations were selected to avoid regions with magnetic rock. In the field the area around a planned point was examined with a proton magnetometer. If no serious anomalies were found, the point could be used.

6.2 Mapping the Field Stations

All field stations were marked with aluminium bolts when situated on solid rock. The major part, however, was to be found in gravel deposits near the sea or on weathered rock, here 60-70 cm long aluminium tubes were forced into the ground. In this way a permanent network enables remeasurments of the magnetic field in the future.

6.3 Positioning

When possible, the exact position of a station was determinded by topographical methods. Stations were normally marked on aerial photos and topographical maps.

6.4 Determination of Azimuth

In each field station the surveyor had to determine the direction to true north. During the survey two methods were used:

1. Determine the station's position and an azimuth by observations to triangulation points, using theodolite.
2. Determine the true north direction using gyro theodolite.

Alt. 1 was the methode mainly used, however it demands good weather conditions. This is a problem in Svalbard where fog and low cloud cover is a common obstacle during the summer. In addition, the triangulation network on Svalbard in general is sparse. This made solutions by triangulation impossible in some areas, especially in eastern and northern regions.

Alt. 2 was used for many of the measurements in east and north. Without the gyro many of the points would have been given up as no triangulation points could be seen. According to the gyro's users manual, the instrument is constructed for use below 70^0 latitude. Exceeding this the accuracy is supposed to decrease. In 1985 the gyro was used as far north as $80^0 15'$. The oscillation around the true north axis had a relatively low frequency, but the gyro still proved to be reliable. The accuracy was found to be sufficient for magnetic purpose, exceeding that of the QHM's telescope and circle reading devices.

6.5 Magnetic Observations

It proved to be very difficult to avoid disturbances from the external field. The survey was carried out during what was supposed to be quiet periods, despite this nearly all measure- ments were affected more or less dramatically.

Special care had to be taken when carrying out magnetic measurements, such as dressing to avoid magnetic disturbance, as well as keeping all other equipment at a distance.

The measurements were carried out in two sections:

1. QHM

In each station a QHM was mounted on a non-magnetic tripod. Observations were normally carried out to enable calculation of two values of the magnetic declination D and two values of the horizontal field component H. Points of time were noted together with the internal temperature of the QHM.

If there was time for it, extra measurements were done.

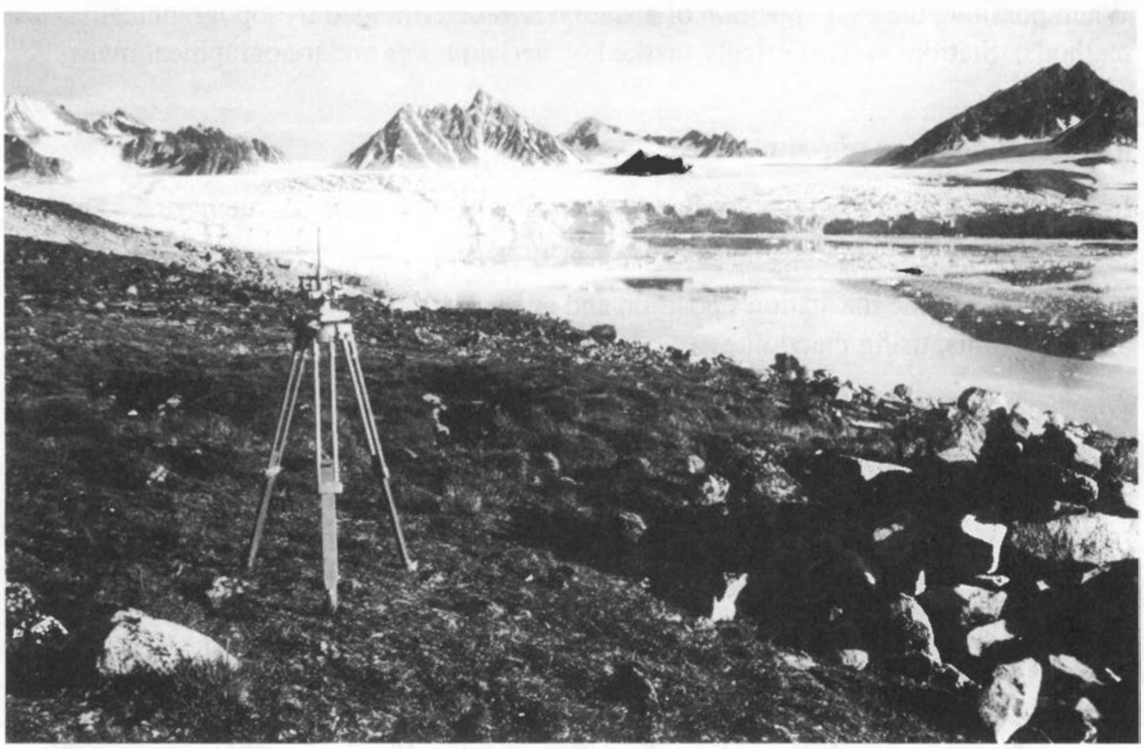

Fig. 2: Measuring with QHM

The accuracy of the QHM used in field measurments in Svalbard are not supposed to exceed 1' due to the latitude. The instruments were very sensitive for wind and were difficult to use in humid weather, however, the QHMs proved to be very reliable.

2. Proton Magnetometer

To determine a good average value for the total field intensity readings were done minimum six times in each station, with half minute intervals. All points of time were noted. The magnetometers were easy to operate and highly reliable.

7. DATA PROCESSING

The purpuse was to compile isomagnetic maps of the four components D, F, H and Z. All values should be calculated back to epoch 1985. 5 - that is for June 1985 - to coincide with The World Magnetic Survey standard. To do this all field measurements had to be corrected for diunal variations, in addition those from 1986 and 1987 also were corrected for secular variations.

7.1 Removal of Diurnal Variation

Each field component had to be corrected for diurnal variations to determine the actual quiet mean values at the stations. The corrections were stright forward. Field data were recorded with the point of time noted for all observations. Available data from the observatories were studied. Registrations from 1987 were stored directly in digital form while those from 1985 and 1986 were digitized from registration paper sheets. A computer programme gave the differences between actual field values at the noted points of time and corresponding quiet mean level were calculated. The differences were removed from the field observation to get the quiet mean value for the stations. In addition a three hours mean value was calculated around each observation moment.

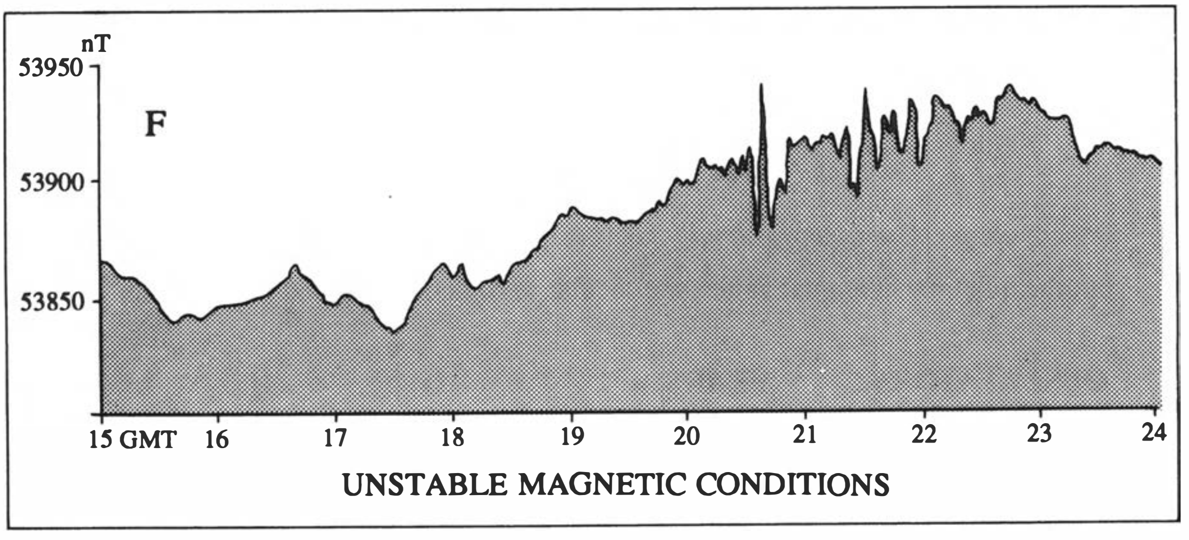

Fig. 3: Diurnal variation of Z at an observatory during unstable conditions.

Experiences from similar projects in the Arctic show that such corrections are applicable within 100-150 km from the observatory (Wilhjelm 1971). Outside this range the spatial correlation decreases rapidly. In case of several observatories a linear interpolation is an acceptable procedure.

For stations within a range of 150 km from Ny-Ålesund the diurnal corrections were taken directly from the registered data there. South of 78^0 45' N on Spitsbergen and Edgeøya - and on Hopen - corrections were applied averaging the three hours mean values from the Ny-Ålesund and Bjørnøya observatories. Outside these areas - like Kong Karls Land, Nordaustlandet and Kvitøya - corrections were not applied due to large uncertainties.

7.2. Secular Variation

The secular variation is the difference between the annual quiet mean values.

The field measurements were done during three seasons. Since all components should be given for epoch 1985. Five secular variations were applied all measurements from 1986 and 1987. Values from Ny-Ålesund were used north of $78^0$45'N, south of this latitude average values for Ny-Ålesund and Bjørnøya were applied.

At Ny-Ålesund and Bjørnøya the annual quiet mean values for the three components D, H and Z are listed below:

OBSERVATORY	YEAR	D	H	Z
NY-ÅLESUND:	1985	2°42' W	7496 nT	53800nT
	1986	2°36'	7460	53780
	1987	2°29'	7425	53770
BJØRNØYA:	1985	3°47' E	9155 nT	52890nT
	1986	$3^0$55'	9132	52890
	1987	$4^0$01'	9104	52890

From the quiet mean annual values the secular variations are found to be:

OBSERVATORY	**YEARS**	**D**	**H**	**Z**
NY-ÅLESUND:	1985-86	6' E	-36 nT	-20 nT
	1986-87	7'	-35	-10
BJØRNØYA:	1985-86	8' E	-23 nT	0 nT
	1986-87	6'	-28	0

7.3 Determining the Components

For a field station the final value of a component C is given as follows:

$$C = C(St,t) + \Delta C$$

ΔC	=	C(Ob,s) + [C(Ob,85) - C(Ob,t)]
C	=	final field station value, epoch 1985.5.
C(St,t)	=	value measured at the field station at time t.
ΔC	=	correction taken from the observatory
C(Ob,s)	=	secular variation found at the observatory.
C(Ob,85)	=	reference value for epoch 1985.5 calculated at the observatory.
C(Ob,t)	=	value measured at the observatory at the time the field measurement was done.

The observatories registrate the components D, H, Z and belonging corrections, while D, H and F were measured in the field. This meant that ΔD and ΔH could be found directly from the recorded data, while ΔF was defined like $\Delta F = \Delta Z/\sin I$. Following this procedure the field component values were given as:

$$D = D(St,t) + \Delta D$$

$$H = H(St,t) + \Delta H \cos I = H / (F + \Delta Z)$$

$$Z = H \tan I$$

$$F = F(St,t) + \Delta Z/\sin I$$

8. RESULTS

8.1 Presentation of Field Station Measurements

Location of all field stations and the two observatories are showed on the map in appendix 1.

The field stations are listed in appendix 2. The list contains this information about each field station:

- Number and name
- Measurement date
- Position
- The magnetic components D, F, H, Z and I
- Name of observator

The listed values in appendix 2 are average values found in each station. F is the average of minimum six measurements, D and H were measured minimum two times.

8.2 Geomagnetic Contour Charts

The results of the ground magnetic survey in Svalbard are represented by isomagnetic maps for epoch 1985.5. Four separate maps at a scale of 1:2 000 000 were compiled for D, H, Z and F. For each map the component in question is represented by contour lines.

The contour lines were drawn by hand simply by interpolating linearly between the field station values.

The declination map has contour lines with 30' intervals. The intensity maps have contour lines with 50 nT intervals.

To ease the reading relative highs are indicated by an arrow pointing up (▲) and relative lows by an arrow pointing down (▼). The isoline maps pertaining to the survey appear in appendix 4 - 7:

- Appendix 4 : Geomagnetic declination D, epoch 1985.5.
- Appendix 5 : Geomagnetic field's total intensity F, epoch 1985.5.
- Appendix 6 : Geomagnetic field's horizontal component H, epoch 1985.5.
- Appendix 7 : Geomagnetic field's vertical component Z, epoch 1985.5.

8.3 Correction Table for Secular Variation

The stucture of the contour lines compiled for epoch 1985.5 is supposed to be representative for the actual magnetic field for the following 10-15 years.

To find an updated value for the magnetic components, the epoch 1985.5 values have to be corrected by the secular variation since June 1985. Tables of assumed secular variations for D, F ,H and Z are found in appendix 3.

8.4 Valuation of the Collected Data

The present survey yields the best maps of the magnetic field in Svalbard so far. However, a couple of weak points are evident:

* In certain areas the anomalies are so large that a more dense network is needed to resolve detailed structures.

  It is evident how to heal this weakness: More measurements in the actual areas.

* The reduction to quiet mean level is not properly carried out for measurements too far from the geomagnetic observatories.

  This problem was especially serious when operating around Kvitøya, Kong Karls Land and Nordaustlandet in August 1985. All stations there are outside the 150 km limit set for applying diurnal corrections found in Ny-Ålesund. In addition to this the magnetic conditions were very unstable. When the field observations were carried out the registrator in Ny-Ålesund noted significant fluctuations.

  This calls for more observatories. Hornsund is already there and should be used in a future supplement survey of southern Spitsbergen. In 1988 Nordlysobservatoriet established an observatory on Hopen. This station will improve surveys on Edgeøya and Tusenøyane and of course provide important data from Hopen itself. Still lacking is the coverage of the northeastern part of Svalbard. This may be solved by putting out automatic observatories during a field survey.

* In the most remote areas uncertainties were connected to the determination of azimuth due to few triangulation points or limitations of available instruments.

To solve this the field stations should be connected to triangulation points by more complex topographical surveying or by bringing two GPS (Global Positioning System) satellite recievers which would give both position and azimuth. The gyro theodolite used was not made for high latitudes. The gyro oscillated with relatively big amplitudes and needed a long time to stabilize. Longer observation periods were preferable, however time was limited during the field survey.

9. SUGGESTIONS FOR FUTURE WORK

Future ground magnetic surveys should take in advantage the development of the D/i-theodolite. This is an unmagnetic theodolite with a fluxgate sensor mounted parallel to the optic axis that measure declination and inclination (Kring Lauridsen, 1985). For field work the theodolite is superior to the traditional QHM.

The main purpose for the 1985-87 survey was to obtain sufficient knowledge about the magnetic declination for use on the main topographic map series of Svalbard. While planning the survey it was obvious to combine this with measurements needed to determine all the geomagnetic components. However, if the aim is to compile a complete set of high quality maps of the geomagnetic field covering Svalbard an aeromagnetic survey is needed.

The structure of the earth's interior undergoes a constant, but slow and irregular change. As the field originates from this source remeasurments are needed to keep the isoline maps updated. Idealistically this should be done every 10-15 year.

10. ACKNOWLEDGEMENTS

The author wishes to thank the staff at The Auroral Observatory, University of Tromsø - particulary Truls Lynne Hansen - for their considerable contribution to the manuscript. Norsk Hydro has also contributed with useful information.

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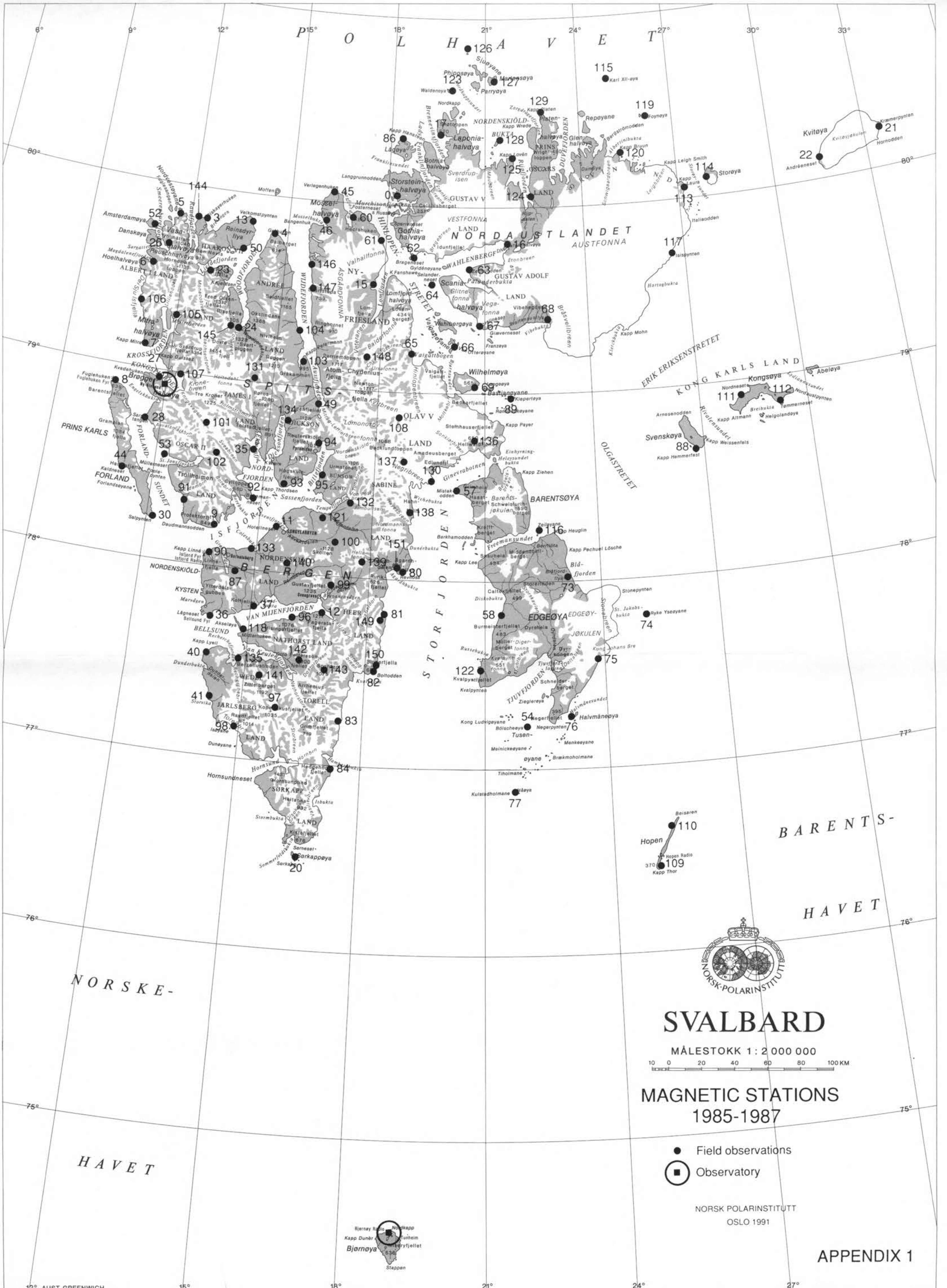
Appendix 1: Map of magnetic stations 1985-1987 ⟶


SVALBARD
MÅLESTOKK 1 : 2 000 000
10 0 20 40 60 80 100 KM
MAGNETIC STATIONS
1985-1987
Field observations
Observatory
NORSK POLARINSTITUTT
OSLO 1991
APPENDIX 1
NORSK·POLARINSTITUTT
POLHAVET
NORSKE-HAVET
BARENTS-HAVET
NORDAUSTLANDET
SPITSBERGEN
EDGEØYA
BARENTSØYA
KONG KARLS LAND
STORFJORDEN
HINLOPENSTRETET
ERIK ERIKSENSTRETET
OLGASTRETET
PRINS KARLS FORLAND
Kvitøya
Hopen
Bjørnøya
12° AUST GREENWICH

No.	Station name	Date	ϕ	λ	D	F	Z	H	I	Obs	No.
0M	KINNVIKA	100885	80°03'03"	18°13'06"	1°14.9'	54683.5 nT	54214.3 nT	7147.8 nT	82°29.4'	BL	0M
3M	BISKAYERHUKEN	170886	79 50 15	12 23 44	-3 05.4	54436.7	53974.8	7078.6	82 31.7	BL	3M
4M	GRÅHUKEN	100885	79 47 55	14 31 59	0 57.5	54532.7	54068.2	7103.4	82 30.9	SH	4M
5M	SABINEODDEN	170886	79 49 56	11 33 01	0 55.7	54372.7	53911.6	7071.1	82 31.7	BL	5M
6M	GRAVNESET	150886	79 33 30	11 01 39	-0 24.4	54340.9	53866.6	7166.9	82 25.3	BL	6M
7M	MITRASKJERET	150886	79 06 43	11 08 18	-3 50.3	54259.1	53751.7	7404.3	82 09.4	BL	7M
8M	FUGLEHUKEN	200786	78 53 48	10 29 28	-4 25.8	54338.2	53819.3	7490.3	82 04.6	KS	8M
9M	ALKEPYNTEN	180786	78 12 38	13 50 39	-1 05.7	54068.9	53502.1	7806.9	81 41.9	KS	9M
11M	VESTPYNTEN	180787	78 15 03	15 25 22	0 13.8	54363.6	53797.5	7815.4	81 44.1	BL	11M
12M	FAGERSTANESET	140886	77 48 23	16 48 28	1 15.7	54202.1	53616.5	7945.3	81 34.2	KS	12M
13M	VELKOMSTPYNTEN	280885	79 50 15	13 48 01	-1 11.9	54434.2	53972.8	7086.6	82 31.2	BL	13M
15M	FAKSEVÅGEN	160885	79 33 03	17 37 05	0 44.4	54493.7	54021.4	7159.7	82 27.0	BL	15M
16M	BODLEYBUKTA	160885	79 47 06	21 45 14	10 11.4	54773.8	54322.8	7014.8	82 38.5	SH	16M
17M	DEPOTODDEN	260885	80 23 06	19 28 56	2 24.5	54912.8	54499.0	6728.4	82 57.7	SH	17M
20M	SØRKAPPØYA	190785	76 28 38	16 32 18	1 47.9	53991.2	53327.9	8436.8	81 00.6	BL	20M
21M	KRÆMERPYNTEN	210885	80 13 35	33 30 11	9 35.9	56317.3	55950.6	6416.5	83 27.5	BL	21M
22M	ANDREENESET	210885	80 03 53	31 32 49	11 36.7	55141.3	54730.3	6719.7	82 30.0	SH	22M
23M	S OF LERNERØYANE	160886	79 33 28	12 38 58	0 30.1	54398.1	53923.5	7172.9	82 25.4	BL	23M
24M	S OF WOODFJORDEN	160886	79 16 44	13 49 48	1 23.8	54387.1	53898.1	7279.8	82 18.5	BL	24M
26M	BJØRNFJORDEN	060887	79 38 38	11 27 00	-3 13.3	54278.5	53806.4	7140.8	82 26.4	BL	26M
27M	BRANDALSPYNTEN	220887	78 56 42	11 52 26	-2 34.9	54319.4	53797.1	7507.7	82 03.3	BL	27M
28M	SARSTANGEN	200786	78 43 29	11 27 22	-4 16.4	54229.1	-	-	-	KS	28M
30M	SALPYNTEN	180786	78 12 12	12 09 21	-2 47.1	54315.9	53826.5	7273.3	82 18.3	KS	30M
35M	FLINTHOLMEN	190786	78 38 33	14 35 02	0 38.3	54374.7	53831.6	7664.3	81 53.8	KS	35M
36M	KAPP MARTIN	210786	77 43 45	13 58 06	-1 12.2	54136.2	53536.2	8036.5	81 27.8	KS	36M

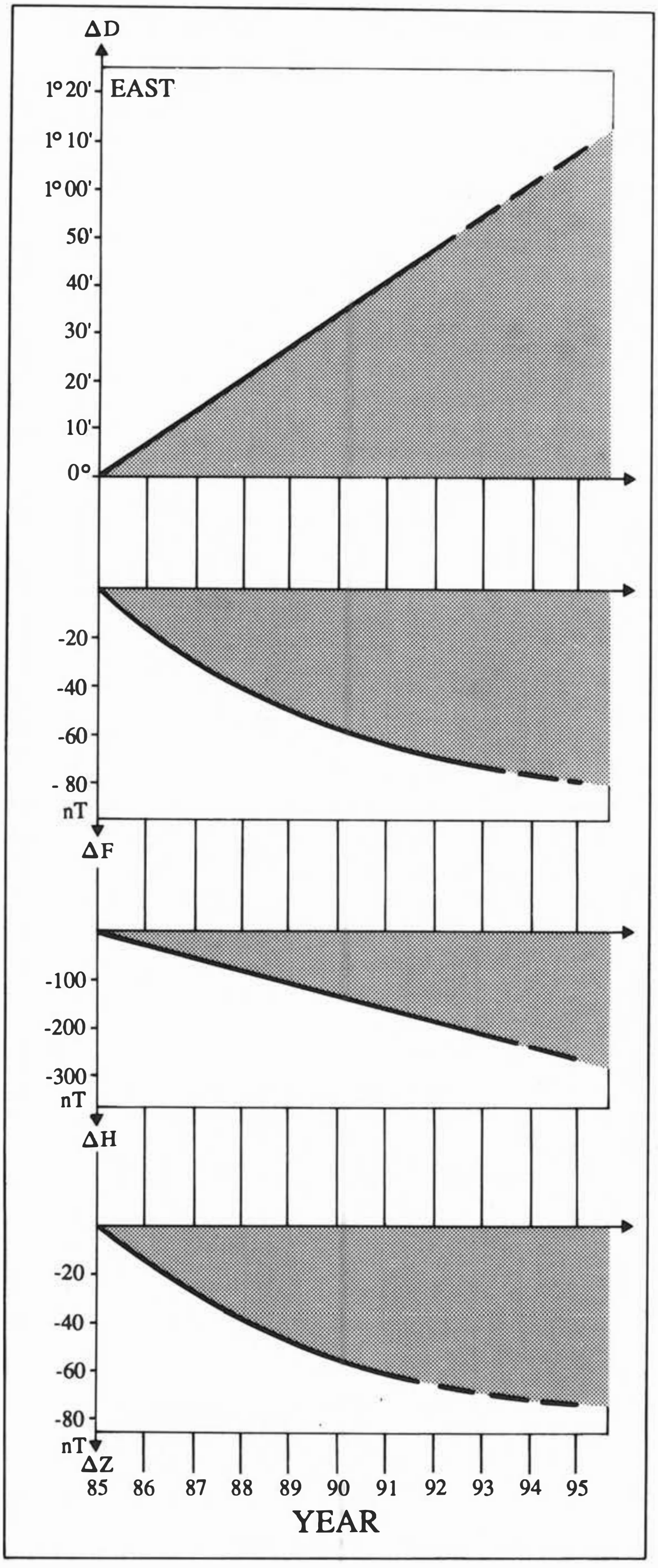
Appendix 2: List of field stations and matching geomagnetic components

No.	Station name	Date	φ	λ	D	F	Z	H	I	Obs	No.
37M	SVARTODDEN	200886	77°47'56"	15°04'56"	0°00.7'	54071.2 nT	53484.2 nT	7951.2 nT	81°32.6'	KS	37M
40M	STRAUMNESET	180886	77 31 32	13 54 44	-1 21.9	54059.3	53458.4	8042.5	81 26.7	KS	40M
41M	KAPP KLAVENESS	180886	77 18 00	14 08 13	-1 16.6	54062.7	53450.8	8113.3	81 22.1	KS	41M
44M	TVIHYRNINGEN	200786	78 27 37	11 04 39	-4 10.9	54288.7	53749.6	7630.3	81 55.2	KS	44M
45M	VERLEGENHUKEN	270885	80 03 42	16 15 59	-	54546.0	54110.2	6951.0	82 45.0	SH	45M
46M	POLHJEM	110885	79 53 36	16 01 33	-0 25.7	54598.0	54139.7	7059.2	82 34.3	BL	46M
49M	OVERGANGSHYTTA	230786	78 54 13	16 22 33	2 31.9	54620.6	54126.6	7325.1	82 17.6	KS	49M
50M	WORSLEYHAMNA	160886	79 41 39	13 38 26	0 46.8	54439.9	53971.2	7131.7	82 28.4	BL	50M
52M	AMSTERDAMØYA	060887	79 44 43	10 51 50	-0 06.8	54449.2	53984.3	7086.6	82 31.3	BL	52M
53M	HERMANSENØYA	210886	78 33 05	12 11 43	-2 27.2	54219.1	53677.5	7640.2	81 54.0	BL	53M
54M	BÖLSCHEØYA	040885	77 13 19	22 00 19	4 35.3	54289.8	53684.9	8081.7	81 26.3	SH	54M
57M	MISTAKODDEN	270785	78 28 53	20 09 05	3 44.5	54427.7	53891.7	7619.9	81 57.1	SH	57M
58M	RAKKARDALEN	250785	77 47 24	21 18 51	4 19.3	54276.7	53701.8	7879.1	81 39.2	BL	58M
60M	CROZIERPYNTEN	090885	79 55 08	16 51 27	0 32.1	54595.7	54143.4	7015.0	82 37.1	SH	60M
61M	LUNDEHUKEN	170885	79 48 52	17 49 48	-0 51.0	54489.9	54031.9	7058.4	82 33.4	SH	61M
62M	BRAGENESET	090885	79 43 15	18 45 40	2 02.7	54708.0	54237.9	7156.8	82 29.0	BL	62M
63M	ZEIPELODDEN	160885	79 39 53	20 28 30	3 54.1	54704.8	54234.0	7161.6	82 28.7	SH	63M
64M	FOSTERØYANE	160885	79 34 27	19 17 45	2 47.5	54411.0	53943.0	7121.3	82 28.8	BL	64M
65M	E OF EMBLATOPPEN	170885	79 11 04	18 52 09	-	54487.1	53998.1	7282.7	82 19.1	SH	65M
66M	VON OTTERØYA	170885	79 14 10	19 59 58	1 15.8	54357.1	53870.3	7258.7	82 19.6	BL	66M
67M	TORELLNESET	170885	79 22 37	20 45 46	0 08.1	54560.7	54070.9	7294.6	82 19.0	BL	67M
68M	VIBEBUKTA	190885	79 22 42	22 46 11	6 11.3	54945.5	54473.7	7184.7	82 29.2	BL	68M
69M	ULENESET	180885	79 01 24	20 38 43	8 40.1	54472.7	53878.7	8022.4	81 31.9	SH	69M
73M	BLÅFJORDSFLYA	050885	78 01 12	23 09 15	6 17.7	54491.8	53938.1	7748.5	81 49.5	BL	73M
74M	RYKE YSEØYANE	030885	77 47 53	25 06 14	7 31.4	54626.0	54074.6	7741.7	81 51.2	SH	74M

No.	Station name	Date	ϕ	λ	D	F	Z	H	I	Obs	No.
75M	STONES FORLAND	050885	77°34'15"	23°48'31"	6°41.7'	54417.7 nT	53835.2 nT	7940.7 nT	81°36.6'	BL	75M
76M	HALVMÅNEØYA	010885	77 16 19	23 03 09	5 51.6	54396.0	53798.6	8039.8	81 00.0	BL	76M
77M	HÅØYA	300785	76 52 36	21 42 29	4 17.8	54172.5	53522.1	8369.0	81 06.8	BL	77M
78M	KAPP LEE STATION	270785	78 05 00	20 49 08	3 43.2	54428.7	53869.3	7783.6	81 46.7	BL	78M
80M	REVNOSA	270785	78 01 57	18 44 52	2 38.8	54287.0	53721.9	7812.6	81 43.5	SH	80M
81M	KAPP MURCHISON	230785	77 49 16	18 24 37	-	54216.0	53632.8	7931.0	81 35.3	BL	81M
82M	BOLTODDEN	210785	77 29 56	18 11 05	-	54240.0	-	-	-	SH	82M
83M	E OF BELCHERFJ.	220785	77 15 43	17 26 03	1 10.2	54186.4	53563.4	8192.9	81 18.2	SH	83M
84M	DAVISLAGUNA	210785	76 58 05	17 16 51	1 51.9	54060.7	53422.6	8281.6	81 11.3	BL	84M
86M	PURCHANESET	260885	80 21 44	18 17 12	0 38.6	54664.8	54253.7	6691.3	82 58.1	BL	86M
87M	KROKDALSKNAUSEN	210786	77 58 12	14 24 25	-0 28.0	54186.2	53613.2	7858.3	81 39.7	KS	87M
88M	KAPP HAMMERFEST	060885	78 39 16	26 46 04	9 39.1	54582.7	54072.1	7448.6	82 09.4	BL	88M
89M	KIEPERTØYA	180885	78 58 49	21 38 56	2 25.2	54589.3	54087.7	7383.2	82 13.6	BL	89M
90M	LEWINODDEN	210786	78 04 49	13 42 55	-1 12.2	54199.2	53623.5	7877.5	81 38.6	KS	90M
91M	HAMNETANGEN	180786	78 19 31	12 50 42	-1 23.9	54165.7	53594.7	7842.9	81 40.5	KS	91M
92M	BOHEMANNESET	220787	78 22 26	14 45 56	-0 12.4	54368.5	53813.9	7744.6	81 48.6	BL	92M
93M	KAPP THORDSEN	190786	78 27 22	15 28 13	0 03.2	54398.0	53847.4	7718.5	81 50.6	KS	93M
94M	W OF PETUNIABUKTA	220786	78 41 54	16 27 18	1 12.6	54501.1	53968.8	7587.0	81 29.9	KS	94M
95M	PHANTOMODDEN	220786	78 31 57	16 27 42	0 33.4	54538.3	53994.4	7667.0	81 55.1	KS	95M
96M	BLIXODDEN	200886	77 45 56	16 00 15	0 47.7	54185.1	53598.6	7950.3	81 33.8	KS	96M
97M	BELVEDERETOPPEN	180886	77 16 56	15 47 47	0 36.6	54042.1	53423.4	8153.3	81 19.4	KS	97M
98M	TORELLKJEGLA	180886	77 09 12	14 50 40	-0 28.1	53995.1	53360.7	8252.1	81 12.5	KS	98M
99M	KJELLSTRÖMDALEN W	140886	77 56 16	17 00 02	1 19.4	54163.6	53584.1	7904.8	81 36.5	KS	99M
100M	BRENTSKARDHAUGEN	170886	78 10 27	16 55 07	1 07.0	54271.8	53711.0	7785.3	81 45.2	KS	100M
101M	GJERSTADTOPPEN	150886	78 45 02	13 08 14	-1 46.3	54211.9	53685.2	7541.0	81 30.2	KS	101M

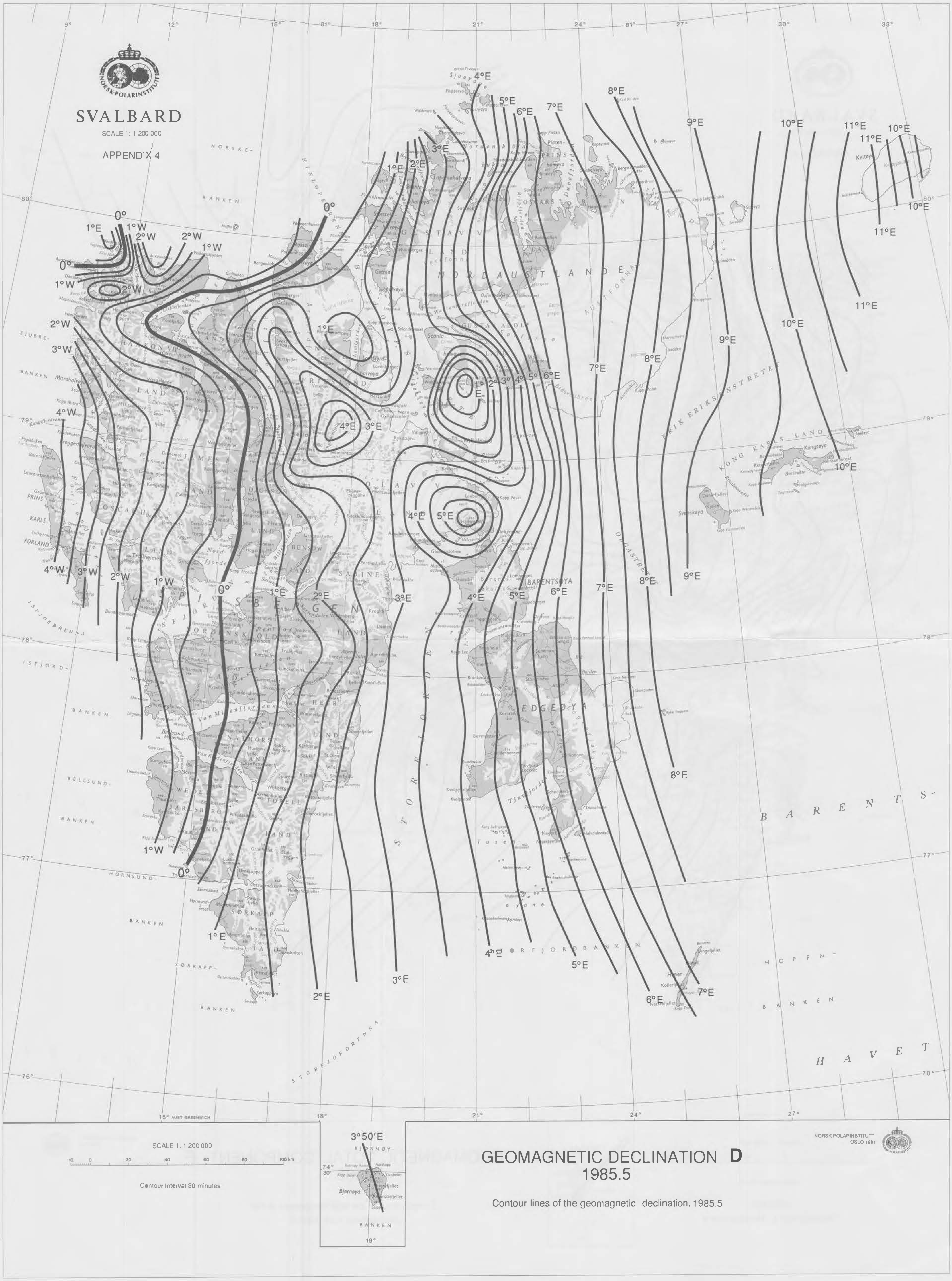
No.	Station name	Date	ϕ	λ	D	F	Z	H	I	Obs	No.
102M	WITTENBURGFJELLET	150886	78°33'55"	13°30'54"	-0°57.6'	54311.4 nT	53769.6 nT	7655.0 nT	81°53.8'	KS	102M
103M	TYSNESET	230786	79 06 46	15 42 41	-	54558.1	54054.7	7386.0	82 13.2	KS	103M
104M	FORSPYNTEN	230786	79 17 55	15 35 11	0 23.9	54623.1	54130.9	7298.3	82 19.3	KS	104M
105M	REGNARDNESET	140886	79 16 36	11 55 56	-1 31.3	54408.5	53896.5	7444.4	82 08.1	BL	105M
106M	TREDJEBREEN	210886	79 20 32	10 51 45	-3 14.4	54323.0	53679.0	7340.7	82 11.8	BL	106M
107M	GERDØYA	140886	78 58 53	12 16 40	-2 21.0	54311.9	53798.0	7454.1	82 06.7	BL	107M
108M	PACHTUSOVFJELLET	240786	78 51 38	18 33 39	2 21.0	54546.3	54033.4	7454.5	82 08.7	KS	108M
109M	KOEFOEDODDEN	020885	76 27 17	24 58 42	6 46.6	54390.0	53738.8	8391.5	81 07.5	SH	109M
110M	BRAASTADSKARDET	020885	76 39 45	25 23 14	7 19.3	54342.0	53703.5	8306.0	81 12.5	SH	110M
111M	KAPP KOBBURG	070885	78 54 55	28 07 56	-	55007.0	54515.0	7346.0	82 19.5	SH	111M
112M	TØMMERNESET	080885	79 50 30	29 15 00	9 40.5	55223.2	54749.8	7215.2	82 29.6	SH	112M
113M	KAPP LAURA	240885	80 02 40	27 10 25	8 29.8	54980.0	54546.4	6891.1	82 48.0	SH	113M
114M	STORØYA	200885	80 05 14	27 54 19	9 05.9	54929.7	54523.4	6668.9	83 01.6	SH	114M
115M	KARL-XII-ØYA	230885	80 39 38	25 00 09	7 24.3	54959.0	54556.0	6643.5	83 03.4	SH	115M
116M	ZEILØYA	050885	78 16 31	22 28 39	5 32.6	54546.7	54003.8	7677.1	81 54.5	SH	116M
117M	ISISPYNTEN	190885	79 42 03	26 40 48	8 33.3	54989.3	54545.8	6969.9	82 43.1	BL	117M
118M	MARIAHOLMEN	210786	77 40 53	14 49 00	-0 36.4	54091.1	53490.5	8037.7	81 27.3	KS	118M
119M	FOYNØYA	230885	80 26 54	26 09 12	9 12.1	55021.6	54621.9	6620.0	83 05.4	BL	119M
120M	KAPP BRUUN	230885	80 15 57	25 20 59	7 06.9	54945.2	54526.0	6774.6	82 55.1	BL	120M
121M	BELVEDERE	220786	78 19 29	16 34 44	0 47.0	54478.8	53923.4	7746.8	81 49.5	KS	121M
122M	HABENICHTBUKTA	290785	77 31 45	20 49 32	2 45.6	54279.3	53689.4	7980.7	81 32.7	BL	122M
123M	WALDENØYA	270885	80 37 01	31 49 14	3 34.9	54769.2	54370.8	6593.9	83 05.1	BL	123M
124M	WORDIEODDEN	250885	80 02 22	22 24 48	6 29.4	54691.5	54280.4	6693.3	82 58.2	BL	124M
125M	KAPP LOVEN	250885	80 15 42	21 46 00	6 31.5	54795.5	54368.5	6827.3	82 50.6	BL	125M
126M	ROSSØYA	240885	80 49 40	20 20 29	-	54948.0	54555.0	6560.0	83 09.0	BL	126M

No.	Station name	Date	ϕ	λ	D	F	Z	H	I	Obs	No.
127M	MARTENSØYA	240885	80°40'28"	21°16'25"	4°15.9'	54935.5 nT	54535.1 nT	6620.7 nT	83°04.7'	SH	127M
128M	SCORESBYØYA	250885	80 21 39	21 26 31	4 30.7	54854.2	54438.3	6742.3	82 56.4	SH	128M
129M	KAPP PLATEN	250885	80 30 00	22 47 10	6 37.3	54809.7	54414.2	6572.2	83 06.8	SH	129M
130M	KVALROSSØYA	240785	78 30 26	19 37 55	-	54794.0	54278.0	7504.0	82 08.0	KS	130M
131M	STERTANE	210886	79 01 28	14 21 33	-0 39.5	54132.3	53610.7	7503.9	82 01.9	KS	131M
132M	REJMYREFJELLET	150886	78 23 29	17 17 51	2 05.9	54322.2	53774.8	7695.0	81 51.4	KS	132M
133M	KAPP LAILA	140886	78 07 20	14 48 59	-0 14.1	54138.9	53567.8	7850.5	81 39.7	KS	133M
134M	W OF LYKTA	220786	78 48 12	15 26 42	0 01.7	54506.3	53988.5	7490.7	82 06.1	KS	134M
135M	LÆGERNESET	170886	77 31 33	14 45 35	-0 27.6	54031.1	53431.0	8029.5	81 27.2	KS	135M
136M	HELLWALDFJELLET	240786	78 44 04	20 47 05	5 55.1	54285.2	53791.1	7306.0	82 15.9	KS	136M
137M	CHIMKOVTOPPEN	250787	78 38 11	18 45 55	2 34.3	54505.3	53974.2	7576.0	82 00.6	BL	137M
138M	TEISTBERGET	270787	78 21 48	19 00 08	3 11.1	54380.5	53826.8	7738.6	81 49.1	BL	138M
139M	SVENFJELLET	250787	78 05 55	17 45 14	1 44.1	54170.1	53595.6	7866.4	81 39.0	BL	139M
140M	GANGDALSTOPPANE	200787	78 02 57	15 48 50	0 34.2	54320.9	53744.5	7883.9	81 39.3	BL	140M
141M	SAUSSUREBERGET	010887	77 26 27	15 22 20	0 10.0	54004.5	53379.5	8191.1	81 16.6	BL	141M
142M	O.PETTERSONFJELLET	010887	77 32 49	16 13 13	0 28.7	54109.9	53506.9	8054.2	81 26.4	BL	142M
143M	SPOREN	010887	77 29 57	16 55 19	1 45.8	54220.2	53604.8	8144.7	81 21.6	BL	143M
144M	ERMAKTANGEN	060887	79 50 12	12 11 51	-2 36.0	54510.1	54045.3	7096.6	82 31.2	BL	144M
145M	SIGURDFJELLET	060887	79 16 38	13 40 27	-1 33.5	54507.1	54014.6	7306.3	82 17.8	BL	145M
146M	NORDBREEN	050887	79 38 40	15 43 51	2 27.0	54729.5	54250.1	7223.8	82 24.9	BL	146M
147M	VILLA MØEN	050887	79 28 25	15 52 33	2 50.4	54631.9	54145.6	7263.0	82 21.6	BL	147M
148M	POINCARETOPPEN	050887	79 10 47	17 32 29	4 30.0	-	-	-	-	BL	148M
149M	N OF AKTERHOLTEN	110887	77 49 06	18 22 47	2 37.3	54246.2	53667.0	7904.4	81 37.3	BL	149M
150M	KVALHOVDEN	110887	77 30 49	18 14 14	2 49.6	54161.1	53568.2	7990.8	81 30.9	BL	150M
151M	AGARDHBUKTA HUT	110887	78 03 05	18 39 46	2 42.9	54321.7	53746.2	7884.5	81 39.3	BL	151M



Appendix 3: Correction tables for assumed secular variations

Appendix 4: *Isoline map of geomagnetic declination for epoch 1985.5*
Appendix 5: *Isoline map of geomagnetic total intensity for epoch 1985.5*
Appendix 6: *Isoline map of geomagnetic horizontal component for epoch 1985.5*
Appendix 7: *Isoline map of geomagnetic vertical component for epoch 1985.5*



GEOMAGNETIC DECLINATION D

1985.5

Contour lines of the geomagnetic declination, 1985.5

SCALE 1: 1 200 000

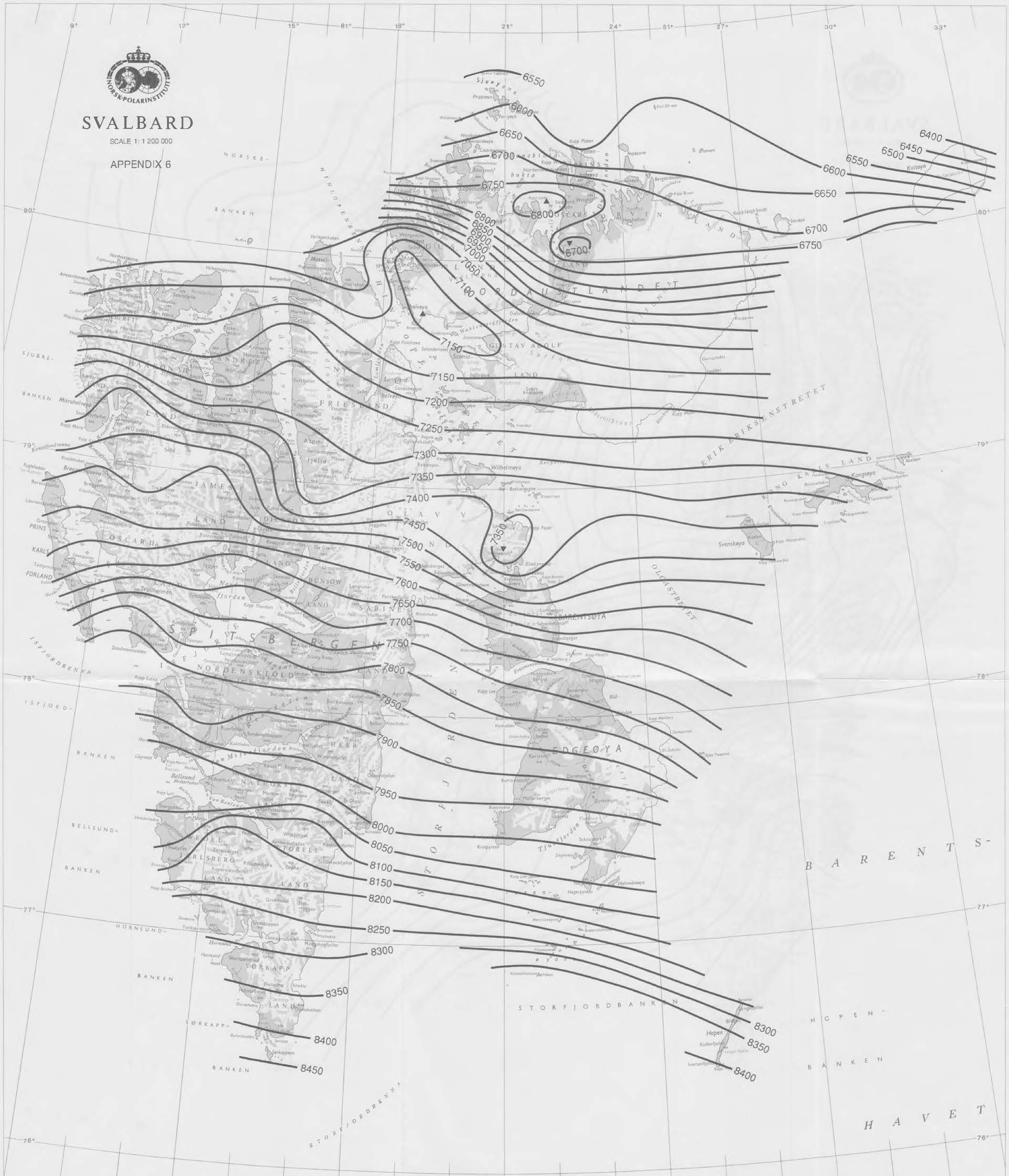
Contour interval 50 nT

LEGEND:
Relative high ▲ Relative low ▼

GEOMAGNETIC TOTAL COMPONENT F
1985.5

Contour lines of the total component of the geomagnetic field, 1985.5

NORSK POLARINSTITUTT
OSLO 1991



SCALE 1: 1 200 000

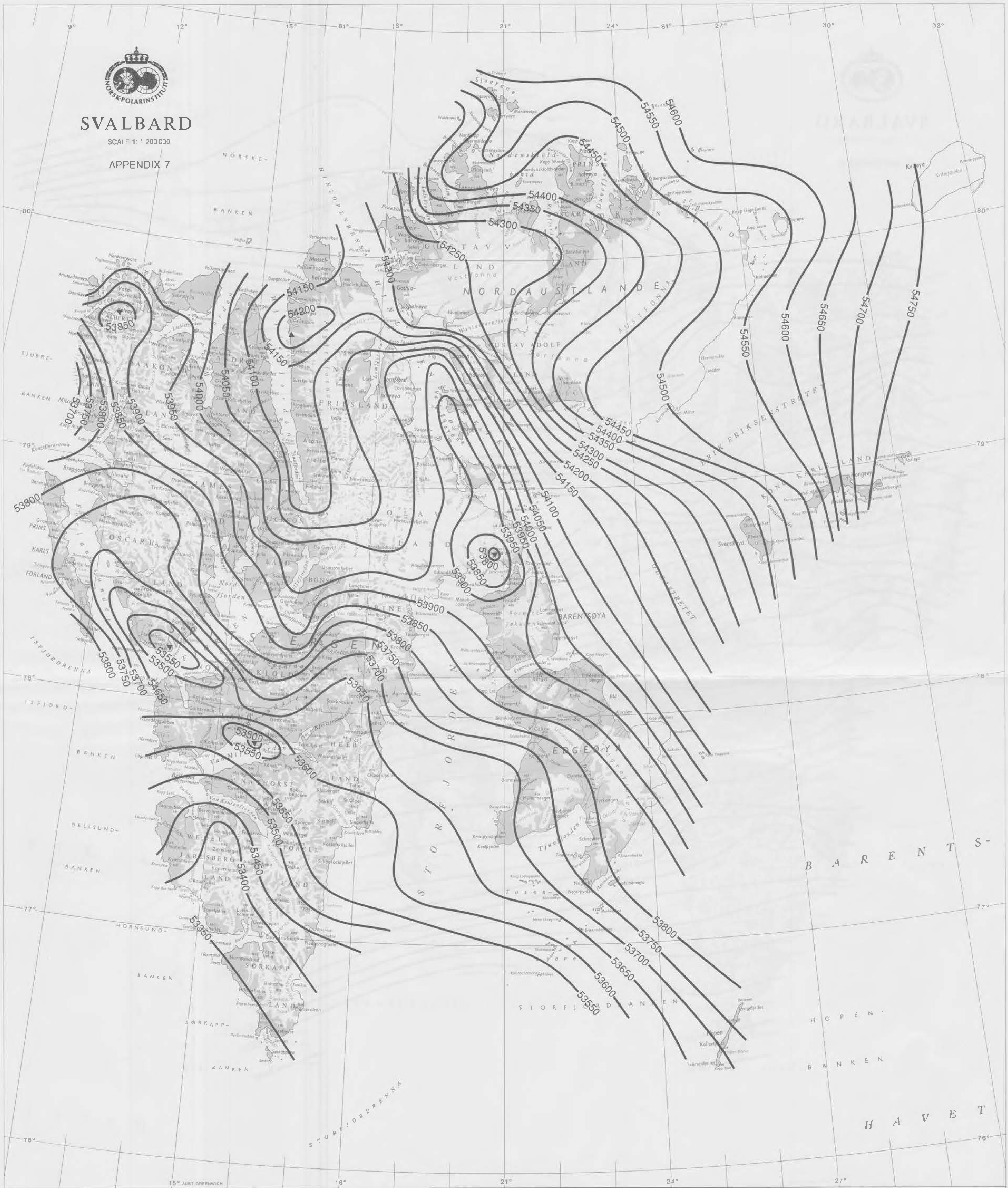
Contour interval 50 nT

LEGEND:
Relative high ▲ Relative low ▼

GEOMAGNETIC HORIZONTAL COMPONENT **H**
1985.5

Contour lines of the horizontal component
of the geomagnetic field. 1985.5

NORSK POLARINSTITUTT
OSLO 1991



SCALE 1: 1 200 000

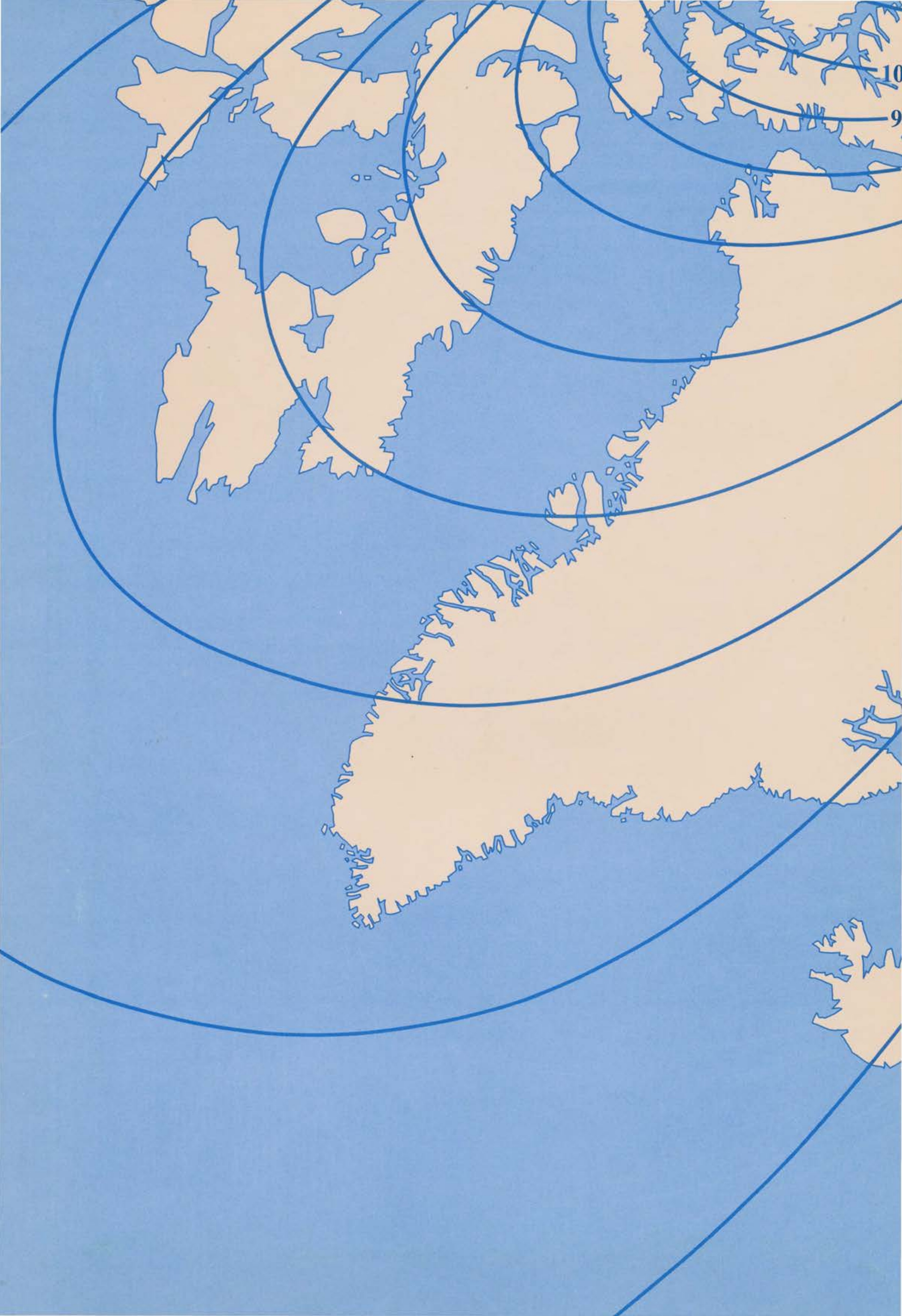
Contour interval 50 nT

LEGEND:
Relative high ▲ Relative low ▼

GEOMAGNETIC VERTICAL COMPONENT Z
1985.5

Contour lines of the vertical component of the geomagnetic field, 1985.5

NORSK POLARINSTITUTT
OSLO 1991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