GEOMAGNETIC REPEAT MEASUREMENTS AT GRYTVIKEN, NOVEMBER 1984

D. A. SIMMONS

British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, UK

INTRODUCTION

One of the programmes lost with the closure of Grytviken was the study of the Earth's geomagnetic field there, and an important use of the data is the updating of models of the Earth's geomagnetic field. The primary product of this modelling is the International Geomagnetic Reference Field (IGRF), and from this are produced maps showing the values of the field over the surface of the Earth and also the rate at which the field is altering, (the Secular Change). The details of the difference between true and Magnetic North (Declination) also appears on the charts produced for navigating ships.

The secular change shows high gradients in the region of the southern Atlantic Ocean and this, coupled with the scarcity of data from the area, makes any observations taken at Grytviken particularly useful. It was therefore decided to make measurements of the field there in the Austral Spring of 1984; such measurements are usually referred to as 'Repeat Measurements'.

OBSERVATIONS

The author and necessary equipment were landed early in the evening of 25 November 1984 and, after some help from the Army with the equipment and electrical installation, observations were started. The observation period occupied the next two days and, because these (26 and 27 November) turned out to be two of the magnetically quietest days of the month, a good set of values was obtained.

A quartz horizontal magnetometer (QHM) was used as in 1975–81 on the west pier in the 'absolute hut'. This instrument enables the horizontal component of the field (H) to be measured and, by sighting a fixed mark of known azimuth, also gives the declination (D). A proton precession magnetometer (PPM) was used on a post a few metres away from the hut to give the total field (F); the vertical field (Z) is calculated from $Z^2 = F^2 - H^2$.

A set of readings takes about twenty to thirty minutes and consists of three readings on the PPM, which determines the field F directly, followed by a set of readings on the QHM and then a further three readings on the PPM. Values of H, D, F and Z were obtained every few hours over the two-day period.

RESULTS

Table I lists the times and values. These values were plotted against time for the two day period and mean values for each two-hour period were read from the graph. From these were calculated mean values for H, D and Z over the two-day period. The values were: H, 17842 nT; D, 351° 24.4′; Z, 24110 nT.

Table II lists these values together with the mean values for the five international quiet days for November for each of the years 1975–81. Also given for H and Z are the mean slopes (secular change) by linear regression for the years 1975–81 and

Table I. Observed values of H, D and Z. The results of individual observations.

Date *Nov.* 1984	*time* (UT)	H (nT)	D (deg min)	F (nT)	Z (nT)
26	00.4	17834	351 25.9	29996	24120
26	02.3	17841	351 25.9	29999	24118
26	05.0	17839	351 22.1	29998	24117
26	07.0	17847	351 22.8	30003	24118
26	09.3	17855	351 21.2	30005	24114
26	11.0	17847	351 19.3	29997	24110
26	13.0	17827	351 20.6	29996	24110
26	15.2	17838	351 27.3	29987	24105
26	16.1	17835	351 28.3	29986	24106
26	17.1	17842	351 20.1	29990	24105
26	18.3	17839	351 28.9	29991	24109
26	19.6	17840	351 26.5	29995	24113
26	21.7	17844	351 26.2	29998	24114
27	00.4	17848	351 26.0	30000	24113
27	09.4	17857	351 16.9	30001	24107
27	11.0	17848	351 17.1	29992	24104
27	12.2	17829	351 21.3	29983	24106
27	14.3	17821	351 24.1	29975	24102
27	16.0	17837	351 28.9	29980	24097
27	17.9	17830	351 27.3	29982	24104
27	19.7	17831	351 27.9	29986	24108
27	22.0	17836	351 27.9	29990	24110
28	01.2	17837	351 24.1	29995	24116
Mean values 27	00.0	17842	351 24.4	29994	24110

Table II. Mean November Quiet day values 1975–1981, with predictions and observed values for November 1984.

Date *Nov.*	H (nT)	D (deg min)	Z (nT)
1975	18637	351 18.8	24414
1976	18563	351 19.5	24374
1977	18471	351 19.0	24340
1978	18363	351 18.8	24313
1979	18281	351 18.6	24272
1980	18198	351 16.9	24237
1981	18106	351 16.7	24213
Secular change per year 1975–81	−90	—	−34
Predicted values 1984 (Nov.)	17836	—	24106
Observed values 1984 (Nov.)	17842	351 24.4	24110
Secular change per year 1975–1984	−89	—	−33
Secular change per year IGRF 1980 value	−86	< 1.0	−19

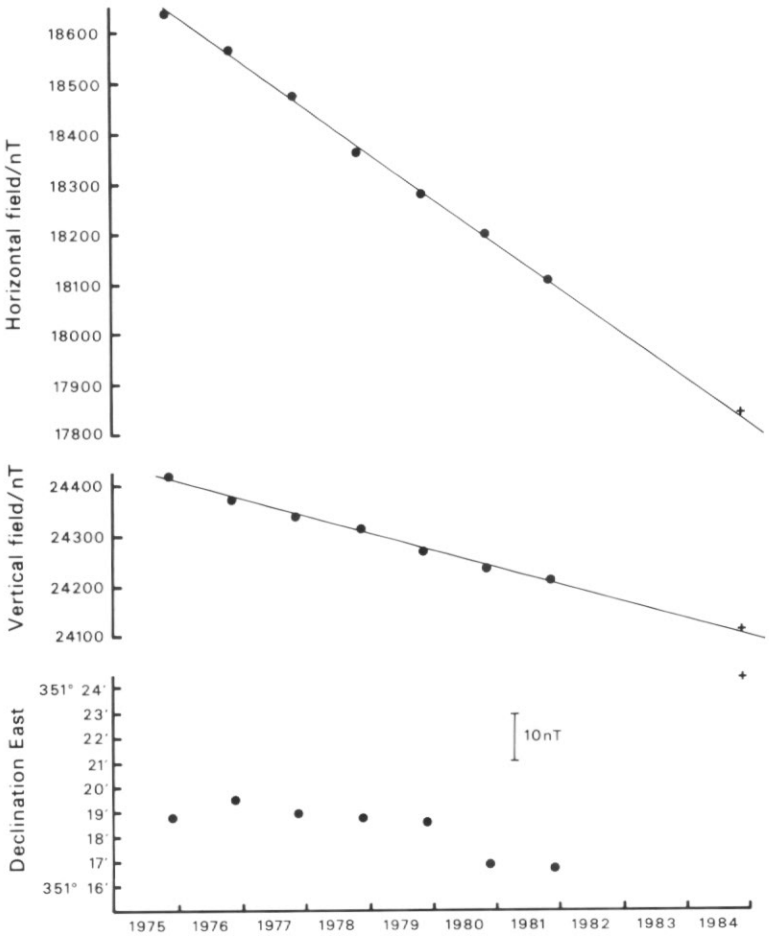

Fig. 1. Mean values of the field for the five international quiet days for November 1975–81, ●, and mean values for the period of repeat measurements, 26–27 November 1984, +. The two straight lines are by linear regression for the 1975–81 values.

1975–84, the predicted values for 1984 from the 1975–81 data and the secular change given by the IGRF 1980.0. Fig. 1 shows these November values plotted against time and includes the 1975–81 regression lines for H and Z.

Discussion

The horizontal component (H)

The 1984 observed value is seen to be close to that predicted from the earlier trend, the secular change given by the 1975–81 data, the 1975–84 data, and the IGRF are all very close.

The vertical component (Z)

The 1984 observed value is very close to that predicted from the earlier trend. However, the secular change given by all the observations taken at Grytviken

(33 nT/a) is very different from that given by the IGRF (19 nT/a), showing the need for more data from the area. The fact that there was a change of site from the PPM between 1981 and 1984 would not account for a change of more than 5 nT in Z values and would make very little difference to the measured secular change.

The declination (D)

These values are more difficult to explain and there must be some doubt as to whether the 1984 results are comparable with the earlier ones. There are several possible effects that could cause a change and these have been considered as follows:

(i) The QHM could have been in error. The instrument has since been recalibrated and this suggests an uncertainty of only one minute of arc in the values given.

(ii) The fixed mark could have been moved. This has been inspected at it is clear that it has not been moved.

(iii) There could have been a significant magnetic field from the PPM battery pack, which was about three metres from the QHM. This has since been checked and the stray field from the battery pack was less than 1 nT at a distance of two metres.

(iv) Some magnetic material may have been brought onto the site between 1982 and 1984. Whilst this cannot be ruled out, the site was inspected and no new material was found.

A report on the geomagnetic programme at South Georgia suggested that there might be some doubt as to the 1980 and 1981 values of D (Simmons, 1985, p. 20). This, together with a possible error of one minute in the 1984 value, could put the change from 1980 to 1984 as low as four minutes, a secular change of one minute per year. This value (equivalent to 5 nT/a) is well within the range of possible values. Further measurements over the next few years should resolve the uncertainty over these values.

Future Work

It is hoped to return to Grytviken every few years to continue this work.

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Reference

Simmons, D. A. 1985. *Geomagnetic measurements at South Georgia 1975–1982.* Cambridge, British Antarctic Survey, 166 pp.