Distribution of Three Geomagnetic Components over Mizuho Plateau, Antarctica

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南極みずほ高原における地磁気三成分の分布

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要旨: 南極みずほ高原の氷床上において，1968年から1974年（第8, 9, 10, 11, 14次南極地域観測隊）にかけて行われた地磁気測量の結果をまとめ，同地域の地磁気偏角，伏角，全磁力の分布図を得た．年度化成を行った年は1970.0年である．地磁気局地異常の一つはサンダーコックヌナタクスの南西地域に，一つは昭和基地とみずほ観測拠点の中間地域に見られた．両地域とも，重力異常の大きい地域に一致する．

Abstract: Distributional maps of declination, inclination and total force of geomagnetism reduced to the epoch of 1970.0 are presented on the basis of the data obtained by the oversnow traverses during the period from 1968 to 1974 over Mizuho Plateau, East Antarctica. One of the local magnetic anomalies appears in a region to the southwest of Sandercock Nunataks and another between Syowa Station and Mizuho Camp. They coincide well with the regions where the large gravity anomalies are given.

1. Introduction

Measurements were carried out of three geomagnetic components in Mizuho Plateau, East Antarctica, in 1968–1971 and 1973–1974 by the oversnow traverse parties of the 8th, 9th, 10th, 11th and 14th Japanese Antarctic Research Expeditions (JARE). The obtained data were published in three separate reports (KAKINUMA and ISHIDA, 1971; YOSHIDA and YOSHIMURA, 1972; ABE, 1975). Meanwhile, aeromagnetic surveys were conducted in Lützow-Holm Bay in 1967–1970, and on the Prince Olav Coast and its vicinity in 1974; as the results,

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contour maps of total magnetic intensity over Lützow-Holm Bay and its coastal regions were presented by TAZIMA *et al.* (1972) and by KANEKO (1976). Considerably large local magnetic anomalies were found in areas near Padda Island, Flattunga, Cape Hinode, and along the Sôya Coast.

This paper gives the areal distribution of not only total intensity but also declination (horizontal angle from the geographical north) and inclination (vertical angle) of geomagnetism over Mizuho Plateau based on the data obtained by the above mentioned oversnow traverse surveys. The general distribution given here will contribute to a future investigation on magnetic anomalies in this plateau. Furthermore, the contour map of declination is useful for field researchers on the ice sheet, because the magnetic direction is generally used for navigation throughout an oversnow traverse, and moreover, almost all directions observed on the ice sheet are commonly measured by angles from the magnetic north and are corrected by using the value of declination at each location, *e.g.*, in measurements of directions of wind, sastrugi, dune, crevasse, surface slope, geological structure and so on.

2. Method of Measurements

Instruments used for measurements were a proton magnetometer (GEONIX Model PMM 611G or G-186 Geometric Co. U.S.A.) for the total force F, and a G. S. I. type magnetometer for the declination D and the inclination I. A fluxgate type magnetometer (G.I.T. TR-type) was also used for D and I in the survey of 1969-1970.

The measurements at each point were carried out on the snow surface more than 50 m away from the site of oversnow vehicles. The values of D and I were measured twice in succession; the values of F ten times at intervals of six seconds. The units of readings were 0.1 min for D and I, and 1 γ for F.

Since the declination D was measured by using the sun, the measurement was impossible under the condition of heavy drifting of snow. Therefore, the number of obtained data of D was less than that of I and F, as described in Section 4.

3. Corrections of Observed Data

The epoch reduction and the height correction should be applied to the observed magnetic values.

3. 1. Epoch reduction

The amount of epoch reduction at a given time and point is obtained by subtracting a magnetic value at the given time from a value at a reference epoch time both at a reference point. It is assumed, in this study, that the

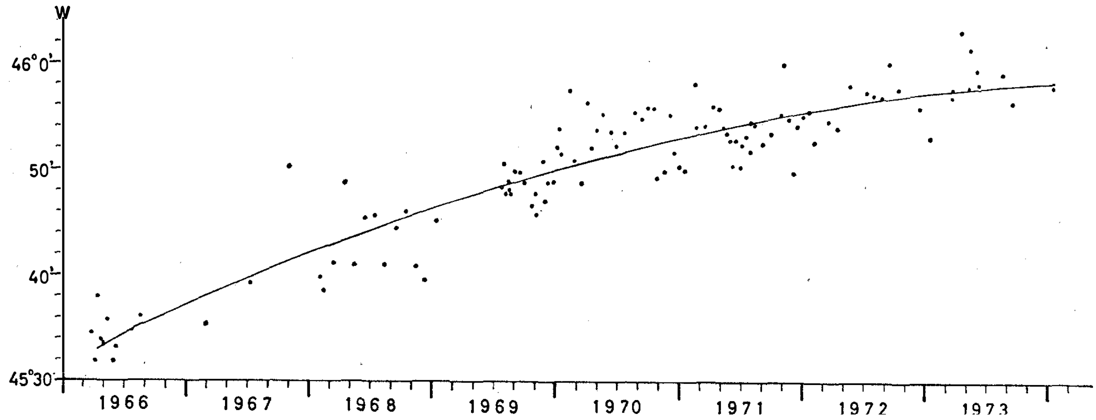

Fig. 1. Secular variation of magnetic declination (westward) obtained by the absolute measurements at Syowa Station during the 1966–1973 period.

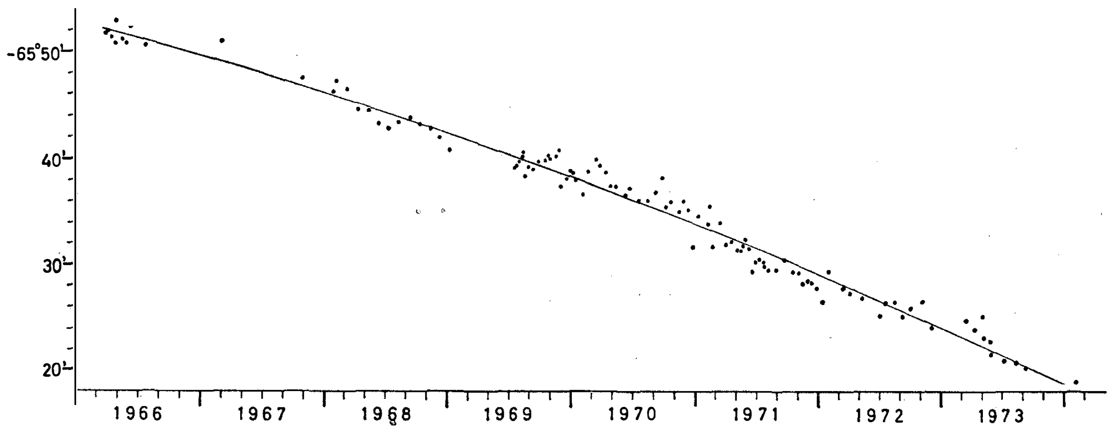

Fig. 2. Secular variation of magnetic inclination (dip) obtained by the absolute measurements at Syowa Station during the 1966–1973 period.

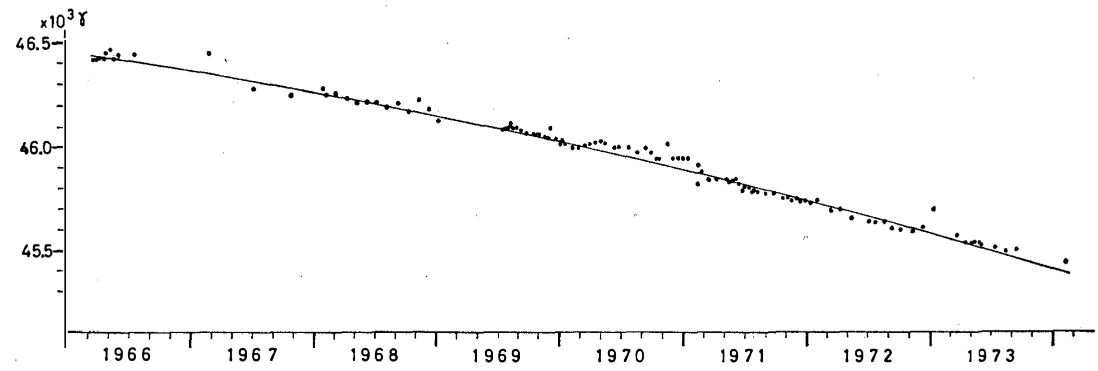

Fig. 3. Secular variation of magnetic total force (in gamma) obtained by the absolute measurements at Syowa Station during the 1966–1973 period.

difference is negligibly small between the amount of the secular variation of the magnetic value at any point in the observational region and that at the reference point, namely Syowa Station (69°00′S, 39°35′E).

Figs. 1, 2 and 3 show the secular variations at Syowa Station of declination *D*, inclination *I* and total force *F* respectively during the period from March 1966 to February 1974 obtained by the absolute measurements of geomagnetism. Regression lines in the quadratic forms were obtained by means of least squares as to each of *D*, *I* and *F* as follows:

$$D=45°29.8'+5.69'(t-1966.0)-0.298'(t-1966.0)^2,$$
$$\text{(westward)} \qquad \text{S.D.}= \pm 2.7',$$
$$I=-65°52.7'+3.04'(t-1966.0)+0.152'(t-1966.0)^2$$
$$\text{S.D.}= \pm 1.2',$$
$$F=46461-85.64(t-1966.0)-5.62(t-1966.0)^2,$$
$$\text{(unit: } \gamma), \qquad \text{S.D.}= \pm 29.0\,\gamma,$$

where t is a calender year. Magnetic values observed in any year can be reduced to a reference epoch by applying the above equations. During these eight years, the average annual change of *D* was +3.3 min/year, that of *I* was +4.3 min/year and that of *F* was $-131\,\gamma$/year. Corrections were not made for the daily variations.

The epoch of 1970.0 was adopted in this paper.

3. 2. Height correction

The effect of elevation (a.s.l.) of an observational point on a magnetic value should be reduced. The amount of height correction can be calculated theoretically by using the magnetic values at the elevation of 0 m and 1,000 m in the IGRF (1965) data (IAGA Commission 2 Working Group 4, 1969). The values for correction were estimated as 0.0 min/1,000 m for *D*, +0.3 min/1,000 m for *I*, and $+20\,\gamma$/1,000 m for *F* on the ice sheet of Mizuho Plateau.

4. Distribution of the Magnetic Components for the Epoch 1970.0

Distributions of the three components *D* (degree westward), *I* (degree in vertical direction) and *F* (γ) for the epoch 1970.0 are shown in Figs. 4, 5 and 6, respectively. Broken lines represent the contour lines based on the reduced values of each component.

The number of points at which data were obtained in these figures is 50 for *D* (Fig. 4), 61 for *I* (Fig. 5) and 179 for *F* (Fig. 6). Oversnow traverse routes along which measurements were made are shown by dotted lines in Fig. 4.

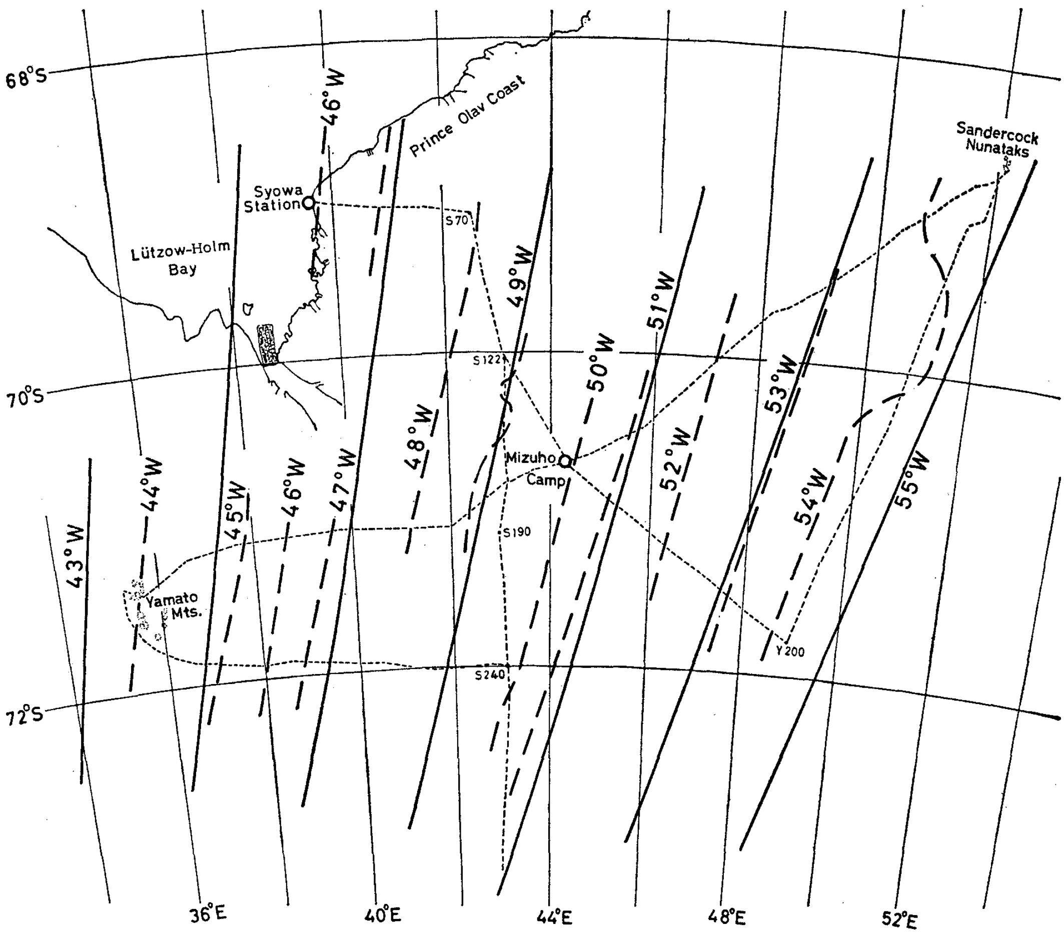

Fig. 4. Distribution of magnetic declination (westward) over Mizuho Plateau.
Broken lines represent the isomagnetics for the epoch 1970.0 reduced from the data measured in 1968–1974; solid lines represent the general distribution which was given by the empirical formula based on the reduced values. The number of points at which data were obtained is 50 along the oversnow traverse routes indicated by dotted lines.

To show the general distribution of the magnetic field, the following quadratic equations as to latitude and longitude can be obtained from the reduced values by means of least squares :

$$M=M_0+a\cdot\Delta\phi+b\cdot\Delta\lambda+c\cdot\Delta\phi^2+d\cdot\Delta\phi\cdot\Delta\lambda+e\cdot\Delta\lambda^2,$$
$$\Delta\phi=\phi-\phi_0, \qquad \Delta\lambda=\lambda-\lambda_0,$$

where M is a magnetic component, ϕ and λ (degree) are latitude and longitude of the observational points respectively, M_0, a, b, c, d and e are parameters which should be determined by means of least squares. The obtained empirical equations for D, I and F are as follows:

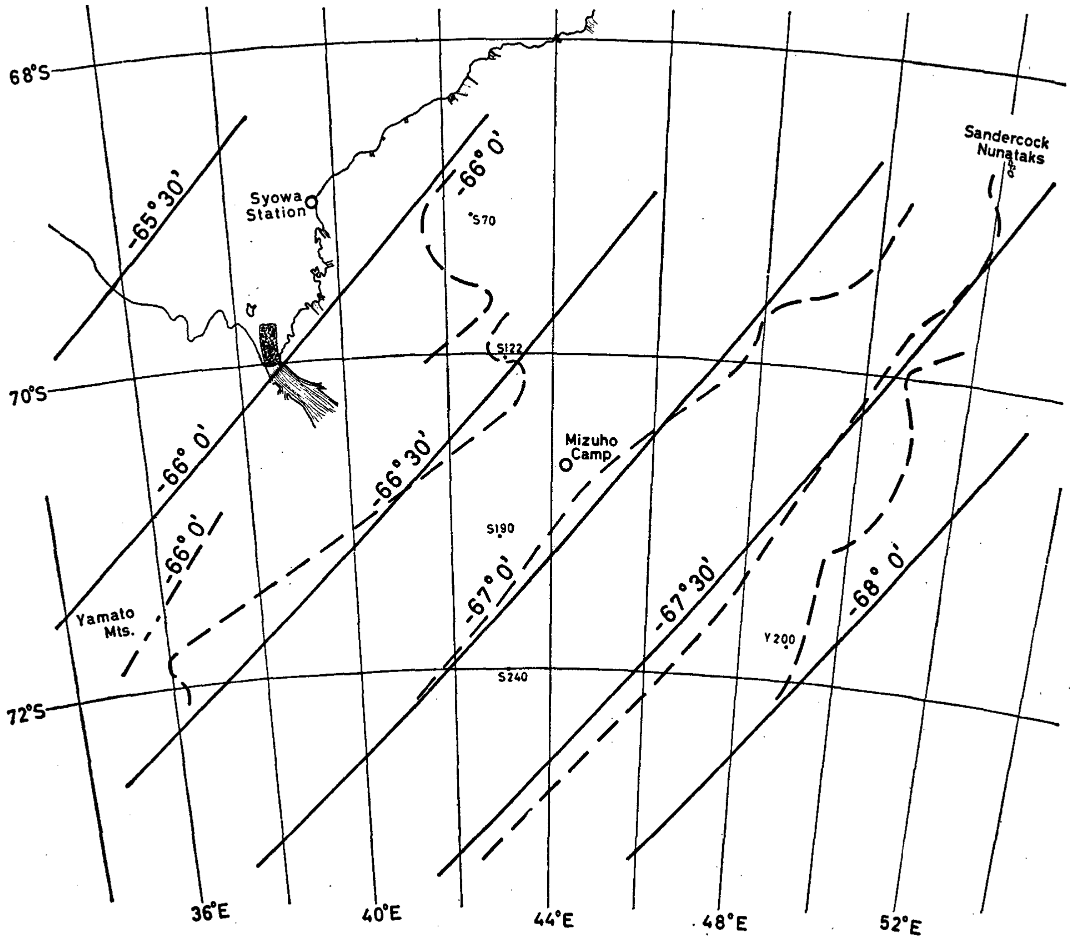

Fig. 5. Distribution of magnetic inclination (dip) over Mizuho Plateau.
Broken lines represent the isomagnetics for the epoch 1970.0 reduced from the data measured in 1968–1974; solid lines represent the general distribution which was given by the empirical formula based on the reduced values. The number of points at which data were obtained is 61 along the oversnow traverse routes shown in Fig. 4.

$$D_{1970}=50°46.0'+37.44'\Delta\phi+45.41'\Delta\lambda+3.87'\Delta\phi^2+1.22'\Delta\phi\Delta\lambda+0.018'\Delta\lambda^2,$$
$$\text{(westward)} \qquad \text{S.D.}=\pm 11.4',$$
$$I_{1970}=-67°0.9'-20.66'\Delta\phi-7.91'\Delta\lambda-1.25'\Delta\phi^2-0.034'\Delta\phi\Delta\lambda-0.15\Delta\lambda^2,$$
$$\text{S.D.}=\pm 7.5',$$
$$F_{1970}=48432+591.8\Delta\phi+210.5\Delta\lambda-15.61\Delta\phi^2-6.95\Delta\phi\Delta\lambda+1.21\Delta\lambda^2$$
$$\text{(unit: } \gamma) \qquad \text{S.D.}=\pm 89.3\gamma,$$

where the values of ϕ_0 and λ_0 are assumed to be 71°S and 45°E respectively.

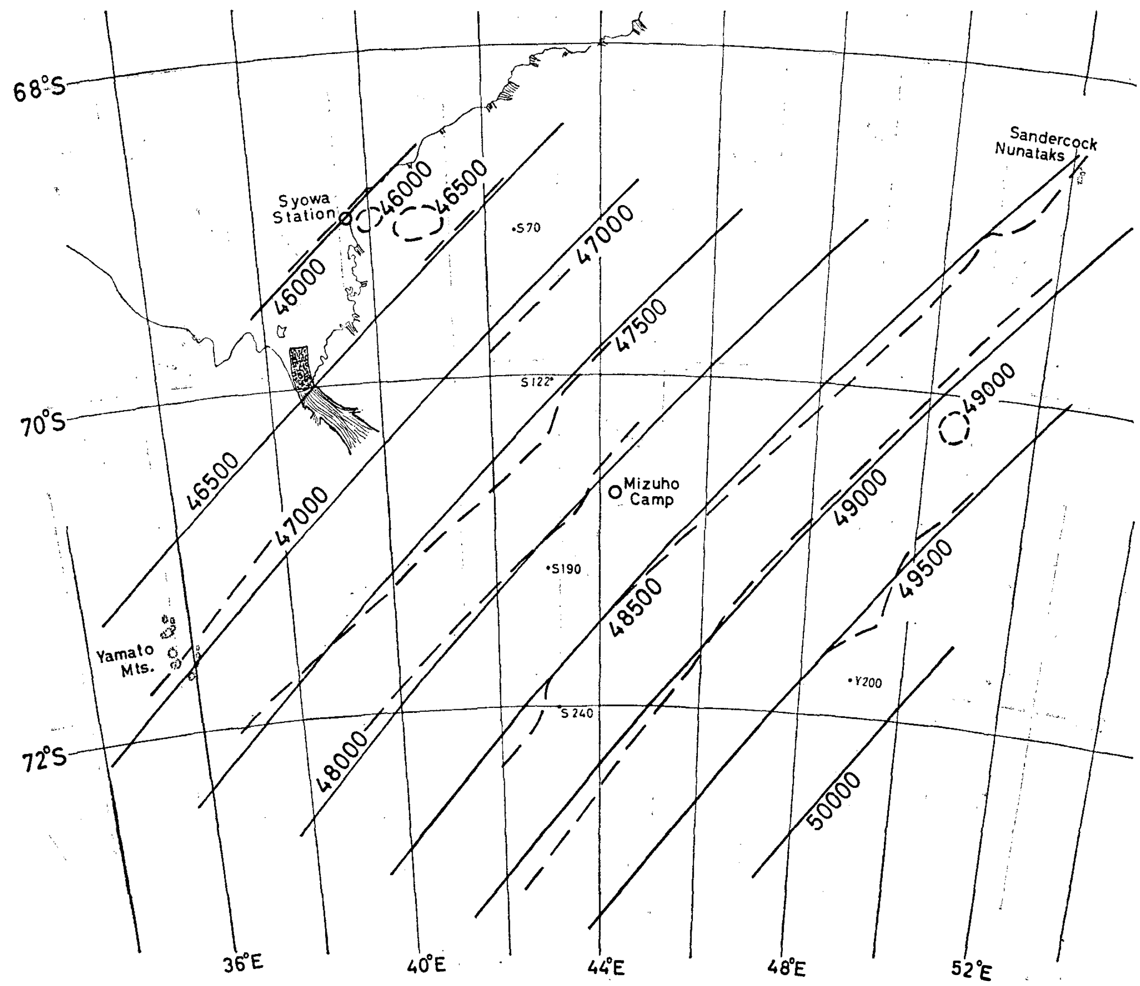

Fig. 6. Distribution of magnetic total force (in gamma) over Mizuho Plateau.
Broken lines represent the isomagnetics for the epoch 1970.0 reduced from the data measured in 1968–1974; solid lines represent the general distribution which was given by the empirical formula based on the reduced values. The number of points at which data were obtained is 179 along the oversnow traverse routes shown in Fig. 4.

Contour lines of mean isomagnetic fields obtained from these three equations are represented by solid lines in Figs. 4, 5 and 6.

A large deviation of the broken line from the solid line can be considered to correspond with a local anomaly of geomagnetism. As for the declination *D*, a considerable local anomaly was found to the southwest of Sandercock Nunataks (see Fig. 4); as for the inclination *I* (see Fig. 5), anomalies were found in the same region as above and also in the region between Syowa Station and Mizuho Camp (70°42′S, 44°20′E). They coincide well with those regions where considerably large gravity anomalies were reported by ABE *et al.*

(1978). The free-air anomaly indicated a large negative value in the former region, while a large positive value in the latter region. Consequently, the existence of a large-scale subglacial trough extending towards the Rayner Glacier was suggested in the former, whereas a large-scale bedrock rise was in the latter. The distribution of Bouguer anomaly also showed irregular patterns in these regions.

As for the total force *F*, slight anomalies were found in the vicinity of Syowa Station and also to the southwest of Sandercock Nunataks (see Fig. 6).

5. Concluding Remarks

General distributions of three geomagnetic components, namely, declination, inclination and total force, over the ice sheet of Mizuho Plateau are presented for the epoch of 1970.0.

Detailed discussions on the magnetic anomalies are not possible for the following reasons:

1) Observational points were not uniformly distributed over the surveyed area, and the number of points was insufficient.

2) The amount of secular variation was fairly large during these six years. The epoch reduction was made imperfectly: the amount of correction for it was obtained by means of empirical equations to the absolute measurements at Syowa Station.

3) The effect of a daily variation was neglected.

The results obtained in this paper, however, may serve as the first step to investigate an accurate magnetic anomaly in future.

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