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Observations of the total intensity T of the geomagnetic field at secular points in the Hornsund area, Spitsbergen, 1980

ABSTRACT: The paper presents the method and results of measurements carried out at four secular points: P_1 — Wilczekodden, P_2 — Hyttevika, P_3 — Gashamna and P_4 — Treskelodden. No essential changes were found in the distribution of the anomalous field ΔT with respect to the results of observations made in 1979.

KEY WORDS: Arctic, Spitsbergen magnetic observations.

1. Introduction

The range of investigations in 1980 at the secular points was limited only to the total intensity of the geomagnetic field. They were carried out apart from the main programme geophysical works that were made in Hornsund at that time. Due to this fact measurements at all points of the network could not be carried out.

The relative values ΔT were determined at the points: P_1 — Wilczekodden, P_2 — Hyttevika, P_3 — Gashamna, P_4 — Treskelodden. They are presented in the paper due to necessity of data documentation for the future analyses of the secular changes. At the same time, since the mothod of measurements was different from the technique applied in 1979 (A. Koblański, St. Małoszewski, J. Śliz, 1985), the paper also presents description of the method and suggestions for future investigations.

2. Method of investigation

The measurements were carried out by means of PMP-4 type proton magnetometers over the band with a sensitivity of ± 1 nT. At all the

points, they were conducted synchronically with base registration and automatic release of the measurement signal of the magnetometers. On this basis, at each of the four pairs of points (P_i, P_0) a few series of cyclic measurements were obtained at constant frequency of 20 observations per minute.

The minimum number of measurements in a series was 50. In establishing the initial moment for its implementations, the direct radiotelephone communication between the base and the field point was used. This way of carrying out measurements prevents the errors of time and eliminates the necessity of recording it. It is particularly essential in the Spitsbergen area, since, as other magnetic investigations show (A. Koblański, St. Małoszewski, J. Śliz, 1984) even small observation time error (about 30 sec) can cause reduction error of up to 5 nT, especially for short series.

The observations were reduced to the post of absolute measurements at the magnetic station of the Polish Polar Station. With respect to the reference point P_0, with the coordinates $\varphi_0 = 77°00.1'$ N, $\lambda_0 = 15°33.0'$ E (according to an estimate from a 1: 100000 topographic map) the longitude increases $\Delta\lambda_{i0} = (\lambda_i - \lambda_0)$ for the points P_i are: $\Delta\lambda_{10} = 0°01.0'$, $\Delta\lambda_{20} = -0°23.6'$, $\Delta\lambda_{30} = 0°21.3'$, $\Delta\lambda_{40} = 0°42.8'$. The following time changes correspond to them respectively: $\Delta t_{10} = 0^m04^s$, $\Delta t_{20} = -1^m34^s$, $\Delta t_{30} = 1^m25^s$, $\Delta t_{40} = 2^m51^s$. They were accounted for in the form of corrections with the opposite sign in the course of the reduction of the external variable field.

3. Characterization of the results

The results of the measurements are illustrated by the curves of changes in the intensity T, shown in Fig. 1. The examples for the points P_1, P_2, P_3 (parts a, b, c) were chosen from a few similar measurements series, whereas in the case of the point P_4 (part d) the curve shown was the only one obtained in the course of these investigations. In the figures a correction resulting from a difference in the geographical longitudes of the points is taken into account.

Table 1

The relative values ΔT of the total intensity

Post	Number of measurements	ΔT [nT]	RMS	max $\lvert\Delta T - \Delta T_i\rvert$ [nT]
P_1	55	−13	0.70	2
P_2	100	−38	0.80	2
P_3	100	−37	0.71	1
P_4	150	−3	3.37	7

It can be seen that the time shifts in the case of the P_1, P_2 and P_3 are practically of no significance for the accuracy of the reduction of the external field. These measurements were taken in a period of exceptionally

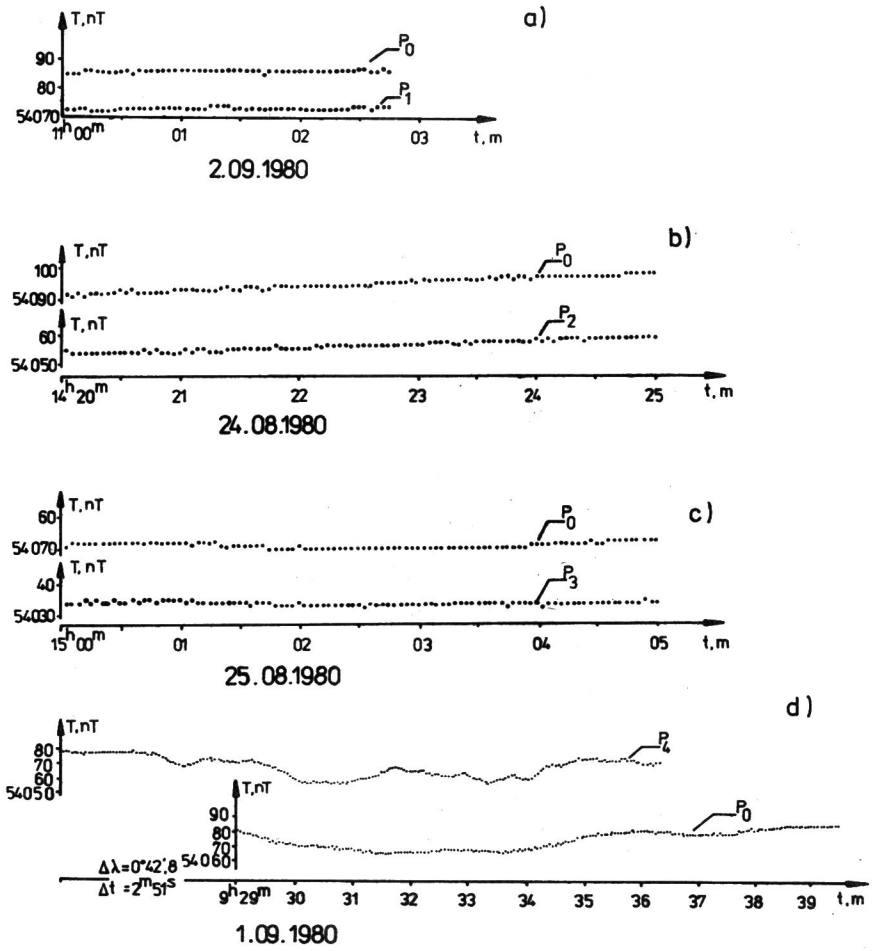

Fig. 1. Comparison of the results of measurements T at secular points. P_0 — base registration, P_i — field registration

calm diurnal run, during changes of the S_q type. The sequences of successive differences ΔT do not depend here on time, and their means rapidly converage to a constant with an accuracy of no less than 1 nT.

Similar properties do not occur for the point P_4. As a result of a probable overlapping of the external and induced fields, the mean values of ΔT are characterized by a large scatter. The analysis of the curves,

including the parts that were desynchronized after the correction for the solar time was introduced, shows that the internal field at this point has at least two components with the periods of about 40 sec (the first) and 3 min. (the second).

These specific properties of the field at P_4 were previously unknown from the measurements carried out in 1979, mainly as a result of a different way of their implementation and elaboration. The differences

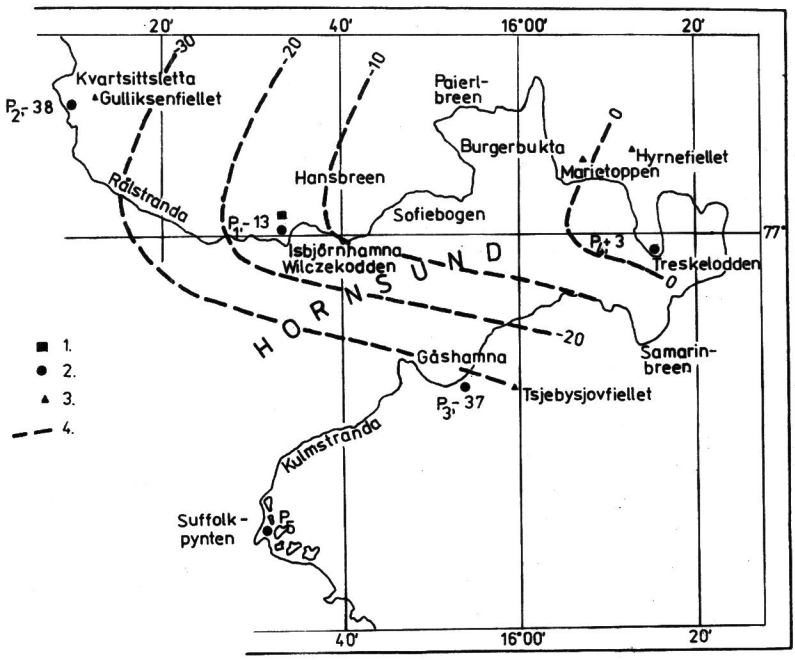

Fig. 2. Map of the T anomalies. 1 — Polish Polar Station, 2 — secular points, 3 — peaks, 4 — isolines in nT

observed for the points P_4 and P_0 are related to different geological situation in their environment. At Wilczekodden (P_0) there are slates and marbles attributed to the Precambrian series, whereas in the vicinity of P_4, at Treskelodden, there are Tertiary formations while the consolidated basement covered by series of mezo- and paleozoic formations lies at a rather vague depth.

Table 1 shows a quantitative characterization of the measurements. The surface distribution in the form of the anomaly map of ΔT in Fig. 2 is shown. In relation to the map from 1979 (Fig. 2, op. cit.) morphology of the anomalous field change slightly. The existing differences

concerning the gradients of anomalies are contained generally within accuracy of both maps.

4. Final remarks

The measurements carried out in 1980 were the first series of observations, perhaps apart from P_4, to satisfy the criterion of accuracy for the investigation of subtle seculur changes on a local scale. Such a concept of future research is favoured by a short distance between the points and their concentration on a relatively small surface area.

According to the author, the reasons for local changes of geomagnetic field should be sought in the nonuniform rate of vertical movements of the crust, which occured in this region after the continuous ice cover from the recent glacial period retreated. Obviously, the mean velocity of this movement, which is estimated (K. Birkenmajer, 1960) at about 2.3 m per century, depends on the geological structure of the subsurface layers of the crust. In this context, secular magnetic points, which are localised in areas built of rock formations of varying age, could be a function of receptors of tectonophysical processes, reflected in, among other things, change in magnetization, both in terms of the modulus and the direction of this vector.

If these investigations were to involve local changes in the magnetic field, some systematicity in carrying out measurements would be necessary. It seems that with present technological possibilities, it would be relatively simple to implement this postulate, at least for the total intensity T. Such measurements should become part of routine geophysical work done by the technical service of the Polish Polar Station. Providing the station with two proton magnetometers, will ensure annual supply of new, accurate data on changes in the magnetic field in this region.

5. Резюме

Для исследования малозаметных аномалии векового хода геомагнитного поля необходимы систематические и высокоточные измерения. В работе описывается метод таких измерений по отношению к напряженности полного вектора T.

На территории Горнзунда были найдены относительные значения модуля этого вектора на четырех пунктах измеряемой сети. Они существенно не отличаются от результатов анологических наблюдений с 1979 года.

6. Streszczenie

Dla śledzenia procesu lokalnych zmian wiekowych pola geomagnetycznego niezbędne są systematyczne i wysokoczułe pomiary. W pracy opisano technikę takich pomiarów w odniesieniu do całkowitego natężenia T.

Wyznaczono względne wartości tego elementu na czterech stanowiskach w rejonie Hornsundu i porównano je z wynikami analogicznych obserwacji z 1979 roku. Nie stwierdzono istotnych różnic w morfologii obu pól czasowych.

7. References

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