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SPACIAL NOISE OF GEOMAGNETIC DIURNAL VARIATION

By

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Abstract

The geomagnetic diurnal variation is convensionally expressed by the equivalent overhead-current-system. Precisely speaking, the morphology of this variation is not simple as local effect is implied. In this paper amplitudes of this variation at the various points in Japan are shown by a distribution map and the correlation between these results and magnetic anomalies is discussed.

As the cause of this correlation, is suggested an idea of induced magnetism caused by statical magnetic field.

1. Introduction

As a proton precession magnetometer is developed and accuracy of geomagnetic observation becomes good, we can deal with geomagnetic problems as precisely as to an order of gamma. But, as a proton precession magnetometer detects total intensity only, all subjects in this paper are concerned with materials of total intensity.

Dr. Tazima showed [1959] geographical distribution of anomalous Sq variation, in which he discussed the conductivity anomaly. Professor Rikitake and others [1966] pointed out spacial difference of geomagnetic variations, and discussed the conductivity anomaly from these results.

Spacial noise used in this paper means these geographical distribution of geomagnetic diurnal variations, but our original purpose is to eliminate local inequalities of geomagnetic variations from magnetic changes different from the geomagnetic variations convensionally known.

Using the survey data in Japan, spacial noise of geomagnetic diurnal variation is considered and then it is compared with geomagnetic anomalies.

The results show some correlation between these two, and it may be suggested that they include the property of induced magnetism in the earth-crust several kilometers in depeth.

2. Data arrangement

Two kinds of data are used here, one is the survey data during 1951 through 1965, gotten by the first order magnetic survey by the Geographical Survey Institute, the other is the Japanese WMS Magnetic Chart for 1965.0 which is published by WDC C2 for geomagnetism [1966].

The survey data are those on land during 1951–1962 at the points covering all Japan. By the first order survey done every one hour during twenty-four hours, we can find the diurnal variation on that day at the survey-point.

The morphology of the diurnal variation curve depends upon not only latitude, but it changes day by day even at the same point. As the vortex-focus of the Sq-current system is situated near the southern part of Japan and changes its position day by day, the latitudinal dependency of the diurnal variation curve of horizonal intensity is very undefinitable, but that of the total intensity is comparatively definitable and does not show remarkable variability day by day. This is fortunate for our treatment. For the reason above mentioned, an amplitude of the diurnal variation of the total intensity is taken as the present treatment. To standardrize an amplitude of Sq-variation observed by the survey, original data are compared with those of the Kakioka Magnetic Observatory on the same day, and amplitude-ratios are dotted against latitude as shown in Fig. 1, and their geographical distributions in Fig. 2a. In Fig. 1 ME, KA, SI, AS and KN are the abbreviations of the permanent magnetic observatories; Memanbetsu, Kakioka, Simosato, Aso and Kanoya. Considering from the amplitude-ratios of these five stations, the definitely latitudinal dependency is not seen. Then, if we omit the values of KA and AS, we can see general tendency of latitudinal dependency regarding the rest; ME, SI and KN, and the curved line connecting these three is considered the latitudinal dependency.

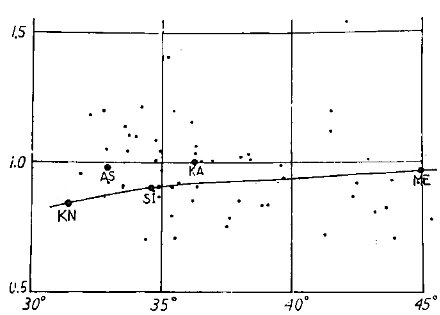

Fig. 1. Latitudinal Dependency of amplitude-ratios at the survey points.

In this treatment, KA and AS are considered to be anomalous stations from the standpoint of the diurnal variation.

After these conciderations, amplitude-ratios of the respective survey-points are normalized referring to this curve, and their geographical distributions are shown in Fig. 2b, but their general tendency is similar to those shown in Fig. 2a in which non-normalized values are adopted. By this figure, we can see several anomalous regions from the point of variation, and we call this "Sq

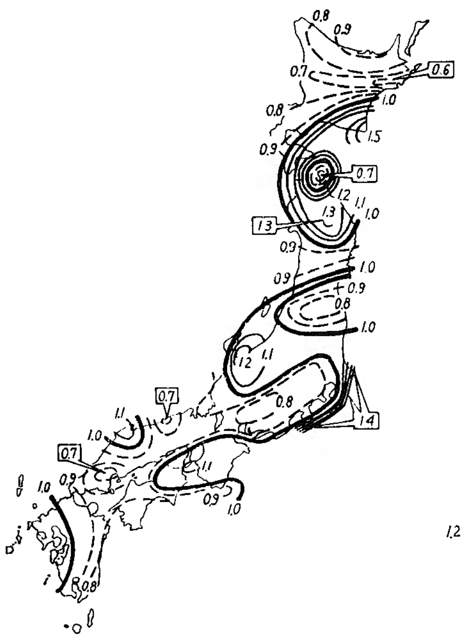

Fig. 2a. Sq Anomaly in Japan.
Expressed by amplitude-ratios referring to the original values.

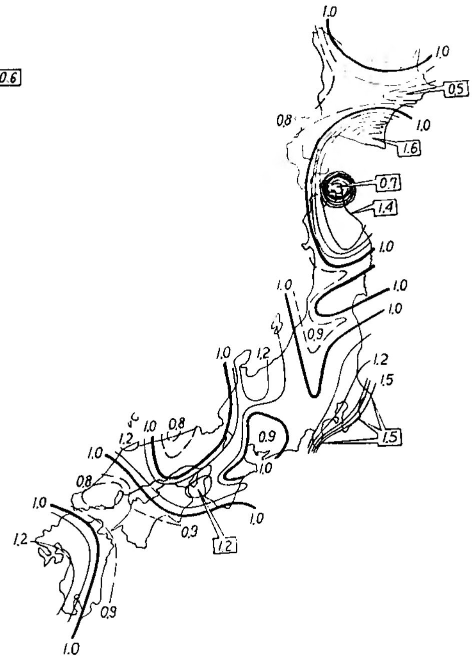

Fig. 2b. Sq Anomaly in Japan.
Expressed by amplitude-ratios referring to the normalized values for latitudinal dependency.

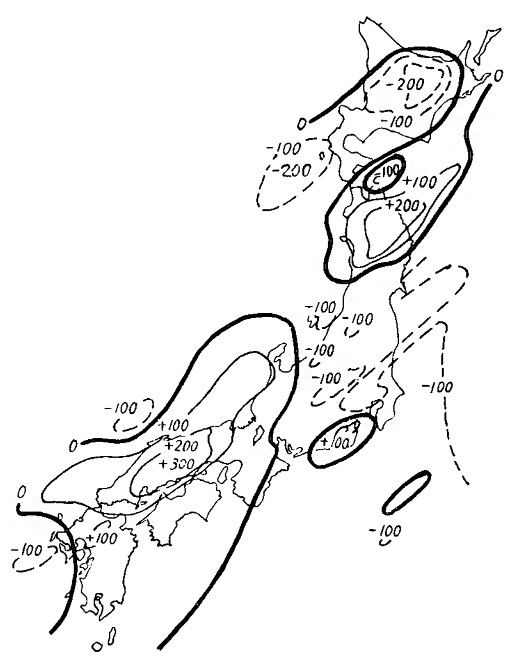

Fig. 3. F Anomaly in Japan. Expressed by contours of every 100 gammas.

Anomaly".

Fig. 3 is the magnetic anomaly as seen from total intensity, derived from Japanese WMS Magnetic chart. This figure shows the difference between observed values by aeromagnetic survey at 10,000 feet in height and culculated values which denote the normal distribution with latitude and longitude. From this figure three anomalous regions are seen in Japan; where anomalies larger than 200 gamma are taken in consideration. As the probable error in the calculated values is ± 143 gamma, the anomalies less than 100 gamma cannot be be taken in consideration. These anomalies are named "F Anomaly" which is distinguished from "Sq Anomaly" as written in the previous paragraph.

3. An interpretation for the correlation between Sq Anomaly and F Anomaly

At the first glance of Figs. 2 and 3, there seems to exist some relationship between Sq Anomaly and F Anomaly, especially in the north-east of Japan, i.e., positive regions of F Anomaly correspond to regions of large Sq Anomaly. But quantitative relations do not show an agreement between these two figures, that is, rate of Sq Anomaly is an order of 10^{-1}, and rate of F Anomaly is an order of 10^{-2}. In this paragraph a treatment about this discrepancy will be discussed. F Anomaly is referred to the aeromagnetic survey done at 10,000 feet above sea level, and Sq Anomaly is referred to the ground survey. If this F Anomaly is reduced to the anomaly of ground level, it is possible to eliminate the quantitative discrepancy between the Sq Anomaly and the F Anomaly.

As one of attempts for practical methods, subterranean structure which is replaced by a magnetic dipole is considered. And if we assume that the magnetic field at 3,000 meters in height (approximate value of 10,000 feet) produced by this dipole is one-twentieth of that at ground level (0 meter in height), this dipole will be situated at 1,500 meters in depth under the ground level. This assumption is undertaken in order to reduce the quantitative discrepancy between Sq Anomaly and F Anomaly, but this fact is also discrepant to the data of the ground survey, shown in the result of the second order magnetic survey of Japan done by the Geographical Survey Institute [1954, 1957, 1960]. But this result is affected by locally magnetized bodies such as volcanos and other iron-rich bodies. The author wishes to consider as follows, that the effect of this subterranean dipole will be clear, if an adequate method of date-arrangement is applied. We cannot mention an adequate method written here, but the principle is as follows, the locally magnetized body considered hitherto is to be more wide body and values considered as wide body are to be strongly affected by local bodies.

4. Suggestion for existence of induced magnetism

It has been mentioned that Sq Anomaly is due to conductivity anomaly, and in fact, spacial noises of geomagnetic variations are mostly affected by electrical conductivity of the subteranean structure. This effect is also seen in Fig. 2. If so, the distribution of Sq Anomaly of Z-component is to be in agreement with that of total intensity. But these agreements are not seen except some spacial regions, for example, South-east coast of Kanto district.

As described in the previous paragraph, it may be said that the distribution of Sq Anomaly is in agreement with that of F anomaly. This fact implys that the anomalous region has high permeability substance under the ground in deep depth, and its value is more or less 1.1. This value is somewhat undefinitable, but is larger than unity at least.

To confirm this suggestion, we have to investigate all sorts of geomagnetic variations as well as the main field and also to make sure that rates of anomaly to original one are constant for all phenomena. But, as above mentioned, some of them are effects of the conductivity anomaly which is dependent upon period of variation.

These treatment is going on, and the results will be published in the near future.

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