Linear Relationship between Amplitudes and Periods of Geomagnetic Variations

By

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概　　要

地磁気変化の振巾と周期を一般的にみると大体比例関係があることは従来なんとなく考えられていたが，それを国際地球観測年中の柿岡の観測結果から確かめた。なお周期10秒以下1秒程度までの超短周期変化にも言及した。

§ 1. Introduction

We sometimes feel needs of knowledge on amplitudes and periods of typical examples of such geomagnetic variations as bay, si, sfe, pt, pc and etc. On this point of view, amplitudes and periods of geomagnetic variations are statistically studied using the data observed at Kakioka during IGY. The results are shown in this short note.

It has been empirically known that amplitudes of geomagnetic variation decreases generally with their decreased period. This relationship will be proved roughly also by the statistical result in this paper. An extraporation of the relation was useful for the design of measuring apparatus of very rapid variation (period <10sec). The measurements of very rapid variation will be described in another paper. But some data of their amplitudes and periods observed at Memambetsu, Hokkaido, Japan are shown in Fig. 7 in this paper.

§ 2. Statistical Studies

Many data of amplitudes and periods of many kinds of geomagnetic variations have been given in the Report of the Geomagnetic and Geoelectric Observations, IGY, 1957-1958, published by the Kakioka Magnetic Observatory. Such geomagnetic variations as pulsations pc and pt, impulse si, solar flare effect sfe, bay b, bp, bs and bps and storm are dealt with in this paper.

The amplitudes and periods of each individual pc are shown in Fig. 1 by dots, where the ordinate and abscissa show the maximum double amplitude and period, respectively. All cases of quality A and B are shown in the figure. A quality A is

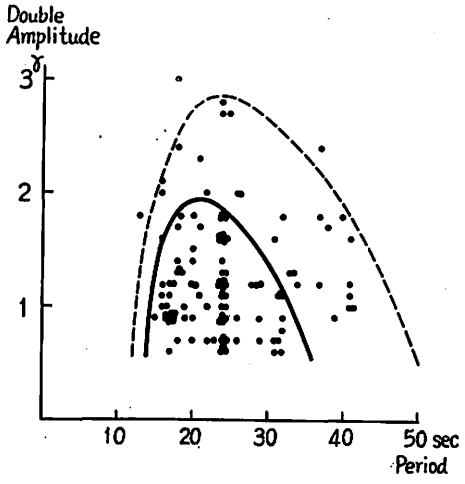


Fig. 1. Double amplitudes and periods of geomagnetic pulsations, pc observed at Kakioka during IGY. (Quality A and B).

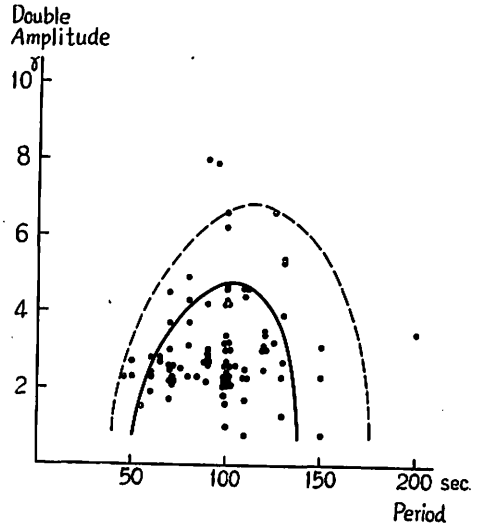


Fig. 2. Double Amplitudes and periods of geomagnetic pulsations, pt, observed at Kakioka during IGY. (Quality A and B).

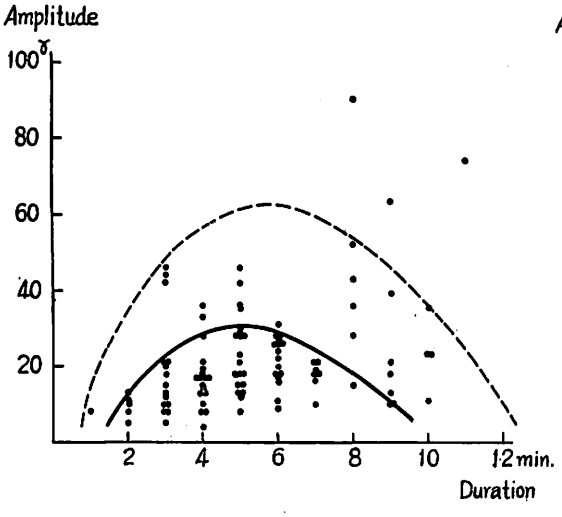


Fig. 3. Amplitudes and Durations of geomagnetic impulse, si, observed at Kakioka during IGY. (Quality A and B).

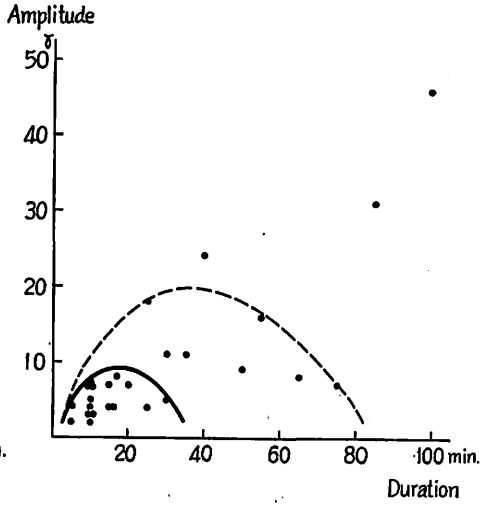


Fig. 4. Amplitudes and Durations of geomagnetic solar flare effect, sfe, observed at Kakioka durng IGY (Quality A, B and C).

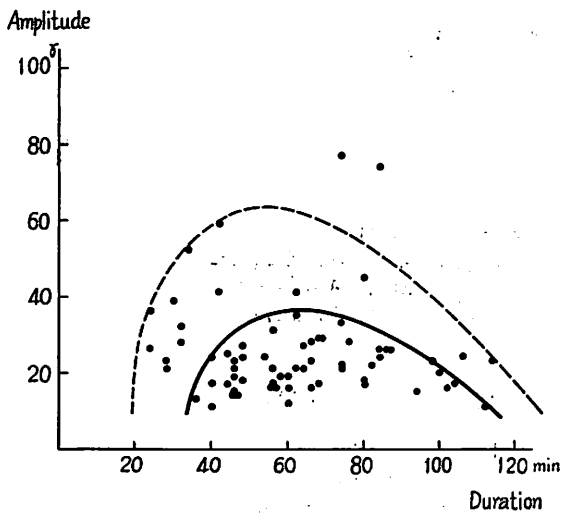


Fig. 5. Amplitudes and Durations of Geomagnetic bay observed at Kakioka during IGY. (Quality A and B).

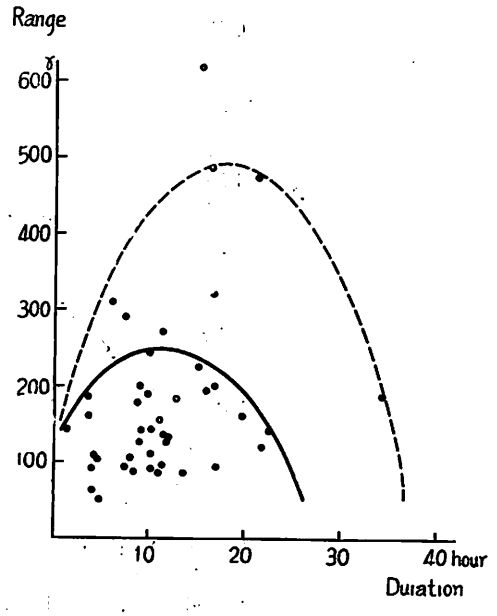


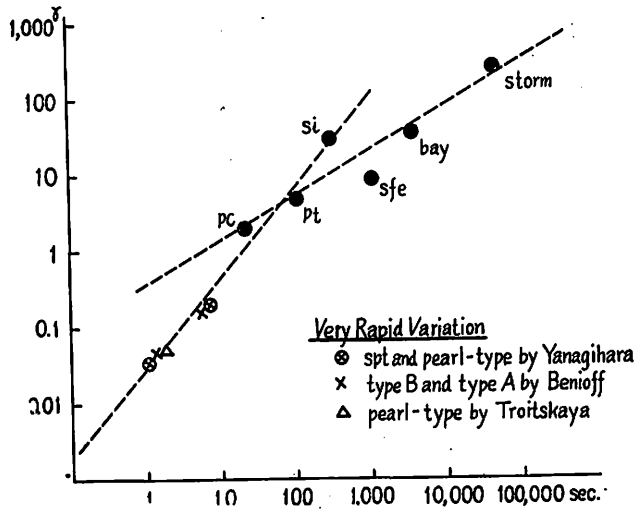
Fig. 6. Ranges and Durations af Geomagnetic Storm obseved at Kakioka during IGY.

given for a distinct phenomenon, and a B is given for a fair or ordinary case. Similar dotted figures for pt, si, sfe, bay and storm are illustrated in the Figs. 2-6. In the cases of si, sfe, bay and storm, the ordinates show their (single) amplitudes or ranges and the abscissae show durations. The durations of bay shown in Fig. 5 are the doubles of time interval from the beginning to the maximum or minimum stage. Similarly twofolds of the time intervals from the biginning of the main phase to the last phase are shown as durations of the storm in Fig. 6.

Occurrences of sfe are so rare as compared with the other phenomena, that those of qualities of A, B and C all are studied in this case.

Examining a dotted figure, the author has drawn two lines which are considered to be outer envelopes of such two regions as dense dotted region and nearly full region with a few exceptional cases. These two lines are drawn on each figures.

The estimate of "dense" or "exception" is rather subjective, but a rough estimate might to more useful than one thought. A rigid statistical study, such as obtaining a mean amplitude, has no general means, because if a lowest value of used data is changed the mean amplitude should be changed. Therefore, the rough estimate is preferable to the rigid statistical studies, provided that an application is suitable. The top points of the dense dotted region may be considered to be representatives of the phenomena. A phenomenon shown by the point is a greatest one of ordinary case



Double Amplitude (pc, pt and very rapid variation), Amplitudes (si, sfe and bay) or Range (storm)
Periods (pc, pt and very rapid varition) or Durations (si, sfe, bay and storm)

Fig. 7. Relation between Amplitude and Period of geomagnetic variation.

with the most probable period, that is, one of the most typical case.

§ 3. Relation between amplitudes and periods of geomagnetic variation

Rough estimates of amplitudes and periods of the most typical case of geomagnetic pc, pt, si, sfe, bay and storm at Kakioka are given in the former section. They are illustrated also in Fig. 7. Their relations are roughly linear as expected. The linear relationship has no direct physical meaning, of course. Rather it can be said that one have remarked only larger phenomena when their durations are long. Most remarkable phenomena in a certain period region must generally have largest amplitude among the same period group. So that one must study that phenomena first.

Geomagnetic variations with period shorter than 10 sec have not been known so well as yet. Recently we have planed to measure geomagnetic very rapid variations with such period. As to how to design its responsibility of the apparatus, the apparent linearity shown in Fig. 7 is of useful help. Our preliminary apparatus and some results get by it will be reported in another paper. But some typical amplitudes and periods observed by it are shown in Fig. 7 together with Benioff's and Troitskaya's results on the variation of same period. Their typical amplitudes and periods are estimated by the same manner as explained in the cases of pulsation, si etc, while

the corresponding points of Benioff's and Troitskaya's results in Fig. 7 are the author's deductions from their papers.

Surveying the Fig.7 all through, one may find that the relation is not linear but rather has some curveture which shows less amplitudes in the both ends of period than the expected from linearity. This might be true because the data have been taken from observations. But it should be remember that estimate is rough. Again, the very rapid variations used here were observed at the different stations during more calm period than IGY as to the solar activity. Anyway, the relations must have no direct physical meaning and it is rather safe to say that their relation is roughly linear.