ERRATA

Page	Line	Read	For
34	3 (from the bottom)	later	latter
38	Fig. 5 (c)	Cheltenham	Cheletenham

S. i. Phenomena

By Yushin Yamaguchi

Part I. General description

概　　要

地磁気の急変化の中，s・s・c，p・s・c，s・f・e 以外に未だその性質の余り明瞭でないものがある．その種の変化の主なる特徴を記述した．

§ 1. Introduction

Among the impulsive variations of the terrestrial magmetic field, mainly in the quiet state, there are some types of the variations, of which characters are still in the vague. While the so-called s. s. c., bay and s. f. e.. variations impulsively occur, of which characters are rather well known, though imperfectly even from morphological standpoint. The definition of s・i employed by I. A. T. M. E. [1] are quated, as follows, from "Hints for the diagnosis of sudden commencements (s. c.) and solar-flare-effects (s. f. e.)"

"a, sudden commencements

.....

b, sudden commencements of polar or pulsational disturbances

.....

c, sudden impulses (s. i.)

Sometimes there appear in the magnetograms sudden displacements of the recorded traces, which cannot be interpreted as s. s. c. or p. s. c..A few examples for the year before 1950 are : 1950 May. 31d 13h 58m, May 22d 12h 18m, Aug. 14d 21h 45m."

Following the conception, some studies are published [2] [3] [4] [5].

Besides these studies, Newton [6], Imamiti [7] and Howe [8] respectively remarked impulsive variations in the magnetograms and indicated a few characters of them.

Otherwise, the irregular, impulsive variations in the disturbed state, also have been examined by some authors [9]. Irregular variations may contain the above mentioned type in the quiet state, though it is difficult to classify into such types. According to the circular letter from the General Secretary of CSAGI dated

June. 30, 1957, Resolutions (Copenhagen meeting, April 9~11, 1957) states that "if the observer sees an important sudden impulse during a storm, but doubts that it represents the beginning of a new storm, he should report it as si. Occasionally if a magnetic storm apparently begins with two or more sudden movements the observer should report each movement as ssc. unless he doubts that one or the other is actually the beginning of the storm. In the latter case, the clear commencement should be reported as ssc, the other as si."

This author notated the impulsive variation, excluded s. s. c., p. s. c. and s. f. e, in the quiet state, as s. i. formerly [10].

In this paper, titled as s. i. phenomena, the author describes more or less circumstantially the impulsive variation, mainly in the quiet state.

§ 2. Morphological classification of the variation

In the middle latitude, the impulsive variation, excluded s. s. c., p. s. c. and s. f. e. can be classified into four fundamental modes.

Sometimes, each class of them can be more closely divided into s. i., s. i*., and inverted s. i., such as, s. c., into s. s. c., s. s. c*, and inverted (or reversed) s. c. This subdivision may be more important in the districts near the auroral zone. Also, whether the same type appear for each component of the terrestrial magnetic field or not at the same time, will be an interesting problem in such parts over the earth. These variations are first remarked by Newton [6]. Independently, each type is examined by some investigators respectively. The typical cases of the III, and the IV are reproduced.

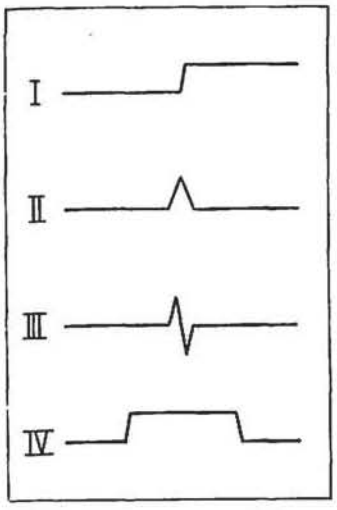


Fig. 1. Idealized model of the four fundamental classes of the S. i.

It must be acknowledged, however, that the classification is reasonable at one station and the variation at the same time are, not always, of the same type over the world. The circumstances will be stated in the latter section.

§ 3. The after effect

Whether they are followed by storminess or not is one of the criteria, which distinguish the variations from S. C.. Grancing over the magnetograms, the

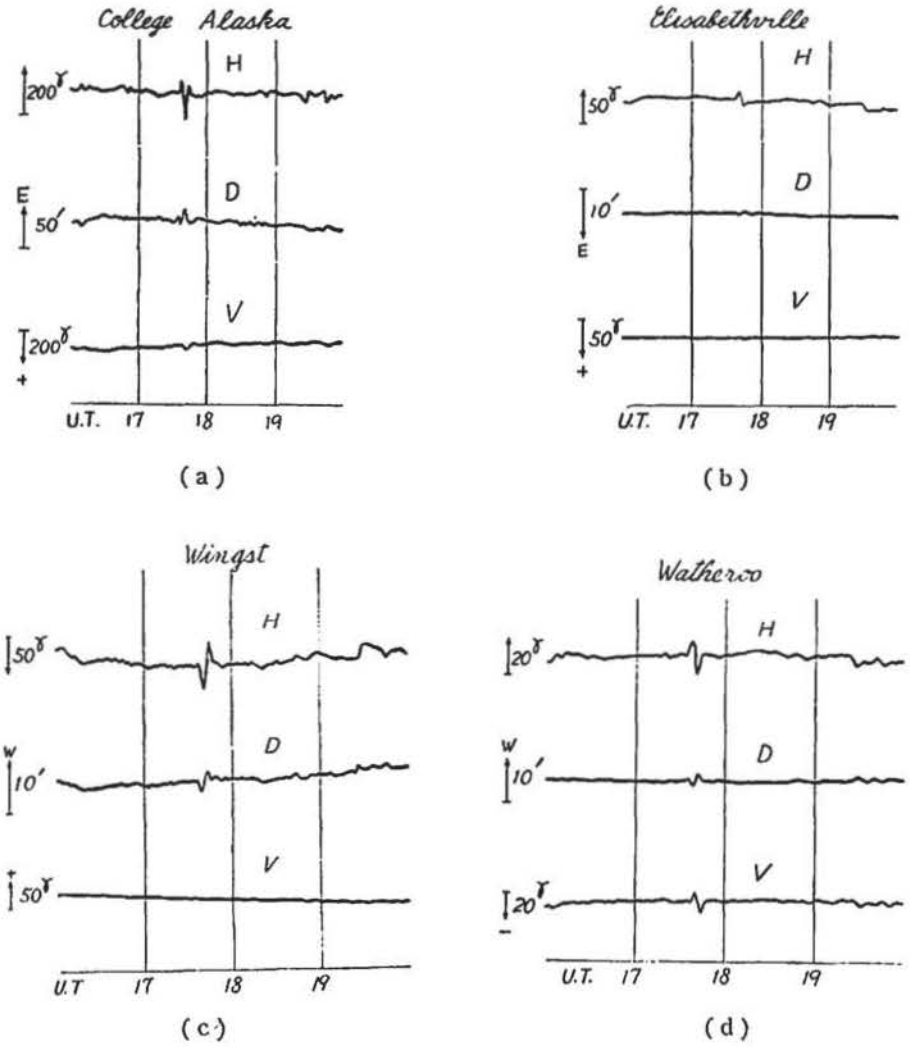
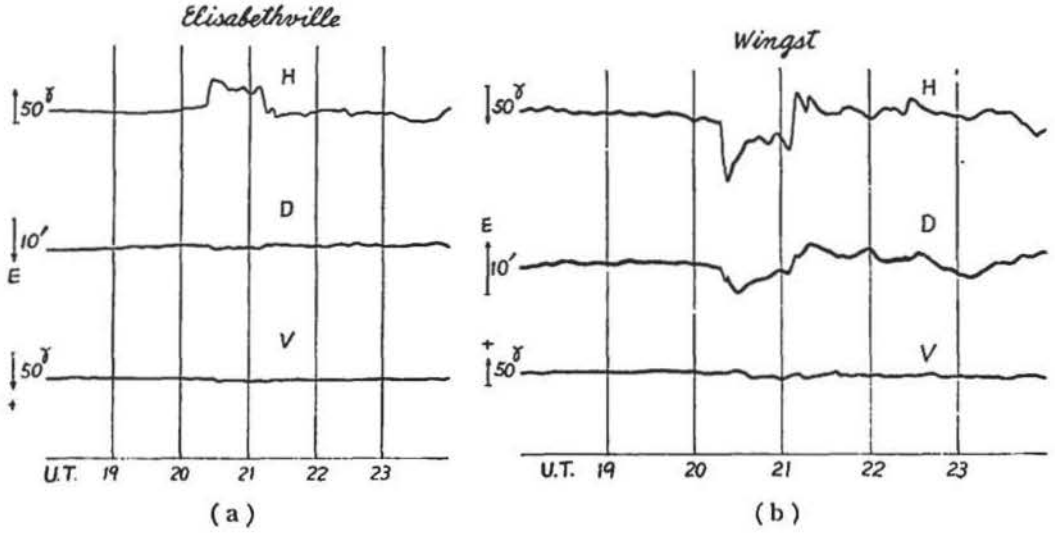
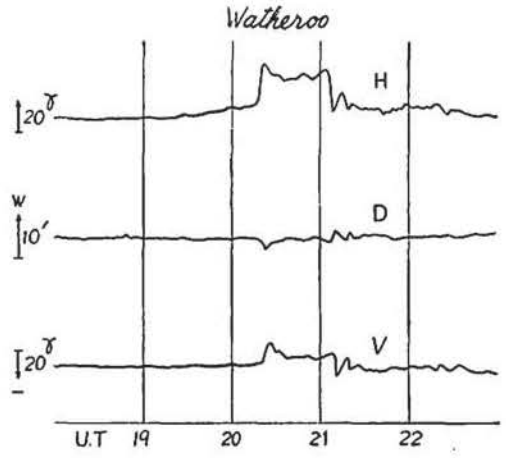


Fig. 2a–d. Typical case of III(Oscillatory) 1946, May, 6.





(c)

Fig. 3, a–c. Typical case of IV(Desk) 1939, June, 22.

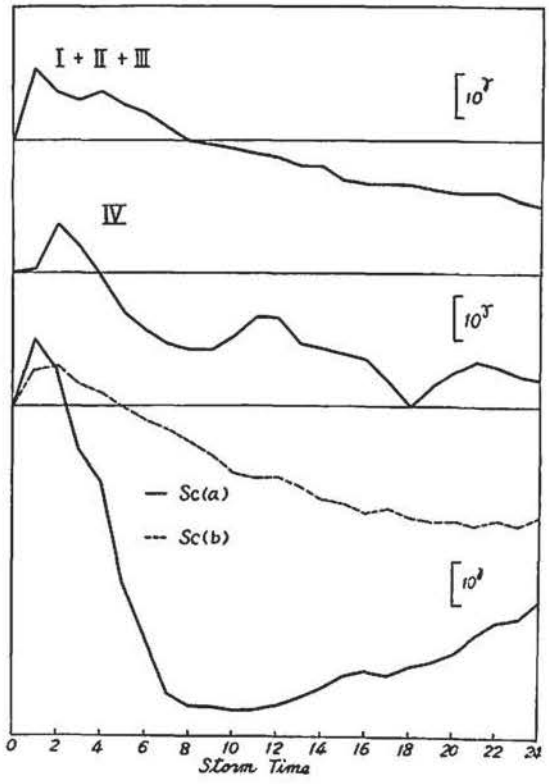


Fig. 4. The average storm time variation of S. C (after Y. Yokouchi) and S.i. S. C (a) : Ordinary typical storm, S. C (b) : Sudden Commencements followed by irregular variations of fairy long period, Kakioka.

s. i's are not followed by storminess. While the after effects of the S. C. are statistically composed of SD and Dst field.

The after effects of the s. i, corresponding to Dst, are shown in Fig. 4. The curves of I+II+III and IV are determined from the data of 123 cases and 65 cases, respectively. Those of S. C. are determined from 143 cases and 132 cases. The after effect of s. i. is clear statistically, though its magnitude is only one tenth of S. C.

§ 4. The simultaneity of occurrence over the world

Although, at the present state, the sufficient time accuracy can not be desired, the S. C. variations occur within one minute all over the world. Examining the magnetograms at many observatories over the earth, of the typical s. i, the simultaneity are ascertained within the accuracy of the time keeping of the recording instruments. The observatories, of which magnetograms are examined, are tabulated, in the Table 1.

§ 5. The direction and the magnitude of the variation vector

The vectors in the horizontal plane are nearly in the magnetic meridian plane, But, nearer to the auroral zone, the variation of declination become

Table 1. List of magnetic observatories

Observatory	Abb.	ϕ	λ	Φ	Λ	ψ
Thule	TH	76.5°	291.1°	88.0°	0.0°	0.0°
Godhaven	GO	69.2	306.5	79.8	32.5	−17.5
Trmsö	TR	69.7	18.9	67.1	116.7	−30.8
College	CO	64.9	212.2	64.5	255.4	27.0
Lerwick	LE	60.1	358.8	62.5	88.6	−23.6
Sitka	Si	57.0	224.7	60.0	275.4	21.4
Eskdalemuir	Es	55.3	356.8	58.5	82.9	−20.4
Lovö	Lo	59.4	17.8	58.1	105.8	−22.1
Rude Skov	RS	55.8	12.4	55.8	98.5	−20.6
Abinger	Ab	51.2	359.6	54.0	83.3	−18.4
Manhay	Ma	50.3	5.7	52.0	88.8	−18.2
Cheltenham	Ch	38.7	283.2	50.1	350.5	2.4
Ebro	Eb	40.8	0.5	43.9	79.7	−15.0
San Fernando	SF	36.5	353.8	41.0	71.3	−13.6
Tucson	Tu	32.2	249.2	40.4	312.2	10.1
San Juan	SJ	18.4	293.9	29.9	3.2	− 0.7
Helwan	He	29.9	31.3	27.2	106.4	−12.7
Kakioka	Ka	36.2	140.2	26.0	206.0	6.2
Honolulu	Ho	21.3	201.9	21.1	266.5	12.3
Alibag	Al	18.6	72.9	9.5	143.6	− 7.2
Huancayo	Hu	−12.0	284.7	− 0.6	353.8	1.3
Ellisabethville	El	−11.7	27.5	−12.8	94.1	−11.8
Apia	Ap	−13.8	188.2	−16.0	260.2	11.7
Pilar	Pi	−31.7	296.1	−20.2	4.6	− 1.1
Tananarive	Tn	−18.9	47.5	−23.7	112.4	−11.2
Cape Town	CT	−33.9	18.5	−32.7	79.9	−13.7
Watheroo	Wa	−30.3	115.9	−41.8	185.6	1.3
Toolangi	To	−37.5	145.5	−46.7	220.8	9.5

Notes : ϕ, λ = Geographic latitude and longitude.
Φ, Λ = Geomagnetic latitude and longitude.
ψ = Angular difference in direction at observatory between geographic and geomagnetic meridians, positive when measured from north around by east.

larger. The magnitude, qualitatively speaking, becomes larger near the auroral zone. As in the case of S. C., the diurnal components of the vector ought to be examined, with their dependency on the magnetic or geographical latitude.

It seems to be necessary that a number of cases are statistically examined. In this section, the suggestive conclusions are based on the analysis of typical cases.

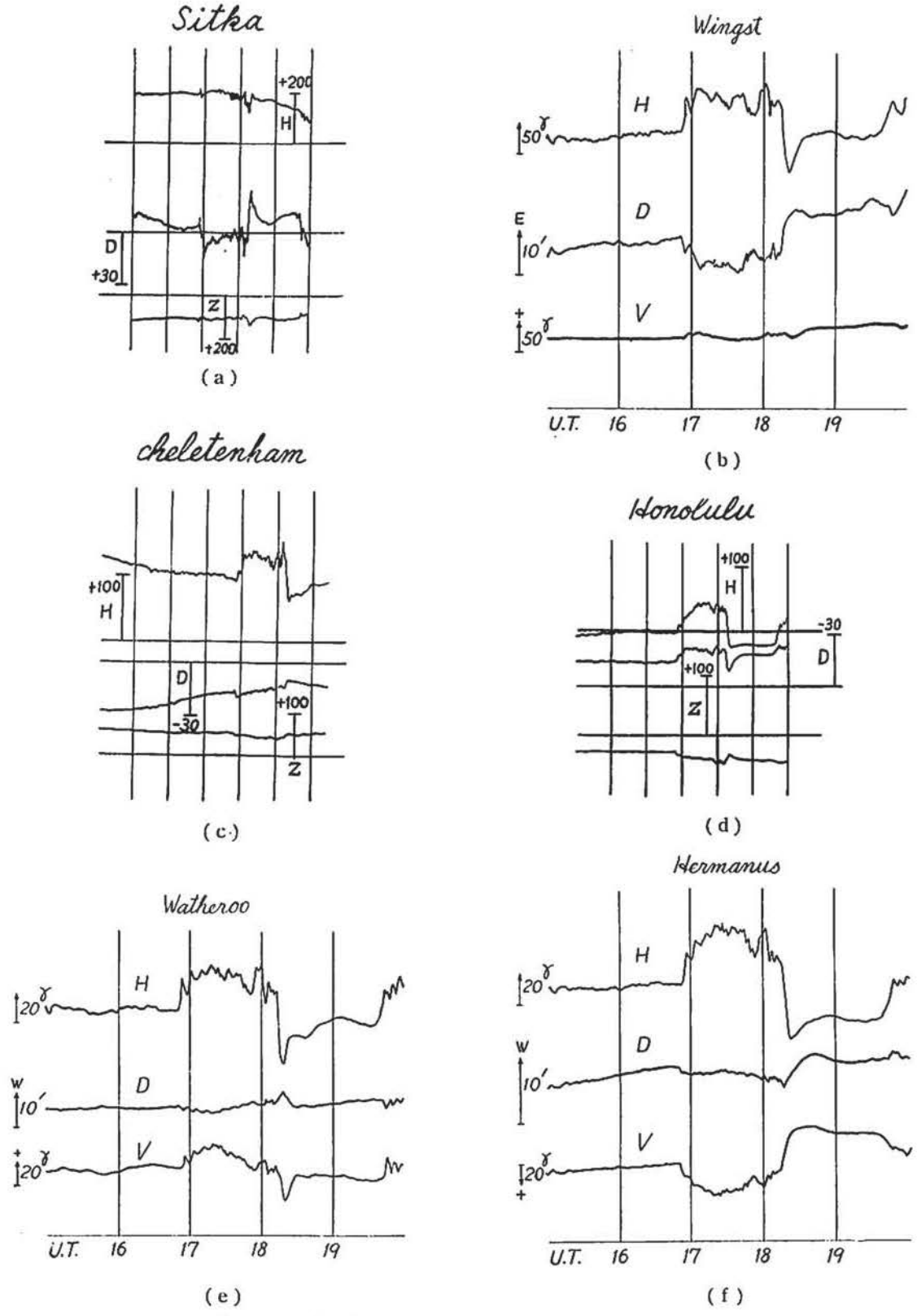
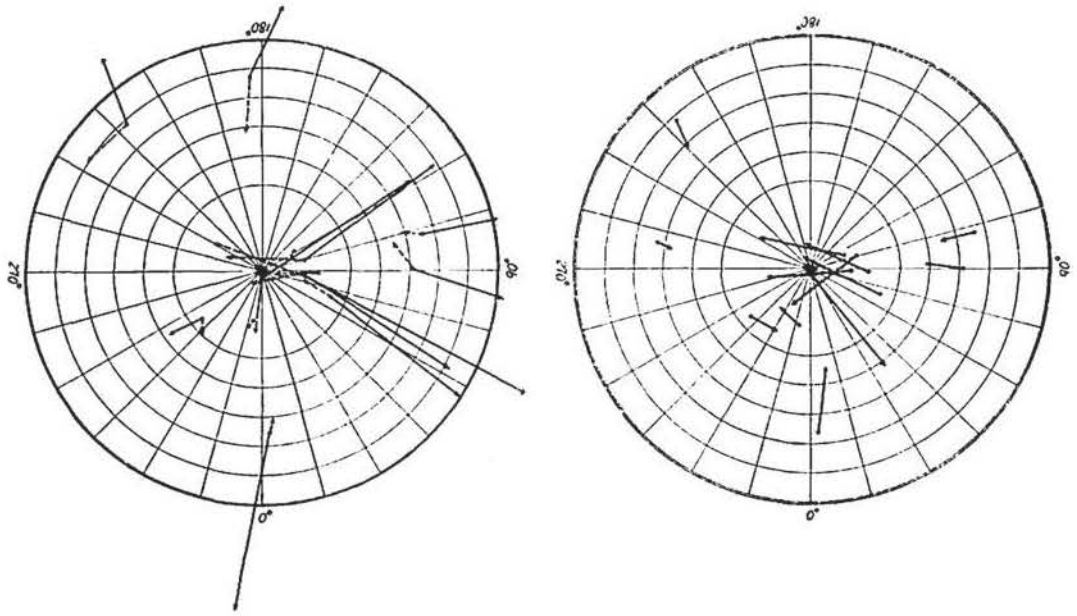


Fig. 5, a–f. The magnetograms on Apr. 6, 1948.



(a) (b)

Fig. 6, a–b. The distribution of the variation vector over the world. (N)
a : The first impulse on Apr. 6, 1948. (dotted line)
The second impulse on Apr. 6, 1948. (full line)
b : The first impulse on June 22, 1939.

§ 6. Some remarks

The first type (the Step type) are examined by some authors [2] [3]. According to their results, the semi-diurnal component of the daily occurence frequency is rather large than the diurnal component. The same statistical treatment of SC results in that the diurnal component is larger than the semidiurnal.

Kakioka S. i. $4.18 + 0.84\cos(\theta + 50°) + 1.02\cos 2(\theta - 38°) + \cdots\cdots$

S. C. $4.16 - 1.94\cos(\theta - 25°) + 0.88\cos 2(\theta - 19°) + \cdots\cdots$

(after Yokouchi)

HO, Wa, SJ, S. i. $4.17 + 0.33\cos(\theta + 43°) + 0.71\cos 2(\theta - 34°) + \cdots\cdots$

Si. Tu. Ch S. C. $4.17 - 0.30\cos(\theta - 63°) + 0.10\cos 2(\theta + 75°) + \cdots\cdots$

(after Ferraro)

This fact may be very important from the view of few differences between the S. C. and s. i, while the diurnal behaviour of S. C. are not much large and further more examination will be necessary, in order to establish the event. At the same time, it is interesting, the cases of the increasing of horizontal intensity are more frequently occurred than the cases of the decreasing. The ratio of $\Delta H > 0$ to $\Delta H < 0$ is 1.3 at Kakioka for 1946–1950.

The ratio of the first impulse to the second, of the fourth type (the Desk type) may perhaps depend on the local time and the geomagentic latitude of the

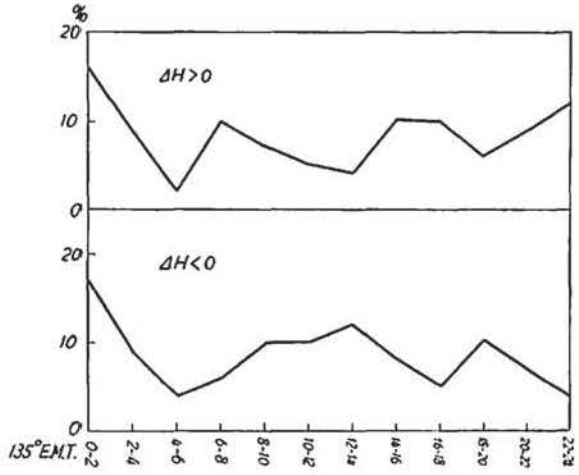


Fig. 7. The diurnal variation of occurrence frquency.

observatories, and the statistical examination will be necessary.

Also, the classification of the variation type seems to depend more or less on the geomagetic position of the observatories owing to the feather-like changes just before or after the main impulse.

The most frequent duration of the Desk type—— universal character—— is about 30 minutes.

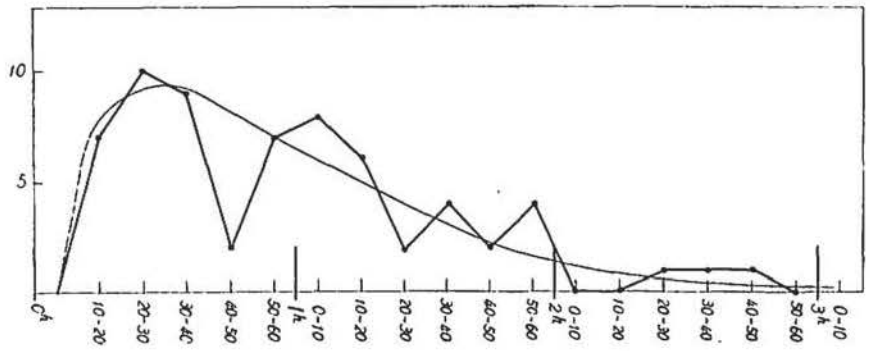


Fig. 8. The frequency distribution of the duration of Desk type.

Ackowledgemetn

The author wishes to thank to Dr. Yoshimatsu, the Director of the Kakioka Magnetic Observatory and Mr. Hirayama, the Chief of the Technical Section of the Observatory, for their affectionate encouragment and helpful advices.

References

(1) Veldkamp, J. (1950) : Hints for the diagnosis of sudden commencements (S. C.) and solar-flare-effects (s. f. e.)
(2) Ferraro, V. C. A. et al (1951) : J. G. R. **56**, 177
(3) Yokouchi, Y (1951) : Memoirs of the Kakioka Magnetic Observatory. **6**, No. 2, p. 204
(4) Yoshimatsu, T. (1950) : J. G. G. vol. II, No. 2
(5) Jacobs, J.A. & T. Obayashi (1956) : The University of Tronto, Scientific Report No. 3
(6) Newton, S. (1947) : Terr. Mag. **52**, 441
(7) Imamiti, S. (1951) : Memoirs of the Kakioka Magnetic Observatory. **6**, No. 1, p. 18
(8) Howe, H. H. (1936) : Terr. Mag. **44**, 339
(9) Chapman, S. (1940) : Geomagnetism