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On the Geomagnetic Pulsation pc - (I)
World-wide Distribution of the Horizontal Disturbing Vector

By

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概　　要

世界的に分布している10観測所で，1958年4月29日12時から30日12時（世界時）までの24時間に同時に観測された地磁気脈動 pc について．その擾乱ベクトルの汎世界的分布が幾分詳細に調査された．既に多くの研究者によつて指摘されている様に，地磁気脈動 pc もかなり広い範囲に亘つて同時に出現するが，また明らかに地磁気脈動 pt に比較して一層著るしい局地性を有することが認められる．即ち，確かにどの観測所においても午前の時刻にそのベクトルの大きさは極大になるが，その周期，ベクトルの大きさ，主方向及び廻転の向きは，各観測所毎に或は同一観測所に於いても観測時刻毎に極めて複雑に変化する．従つて，特に pc に関しては，水平ベクトルの変化ばかりでなく鉛直成分の変化或は地球の誘導の影響も同時に考慮しなければならないであろう．

§ 1. Introduction

As regards the daily behavier and the other characteristics of the occurrence frequency, period, amplitude etc. of the geomagnetic micropulsations at a station, many statistical investigations have been carried out. On a different standpoint, we shall attempt to investigate in the present paper both the daily course and the world-wide distribution of the horizontal disturbing vectors of pc-pulsation on specially selected days, using the simultaneous rapid-run magnetograms at ten stations distributing rather world-widely.

In the years 1896 to 1897, M. Eschenhagen (1896–97) firstly found the simultaneity of occurrence of his elementary waves at two stations as far apart as several hundred kilometers. Since then, many researchers have investigated above simultaneity. M. Schumberger and G. Kunetz (1946) carried out a cooperative observation of earth currents in France and in Madagascar, and confirmed such simultaneity. G. Kunetz (1954) made also similar cooperative observations at seven stations in U. S. A., Venezuela, Gabon (Africa), Sahara (Africa) and Sicilly, and found considerably good correlations in some cases. Y. Kato et al. (1954) observed simultaneously the rapid pulsations of the terrestrial magnetic field with their induction magnetographs at Onagawa and Memambetsu in Japan. They put forth that the beginning times and the periods of them are quite same or similar. But the amplitude of dZ/dt at Onagawa was larger than that at Memambetsu. J. J. Ahmed and W. E. Scott (1955) confirmed the simultaneity in Arctic, Antarctic and Equatorial regions. Y. Kato and M. Okuda (1956) observed the very similar pc-pulsations at the same time at Memambetsu and Paradeniya (Ceylon). J. A. Jacobs and K. Sinno (1960) investigated the world-wide characteristics of some examples of the pulsations, and deduced their equivalent overhead current systems. But they have not shown the systems for their shorter period pc's in question, because the pc's are not synchronous at different stations. Recently, T. Saito (not yet published) showed the simultaneous directions of the horizontal disturbing vectors of pt at three stations in North America.

§ 2. Results of Investigation

The data used in our investigation are microfilm copies of the rapid-run magnetograms obtained between 29 th and 30 th April, 1958, at the following ten magnetic stations: Fredericksburg, Tucson, Sitka, Point Barrow, College, Honolulu, Guam, Memambetsu, Koror and Lovö. The locations of these stations are given in Table 1. Unfortunately, we could not use the data for the Europe-Africa zone except

Table 1. Stations supplying data used in this report

Station	Abbr.	Geographic		Geomagnetic	
		Lat.	Long.	Lat.	Long.
Fredericksburg	Fr	38° 12′ N	77° 22′ W	46.6° N	349.9° E
Tucson	Tu	32° 14′ N	110° 57′ W	40.4° N	312.1° E
Sitka	Si	57° 03′ N	135° 20′ W	60.0° N	275.4° E
College	Co	64° 51′ N	147° 50′ W	64.7° N	256.5° E
Point Barrow	PB	71° 18′ N	156° 46′ W	68.6° N	241.0° E
Honolulu	Ho	21° 18′ N	158° 08′ W	21.0° N	266.4° E
Guam	Gu	13° 27′ N	144° 45′ E	3.9° N	212.8° E
Memambetsu	Mb	43° 55′ N	144° 12′ E	34.0° N	208.4° E
Koror	Kr	07° 16′ N	134° 32′ E	3.3° S	203.5° E
Lovö	Lo	59° 21′ N	17° 50° E	58.2° N	105.8° E

only one station Lovö in the present paper because we have had more than the above-mentioned station's copies. For each station, the scale-values in γ/mm of horizontal intensity- and declination-variometers and speeds of recording in mm/min. are given in Table 2. We enlarged the copies to about full-size and measured by a magnifiyng glass with a scale graduated in each 0.2 mm. So that, the measurable minimum amplitudes are about one fifth of those scale values. But, the sensitivities of those declination variometers, for the low latitude stations, are not sufficiently high, so that, derived horizontal disturbing vectors are not so much accurate.

Adopted days are in rather disturbed state. On 26 th, April, a sc-storm of

Table 2. Scale values and speeds of recording

Station	Scale Value in γ/mm		Speed of Recording in mm/min.
	H-Variometer	D-Variometer	
Fredericksburg	1.6	2.8	4.0
Tucson	2.8	3.8	4.0
Sitka	4.6	4.5	4.0
College	4.5	3.4	4.0
Point Barrow	5.1	2.8	4.0
Honolulu	3.0	4.2	4.0
Guam	1.6	5.2	4.0
Memambetsu	0.66	0.74	6.0
Koror	1.5	5.9	4.0
Lovö	2.0	2.5	6.0

quality "C" was noticed at the Memambetsu Magnetic Observatory. On 29 th to 30 th, we observed one clear bp-disturbance started at 16 h 51 m U.T. as two more doubtful bp-disturbances. On the days, ΣK was 24 and 23, respectively. On account of the occurrence of very distinct pc-pulsations the days were selected for the present study. At high latitude stations, those pc-pulsations were overlapped on the other more intense disturbances having longer periods. Picking out the possibly typical continuous two cycles of the pc-pulsations which occur simultaneously for all stations every one hour, the direction of the principal axis and the rotational sense, for each horizontal disturbing vector were calculated from the phase-angle between H- and D-variations and those maximum amplitudes. The average and extreme values of period for each station are shown in Table 3, together with the maximum H- and D- amplitudes for the above two cycles. In Figure 1, the daily course of

Table 3. Average and extreme values of periods, and maximum amplitude

Station	Average Period		Range of Period		Maximum Amplitude	
	H	D	H	D	H	D
	sec.	sec.	sec.	sec.	γ	γ
Fredericksburg	23.2	22.6	33.5-17.0	31.0-16.0	1.28	0.81
Tucson	23.9	23.3	32.5-18.0	32.5-18.0	1.73	0.54
Sitka	24.4	26.4	38.5-16.5	47.0-19.0	2.92	2.32
College	22.9	24.5	32.5-15.5	46.5-15.0	2.49	3.57
Point Barrow	25.6	26.2	39.5-17.0	39.5-15.0	6.80	3.75
Honolulu	28.4	27.0	43.0-18.5	39.5-14.0	0.56	0.26
Guam	24.3	25.0	35.5-18.0	28.5-23.0	0.50	0.25
Memambetsu	21.9	21.9	28.0-14.5	33.5-13.5	0.78	0.99
Koror	33.4	23.4	64.0-19.0	27.5-19.0	0.53	—
Lovö	25.4	24.3	45.0-16.5	42.0-17.0	1.22	1.74

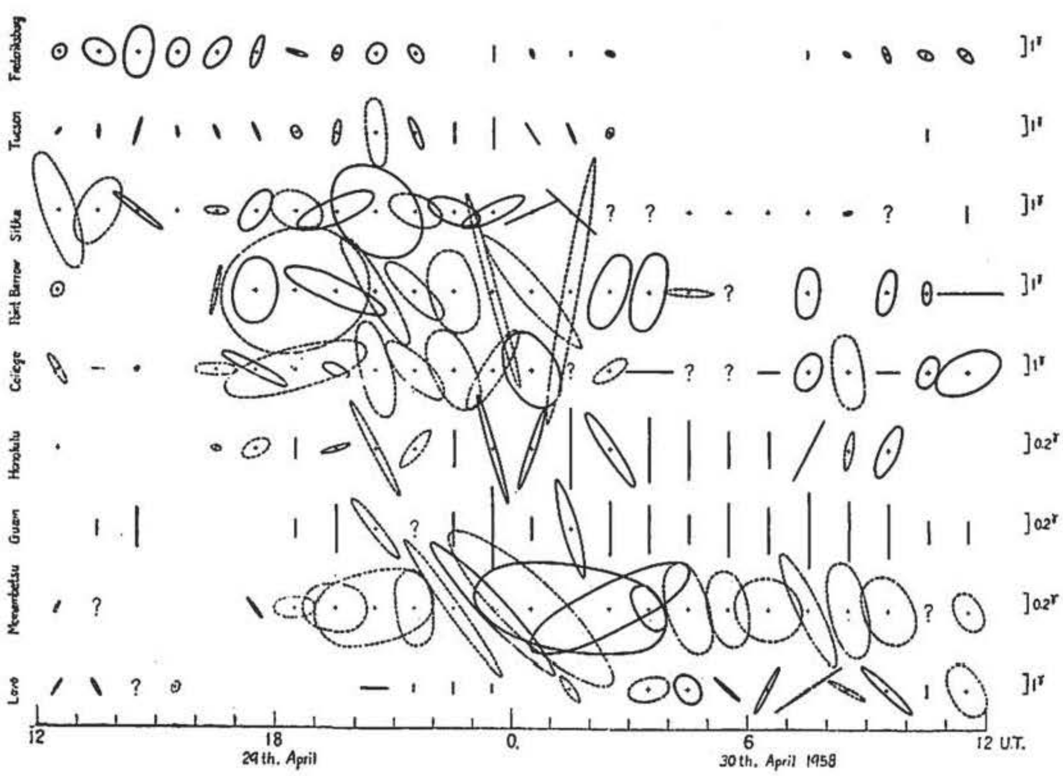

Fig. 1 World-wide distribution of the horizontal disturbing vectors
—— counter-clockwise rotational sense ······ clockwise rotational sense

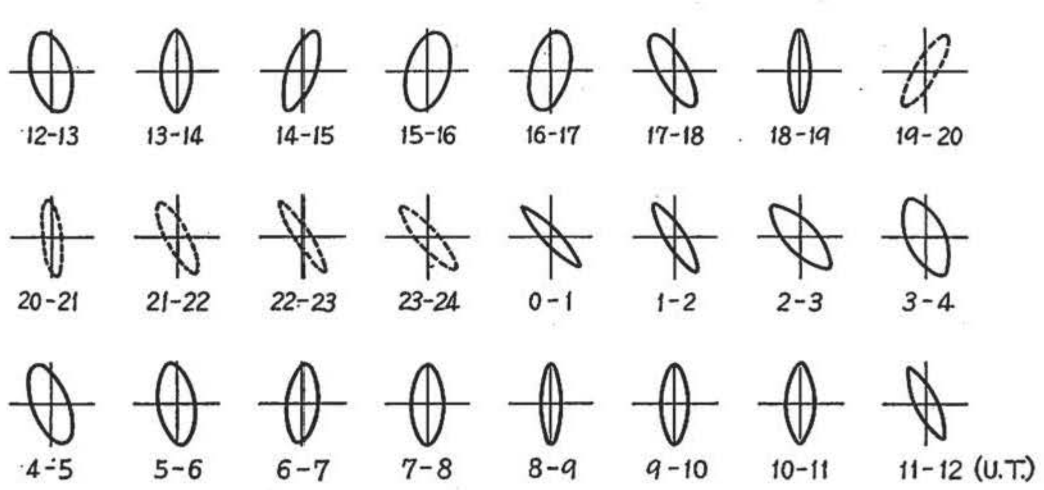

Fig. 2 The diurnal variation of the vectors at Memambetsu (1957-1958) (The long axis of lows ellipse is given in unit length for all figures)
—— counter-clockwise rotational sense ······ clockwise rotational sense

those horizontal disturbing vectors are given. The full-lines mean counter-clockwise rotational sense and the broken lines do clockwise one. In the figure, vectors for rather low latitude stations—Honolulu, Guam and Memambetsu—are enlarged five times as large as that for the other stations. As already described, two of the

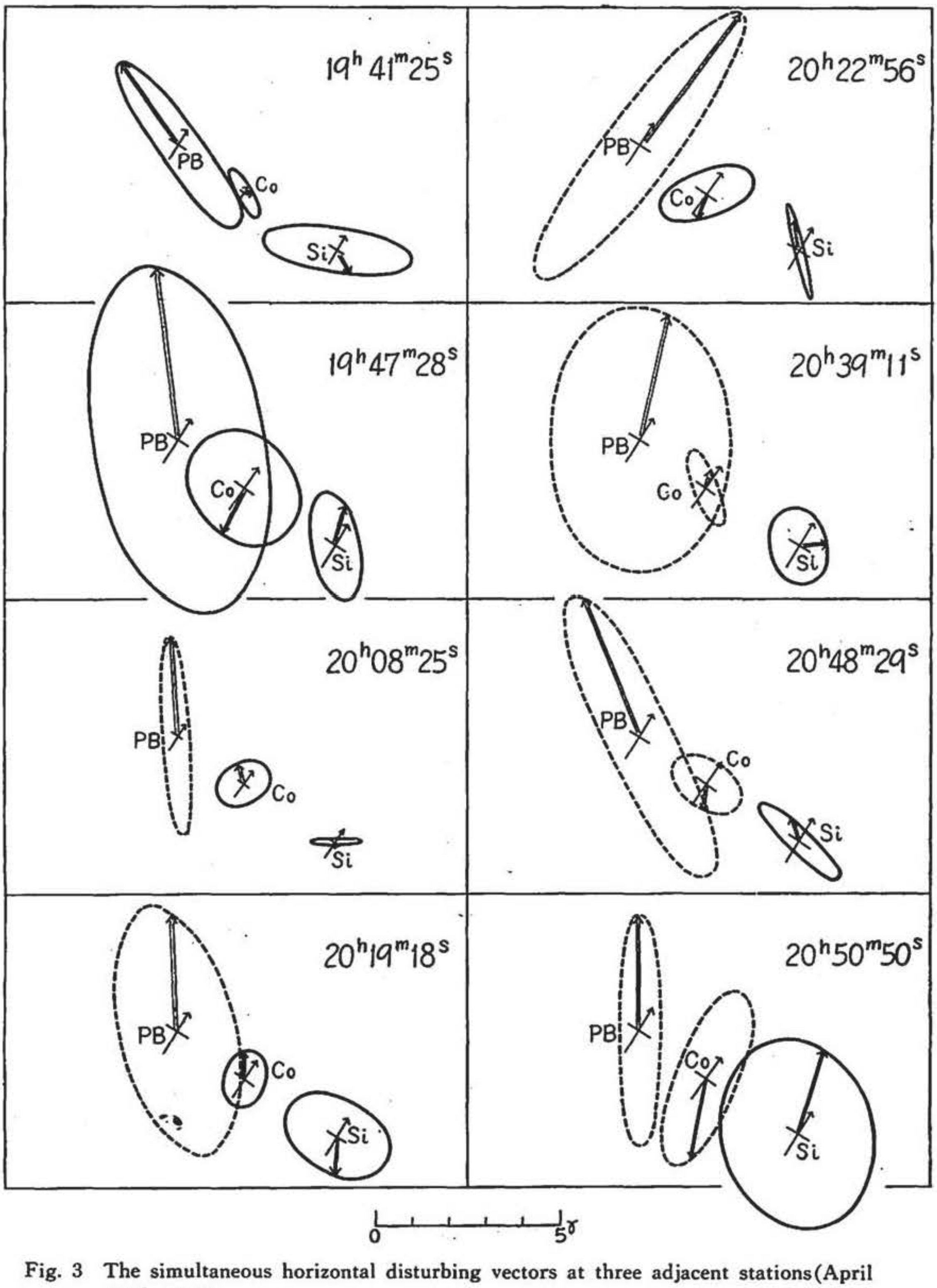

Fig. 3 The simultaneous horizontal disturbing vectors at three adjacent stations (April 29 th, 1958)
—— counter-clockwise rotational sense ······ clockwise rotational sense

authors found that the rotational sense inverts statistically for several hours in the early morning at Memambetsu and Kanoya Magnetic Observatories (see Figure 2). In the present investigation, however, we couldn't ascertain whether the above character was true or not. According to our little data, it is difficult to have such a decided conclusion on the rotational sense. The direction of the principal axis is roughly north-southwards. But on account of deficiency of the sensitivity of the D-variometer, it is very difficult to obtain the accurate direction at the low latitude stations, i.e. Honolulu, Guam and Koror. As a rule, the size of the vector is larger in the morning time, in accordance with the other investigator's, though the space and time distributions of the direction or the rotational sense of the vectors usually assume very complicated aspects. The mean periods are about 20–25 sec, namely, it may be said that we treated with some typical pc-pulsations. They are equivalent to that of Sinno's shorter pc-pulsation.

We also investigated in more detail simultaneous horizontal disturbing vectors at three rather adjacent stations, Point Barrow, College and Sitka, situated near the auroral region. From the results, we found that, even at such adjacent stations, the above characters of complicated space and time distribution are still maintained. An example is illustrated in Figure 3. On the succeeding eight diagrams of the figure, the directions of the disturbing vectors at the corresponding times are shown by arrows, together with those vector-ellipses, for all three stations.

§ 3. Conclusions

In the present paper, we point out that the pulsation pc occurs simultaneously in fairly wide region of the world. On the other hand, it is likely that the pulsation has the maximum vector intensity in the forenoon hours. In other words, the pulsation occurs possibly simultaneously on the world-wide scale but is more intensely controlled by the local time. As already stated, it may be deduced that the pulsation of such period is severely affected by the electrical properties of the earth's curst beneath that place.

In near future, we shall attempt to investigate the disturbing vectors combined with the corresponding vertical components, in connection with the process of the earth's induction.

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