Frequency Analysis of the Geomagnetic Pulsations

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Abstract: The geomagnetic pulsations were continuously recorded on the magnetic tape at Maui Island, Hawaii (geomagnetic coordinate; 21°42'N, 265°36'W) in the period from 16th to 31st May 1965, using the induction magnetometer.

The geomagnetic pulsations which were recorded on the magnetic tapes are reproduced through the band pass filters. The difference of the frequency band of each channel is half octave and the central frequency of the filters are from 1 cps to 96 cps.

We could analyse the frequency of the geomagnetic puslations of pc's (continuous pulsations) and also pi's (irregular type pulsations) and found the characters of these geomagnetic pulsations.

1. Instrumentation

The induction magnetometer is constructed from the induction coil of which numbers of turn is 10^5 and is wound around the permalloy bar (the length is 1500 mm, the diameter is 20 mm and the inductance of the coil is about 5500 Henry). The frequency response curve of this equipment is shown in Fig. 1. Two components (north and east component) of this induction magnetometer were buried about 50 cm under the ground to avoid the wind noise and so on.

The recording system is shown in Fig. 2-a. The signals of EW and NS components were recorded on the first and the second channel of the tape recorder respectively and

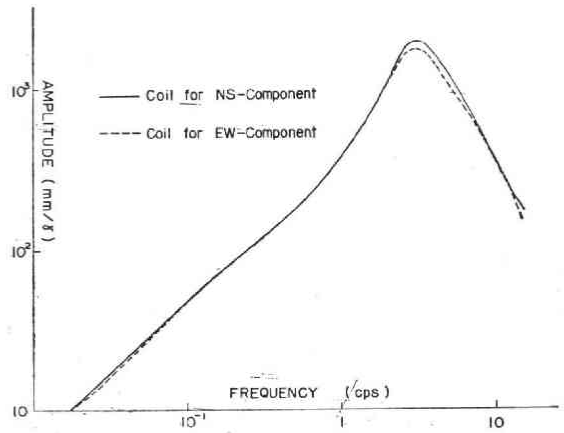


Fig. 1 Frequency response curve of the induction magnetometers. The original signals up to 1 cps are detectable.

DC level is recorded on the third channel in order to check the magnetic noise which would come from the recording system, and the time signals come from the crystal clock were recorded on the fourth channel.

2. Method of frequency analysis.

The analysing system is shown in Fig. 2-b. The signals on the magnetic tape are playbacked by a speed of 50 times of original speed through the band pass filter and we could analyse the original signals to the frequency range from 42 sec to 5 sec. In order to analyse the longer period from 50 sec to 210 sec the original magnetic tape was recorded again on the another magnetic tape and analysed again by the corresponding speed of 250 times of original speed. (we call this "re-play back" in this paper.) Corresponding period by these playback and re-playback system is shown in Table 1.

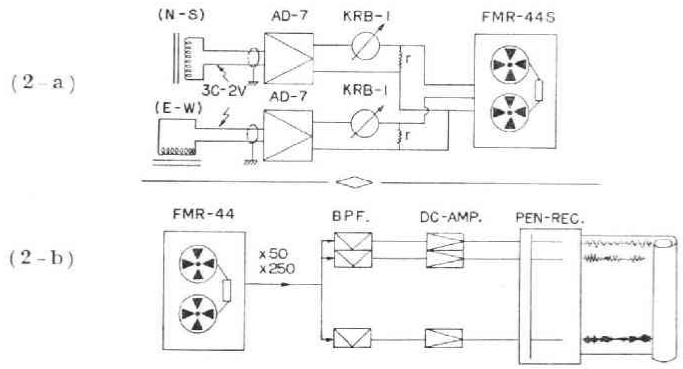


Fig. 2 Block diagram of the recording and the analysing systems.

Table 1 Corresponding period by playback and re-playback for the central frequency of the band pass filters.

fo	Play Back (sec)				re-Play Back (sec)			
	x 5	x10	x 25	x 50	x 250	x 500	x1250	x2500
1.00	4.18	8.36	20.9	41.8	209	418	1044	2088
1.55	2.69	5.39	13.5	27.9	135	269	674	1347
2.10	1.99	3.98	9.95	19.9	99.4	199	497	994
3.05	1.37	2.74	6.85	13.7	68.5	137	342	685
4.15	1.01	2.01	5.03	10.1	50.3	101	252	503
6.10	0.68	1.37	3.47	6.85	34.2	68.5	171	342
8.15	0.51	1.03	2.56	5.13	25.6	51.2	128	256
12.8	0.33	0.65	1.65	3.26	16.3	32.6	81.6	163
16.6	0.25	0.50	1.26	2.52	12.6	25.2	62.9	126
26.0	0.16	0.32	0.80	1.61	8.03	16.1	40.2	80.3
37.5	0.11	0.22	0.56	1.11	5.57	11.1	27.8	55.7
49.5	0.084	0.17	0.42	0.84	4.22	8.44	21.1	42.2
75.0	0.056	0.11	0.28	0.56	2.78	5.57	13.9	27.8
96.0	0.043	0.087	0.22	0.43	2.18	4.35	10.9	21.8

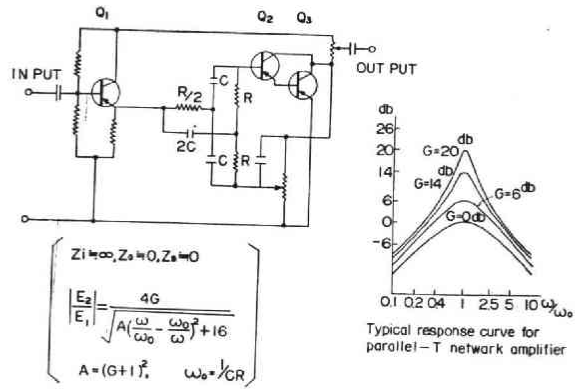


Fig. 3 Circuit, transmission characteristic and typical response curve of the band pass filter.

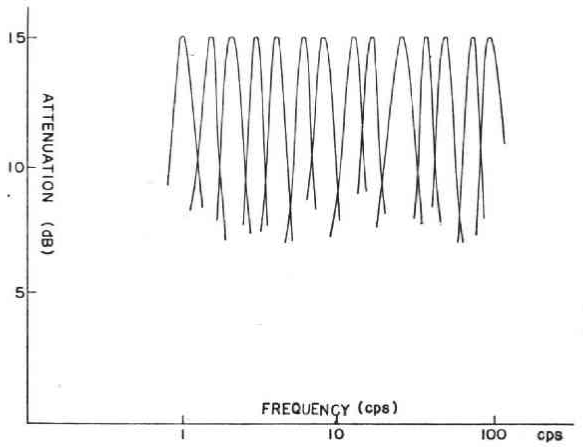


Fig. 4 Frequency response of the band pass filters.

The circuit and the characteristics of the band pass filters are shown in Fig. 3 and Fig. 4.

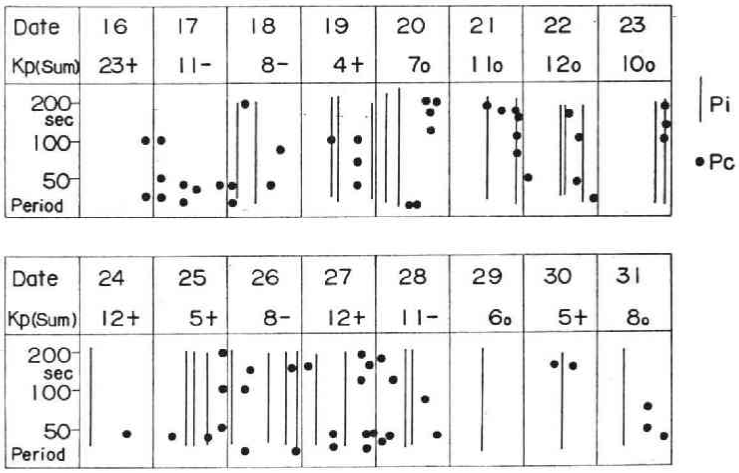
3. Results obtained by the spectrum analysis.

The geomagnetic micropulsations of pc 3, pc 4, pc 5 and pi 2 which were observed during the period of our experiment at Maui are shown in Table 2 with the magnetic activity (Kp sum) at that time.

3.1 The continuous pulsation pc is observed most frequently at 6h–7h in the morning and the amplitude of EW component is rather intense than that of NS component.

The distinguished period is 70 sec in the morning and shifts to 30 sec in the afternoon. On a geomagnetic active day, the pc's become intense even in the night time and both EW and NS component become intense.

Table 2 Observed pc and pi type pulsations and the geomagnetic activity (Kp Sum) during the observation.



The solid points and narrow lines show the distinguished period of pc and the periodic range of pi respectively. The time is used in UT.

Figs. 5-1 ~ 5-4 show examples of above mentioned pc's.

The time dependence of period spectra are shown in Figs. 6-1 ~ 6-8. The maximum amplitude of pc is read every interval of 15 minutes for every periodic band of wave and the equi-intensity curve is shown in these figures.

3.2 We had some interesting characteristics of pi's. First of all, pi's have broad periodic band from 5 sec to 210 sec and pi's are observed not only in the night time but in

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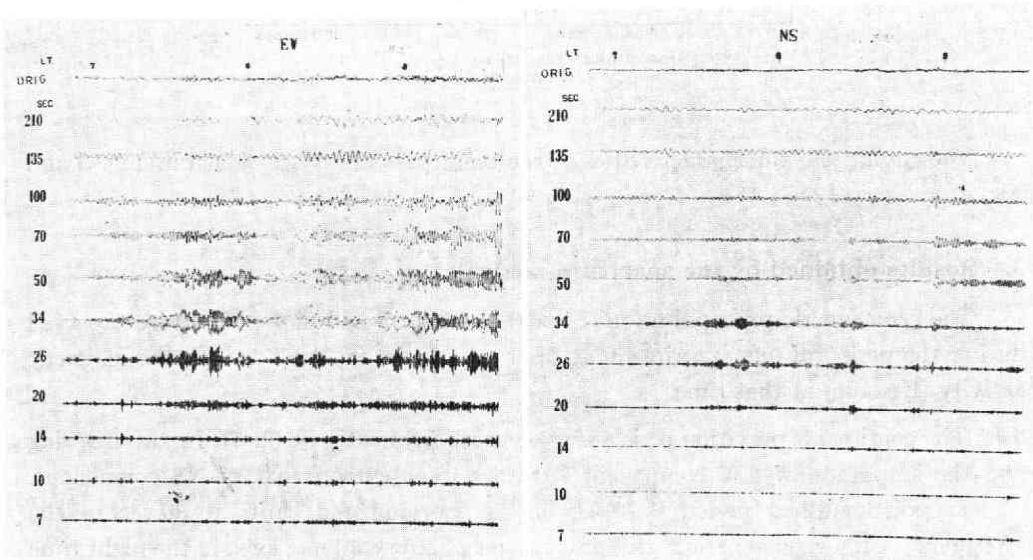

Fig. 5-1.

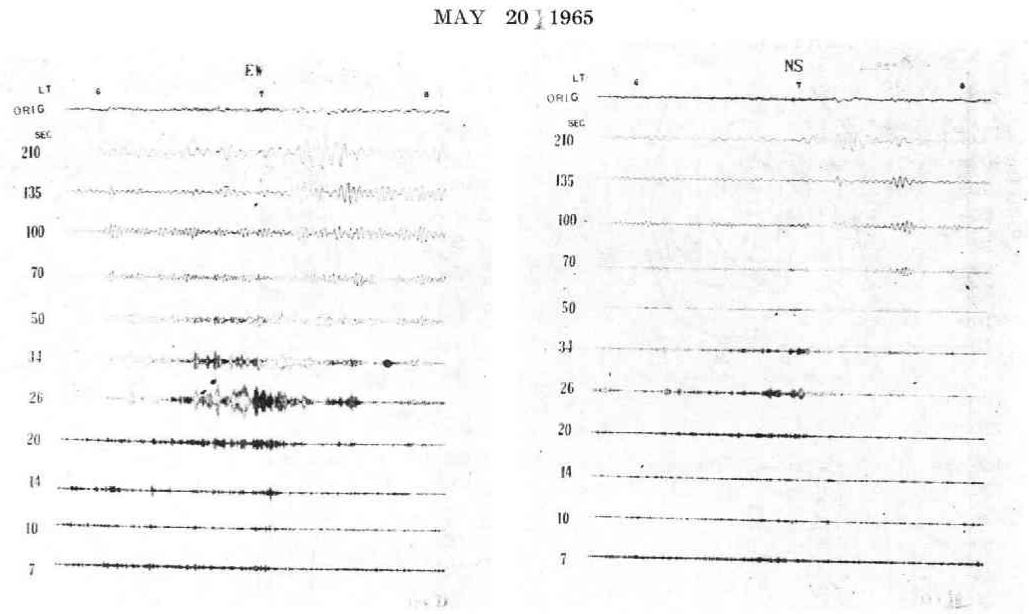

Fig. 5-2.

Fig. 5-1 Fig. 5-2 Example of the wave form chart of pc by the frequency analysis during in the morning.

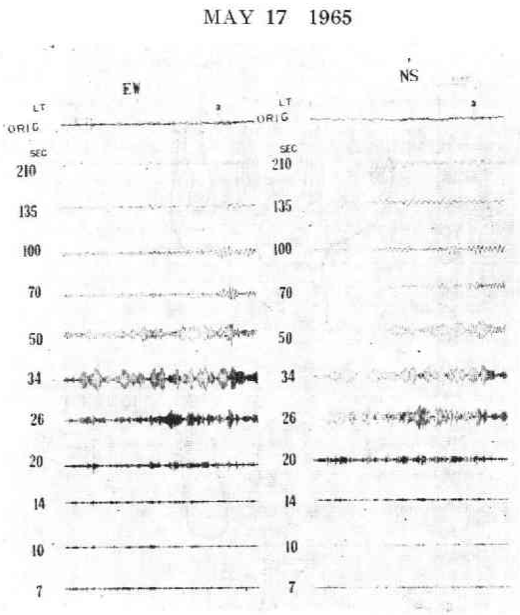

Fig. 5-3.

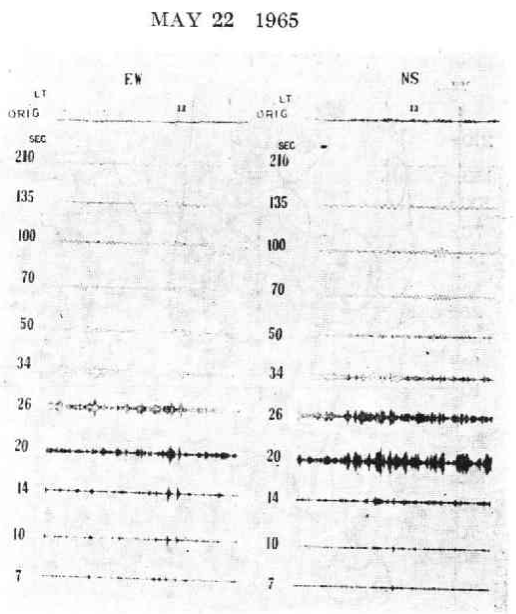

Fig. 5-4.

Fig. 5-3. Example of the wave form chart of pc by the frequency analysis during in the night time.

Fig. 5-4. Example of the wave form chart of pc by the frequency analysis during in the day time.

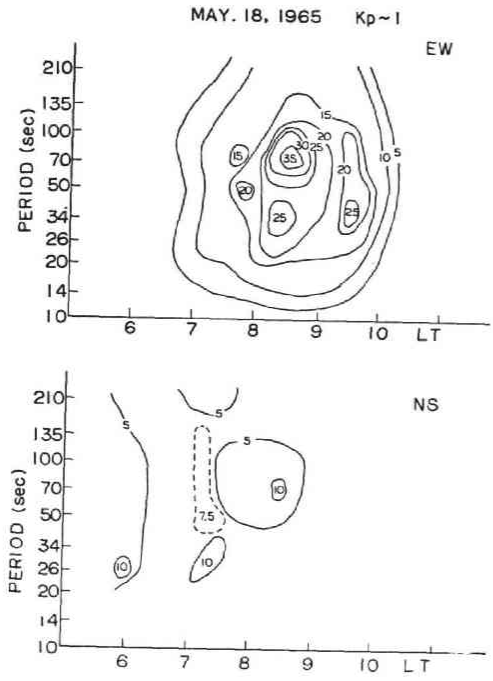

Fig. 6-1.

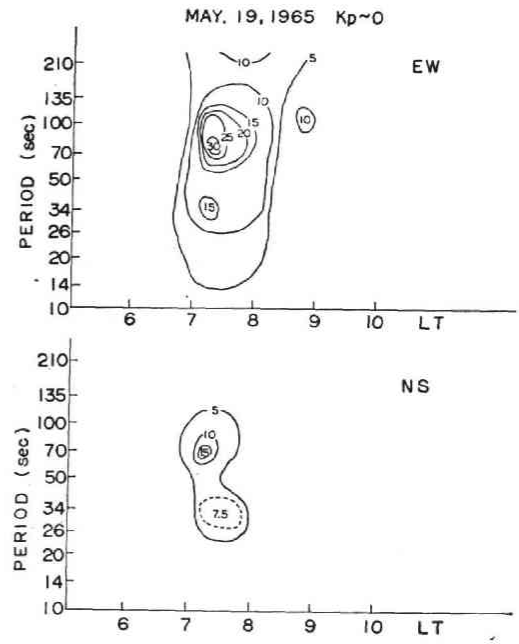

Fig. 6-2.

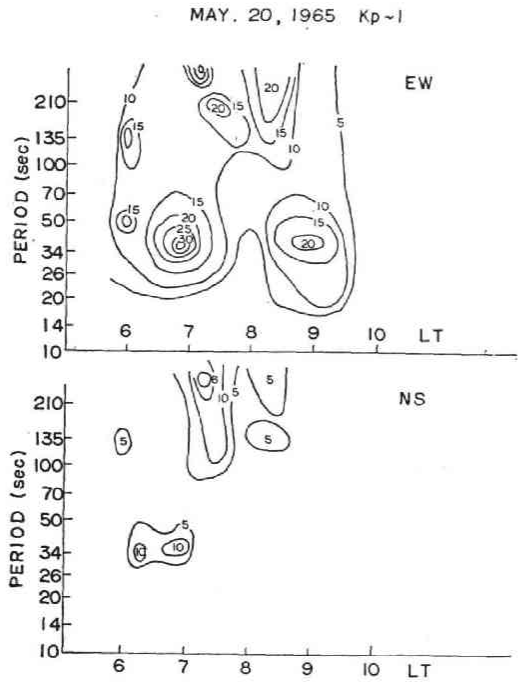

Fig. 6-3.

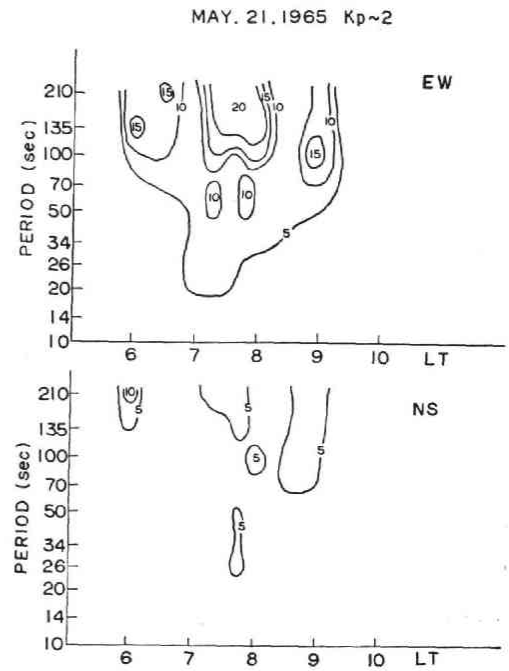

Fig. 6-4.

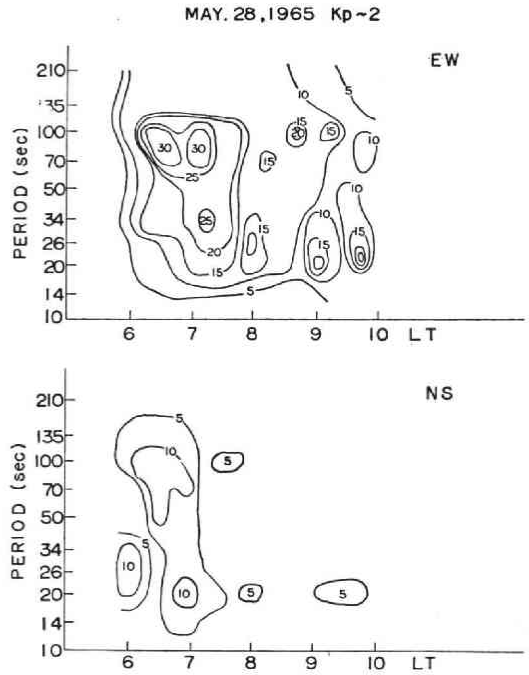
MAY. 28, 1965 Kp~2
EW
NS
PERIOD (sec)
210
135
100
70
50
34
26
20
14
10
6 7 8 9 10 LT

Fig. 6-5.

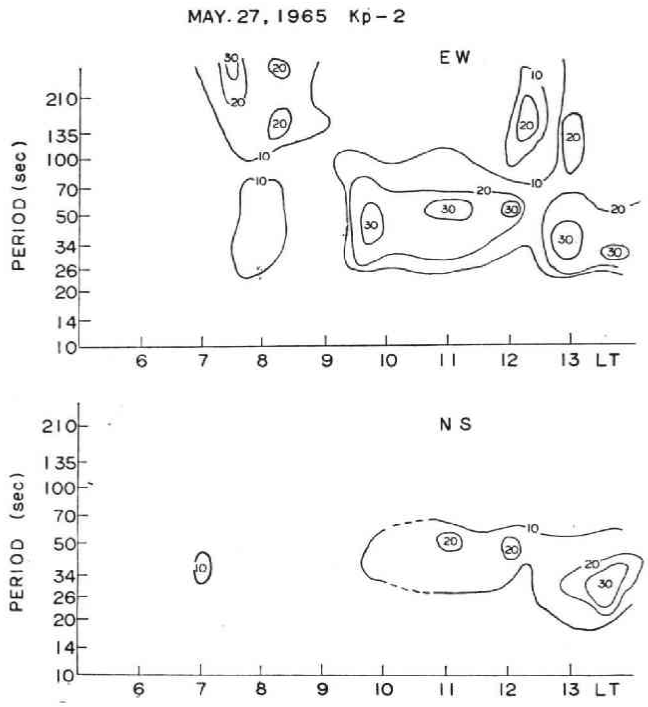
MAY. 27, 1965 Kp - 2
EW
NS
PERIOD (sec)
210
135
100
70
50
34
26
20
14
10
6 7 8 9 10 11 12 13 LT

Fig. 6-6.

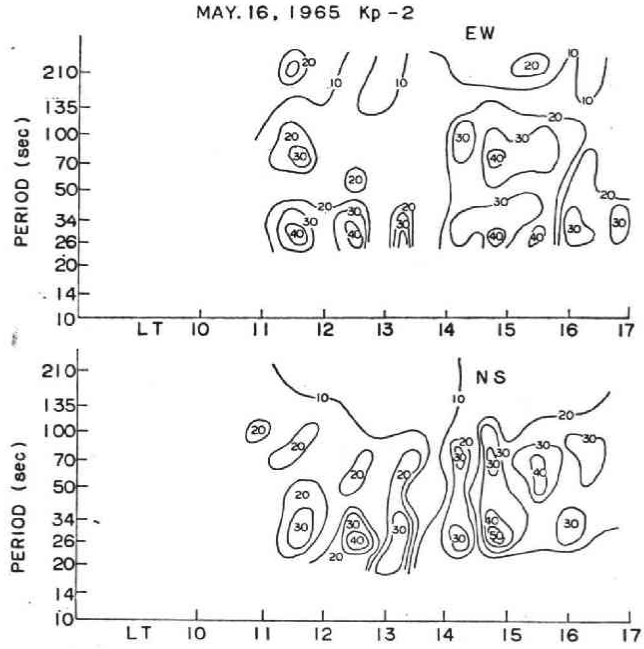

Fig. 6-7.

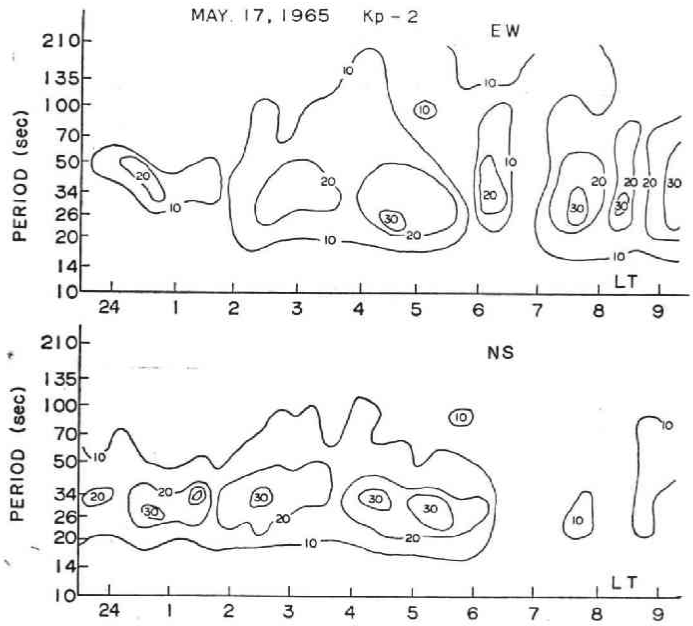

Fig. 6-8.

Fig. 6-1 ~ Fig. 6-8 Time dependence of period spectra.

The vertical axis is periodic range (seconds) and the horizontal axis is local time and the number on a contour line shows the relative intensity.

the day time.

The typical wave forms of pi are shown in Fig. 7–1 ~ Fig. 7–3. Fig. 8 shows the local time dependence of occurrence of pi and the ratio of the intensity between NS and EW component, that is the ratio $R=\int A(\mathrm{NS})dT/\int A(\mathrm{EW})\ dT$, where A(NS) and

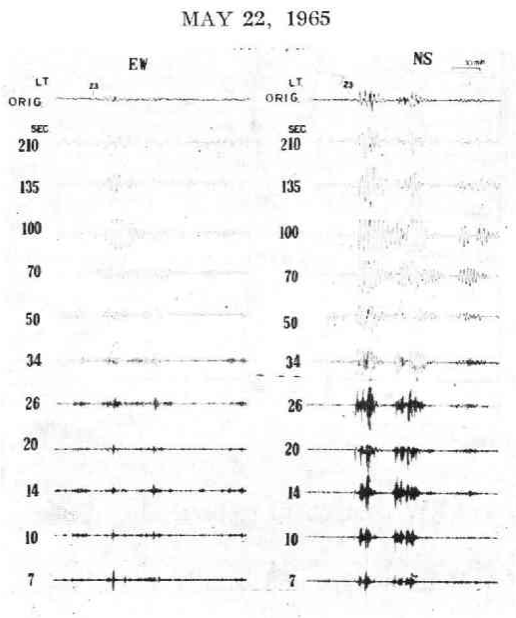

Fig. 7-1.

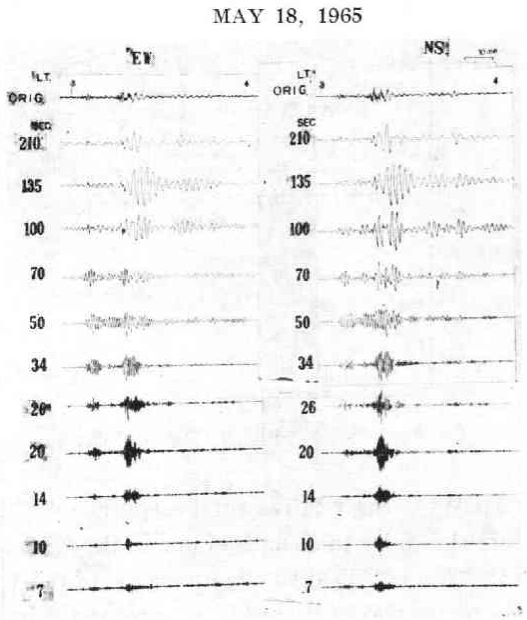

Fig. 7-2.

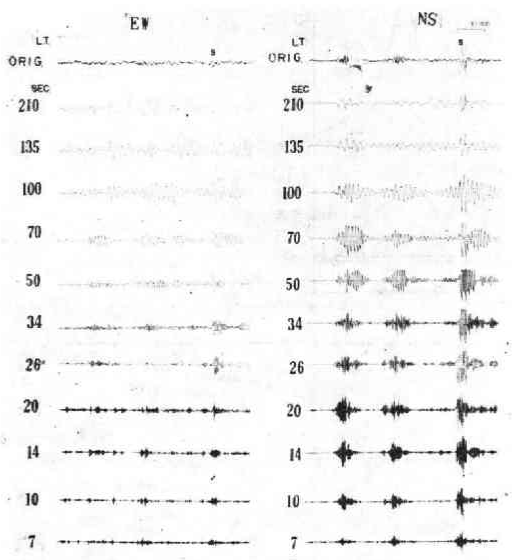

Fig. 7-3.

Fig. 7–1 ~ Fig. 7–3 Examples of the wave form chart of pi by the frequency analysis.

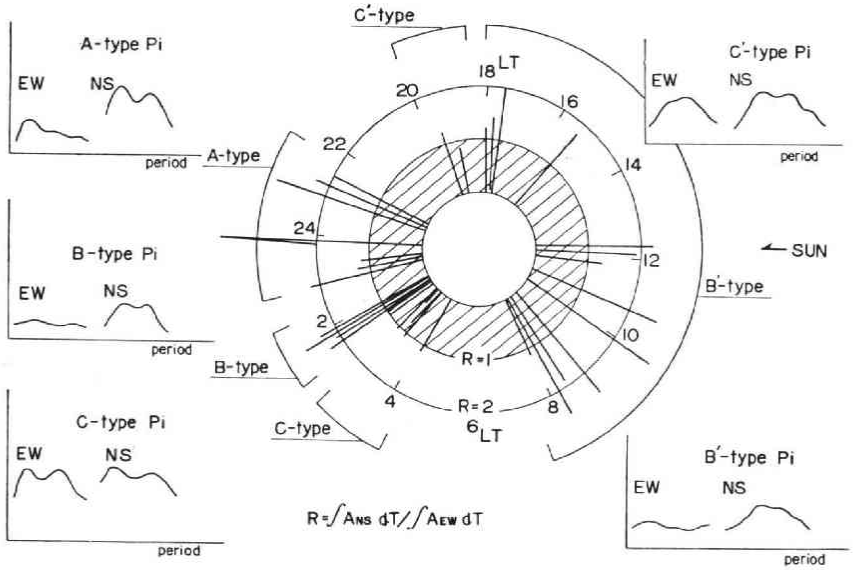

Fig. 8 Ratio of the two components with local time.

A(EW) is the relative total amplitude of NS and EW component respectively. These are shown by the length of line in the figure.

We classified the morphology of pi's to A, B and C type and also B' and C' type in proportion to B′ and C′ type respectively.

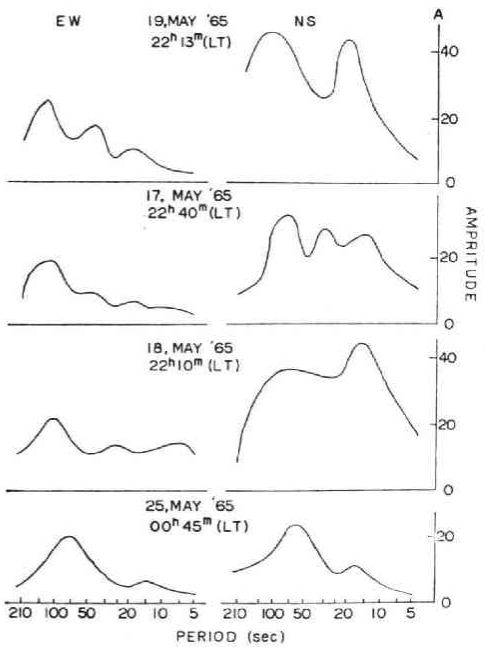

Fig. 9-1.

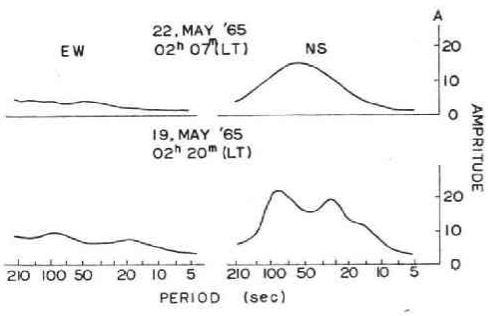

Fig. 9-2.

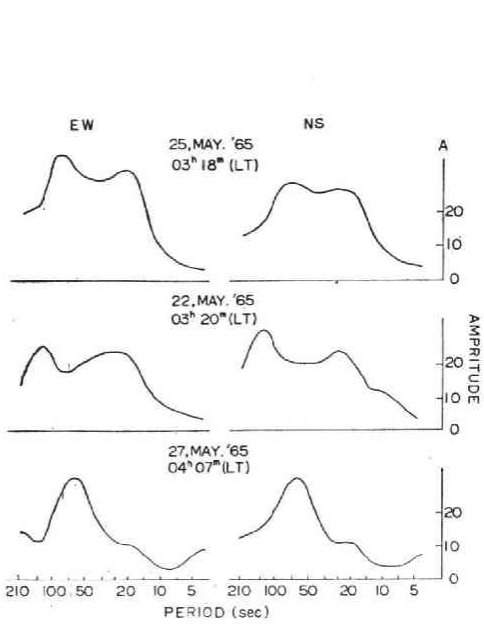

Fig. 9-3.

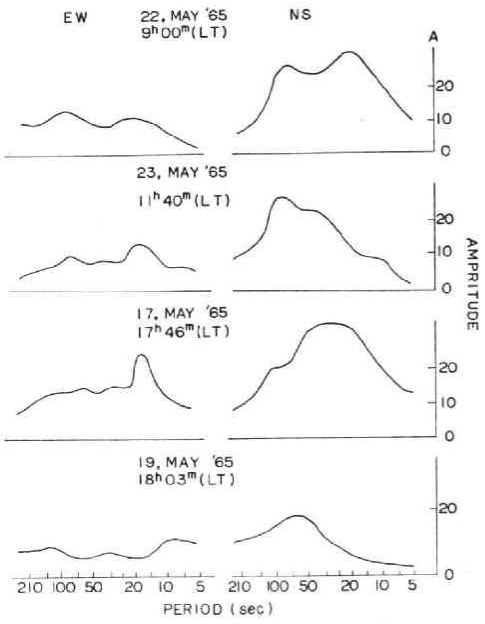

Fig. 9-4.

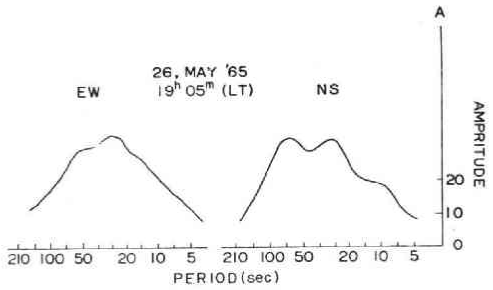

Fig. 9-5.

Fig. 9-1 ~ Fig. 9-5. Five spectra types of pi's
The vertical axis is relative intensity and the horizontal axis is periodic band.

The A type pi's (Fig. 9-1) occur at 22h–1h (local time) and this type is the most typical pi. The intensity of NS component is more remarkable than that of EW component. It is remarkable that pi's composed of distinguished period of 100 sec and its higher harmonics.

The B type pi's occur at 2h–4h (Fig. 9-2) and EW component has small intensity over broad periodic band.

The C type pi's occur at 3h–4h (Fig. 9-3). The intensity of both components become comparable and the distinguished periods are about 100 sec and 30 sec.

While the B' type pi's Fig. (9–4) are observed at the day time and C' pi's (Fig. 9–5) are observed at the evening time. These types are different from the night time pulsations. Thus we could make clear the characters of the geomagnetic micropulsations by this investigation of frequency analysis.

Reference

Hirasawa, T., T. Oguti and T. Nagata, 1965 : Dynamic spectrum of geomagnetic pulsations at low latitude. *Rep. Ionos. Space Res. Japan*, **19**, 452.