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A PRELIMINARY REPORT ON Pc 4 PULSATIONS OBSERVED AT TOTTORI

By

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Abstract

An observation of geomagnetic and telluric pulsations was made at Tottori Sand Dune. Hodographs for pulsations, mainly Pc 4, were studied and it was found that the rotations of the vectors were clockwise at night and that the main axis of hodograph changed its direction with local time.

1. Introduction

The observation of pulsations by induction magnetometer was made at Tottori ($\Phi=25°$, $\lambda=201°$) and pulsations mainly of Pc 4 type were caught. The present paper reports and discusses some results of the observation.

Polarization of hodographs (or vectrograms) of pulsations has often been discussed for the purpose of searching for the mechanism of occurrence of pulsations, their propagation mode or investigating the state of the magnetosphere. However, the data seemed to be insufficient especially at low and middle latitudes, and so by this observation we intended to get new data for further study. The morphology of pulsations is excellently summarized by Saito [1964, 1969]. It has been shown by Saito that hodographs of Pc 4 pulsations have tendencies in northern mid latitueds such as the sense of rotation is clockwise in the day and counterclockwise at night (see also Mather et al. [1964]) and the main axis of rotation is parallel to the line of geomagnetic force at the observing station.

We observed one component (north-south) of telluric currents at the same time, and it is suggested from the results that the effect of induced parts of magnetic pulsations should not be overlooked in the study of pulsation.

2. Observation and results

The observation of geomagnetic pulsations was made at Tottori Sand Dune from July 30 to August 5, 1971, by permalloy cored induction magnetometers of two horizontal components with DC-amplifiers and a pen recorder. Periodic components shorter than a few seconds are electrically filtered. A north-south component

of telluric current is recorded by the same recorder using the same type of amplifier and filter. The chart speed was 1 cm/min. At Tsuyama in this period observations of geomagnetic pulsations and normal-run variations were made by Miyakoshi and Sumitomo. For routine works a fluxgate magnetometer and a proton magnetometer were working at Tottori, and a fluxgate magnetometer and induction coil magnetometers at Mizuho. All these data are available for future study. The locations are shown in Fig. 1. Our station, Tottori, was used for telluric observation before by Miyakoshi et al. [1970].

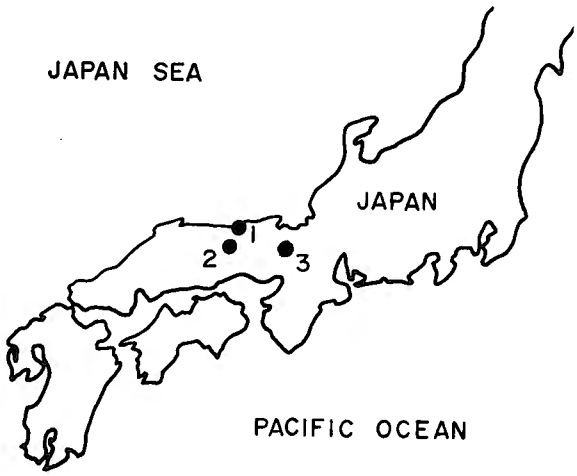

Fig. 1. Locations of stations. 1. Tottori, 2. Tsuyama, 3. Mizuho.

The period of observation was rather geomagnetically calm except for the day-time on Aug. 2 (from 22^h, Aug. 1 to 07^h, Aug. 2, in UT), when the local largest value of K index was 4. Except during these hours local K's did not go above 3. As the data in the daytime on Aug. 2 were omitted, the results are independent of the disturbed geomagnetic field. The observation was made during the hottest period in Japan, and the surface temperature of the sand at day and night varied greatly. To avoid the floating due to such temperature difference, coils were buried in the sand about 70 centimeters deep, and the observations were made mainly at night.

Of about 60 pulsations or pulsation-like events, 26 events are chosen as Pc 4, when "continuous" events are interpreted as ones which have repetitions of over 4 times of same kind of wave patterns. Hodographs are drawn for them. There seems to exist four types in rotation sense. The first two are clockwise and counter-clockwise. The third is the type in which clockwise rotation soon becomes counter-clockwise or vice versa, and the last is one which oscillates straightly to and fro rather than makes round motion. Typical cases are shown in Fig. 2 for each type with traces of original pulsation magnetograms. Of 26 events the third type is 6 and the fourth is 2 and the remaining 18 events rotate clockwise or counterclockwise. They are sum-

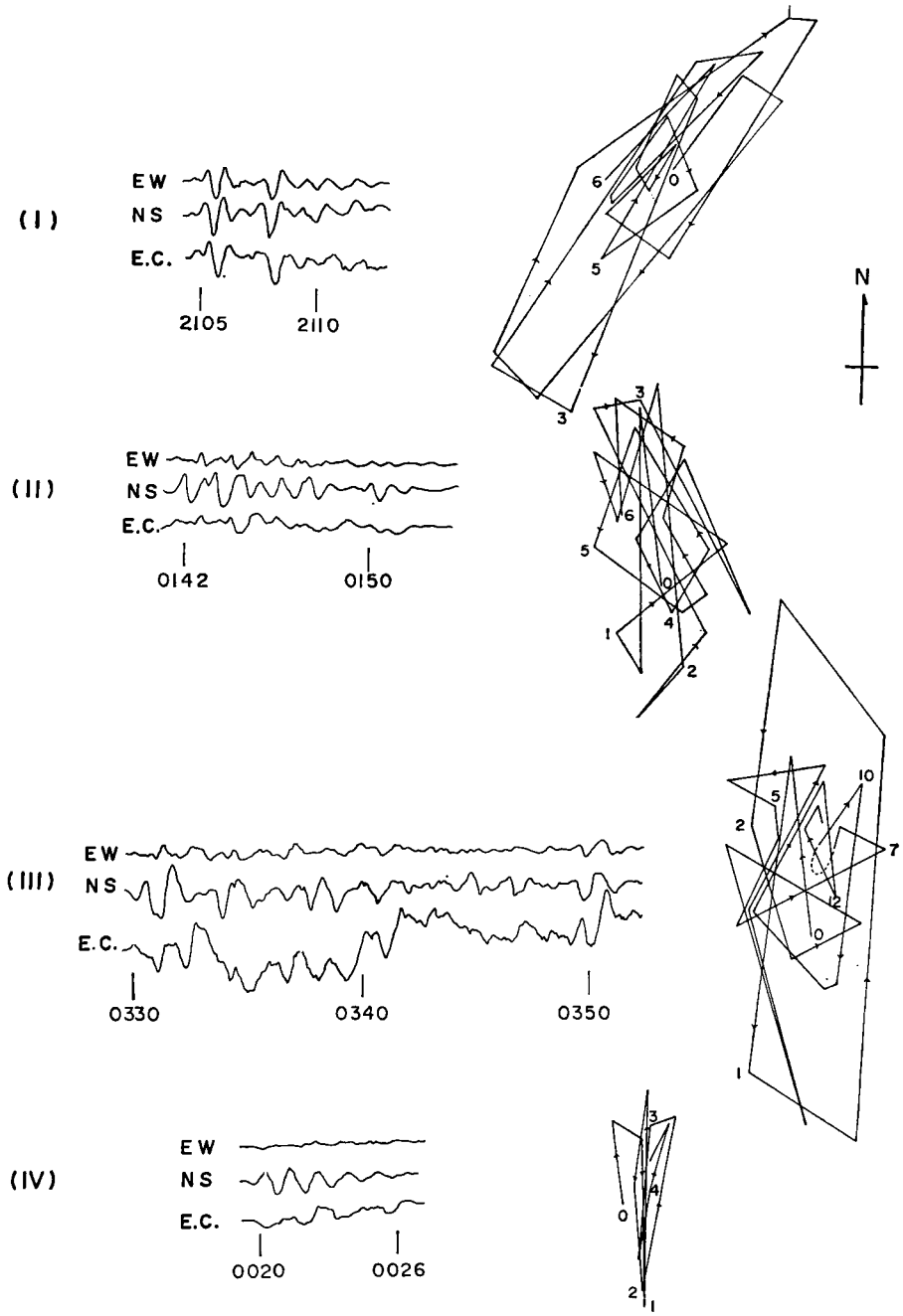

Fig. 2. Four types of hodographs with traces of original curves. Curves are geomagnetic east-west, north-south and telluric north-south components from the top of the paper and their senses are eastward, northward and southward towards the top of the paper. The sensitivities are 0.43 γ/sec and 0.11 v/km for geomagnetic and telluric fields, respectively, per variations of the length of time interval of 10 minutes. Events are observed on (i) Aug. 2, (ii) Aug. 2, (iii) Aug. 1 and (iv) Aug. 2. Time marks on the figure do not show accurate time.

Table 1. Local time dependence of rotation sense of hodographs of pulsations, Pc 4.

local time	$0^h - 6^h$	$6^h - 12^h$	$12^h - 18^h$	$18^h - 24^h$	total
clockwise	5	2	0	9	16
counter-clockwise	1	0	0	1	2

marized in Table 1 with the local time of their occurence. Though we have little data for the daytime, the dominancy of clockwise rotation at night is clearly seen. The result is contrary to Mather et al. [1964] who described the rotation sense in northern middle latitudes as counterclockwise at night (18^h—6^h), though the location of our station is rather lower in latitude than theirs.

As we did not observe the vertical component we could not investigate the three dimensional structure of the hodograph, so the main axes of hodographs in horizontal plane were investigated. Though the main axis of hodograph from its nature is not decided truly accurately, carefully decided results are shown in Fig. 3 again with the occurring (local) times of the events. The number of lods does not equal 26, for some of the first and the second type hodographs have round shapes with no definite main axes, on the other hand the third type hodographs have clear main axes. In this figure the tendency is seen that the main axes which are along magnetically north-east to south-west in the evening (18^h—24^h) change their direction rotating counter-clockwise from north-south at local midnight to north-west to south-east direction in the early morning. Directions of axes are rather more random in the morning than in the evening.

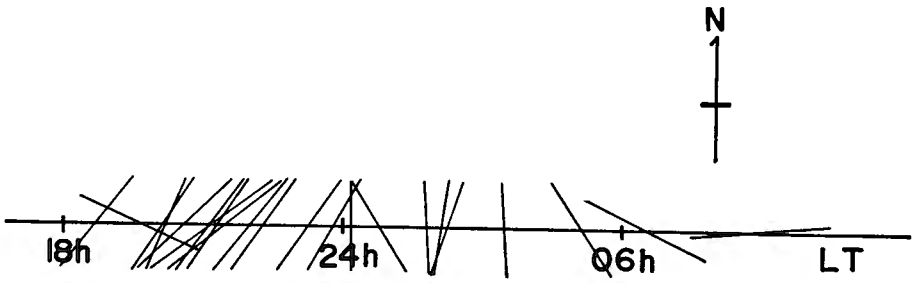

Fig. 3. Main axes of horizontal hodographs are shown by lods. Their local time changes are seen.

On the earth current at Tottori Sand Dune it is reported by Miyakoshi et al. [1970] that the tendency is that the field polarize in the direction of northwest-by-west to southeast-to-east for variations of periods longer than ten minutes. For shorter periods as pulsations it was found this time that the tendency is obscured. It was found that the north-south component of telluric field resembles the eastwest component of geomagnetic field and does not resemble the north-south component as Fig. 4. This relation is quite natural for ordinary stations, but it was not

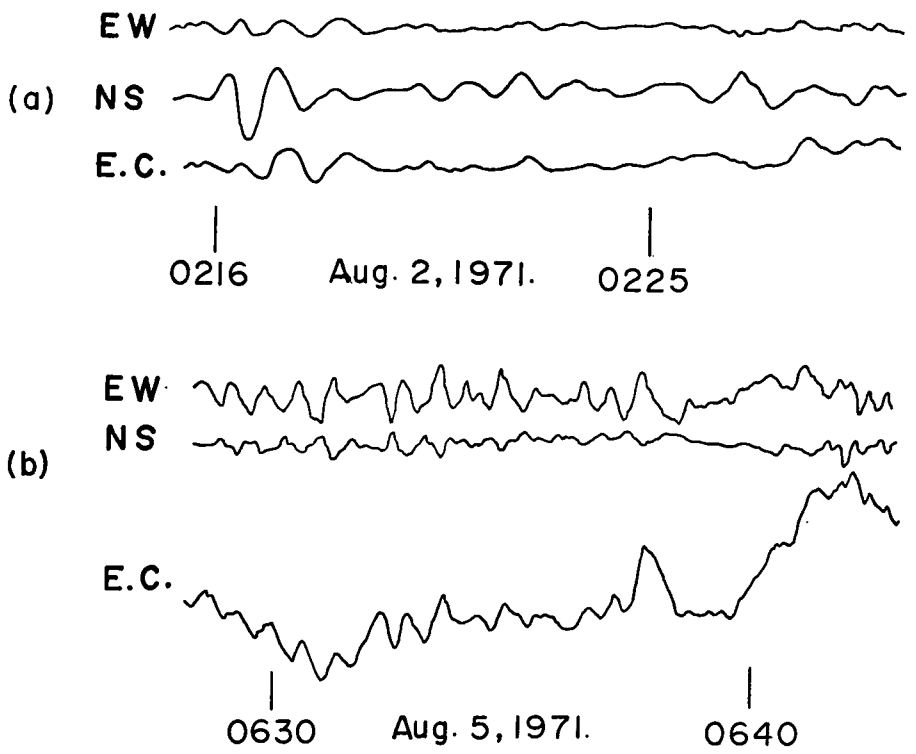

Fig. 4. Examples in which the variation of one component ((a) north-wouth and (b) east-west) of geomagnetic fields is dominant. It is seen in (a) that telluric field shown by E. C. does not resemble magnetic field especially from middle to last part of curves, but in (b) the telluric field resemble EW component of magnetic field. The length of a time interval of 10 minutes give sensitivities of each field, and they are 0.43 γ/sec and 0.11 volt/km for magnetic and telluric fields, respectively. The senses of the fields are eastward, northward and southward increase towards the top of the paper for magnetic EW, NS and telluric NS components, respectively.

true for longer period at Tottori (Miyakoshi et al. [1970]). This evidence will be studied in future in relation to the earth's interior at Tottori district, but now we want to pay attention to the evidence in another sense. That the geomagnetic field resembles the telluric field denotes in return that the geomagnetic field is influenced by induced telluric currents and if there exists some anomalous features in the ground the observed geomagnetic field is distorted by them. As these features are often ignored in the study of pulsations, we want to stress the fact.

3. Discussion

As a preliminary report hodographs of Pc 4 events are studied, and the clockwise rotation at night and the change of main axis are found. For the former the sense of rotation is contrary to already reported results. But as there are a very few reports

for middle or low latitudes, the contrast would not be concluded at once. To avoid, however, the influence from the variations of higher frequency, the frequency analysis will be necessary in the future study. As described in the last paragraph of section 2, Tottori Sand Dune is anomalous for the earth current, underground influence might be a reason for the contrast.

There seems to exist some tendencies as to local time changes of frequency of Pc 4, i.e. the shorter periods in the morning are seen. Spectral analysis is expected to give some peak frequency of occurrence. We are also interested in the noise-like variations observed with pulsations as reported recently by Rankin and Jacobs [1970] which can be interpreted as being due to a group of travelling charged particles or to meteors. These are to be studied in the future.

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