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# THE TEMPORAL [DIURNAL] DISTRIBUTION OF GEOMAGNETIC AND EARTH-CURRENT PULSATIONS

by

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## 1. Argument

It has been known for some time that earth-current pulsations exist in two essentially different types, namely, pulse-trains which continue for some time (type pc), and pulsations which appear suddenly on a quiet trace background, often preceding or accompanying bay-disturbances (type pt). At Kakioka the time-distribution of the pt pulses is found to have a maximum at about 23 hrs local time, according to K. Yanagihara's reported results [1].

On the other hand, in a paper [2] by V.A. Troyiçkaya (Geophysical Institute, Academy of Sciences USSR) it is stated that the pt pulses are world-wide and simultaneous; that their temporal distribution exhibits a GMT diurnal variation with a maximum at 18~19 hrs.

In order to confirm whether the world-wide diurnal variation of pt's depends on local time or on GMT, the author studied the frequency-distribution of pt's in the Kakioka, Sitka, Cheltenham and Toledo data. The conclusion at which we arrived is that the world-wide diurnal variation is according to local time.

## 2. Temporal distribution of the pt-type earth-current pulsation at Kakioka

The author's investigation covered the three-year interval 1950~1952, thus including the period of Troyiçkaya's research in Central Asia (1951~1952). During the said interval the total count of pt-pulsations was 436, and for our research we took those of amplitude > 3mV/km. The distribution of these pulsations by amplitude is such that those of 10-20 mV constitute 55% of the total. The distribution in time is shown in Figure 1. In the daytime hours the number of occurrences is small; the pulsations are mostly concentrated between 22 and 02 hrs (local time), with the maximum at about 23 hrs. Our results are thus practically identical with Yanagihara's.

To find out whether the time-distribution was different for different amplitudes, we divided the pulsations into two groups, of amplitude below 20 mV and above 20 mV respectively, and we investigated the distribution of these groups. The result, as shown in Figure 2, was that the maximum for amplitude less than 20 mV occurs about an hour later than the maximum for amplitudes greater than 20 mV, but generally speaking there is no great difference: the distribution in time seems to have little dependence on amplitude.

## 3. Temporal distribution of earth-current pt's in Central Asia and their simultaneity, according to V.A. Troyiçkaya [2]

Troyiçkaya's earth-current observations were made in the two-year period 1951~1952 at five observatories in Central Asia. The results of her study of the pt distribution are shown in Figure 3. In the interval 00~12 hrs GMT practically no pt's appear; the bulk of them occurs in the interval 12~24 hrs GMT. The maximum is at 18~19 hrs GMT (23~24 hrs, according to local time of meridian 75°E), coinciding with the time when the sun passes the magnetic pole of the northern hemisphere. She further says that the pt's have a recurrence tendency, persisting in many cases for several days; that the maximum at 18~19 hrs GMT occurs not only at the observation points in Central Asia but is also found to occur at Shaçk (near Moscow) during the same interval /of years/, agreeing in fact with Figure 3. Moreover, according to the records of eleven earth-current observatories * within the area 34°E ~ 142°E and 39°N ~ 73°N, the pt's occur simultaneously; from this fact she argues that they are simultaneous over the whole terrestrial globe and that their diurnal variation over the whole globe is according to GMT.

## 4. Temporal distribution of pt's at Sitka, Cheltenham, and Toledo

In connection with Troyiçkaya's results as set forth above, we have no information as to what size of pulsations she selected for study, but if we assume that they were of the same order as those studied by the author of the present paper, then the maximum in the pt-distribution at Kakioka should occur at 3~4 hrs Japan time (= 18~19 hrs GMT). Actually, however, it is 4 to 5 hrs away. In order to decide whether the world-wide temporal distribution of pt's in the geomagnetic field follows a GMT diurnal variation or a local-time diurnal variation, we investigated the Sitka and Cheltenham geomagnetic records [3] and the Toledo earth-current material [4] for the same two-year period (1951~1952) as in Troyiçkaya's research. Our results, as shown in Figure 4, are that in each case the maximum is found at 23~24 hrs local time; in each case the temporal distribution of pt's is the same as at Kakioka.

## 5. Consideration of the results

The author has considered three observation points in addition to Kakioka. If to these data we add Troyiçkaya's results, obtained at Alma-Ata in Central Asia, we are in a position to compare five frequency distributions of pt's, all referring to the same period of time. The distribution in terms of GMT for each of these cases gives us the picture shown in Figure 5, where it is seen at a glance that the world-wide temporal distribution of geomagnetic pt's has a diurnal variation which is not according to GMT but according to local time in every case.

As regards simultaneity of pt's, it appears that there may indeed be simultaneity /of individual bursts/ over quite large areas, provided the conditions are right, but the amplitudes are not the same from place to place;

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* Alma-Ata, Kegen, Chilik, I-Li (Tien Shan Region), Garm (Northern Pamir), Shaçk (Riazan oblast), Irkutsk, Lovozero, Matochkin Shar, Tiflis, Southern Sakhalin.

the individual bursts are subject to a local time influence, so that they exhibit different amplitudes at each place. Consequently, even though individual pulsations may be simultaneous over quite a large area, when we examine the frequency distribution at different places, what we have is a distribution built up by pulsations which have been greatly modified by a local time effect.

In Troyiçkaya's paper, thirteen pt records are cited, * but the only one of these which indubitably corresponds to a Kakioka record is the pulsation at 17~19 hrs, January 7, 1951.

This pulsation was simultaneous at Alma-Ata, Chilik, Garm, South Sakhalin, Irukutsk and also at Kakioka; thus over quite a large area.

## 6. Summary

We have investigated the temporal distributions of pt-type geomagnetic pulsations at Kakioka, Sitka, Cheltenham and Toledo, and have compared them with Troyiçkaya's results for Central Asia. We find that the temporal distribution of pt's does not exhibit a world-wide GMT diurnal variation; the diurnal variation is according to local time at each place.

In conclusion, the author expresses his gratitude to the Director, Dr. T. Yoshimatsu, for his encouragement, and to Mr. K. Yanagihara for his direct guidance in this work; also to the Head of the Department, Mr. Yokouchi, for making it possible to publish it.

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* 1950 Aug. 27, 18 hrs ~ Aug. 28, 6 hrs (GMT), Garm obs.
1951 Jan. 6, 18 hrs ~ 22 hrs, Chilik.
1951 Jan. 7, 17 hrs ~ 19 hrs, Alma-Ata, Chilik, Garm, Southern Sakhalin, Irkutsk
1951 Mar. 13, 21 hrs ~ Mar. 14, 7 hrs, Kegen, Garm.
1951 Mar. 21, 23 hrs ~ Mar. 22, 7 hrs, Garm, Kegen, Chilik.
1951 Sept. 13, 23 hrs ~ Sept. 14, 5 hrs, Obi-Garm, Garm, Dzhergatal.
1952 Feb. 24, 23 hrs ~ 23 hrs, 40 min, Sicily, Gabon, Sahara, Venezuela.
1952 June 4, 18 hrs ~ 22 hrs, Kegen.
1952 Nov. 2, 19 hrs ~ 20 hrs, Alma-Ata.
1952 Nov. 3, 19 hrs ~ 20 hrs, Alma-Ata.
1952 Nov. 15, 18 hrs ~ 22 hrs, Alma-Ata.
1954 July 30, 23 hrs ~ 24 hrs, Vilkiya (Lithuania), Alma-Ata.
1954 Aug. 22 hrs ~ 23 hrs, Vilkiya (Lithuania), Alma-Ata.

## REFERENCES


1) Yanagihara, K. (1957): Memo. Kakioka Mag. Obs., 8, 49-59.

2) Troyiçkaya, V.A. (1955): T 174 R, T 190 R, Defence Research Board Canada, 1955 (English translations by E.R. Hope).

3) U.S. Department of Commerce, Coast and Geodetic Survey (1951, 1952): Magnetograms, Sitka, Cheltenham.

4) Observatorio Central Geofisico De Toledo (1951, 1952): Corrientes Teluricas, 1951, 1952.


Translator's Note:- It was perhaps to be expected (see DRB translation T 174 R, page ii) that Troyiçkaya's thesis of a GMT variation would be disproved, but this of course does not mean that the data adduced by Troyiçkaya are incorrect. Rather they are evidence of a Eurasian asymmetry in the distribution of the pt-pulsations, an asymmetry which will obviously repay study.

For the further development of this subject, see the three papers (in English) by Kazuo Yanagihara, in the Memoirs of the Kakioka Magnetic Observatory, vol. 8 (1957), No.1, pages 49, 61 and 69. See also M.V. Okhoçimskaya, Seasonal Distribution of Short-period Oscillations of the Terrestrial Electromagnetic Field, Izv. Akad. Nauk SSSR, Geophys. Ser., 1956, 8, 999 (DRB translation T 228 R).

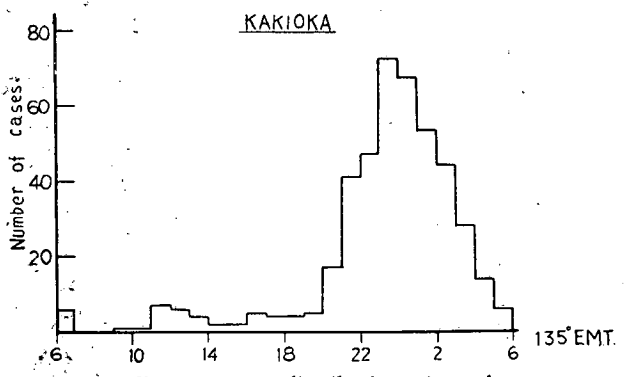


Fig 1. The frequency distribution of earth-current pt at Kakioka, 1950～1952.

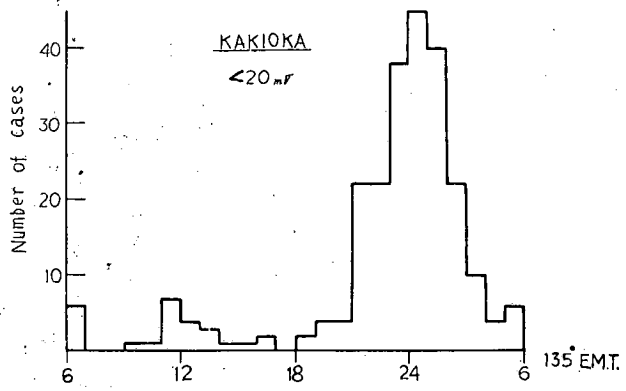


Fig 2 A. The frequency distribution of earth-current pt (<20mV) at Kakioka, 1950～1952

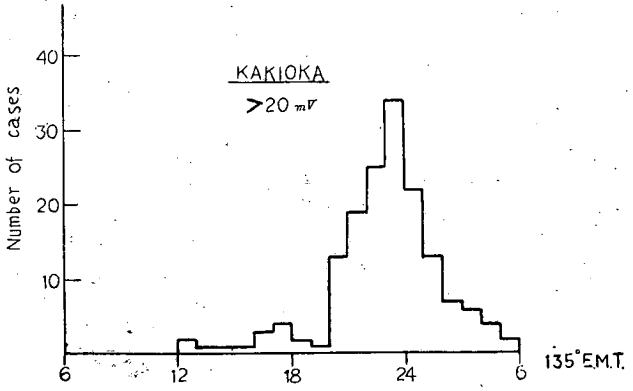


Fig 2 B. The frequency distribution of earth-current pt (>20mV) at Kakioka, 1950～1952

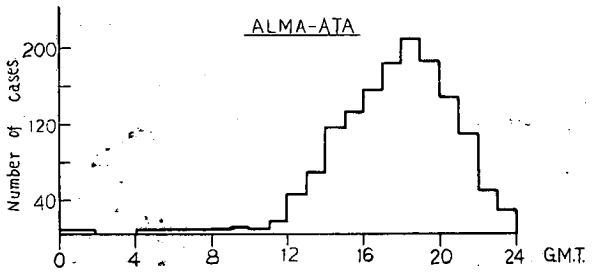


Fig 3. The frequency distribution of earth-current pt at Alma-Ata, 1951~1952 (after Troyickya).

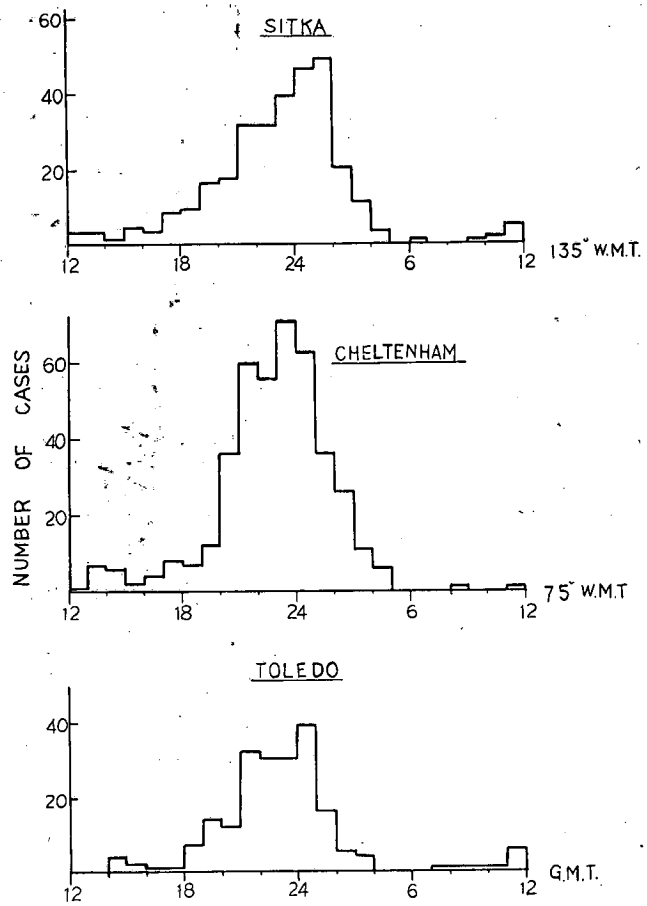


Fig 4. The frequency distribution of geomagnetic pt at Sitka and Cheltenham for 1951~1952 and earth-current pt at Toledo, 1951~1952.

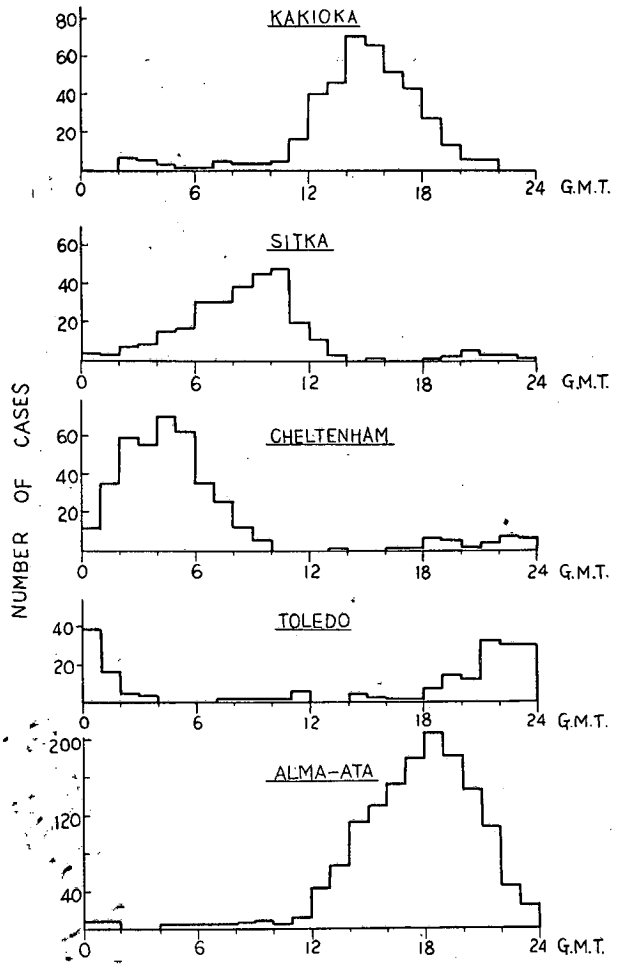


Fig 5. The frequency distribution of geomagnetic pt on G. M. T. at Sitka and Cheltenham and earth-current pt, Kakioka, Toledo and Alma-Ata, 1951~1952

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