Pc 1 PULSATIONS OBSERVED AT CAMBRIDGE BAY IN THE CUSP REGION AND FORT SMITH IN THE AURORAL REGION

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Abstract: In order to understand the generation mechanism of daytime Pc 1 magnetic pulsations with 0.3–0.7 Hz in the polar cusp and auroral regions, the authors analyzed the dynamic power spectra of the magnetic pulsations observed by the high sensitive induction magnetometer at Cmabridge Bay ($\Phi=76.8°$ $\Lambda=299.6°$) and Fort Smith (67.3°, 300.0°) during the period from 14 to 30 August 1974. It is found that Pc 1 pulsations having a patch-like structure were detected at Cambridge Bay in the cusp region near local noon, but were not observed at Fort Smith in the auroral region. On the other hand, during the period from 1300 to 1500 local time (LT) Pc 1 pulsations showing rising frequency with time appeared at Fort Smith in the sub-cleft region, while Pc 1 pulsations having rather stationary frequency were observed simultaneously at Cambridge Bay in the polar cusp region. After 1500 LT, the patch-like Pc 1 pulsations disappeared at Cambridge Bay.

From the spectrum analysis, a possible model for mechanism of excitation and propagation of daytime Pc 1 is proposed as follows; Pc 1 pulsations observed in the cusp region are the ion cyclotron wave which is excited near the dayside cusp magnetosheath boundary and propagates along the open field lines in the dayside cusp region. On the other hand, Pc 1 pulsations at Fort Smith in the auroral or sub-cleft region are the ion cyclotron wave, generated in the entry layer where the magnetic field is more intense than that in the magnetosheath.

1. Introduction

In order to investigate the characteristics of magnetic pulsations in the north polar cusp and in the auroral region, one of the authors (Y. KATO) carried out the magnetic observation with his colleagues at Cambridge Bay in the polar cusp ($\Phi=76.8°$, $\Lambda=299.6°$) and at Fort Smith in the auroral zone (67.3°, 300.0°) during the period from 14 to 30 August 1974. The pulsation signals were detected simultaneously with the portable induction magnetometers (KATO, 1977). The investigation on the general characteristics of daytime pulsations in the vicinity of the dayside cusp and the nighttime pulsations associated with substorms in the period of this observation were already reported in detail by KATO (1977).

As the magnetic observations were carried out in the summer time, Cambridge Bay is regarded to be located in the cusp region during the interval from about 1030 to 1500 local time (LT) (see Fig. 1), and the geomagnetic pulsations, period of which is shorter than 8 s, were more active at Cambridge Bay. In the present paper, daytime Pc 1 pulsations in the cusp region and in the auroral region adjacent to the cusp region

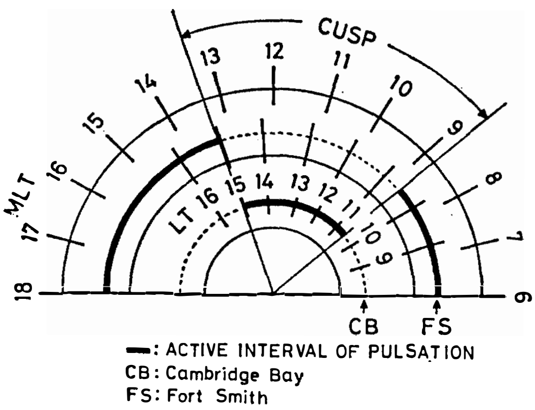

Fig. 1. Schematic illustration of the situation of Cambridge Bay in the cusp region and Fort Smith in the auroral zone. Cambridge Bay was located in the cusp region during the period from 1030 to 1500 LT. Solid lines indicate the active interval of magnetic pulsations at the stations.

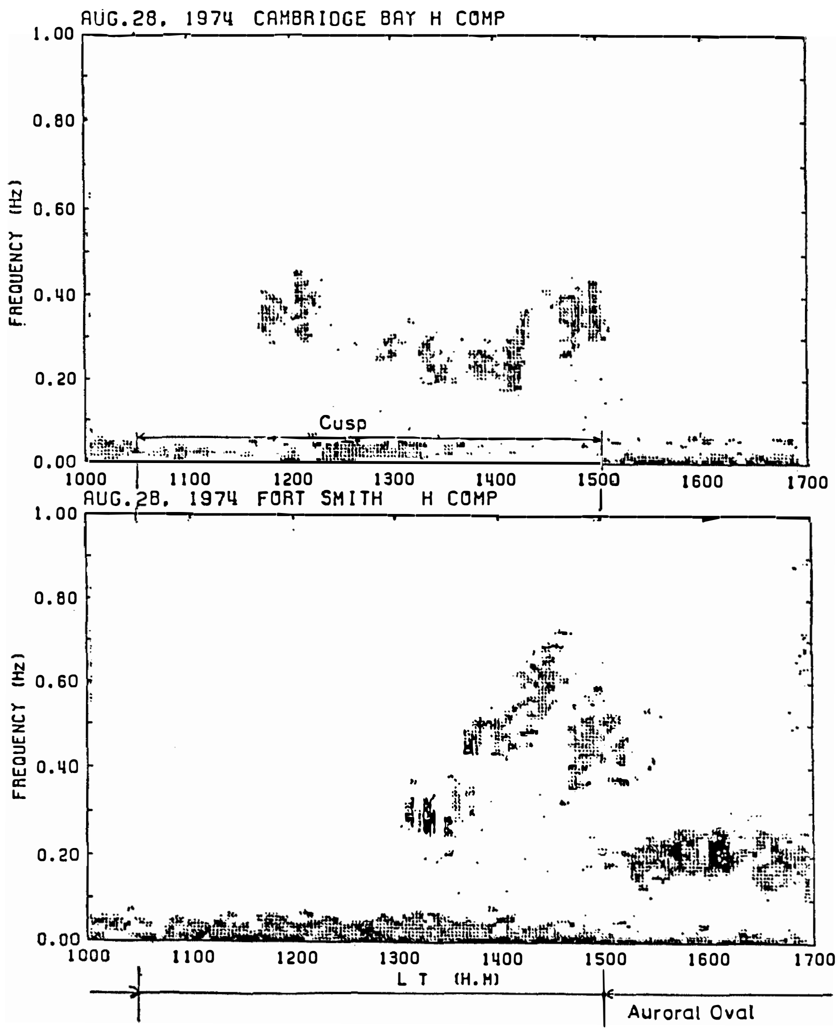

Fig. 2. Dynamic power spectra of daytime Pc 1 pulsations in the H component observed at Cambridge Bay (top panel) and Fort Smith (bottom panel) during the period from 1000 to 1700 LT on August 28, 1974.

are investigated by examining dynamic spectra of the magnetic pulsations. It is found that Pc 1 pulsations having a patch-like structure were detected at Cambridge Bay in the cusp region near local noon, but were not observed at Fort Smith in the auroral region. On the other hand, during the period from 1300 to 1500 LT Pc 1 pulsations with the frequency rising with time appeared at Fort Smith in the sub-cleft region, while Pc 1 pulsations having rather stationary frequency were observed simultaneously at Cambridge Bay in the polar cusp region.

2. Pc 1 Pulsations in the Polar Cusp and Sub-Cleft Regions

Figure 2 shows one example of the dynamic spectra of magnetic variations observed at Cambridge Bay and Fort Smith. Daytime Pc 1 pulsations with frequency of about 0.2–0.7 Hz observed at both stations indicate a patch-like structure. It is noteworthy that near local noon the Pc 1 pulsations can be detected only in the cusp region (Cambridge Bay), but not observed in the sub-cleft region (Fort Smith). In the afternoon time from 1300 to 1500 LT Pc 1 pulsations were observed simultaneously at both stations, but the dominant frequency of the Pc 1 pulsations was slightly higher at Fort Smith (*i.e.*, 0.3–0.7 Hz) than at Cambridge Bay (*i.e.*, 0.2–0.4 Hz). After 1500 LT, Pc 1 pulsations appeared predominantly only at Fort Smith in the auroral zone as shown in the figure.

The same Pc 1 events observed at both stations are presented in the records of induction and ordinary magnetograms in Figs. 3 and 4. Since the ordinary magnetometer was not operated at Fort Smith, the ordinary magnetogram at Baker Lake ($\Phi=73.8°$, $\Lambda=318.5°$) is used for the reference in the figures. From the dynamic

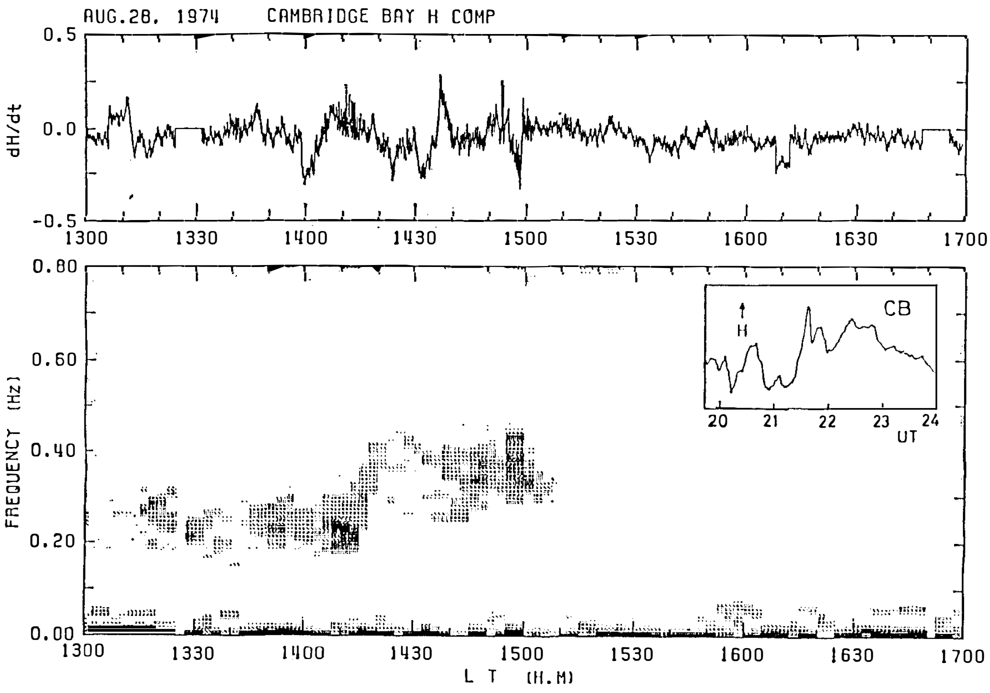

Fig. 3. Dynamic spectrum of daytime Pc 1 pulsations and induction and ordinary magnetograms obtained at Cambridg Bay.

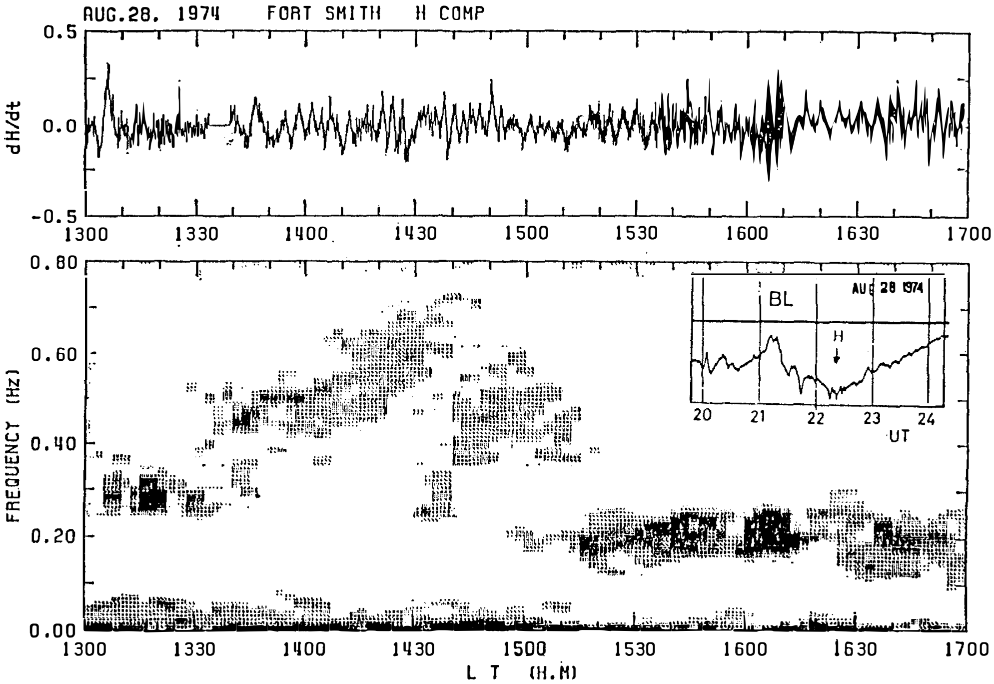

Fig. 4. Dynamic spectrum of daytime Pc 1 pulsations and amplitude-time records at Fort Smith, and ordinary magnetogram obtained at Baker Lake.

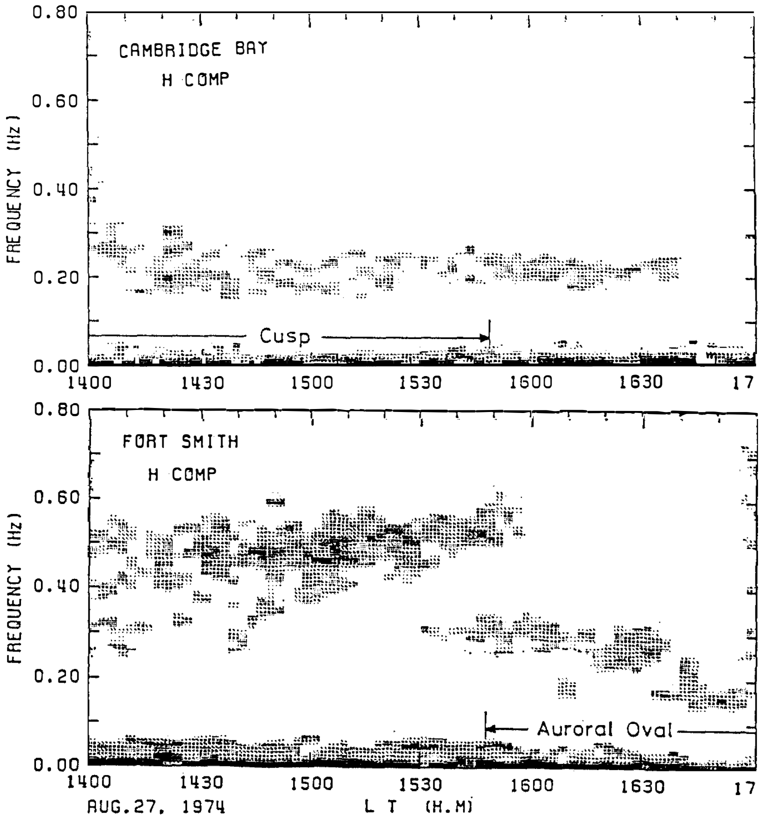

Fig. 5. Another example of dynamic spectra of daytime Pc 1 pulsations observed at Cambridge Bay (top panel) and Fort Smith (bottom panel) during the interval from 1400 to 1700 LT on August 27, 1974.

spectra of the induction magnetograms at Cambridge Bay, we found that the activity of magnetic pulsations in the cusp region becomes suddenly calm after 1500 LT, when the station goes beyond the cusp region.

Figure 5 shows another example of Pc 1 pulsations observed at both stations. In this case the dominant frequency of Pc 1 pulsations at Fort Smith indicates a positive gradient in the dynamic spectrum from 0.3 to 0.6 Hz according to the local time, that is, the observation site at Fort Smith is located in the sub-cleft zone near local noon and in the auroral zone after 1530 LT. On the other hand, before 1530 LT Pc 1 magnetic pulsations with a patch-like structure were detected at Cambridge Bay in the cusp region. After 1530 LT Pc 1 pulsations having a continuous band were observed at Cambridge Bay, indicating that the station entered in the auroral zone in this case due to the intense substorm activity.

3. Conclusion; A Possible Model of Dynamic Pc 1 Pulsations in the Polar Cusp and Sub-Cleft Region

On the basis of the above-mentioned analysis, the authors propose the possible model of generation mechanisms of Pc 1 pulsations in the polar cusp, sub-cleft and auroral regions. Daytime Pc 1 pulsations in the dayside cusp are believed to be ex-

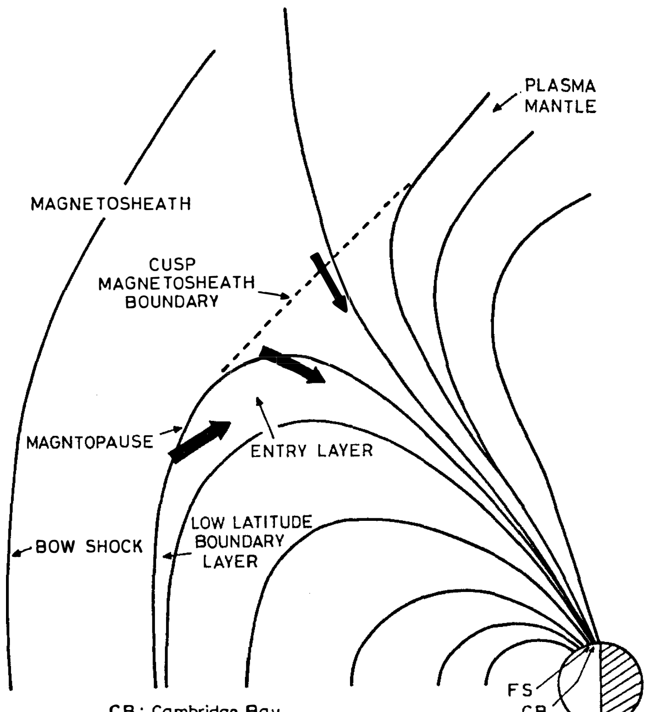

Fig. 6. Schematic illustration of the generation and propagation mechanisms. The daytime Pc 1 pulsations observed in the polar cusp region are believed to be ion-cyclotron wave which is excited near the cusp magnetosheath boundary and propagates along the field lines in the cusp into the polar ionosphere. On the other hand, Pc 1 pulsations detected in the sub-cleft region must be ion-cyclotron wave excited in the entry layer, where the excitation region would move across the ambient magnetic field toward the inner magnetosphere.

cited by the ion-cyclotron instability in the magnetosheath near the cusp magnetosheath boundary (*cf.* FUKUNISHI, 1984) and to propagate along the magnetic field lines through the dayside cusp into the polar ionosphere near Cambridge Bay. On the other hand, daytime Pc 1 pulsations observed at Fort Smith in the sub-cleft region must be also ion-cyclotron wave, generated in the entry layer where the magnetic field is more intense than that in the magnetosheath. Therefore, the dominant frequencies of Pc 1 pulsations obtained at Fort Smith in the sub-cleft region are higher than those observed at Cambridge Bay in the cusp region. From the rising frequency in the dynamic spectrum of Pc 1 observed in the sub-cleft region, the excitation region is believed to move across the ambient magnetic field toward the earth's surface in the entry layer. The schematic illustration of the model is summarized in Fig. 6.

The figure shows the conclusion of our analysis. However, more precise simultaneous ground-satellite observations are needed to confirm the model.

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