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主　論　文　の　要　旨

論文題目 Study of generation mechanism of Pc1 pearl structures using multi-point ground-based induction magnetometers
（地上多点誘導磁力計を用いた Pc 1 パール構造の発生メカニズムの研究）

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論　文　内　容　の　要　旨

Pc1 geomagnetic pulsation is one of the geomagnetic oscillations in the frequencies of 0.2-5 Hz by induction magnetometers on the ground. These waves are related with electromagnetic ion cyclotron (EMIC) waves generated in the equatorial region of the magnetosphere due to temperature anisotropy of the energetic plasma in the radiation belts. They propagate along the magnetic field line between the northern and southern hemispheres. When EMIC waves reach the ionosphere, they are trapped in the F layer and propagate longitudinally and latitudinally from high to low latitudes through ionospheric duct, observed as Pc1 geomagnetic pulsations. 'Pc1 pearl structure' is a quasi-periodic amplitude modulation of Pc1 pulsations with a repetition period of several tens of seconds. The generation of Pc1 pearl structures can be due to 1) magnetospheric and 2) ionospheric effects. Magnetospheric effects mean that Pc1 pearl structures are generated in the magnetosphere.　In this case the pearl structures should show similar shapes at different locations on the ground. Ionospheric effects mean that Pc1 pearl structures are caused in the ionosphere, for example, due to beating during ionospheric duct propagation.　In this case the pearl structures would have different shapes at different locations. The generation mechanisms of Pc1 pearl structures have not been clearly identified yet.

In this thesis, we investigated the generation mechanisms of Pc1 pearl structures in the ionosphere using multi-point ground induction magnetometers at Athabasca (ATH) in Canada, Magadan (MGD) in Russia and Moshiri (MOS) in Japan,

L ~1.5-4.5). We investigated two Pc1 events simultaneously observed at three stations and compared our observations with model calculations. Case 1 shows that Pc1 pearl structures observed at two stations have different shapes with polarization angle-dependence on Pc1 frequency. Case 2 shows similar Pc1 pearl structures at two stations with a constant polarization angle within Pc1 frequency band. A repetition period of Pc1 pearl structures was ~10 s in case 1 and ~10 to 40 s in case 2. These periods are shorter than those expected from magnetospheric bouncing wave packet effects. We investigated the possibility of beating processes in the ionosphere using model calculations of Pc1 pearl structures. First model considers a distributed source region and shows slightly different Pc1 pearl structures at different observation points. Second model considers a point source, showing identical pearl structures at different observation points. We found that beating processes in the ionosphere with a spatially distributed ionospheric source could cause pearl structures during the ionospheric duct propagation.

Then we investigated the statistical characteristics of Pc1 pearl structures observed at longitudinally (ATH and MGD) and latitudinally (MGD and MOS) separated ground stations from 2008 to 2013. We selected 84 Pc1 events observed simultaneously at longitudinally separated stations and 370 events at latitudinally separated stations. We found that the cross-correlation coefficients (pearl similarities) of Pc1 amplitude envelopes have a peak of occurrence at ~0.2 for the longitudinally separated stations, and at ~0.8 for the latitudinally separated stations. More than half of the events in both pairs show low cross-correlation coefficients (<0.7). We suggest that ionospheric effects could be the dominant mechanism for Pc1 pearl structures in the ionosphere. High similarity Pc1 pearl structures at the longitudinally separated stations are concentrated between 6 and 15 UT (nighttime at these stations). The similarity of Pc1 pearl structures tends to have weak negative correlation with the standard deviation of the polarization angle (R ~ -0.2) in both cases. This result suggests that beating processes in the ionosphere with the spatially distributed ionospheric source, could contribute generating of Pc1 pearl structures during the ionospheric duct propagation. However, the similarity of Pc1 pearl structures is less correlated with central frequency, bandwidth and AE index.

These results suggest that ionospheric effects could be the dominant mechanism for Pc1 pearl structures in the ionosphere. However we cannot exclude the possibility of magnetospheric effects to generate the Pc1 pearl structures, which is a future topic beyond the present research.