CHAPTER I

INTRODUCTION

1.1 Purpose

The purpose of this research is to make a temporal correlation between the amplitude and occurrence of Pc 1 geomagnetic oscillations and the state of the local ionosphere. If we have a chance we may seek evidence for Pc 1 oscillations that propagate across magnetic field lines. The reason is to find out the direction in which Pc 1 is propagated in this location and to study certain aspects of geomagnetic - ionospheric conditions near the equator. Scientists have observed geomagnetic oscillations most often at auroral latitudes and found relationships between these oscillations and auroral phenomena, such as visible auroral and auroral hiss. Moreover, a connection was found between geomagnetic oscillations and auroral ionospheric conditions; e.g., auroral absorption.

The equatorial region is unique for geomagnetic studies because here the earth's magnetic lines of force are nearly horizontal, and the earth's atmosphere is most exposed to the sun's ionizing radiation. Therefore we would expect the relations between geomagnetic oscillations and ionospheric conditions near the equator to differ substantially from those in auroral or higher latitudes. We therefore hope that our observations may provide basic information on the relationships between Pc 1 and ionospheric conditions near the equator.

1.2 Background

Pc 1 is the designation given to the regular geomagnetic fluctuations in the frequency range 0.2 to 5.0 Hz. They are caused by the dynamic interaction of particles thrown out by the sun with the earth's magnetic field. In the frequency range of Pc 1, there are other forms of fluctuation such as "pearls" (a regular beating oscillation) and transients. Pc 1 and pearl activity were probably first reported about

30 years ago by Harang[1] (1936) and Sucksdoff[2] (1936). Comprehensive studies of these oscillations have been published recently by Campbell and Stiltner[3] (1965), Dawson[4] (1965), and Tepley[5] (1965). Unlike lower frequency geomagnetic phenomena there is no lead-lag cross-correlation relationship between Pc 1 and geomagnetic activity K indices and no clear dependence of Pc 1 on appearance of sudden commencement magnetic storms or on Zurich sunspot numbers. Wentworth[6] (1964a) observed that the Pc 1 activity is more likely to occur in the seven days after geomagnetically quiet periods.

Dessler[7] (1959), Francis and Karplus[8] (1960), Fejer[9] (1960), Karplus et al.[10]

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[1] Harang, L. 1936. Oscillation and Vibrations in magnetic records at high-lattitude stations. Terrest. Magn. Atmosph. Elec., 41: 329-336.

[2] Sacksdoff, E. 1936. Occurrences of Rapid Micropulsations at Sodankyla during 1932 to 1935. Terrest. Magn. Atmosph. Elec., 41: 337-344.

[3] Campbell, W.H., and Stiltner, E.C. 1965. Some Characteristics of Geomagnetic pulsations at frequencies near 1 Hz. J. Res. NBS., Radio Sci., 69D: 1117-1132.

[4] Dawson, J.A. 1965. "Geomagnetic Micropulsations with emphasis placed on the properties and interpretation of Pearls." Unpublished Doctorial's Thesis, Department of Physics, Alaska University.

[5] Tepley, L. 1965. Regular oscillations near 1 C/S observed at Middle and Low latitudes. J. Res. NBS., Radio Sci., 69D: 1089-1105.

[6] Wentworth, R.C. 1964a. Enhancement of Hydromagnetic Emissions after Geomagnetic Storms. Journal of Geophysical Research, 69: 2291-2298.

[7] Dessler, A.J. 1959. Ionospheric Heating by Hydromagnetic Waves. Journal of Geophysical Research, 64: 379-401.

[8] Francis, W.E., and Karplus, R. 1960. Hydromagnetic Waves in the ionosphere. Journal of Geophysical Research, 65: 3593-3600.

[9] Fejer, J.A. 1960. Hydromagnetic Wave Propagation in the Ionosphere. J. Atmosph. Terrest. Phys., 18: 135-146.

[10] Karplus, R., Francis, W.E. and Dragt, A.J. 1962. The Attenuation of Hydromagnetic Waves in the Ionosphere. Planet. Space Sci., 9: 771-786.

(1962), Prince et al.[11] (1964), Wentworth[12] (1964b), and Greifinger and Greifinger[13] (1965) studied the attenuation on Pc 1's by the ionosphere and concluded that ionospheric attenuation depends on ionization density; i.e., greater ion density results in greater wave dissipation.

Attenuation of Pc 1 by the ionosphere is relatively small but studies have shown that it seems to increase with wave frequency and with geomagnetic K_p index. Greater attenuation was found when the K_p index was 3 or larger. From studies on the dynamic characteristics of the ionosphere. Bibl[14] (1960) showed that there is a positive correlation between the mangitude of F region ion density and (a) the intensity of magnetic activity measured by means of both local and planetary magnetic indices, and (b) the intensity of the sporadic E layer, E_s. Tepley[15] (1964), Gendrin and Troitskaya[16] (1965), observed Pc 1 at the mirror point[17] stations Kauai, Hawii; tongatapu, South Pacific; and Borok, U.S.S.R. and Kerguelen Island. They found Pc 1 to be a conjugate signal. At each of mirror points they observed Pc 1's either simultaneously or with some small time delay.

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[11] Prince, C.E., Bostick, Jr., F.X. and Smith, H.W. 1964. A study of the transmission of plane Hydromagnetic Waves through the upper atmosphere. Elec. Eng. Res. Lab., Univ. Texas, Rept., 134: 1-221.

[12] Wentworth, R.C. 1964b. Evidence for maximum production of Hydromagnetic Emission above the afternoon hemisphere of the earth, I and II. Journal of Geophysical Research, 63: 2698-2705.

[13] Greifinger, C., and Greifinger, P. 1965. Transmission of Micropulsations through the lower ionosphere. Journal of Geophysical Research, 70: 2217-2231.

[14] Bibl, K. 1960. Dynamic Characteristic of the Ionosphere and their Coherency with the local and planetary magnetic index. Journal of Geophysical Research, 65: 2333-2342.

[15] Tepley, L. 1964. Low latitude observations of fine structured Hydromagnetic Emissions. Journal of Geophysical Research, 69: 2273-2290.

[16] Gendrin, R.E., and Troitskaya, V.A. 1965. Preliminary results of a Micropulsation experiment at conjugate points. Radio Sci., 69D: 1107-1116.

[17] Sandstrom, A.E. 1965. The Radiation Belt of the Earth, p.359, Cosmic Ray Physics. New York: John Wiley and Sons.

Pc 2 micropulsations lie in the frequency range adjacent to that of Pc 1, i.e., Pc 2 is the designation given to the regular geomagnetic fluctuations in the frequency range 0.2 to 0.1 Hz. They may be observed simultaneously with the Pc 1 at times. Holmberg[18] (1953) reported that the predominant Pc 2 period varies slightly with season. Kato et al.[19] (1957) showed a 27-day periodicity in Pc 2 related to the K_p variation. Kato and Okuda[20] (1956) reported that during solar eclipses in the equatorial region, the amplitude of Pc 2 is reduced.

1.3 Method of Approach

The method of approach is to record systematically the magnetic and electric components of Pc 1 oscillations by means of three mutually orthogonal air-core coil antennas and two orthogonal pairs of special earth electrodes. From the complete field description we can then study the activity of the oscillations and their polarizations as a function of time. Information on ionospheric conditions is available through the ionosphere sounder work being carried out to MRDC in Bangkok and from a radio noise absorption monitor operated by ASRCT at the TREND site. Both devices are operated on a routine 24 hour-a-day basis. Additional information concerning the state of the ionosphere is available from published daily magnetic indices and from predicted sunspot and solar flare alerts cabled from the ESSA Laboratory in Boulder, Colorado, and received daily by MRDC.

It is planned to record micropulsation data on a routine 24 hour-a-day basis for a period of one month, select samples of data for study, and analyze this data with the

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[18] Holmberg, E.R.R. 1953. Rapid periodic fluctuations of the geomagnetic field. Geophysical Supplement, Monthly Notices Roy. Astron. Soc. Geophys. Suppl., 6: 476-481.

[19] Kato, Y., Ossaka, J., Okuda, M., Watanabe, T., and Tamao, T. 1957. Investigation on the Magnetic disturbance by the induction magnetograph, VI, on the daily variation and the 27-day recurrence tendency in the Geomagnetic pulsation. Sci. Rept. Tohoku Univ., Fifth Ser., 8: 19-23.

[20] Kato, Y., and Okuda, M. 1956. The Effect of the Solar Eclipse on the rapid pulsations of the earth's magnetic field. Sci. Rept. Tohoku Univ., Fifth Ser., 7: 37-43.

aim of establishing whether correlations exist between Pc 1 activity and polarization and the conditions of the local ionosphere.

Computer programs have been written to analyze the spectral components of the recorded pulsations and to display the polarizations of the field. The programs were written in FORTRAN for the National Statistical Office IBM 360/40 and it is planned to run the analyzer on the IBM 1800 computer at the Chulalongkorn University Computer Sciences Laboratory.