Some Properties of Pc 1 Pulsations at Choutuppal (Hyderabad)*

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A study of Pc 1 pulsation data obtained at Choutuppal (geomag. lat., 7°28'N) during the period 1967-74 revealed several interesting features, viz. (i) a distinct winter maximum in Pc 1 activity; (ii) an inverse relationship of Pc 1 activity with sunspot activity; (iii) preferential appearance of longer period Pc 1 pulsations during disturbed magnetic intervals. The results of this study which are pertinent to equatorial region are discussed in relation to those reported for middle and higher latitudes.

1. Introduction

The Pc 1 class of pulsations of the geomagnetic field has received considerable attention, particularly during the past decade. But most of the observational studies reported were confined to either middle or higher latitudes, while the observations regarding these pulsations at low and equatorial latitudes are relatively sparse. In this paper is presented a brief account of some of the salient features of the Pc 1 pulsations observed at Choutuppal (geomag. lat., 7°28', long., 148°14'), a sub-equatorial station.

2. Analysis

The permanent pulsation observatory at Choutuppal has been in continuous operation since February 1967. At this station, both telluric and magnetic components of pulsations are being photographically recorded at two different chart speeds viz. 90 mm/hr and 30 mm/min. Telluric signals are registered from two pairs of lead electrodes laid in the ground in NS and EW directions. The magnetic signals are being recorded by means of three-component induction magnetometer consisting of a core-coil assembly coupled with a high-gain amplifier system (for details see ref. 1 and 2). Telluric as well as magnetic recordings at 30 mm/min chart speed obtained at this observatory during an interval of about eight years from February 1967 to December 1974 form the data for the present study. This study includes (i) the examination of the persistence of the reported winter maximum in Pc 1 activity at Choutuppal; (ii) the relationship between Choutuppal Pc 1 activity and the sunspot activity; and (iii) the distribution of Pc 1 periods at Choutuppal in relation to magnetic activity.

The Pc 1 pulsations appear at this station quite infrequently as compared to other types, e.g. Pc 3 and Pc 4. The amplitudes often are very small and, on earth-current components they amount to about 1 mV/km while on magnetic components a few tens of milligammas. The pearl structure of the Pc 1 pulsations can be clearly seen only rarely while in most of the cases, continuous type of emissions are observed. For the present study, all the pulsations in the period range form 0-2 to 5 sec (classified as Pc 1 according to I.A.G.A. Resolution at the 13th General Assembly of I.U.G.G. 1963) are picked up from the records.

Fig. 1—Seasonal variation of Pc 1 activity during 8-yr period (1967-74)
3. Discussion

As a result of increased theoretical and experimental studies during the last decade, there is a significant contribution to the knowledge on the origin and propagation of the Pc 1 pulsations. According to the present theoretical models, Pc 1
Pulsations are believed to be due to hydromagnetic waves of ion-cyclotron mode bouncing back and forth along the magnetic lines of force in higher latitudes, the generation of these hydromagnetic waves being ascribed to a plasma instability process at 4-8 earth radii in the vicinity of the equatorial plane caused by nonthermal and electrically charged particles, presumably protons. The pulsations that are thus generated reach the earth at high-latitude regions travelling along geomagnetic field lines. The propagation of these pulsations to the low latitude regions is shown to be through an ionospheric waveguide centred on the phase velocity minimum in the F2 region. These theories would explain to a considerable extent, many of the observed features of these pulsations. In fact, the nighttime maximum in the diurnal occurrence pattern and the predominance of shorter periods at this station are in line with the predictions of the ducted-mode theory. The nighttime maximum in the low latitudes is attributed to increased attenuation of these signals during daytime in the ducted-mode propagation. The occurrence of shorter period Pc1 pulsations in low latitude regions is viewed as a consequence of the low frequency cut-off in the ducted-mode propagation.

The seasonal variation of Pc1 activity is not yet thoroughly investigated and much less for equatorial stations. Troitskaya notes that at middle latitudes a summer minimum exists and indicates that the activity has a maximum during equinoxes in the auroral zone. Fraser-Smith, based on a detailed analysis of 11-yr (1955-1966) data for middle latitudes, concluded that the Pc1 activity in these latitudes shows a semi-annual variation with a maximum close to the equinoxes and a distinct minimum during January and February. He interpreted the semi-annual variation as that due to the mechanism responsible for the 6-month variation in geomagnetic disturbance. On the other hand, the analysis of the data covering a nearly eight-year period at this sub-equatorial station clearly shows a distinct winter maximum in the Pc1 activity confirming the indication of this fact reported in an earlier study. This seasonal behaviour at this station may probably indicate more favourable conditions for propagation of Pc1 signals, during winter towards low latitudes.

The relationship of Pc1 activity to the solar activity was first studied by Benioff from his data covering the maximum sunspot phase (1955-59) of the solar cycle and he observed that there was a rough inverse relation between the two. From a detailed analysis of data, Matveyeva et al. and Fraser-Smith also found an overall inverse relation between the two. The present study on the Pc1 pulsations at this low-latitude station also reveals (see Fig. 2) an inverse relationship. This inverse relationship is generally believed as due to the increased ionospheric absorption at Pc1 frequencies with the increase in sunspot number.

In the theories concerning the propagation of Pc1 pulsations towards the equator, it has been shown that there exists a low frequency cut-off for each of the propagation bands. In particular, Greifinger and Greifinger, discussed the propagation characteristics of ionospheric waveguide for various local times and conditions of sunspot activity. Their computed values for the low-frequency cut-off show that the value of the cut-off frequency in the two lowest bands, is different for the sunspot maximum and minimum conditions, this frequency being lower during active intervals as compared to the quieter conditions. Thus, the low-frequency cut-off assumes still lower values during disturbed conditions (corresponding to sunspot maximum) relative to values during quieter intervals (corresponding to sunspot minimum). The preferential appearance of longer period pulsations at these latitudes, during magnetically disturbed intervals, as mentioned in the previous section might reflect the lowering of low-frequency cut-off during disturbed periods.

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