Ultra Low Frequency (ULF) magnetic field anomalies observed at Agra and their relation to moderate seismic activities in Indian region

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Abstract

A three -component search coil magnetometer (f = 0.01 – 30 Hz) has been employed to monitor the earthquake- induced magnetic field anomalies at Agra (Geograph. lat.27.2^{0}N, long. 78^{0}E), India. The results show that the magnetic field amplitudes of the three components are normally low in the range of 0.03 – 0.7 nT, but they are enhanced to large values in the range of 0.3 – 5 nT (the X- component along the north- south direction being the lowest) occasionally. The six month data between September, 2002 to February, 2003 have been analyzed and two cases of abnormally largest amplitude enhancements are selected for detailed study. These two cases correspond to 23 November, 2002, and 5-6 February, 2003. The enhancement in amplitudes for these cases are examined in the light of magnetospheric micropulsations and earthquake- generated ULF emissions. For this purpose, the amplitude variation is examined with variations of polarization parameter (Z/X) and ∑ Kp. It is found that the enhancements are most probably caused by the ULF magnetic field emissions generated during moderate earthquakes(3.5<M<6) that occurred in India and neighboring Pakistan successively within ± 1 day.

Case 1 : 23 November, 2002

Fig.1 shows the amplitude records of the three components corresponding to three nights between 22 November and 25 November 2002. The ordinate shows the amplitude in nT and the abscissa shows the local time from 2100 h to 0600 h. As mentioned earlier, the observations are usually started at 2100 h and continued till 0530 h next day. The starting and ending dates are shown for X components only but hey are the same for the rest of two components also. The data show dark bands of background magnetic field amplitudes which are centered at 0.0 nT and fringes type noises which are due to local artificial and man- made disturbances. The later are produced by power line radiation and electrical machines running in the near by buildings. Such noises are almost eliminated when there are power failures on the campus and system is operated on batteries. The main attention is to be given to the variation in the background magnetic field amolitudes

indicated by the dark bands. It may be seen here that on 22 November 2002 the amplitudes of the three components are small as usual, but they are enhanced considerably on 23 November 2002, the largest enhancement occurred in the Z component. We do not have complete data for 24 November 2002, but it can be seen easily that the enhancement dropped abruptly around 0300h on 24 November 2002. Since then the amplitude remained at normal level and continued so on 25 November 2002. The start time of the enhancement is not known because the observations were not made before 2100hrs.

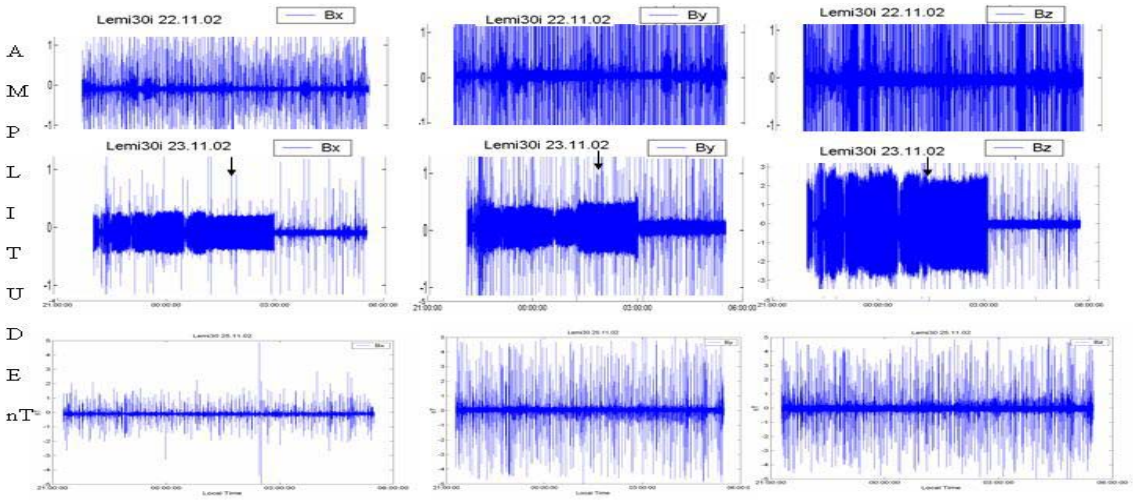

Fig. 1

Case 2 : 10 December, 2002

The case of largest enhancement in the amplitudes of the Z component in whole of the data set corresponding to the six months of observations is shown in Fig. 2.

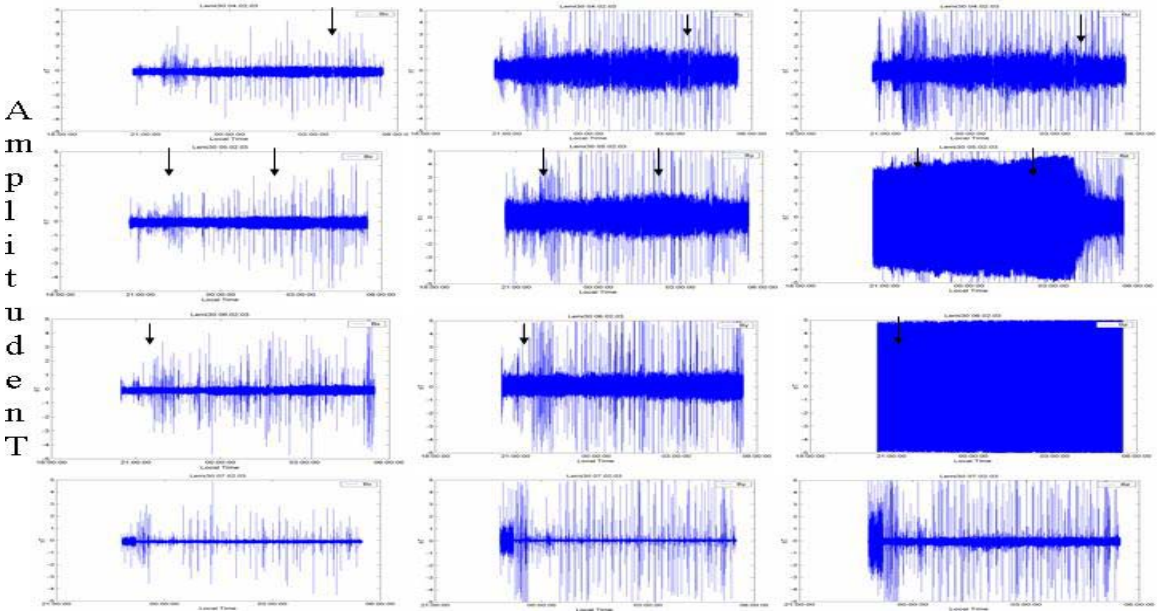

Fig. 2

Here we show the data for four days from 4 February 2003 to 7 February 2003 and the largest amplitude enhancements can be seen in the Z components on 5 and 6 February 2003. The amplitudes of Y and Z components on 4 February 2003 are also enhanced as compared to the usual normal amplitudes. The starting times of the enhancement cannot be determined because they occurred some time during day hours when the experiment was switched off, but the end times can be seen from the data clearly. The enhancement of 5 February 2003 reduced to about normal level around 0400hrs (on 6 February 2003), and that of 6 February 2003 returned to normal about half an hour before midnight of 6/7 February 2003.

In Fig. 3 we present the results of statistical analysis of the data. In fact, we have determined the mean value (m) and standard deviation (σ) using the amplitude records of all the three components obtained from six months of observations. In order to distinguish the large enhancements in amplitudes enhanced amplitude flucations we have increased the domain of standard deviation to ±1.5 σ. The mean and standard deviation for all the three components are shown in the first three panels of the figure by solid lines. The amplitude variation of the three components are shown by solid curves in these three panels. Here, we find that the amplitudes of the three components are within the standard deviations during the whole period of analysis except on two days 23 November 2002 and 5-6 February 2003, when the Z components are abnormally enhanced. On 5-6 February 2003 the X and Y components are enhanced also.

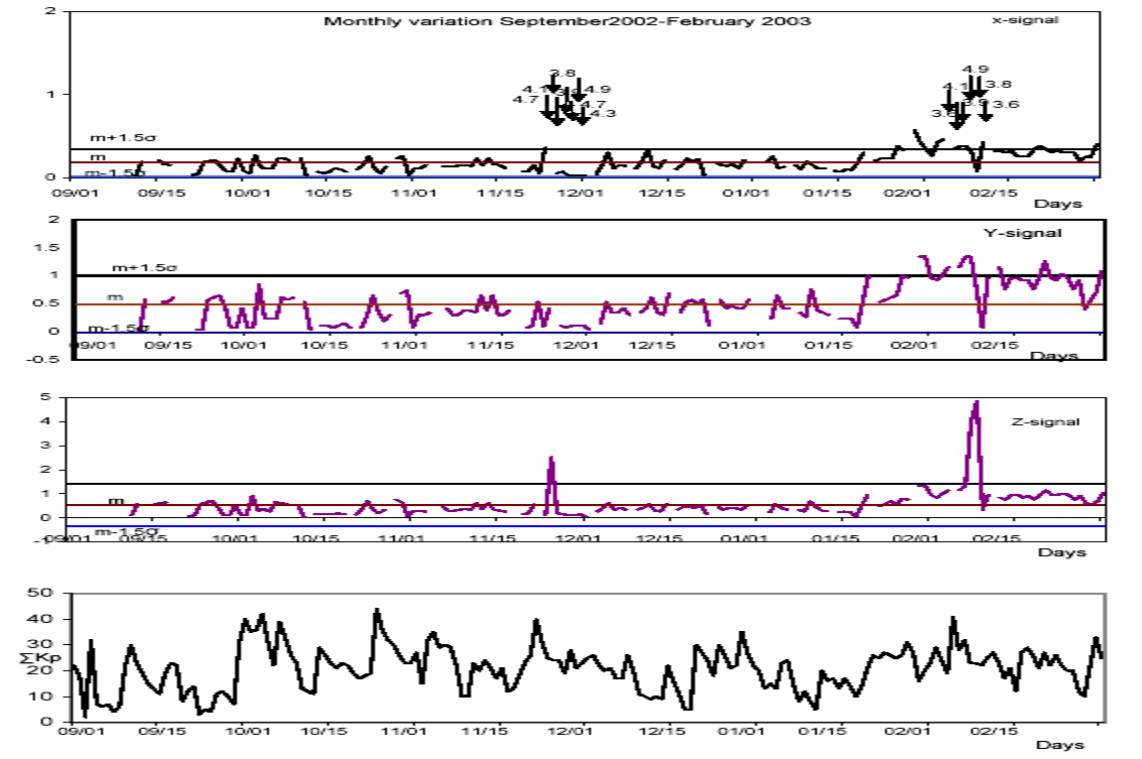

Fig. 3

Our results that the largest enhancements in the back amplitudes of the magnetic field components are due to earthquakes that occurred in India and adjoining area at distances of about 1000 km and less and not due to magnetospherically generated micropulsations is supported also by a study of variation of polarization parameter Z/X. It has been shown that the parameter Z/X <1or > 1 depending upon whether the ULF emissions belong to magnetospheric origin or earthquake origin (Molchanov et al., 1992, Haytakawa et al., 1996). The result in the top panel show that except on sum occasions the parameter has the values exceeding one mostly. The value of parameter is much larger on the two days of large enhancement in the amplitude considered in the paper. Hence, the observed enhancement in the amplitudes of the magnetic field components may possible due to earthquakes that occurred in the region.

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