

**OBSERVATIONS MADE BY DEMETER MICRO-SATELLITE FOR
ULTRA LOW FREQUENCY AND EXTREMELY LOW FREQUENCY EMISSIONS
DURING INDONESIAN EARTHQUAKE**

Shourabh Bhattacharya and A.K.Gwal

*Space Science Laboratory, Department of Physics, Barkatullah University,
Bhopal-462 026, India
Email: shourabhbhattacharya@rediffmail.com*

ABSTRACT

The beguiling nature of earthquakes and their frequent occurrences, have invigorated the scientists to investigate on the various phenomenology related to this major disaster. The field of seismo-electromagnetism refers to the electric and magnetic field anomalies observed during strong seismic events. In this paper, the authors present some vital results of electromagnetic emissions that were observed by DEMETER satellite in the Ultra Low Frequency (ULF) and Extremely Low Frequency (ELF) range during the Irian Jaya earthquake in Indonesian region (M= 6.1, latitude 3.68 °S, longitude 135.46 °E, 07:36:47 hrs. UTC and depth 35 km.) The observations are expected to emphasize on the electric and magnetic field anomalies in ULF and ELF range related to the Indonesian earthquake.

INTRODUCTION

Recent years have evidenced large number of disastrous earthquakes, which have inflicted enormous damage to mankind. The various phenomenology associated with earthquakes have acquired specific attention of the scientists. Some of the interesting aspects found to be associated with seismic activities involve variations in ionospheric parameters and the generation of electromagnetic emissions in the large frequency range from Ultra Low Frequency to High Frequency. The experimental investigation on electromagnetic effects refer to the electric and magnetic field perturbations that are associated with major geophysical hazards such as earthquakes and volcanic activities and they could be used as short term precursors for studying the related phenomena [1]. Comprehensive investigations reveal that these emissions could result due to certain properties related to lithospheric activities where the process of piezo electricity, electro kinetic effect and micro fracturing are involved [2]. The famous Loma Prieta activity is a good example of low frequency emissions observed during the earthquake [3]. Role of satellites to detect electromagnetic ELF/VLF signals has been discussed [4]. Through this paper, the authors try to emphasize on the ULF and ELF range of emissions that have been detected with the help of a low orbiting DEMETER (Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions) satellite. The earthquake occurred in the Irian Jaya region of Indonesia on 28 November 2004 (latitude 3.68 °S, longitude 135.46 °E, 07:36:47 hrs. UTC and depth 35 km) and measured an ominous 6.1 on the Richter scale. Apart from this main shock, a number of comparatively smaller magnitude foreshocks and aftershocks have also been observed in the same region.

DEMETER SATELLITE

A major advancement for detecting and evaluating the electromagnetic precursors through satellite has been accomplished by the successful launch of DEMETER (Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions) satellite from Baikonour in June 2004. This satellite is the first of its kind in the micro satellite series, merely weighs 120 kg and is developed under the inspection of CNES, France. The distinguishing feature of the satellite lies in the fact that it aims at studying the ionospheric as well as the electromagnetic precursors simultaneously associated with strong seismic events.

RESULTS AND DISCUSSION

We present results for a major earthquake that occurred in the Irian Jaya region of Indonesia (latitude 3.68 °S, longitude 135.46 °E, 07:36:47 hrs. UTC and depth 35 km) on 28 November 2004. Fig.1. shows location of the activity. The pass of DEMETER one day before the activity has been shown in Fig.2.

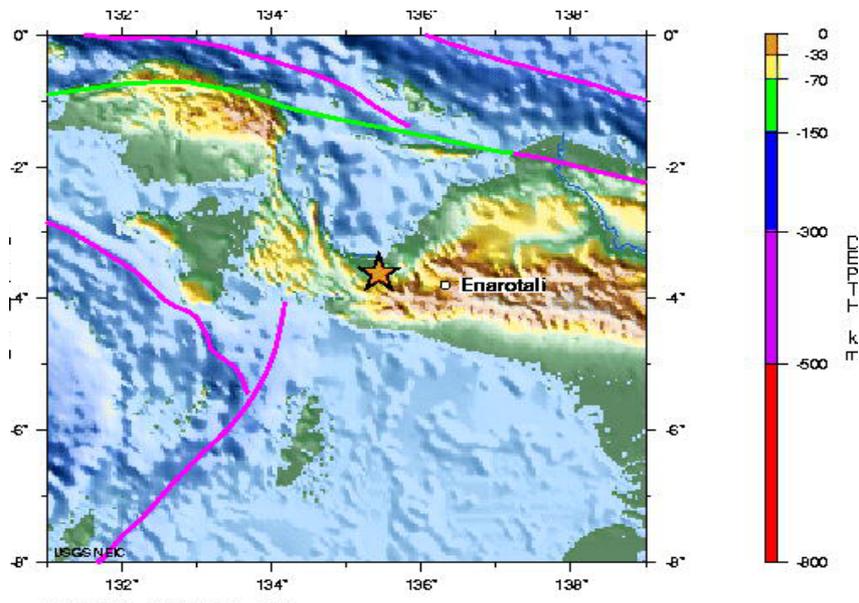


Fig.1. Earthquake location in Irian Jaya region of Indonesia near Enarotali.(courtesy USGS)

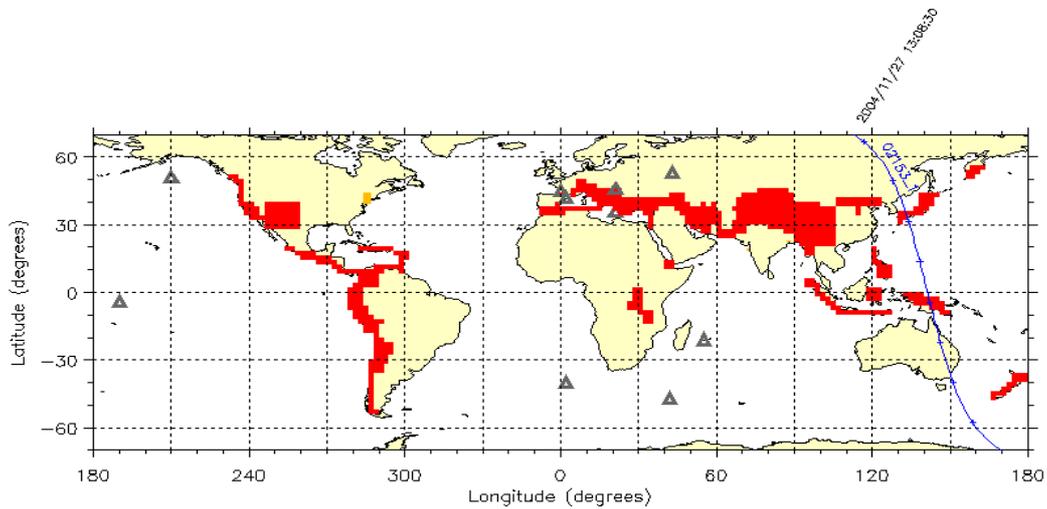


Fig. 2. DEMETER satellite orbit no. 2153 up on 27-11-2004.

The spectrogram results for VLF electric and magnetic fields are presented in Fig.3. Observations in Fig. 4. indicate that anomalous precursory ULF activity (z component) persisted around 0.095 Hz. during pass of DEMETER satellite (27-11-2004, 12:48:00 hrs. UT, orbit no. 2153 up) over the Irian Jaya region one day before the earthquake that occurred on 28-11-2004. We can also observe significant variations in the ELF magnetic field (z component) around 610 Hz. as shown in Fig. 5.

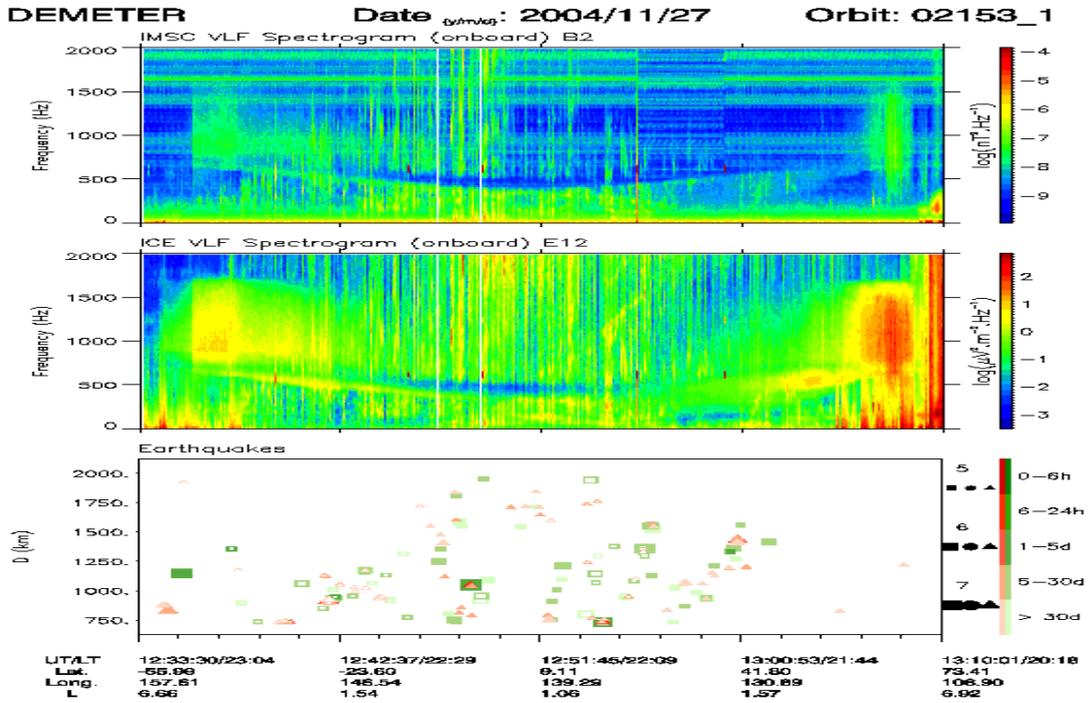


Fig. 3. Spectrogram results for electric and magnetic field components on 27-11-2004.

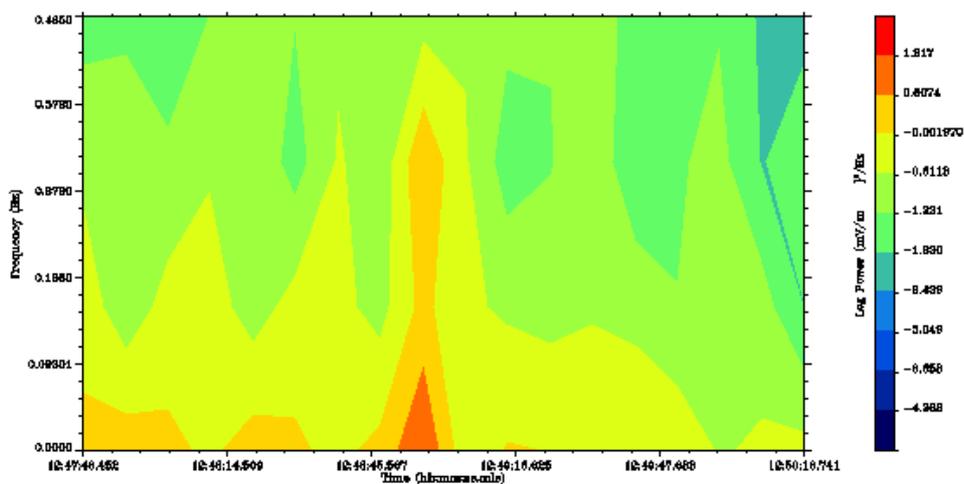


Fig. 4. Anomaly in ULF electric field variation on 27-11-2004.

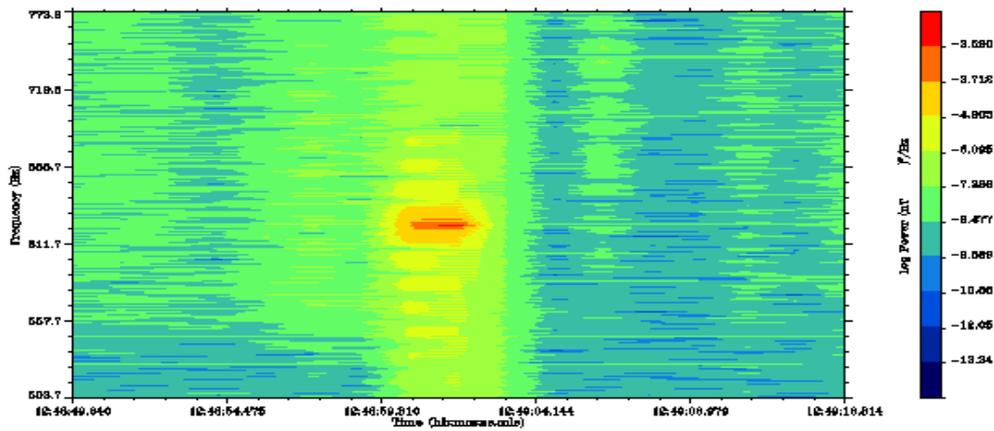


Fig. 5. ELF magnetic field variations on 27-11-2004.

CONCLUSIONS

Data from low orbiting satellite have been employed to present a correlation between seismic activity and electromagnetic emissions. The above observations suggest the presence of electromagnetic anomalies during seismic activity in Indonesian region. It also suggests dominance of ULF and ELF range as compared to other higher frequency emissions [5]. Under such conditions, long term investigations for taking up such studies are felt mandatory to evaluate the electric and magnetic field anomalies associated with earthquakes.

ACKNOWLEDGEMENTS

Authors are thankful to the members of CNES, France for their assistance in completion of the paper.

REFERENCES

- [1] M.Parrot, "Use of satellites to detect seismo-electromagnetic effects", *Adv. Space Res.* vol. 15, No.11,pp(11)27-pp(11)35, 1995.
- [2] M. Parrot, "Electromagnetic noise due to earthquakes", *Handbook of Atmospheric Electrodynamics*, (edited by H. Volland), vol. 2, 95-116, 1995.
- [3] A. Bernardi, A.C. Fraser-Smith, P.R. McGill and O.G. Villiard Jr., "ULF magnetic field measurements near the epicenter of the Ms 7.1 Loma Prieta earthquake", *Phys.Earth Planet. Inter.*, vol. 68, 45-63, 1991.
- [4] M. Parrot, "Statistical study of ELF/VLF emissions recorded by a low-altitude satellite during seismic events", *J. Geophys.Res.*, vol 99, no. A12, 23,339-23,347, 1994.
- [5] R. Kawate, O.A. Molchanov and M. Hayakawa, "Ultra low frequency magnetic fields during the Guam earthquake of 8 August 1993 and their interpretation", *Phys.Earth Planet. Inter.*, vol. 105, 229-238, 1998.