Paper No. 726. (quote when citing this article)
Eleventh World Conference on Earthquake Engineering
ISBN: 0 08 042822 3

A COMPARISON OF GROUND ELECTROTELLURIC ACTIVITY BETWEEN TWO REGIONS OF DIFFERENT SEISMICITY

F. ANGULO BROWN[1], E. YEPEZ[1], J.A. PERALTA[1] and C.G. PAVIA MILLER[2,1]
[1] Departamento de Física, Escuela Superior de Física y Matemáticas, Instituto Politecnico Nacional.
Edificio 9 U.P."A.L.M." 07738 México D.F., MEXICO.
[2] Area de Física, Universidad Autónoma Metropolitana-Azcapotzalco.
Av San Pablo 180 02200 México D.F., MEXICO.

ABSTRACT

In this work we present a comparative study of the ground electrotelluric behavior of two regions with notorious differences in their seismicity levels. The first one includes electrotelluric monitoring stations at Mexico City and Cholula Puebla. The second one embraces five stations located along the Pacific coast in the Mexican state of Guerrero. The seismic activity in this last region is much larger than that of the first mentioned zone. During long monitoring periods the patterns of ground electric field fluctuations for both zones are remarkably different. In the first region we do not find any structured behavior and the fluctuations are mainly white noise. In the second region we also find predominantly white noise, but there are certain time intervals where the noise is not white-type. These intervals seems to precede seisms with $M \geq 6$. We also analyze the electrotelluric time series by means of the power spectra displayed over the time axis. In this approach we use a frequency band between 0 and 0.015 Hz. This analysis confirms the differences previously mentioned.

KEYWORDS

Electrotelluric activity; seismicity; earthquake precursors; Guerrero State Mexico.

INTRODUCTION

In the last years, a great deal of attention has been devoted to the search of electrotelluric precursors to earthquakes (Varotsos and Lazaridou, 1991; Bernard, 1992; Parrot *et al.*, 1993). A very common way for investigating the electrotelluric field behavior is by means of shallow pairs of unpolarized electrodes buried in the ground. The distance between electrodes is typically between 50 and 2500 m (Varotsos and Lazaridou, 1991) and they are used to measure the electric potential difference over certain time interval generating a voltage time series, $V = V(t)$. Those recordings are analyzed by means of several techniques, as the spectral ones, for example. The aim of this kind of studies is to find some self-potential anomalies that could be correlated with the mechanism of preparation of an impending earthquake. Since 1992, we began a long-term program searching for seismic electrotelluric precursors at the western coast of Guerrero state in southern Mexico. This is a very active seismic zone linked to the Middle American

Trench (Suarez *et al.*, 1990). Our program included two electrotelluric control stations installed deep inland, in a zone of low seismicity more than 300 km away from the trench. Along the Guerrero's coast we have five electrotelluric stations covering approximately 300 km of the coast parallel to the trench. With this network of electrotelluric stations we have found some anomalies that seem to be associated with impending earthquakes with $M_{s,w} \geq 6$ (Yépez *et al.*, 1995). In this work we present a comparative study of the electrotelluric behavior between two control stations [Cholula, Puebla (19.1°N,98.3°W) and Mexico City (19.3°N,99.1°W)] and two coastal stations at Acapulco (16.85°N,99.9°W) and Coyuca de Benítez (17°N,100°W). This study shows that electrotelluric behavior is quite different in both zones.

THE DATA RECORDING

A typical station for monitoring the electrotelluric field consists of two pairs of unpolarized stainless steel electrodes (N-S and E-W oriented) buried 2m into the ground and 50 m apart. We register the voltage between the electrodes by a filter and an amplifier coupled to an analog to digital converter driven by a personal computer. Voltage values are stored in a magnetic disk every 2 sec (we also used a 3 and 4 sec sampling interval). The frequency cutoff of the filter was set at 5 Hz (we also used 0.1 and 10 Hz frequency cutoffs). The filters were designed in such a way that their response was flat up to 5 Hz and falling to a negligible value at 10 Hz. The power supply for filter/amplifier was a stable 12 V battery providing long periods of operation. The computer was supplied by a regulated backup system that could work up to 12 hrs during a blackout; a station could work for a few days without human assistance. Nevertheless, each station is driven by an operator who through few and short interventions maintains the station at operation and send the data toward Mexico City, where those are analyzed.

COMPARATIVE ELECTROTELLURIC STUDY

The first considered region is located at the state of Puebla Mexico. We installed a station at Cholula (19.1°N,98.3°W). Recently, González-Pomposo and Valdés-González, (1995) have reported seismicity measurements in this region, which is characterized by seisms with $M_c \leq 4$. The number of microseisms in this zone is in the order of one hundred per year. This microseismicity level is remarkably lesser than that of Guerrero State (Singh *et al.*, 1983). Moreover, in Guerrero State there are very common seisms with $M_c \geq 4$, which are quite infrequent in the Puebla region. Both considered regions have similar surfaces (in the order of 3-6 x 10^4 km^2). In our comparative study we take two Guerrero's stations at Acapulco (16.85°N,99.9°W) and Coyuca (17°N,100°W) as representative stations of the Guerrero's coast.

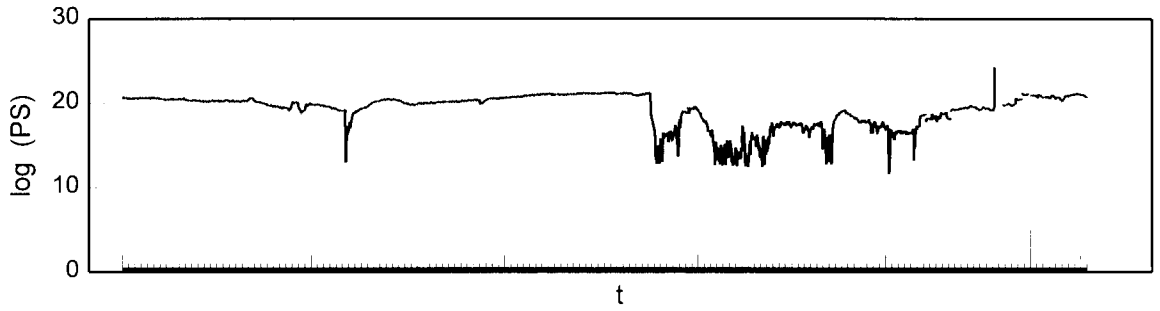

Fig. 1. Log of the Power spectrum versus time over five months of voltage registers from Acapulco station. A seism with $M_w = 6.5$ occurred at October 24, 1993. (marked with the arrow).

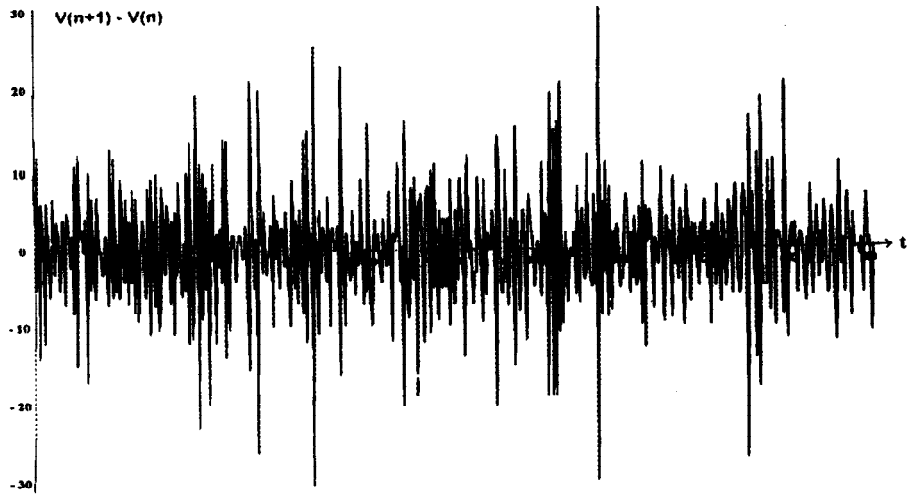

Fig. 6. Voltage increments versus time for a segment taken from a Coyuca voltage times series.

CONCLUSIONS

Our preliminary results suggest that electrotelluric activity depends on seismic activity. The two compared zones in our study have remarkable differences in their seismicity levels, and seemingly this difference is translated to remarkable differences in electrotelluric behavior. This fact is observed through both the ULF-behavior and a brief noise analysis. However, further studies are necessary to confirm our observations. A possible physical explanation of our electrotelluric study would arise from the electrokinetic effect.

Acknowledgments. We thank financial support from Departamento del Distrito Federal (Mexico City Government). We also thank partial support from COFAA-IPN Mexico. We acknowledge to the Servicio Sismologico Nacional that kindly provide us with the seismological data.

REFERENCES

Bernard, P. (1992). Plausibility of long distance electrotelluric precursors to earthquakes. *J. Geophys. Res.*, **17**, 17531-17546.

González-Pomposo, G.J. and C. Valdés-González (1995). Seismicity of the State of Puebla, Mexico, 1986-1989. *Geofi. Int.*, **34**, 221-231.

Jouniaux, L. and J.P. Pozzi (1995). Streaming potential and permeability of satured sandstones under triaxial stress: Consequences for electrotelluric anomalies prior to earthquakes, *J. Geophys. Res.*, **100**, 10197-10209.

Parrot, M., J. Archache, T.J. Berthelier, E. Blanc, A. Deschamps, F. Lefeuuvre, M. Menvielle, J.L. Plantet, P. Tarits and J.L. Villain (1993). High-frequency seismo-electromagnetic effects, *Phys. Earth. Planet. Inter*, **77**, 65-83.

Plotnick E.R. and K. Prestegaard (1993). *Fractal analysis of geological time series in Fractals in geography*, (Nina Siu-Ngan Lam and Lee De Cola Ed.), Prentice Hall, N.J.

Singh, S.K., M. Rodríguez and L. Esteva (1983). Statistics of small earthquakes and frequency of occurrence of large earthquakes along the Mexican subduction zone, *Bull. Seism. Soc. Am.*, **73**, 1779-1796.

Suárez, G., T. Monfret, G. Wittlinger and C. David (1990). Geometry of subduction and seismogenic zone in the Guerrero gap, Mexico, *Nature,* **345**, 336-338.

Varotsos, P. and M. Lazaridou (1991). Latest aspects of earthquake prediction in Greece based on seismic electric signals, *Tectonophysics,* **188**, 321-347.

Yépez, E., F. Angulo-Brown, J.A. Peralta, C.G. Pavía and G. González-Santos (1995). Electric field patterns as seismic precursors, *Geophys. Res. Lett.*, **22**, 3087-3090