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Precursory Anomaly in VLF/LF Recordings Prior to the July 30th, 2009

Aydin Buyuksarac (1), Ali Pınar (2), and Sinan Kosaroglu (3)

(1) Canakkale Onsekiz Mart University, Department of Geophysics, Canakkale, Turkey (absarac@cumhuriyet.edu.tr), (2) Istanbul University, Department of Geophysics, Avcılar, Istanbul, Turkey(alipinar@istanbul.edu.tr), (3) Cumhuriyet University, Department of Geophysics, Sivas, Turkey

An international project network consisting of five receivers for sampling LF and VLF radio signals has been going on to record the data in Europe from different transmission stations around the World. One of them was established in Resadiye, Turkey, located just on the North Anatolian Fault Zone. The receiver works in VLF (16.4, 21.75, 37.5 and 45.9 kHz) and LF (153, 180, 183, 216 and 270 kHz) bands monitoring ten frequencies with one minute sampling interval.

An earthquake of Mw = 4.9 took place 225 km away from the VLF/LF station at the eastern tip of the Erzincan basin at 4 km depth on July 30, 2009. We observed some anomalies on the radio signals (37.5 and 153 kHz) that initiated about 7 days before the earthquake and disappeared soon after the earthquake. We attribute this anomaly to the Mw=4.9 earthquake as a seismo-electromagnetic precursor. The radio anomaly that appeared 7 days before the occurrence of the 2009 Erzincan earthquake is in good agreement with other results indicating precursory anomalies in the project network mostly observed in seismically active countries such as Italy and Greece.

Several data processing stages were applied to the data. Firstly, we processed the time series of the radio signals to understand how the frequency content of the anomaly differs from that of the normal trend. For this purpose we selected two time windows; one covering the anomaly period and the other spanning a normal period. The selected time window length was a 6 day. The sampling interval and the length of the time window limit the observed spectra from 120 seconds to six days. We identified a significant bias (drop) for the signal energy of the anomaly period at the whole frequency band. Secondly, in order to clearly depict the anomaly we estimated the daily Rayleigh Energy of the calculated spectra following the Parseval's theorem. We initiated the estimations well before the anomaly period. Such calculations gave an obvious sign for the impending event. Thirdly, we constructed a spectrogram including the whole frequency band of the data from fortnight before the earthquake to a week after the earthquake. The strongest anomaly in the spectrogram was identified for the periods larger than 60 hours.

In earthquake prediction studies it is crucial to understand the source of the anomaly. Since the sources of the anomaly we are interested in are the earthquakes we tried to derive information on the properties of the earthquake that generated our anomaly in the radio signals. Within this frame, we analyzed the broadband data at several local seismic stations that recorded the event and estimated source parameters such as centroid moment tensor, source radius and stress drop. Our analysis shows that the event was a shallow one showing predominantly normal faulting mechanism and was associated with extremely high stress drop with an average value of about 250 bars.