Observation of Earth's magnetic field in search for earthquake precursors

Shahrokh Pourbeyranvand

International Institute of Earthquake Engineering and Seismology
E-mail: beyranvand@iiees.ac.ir

The changes in the magnetic field associated with the variations in the stress field were first observed by Stacey (1963) and Nagata (1969). Tectonomagnetism involves the variation of the magnetic field associated with the occurrence of the seismic events (Parkinson, 1983; Edwin et al., 1983). Reikitaki (1976) and Melon et al. (1998) studied the geomagnetic effect of earthquakes. A comparison of geomagnetic and seismic data shows the relation between these two quantities is quite evident. (Liu et al., 2006; ; Hayakawa et al., 2007; Ghamry et al., 2013).

In this study, the data are driven from the INTERMAGNET website. Some additional required data such as geomagnetic storm indices are extracted from Solar-Geophysical Data section of National Centers for Environmental Information and Space Weather Archive websites. According to Dobrovolski's relation $P=10^{0.43M}$ (Dobrovolski et al. 1979), it is expected that the precursory phenomena will be observed within a radius up to1000 km from the earthquake for a 7 magnitude earthquake. Among the various magnetic components, the X or horizontal components are usually more suitable for the proposed processing method.

The characteristic curve method is proposed here to reduce the effect of factors affecting the Earth's magnetic field at the magnetic stations' location. After identifying the station's geomagnetic nature, or in other words, the repetitive effect of daily variations observed at the station, the relevant effect is reduced from the data. These anomalies are then compared with the region's seismic activities by examining the anomalies which are more apparent after the above steps. Indeed, we separate the noise from the desired signal and finally the observed anomaly is more distinct. This way the usability of the data as an earthquake precursor is enhanced.

To display the geomagnetic data under discussion, one must first correct the values which are not correctly recorded, by replacing them with the previous or an average value. After selecting the appropriate time interval using the available data from each station, the repeated plot of the observed values over 24 hours interval shows the station's geomagnetic nature in question. This plot shows the characteristic curve.

Thus, each ground station has a characteristic curve for each magnetic field component, which estimates the expected values of these components within the

desired time range. By subtracting these values from the geomagnetic record, it is possible to obtain purer anomalies and correlate them with the seismic activity. After getting the characteristic curve and subtracting it from the record to reduce the effect of the daily variations, the anomalies observed before the earthquakes are more intense. Based on the obtained results, anomalies in the magnetic field can be considered as earthquake predictions.

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