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Seismo-geomagnetic anomalies and $M \geqslant 5.0$ earthquakes observed in Taiwan during 1988–2001

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Abstract

In this paper, a relationship between $M \geqslant 5.0$ earthquakes and diurnal variations of the total geomagnetic field recorded at eight magnetometers in Taiwan during 1988–2001 are examined. One magnetometer station was setup in a seismic quiet area as a reference, while the others were located in areas of high seismicity or crustal activity observing earthquake effects. We compute the distribution of diurnal range ratios between the reference and each observation station for the entire thirteen years as a background and compare it with the monitored distributions during five different time periods before and after an $M \geqslant 5.0$ earthquake occurring within a distance of 50 km from the observation station. Three specific earthquakes with different magnitudes, including the $M = 7.3$ Chi–Chi earthquake show that the monitored distributions one month before and during the month of the earthquakes significantly depart from the associated background. It is found that changes of underground conductivities and currents around the forthcoming epicenter significantly affect the near-by geomagnetic field on the ground during the earthquake preparation period. The statistical results demonstrate that the monitored distributions of geomagnetic anomalies are highly related to the focal mechanism.

Keywords: Geomagnetism; Magnetic anomaly; Diurnal variations; Earthquake forecasts

1. Introduction

Many examples of geomagnetic changes associated with earthquakes have been reported (see papers listed in Hayakawa and Fujinawa, 1994; Hayakawa, 1999; Hayakawa and Molchanov, 2002). Chen et al. (2004) found that temporal changes of geomagnetic field recorded near coming epicenters tended to be constants and that the associated annual change rate approached a small value, from few months to two years before large earthquake occurrences. These long-term datasets are certainly essential for exploring the relationship between geomagnetic changes and earthquake occurrences. However, their shortcoming is the data sampling rate being generally too low for detailed quantitative analysis.

By contrast, a good deal of researches on geomagnetic variations in the ultra-low-frequency (ULF) ranges associated with large earthquakes has been reported (see papers listed in Hattori, 2004). The results show that ULF geomagnetic anomalies possibly appear within a distance of 50–100 km from forthcoming epicenters several hours to few months prior to large earthquakes. Although there appeared many such convincing evidence, the ULF analysis requires rather sophisticated signal processing and relatively high data sampling rate.

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