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PCA-based Geomagnetic Diurnal Variation Analysis: Case Study of Wenchuan Earthquake

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The precursory geomagnetic changes, called Seismic Magnetic Signals (SMS) , have been reported in various frequency ranges. ULF is the most promising one of the ranges to study SMS because of skin effect. So far, a number of convincing evidence of ULF magnetic signature (especially in the period 100 s) has been reported. Different from those in early studies, this research is mainly focus on SMS of longer periods. In order to distinguish earthquake-related magnetic phenomena from anomalies associated with other factors, we have developed geomagnetic diurnal variation analysis method based on principal component analysis (PCA).

As one of the most important geomagnetic changes, geomagnetic diurnal variation which is mainly composed of four harmonics (24h, 12h, 8h, 6h), generally depends on two causes. The main one is perturbations in the ionosphere, and the other one is underground resistivity. Hence the diurnal variation of magnetic stations may contain some information on the local underground conductivity structure.

Considering that PCA method has a strong capability of revealing weak signals from background by detecting the causes of different signature, here we apply it to study geomagnetic diurnal variation to extract information about local underground resistivity and electromagnetic disturbance which are possibly due to the local seismogenic process.

In this paper, we would like to show results of the proposed method for the Wenchuan earthquake (Ms 8.0, depth 14km) occurred in Sichuan, China, on May 12, 2008. We analyzed the data observed at Chengdu, Hanzhong, and Tianshui Magnetic Observatory. The epicentral distance is about 40 km, 400 km, and 420 km respectively.

After applying the PCA method to the geomagnetic diurnal data, it is found that the contribution of the second principal components, which may relate with the local underground conductivity structure and/or the local electromagnetic disturbance possibly due to the local seismogenic process, increased significantly after the main shock. This study shows that the above proposed methodology would be effective in revealing possible earthquake-related signals from background disturbance.

Keywords: Seismic magnetic signals (SMS), Geomagnetic diurnal variation,
Principal component Analysis (PCA), Wenchuan earthquake