

Waveform analysis and statistical study of ULF seismo-magnetic phenomena in Kanto, Japan

Peng Han, Katsumi Hattori, Febty Febriani, Hiroki Yamaguchi, and Chie Yoshino

Graduate School of Science, Chiba University, Japan

Recently electromagnetic phenomena have been considered as a promising candidate for short-term earthquake prediction. And especially passive ground-based observation of ULF (ultra low frequency) geomagnetic signatures is considered to be the most promising method for seismo-magnetic phenomena study due to deeper skin depth. In order to clarify the earthquake-related ULF magnetic phenomena, a sensitive geomagnetic network has been installed in Japan and plenty of data associated with moderate-large earthquakes have been accumulated. In this study, we have analyzed geomagnetic data observed during the past decade in Kanto area, Japan.

First, the ULF magnetic signals at the frequency 0.01Hz have been investigated. We have applied wavelet transform analysis to the 1Hz sampling data observed at three magnetic observatories in Boso Peninsula (Kiyosumi, Uchiura, and Fudago) and Izu Peninsula (Seikoshi, Mochikoshi, and Kamo) , respectively. The signature at the 0.01Hz frequency band has been revealed and daily average energy has been computed. In order to minimum artificial noise, we only use the midnight time data (LT 1:00~4:00). And to remove influences of global magnetic perturbations, the standard station Kakioka has been chosen as a reference station.

After comparing the results at the stations in Boso and Izu Peninsula with those at the Kakioka reference station, it is found that there are several local energy enhancements which only appear in Boso or Izu area. Especially for the case studies of the 2000 Izu Island earthquake swarm, the 2005 Boso M6.1 earthquake, and the 2002 and 2007 Boso slow slip events, significant anomalous behaviors have been detected.

Then, we have applied superposed epoch analysis (SEA) to the above results and make a statistical study. The statistical results have indicated that before an earthquake there are clearly larger probabilities of anomalies than that after the earthquake. Statistical results of daily counts were found significant at about three weeks before, one week before, and one day after the event for Izu area and around two weeks before, few days before, and one day after the event for Boso area, respectively

Finally, we carried out waveform analysis to investigate the detailed waveform of unusual



electromagnetic signals. Preliminary results have indicated that the electromagnetic signals associated with the two slow slip events have some coherence with experimental and theoretical results of electrokinetic phenomena.

Acknowledgements

The authors would like to thank the Japan Meteorological Agency for providing geomagnetic data and the earthquake catalog. Also the authors are grateful to the World Data Center for Geomagnetism at Kyoto University for geomagnetic indices. This research is partly supported by a Grand-in-Aid for Scientific Research of Japan Society for Promotion of Science (19403002) and National Institute of Information and Communication Technology (R & D promotion funding international joint research).

References

- [1.] Mizutani, H., T. Ishido, T. Yokokura, and S. Ohnishi. Electrokinetic phenomena associated with earthquakes. *Geophys. Res. Lett.*, 3, 365–368, 1976.
- [2.] Hayakawa M, Molchanov OA. *Seismo electromagnetics Lithosphere–Atmosphere–Ionosphere coupling*. Terra Scientific Publishing Company (TERRAPUB), Tokyo, 2002
- [3.] Uyeda S, Hayakawa M, Nagao T, Molchanov O, Hattori K, Orihara Y, Gotoh K, Akinaga Y, Tanaka H. Electric and magnetic phenomena observed before the volcano-seismic activity in 2000 in the Izu Island Region, Japan. *P Natl Acad Sci USA* 99(11): 7352–7355, 2002
- [4.] Hattori K, Takahashi I, Yoshino C, Isezaki N, Iwasaki H, Harada M, Kawabata K, Kopytenko E, Kopytenko Y, Maltsev P, Korepanov V, Molchanov O, Hayakawa M, Noda Y, Nagao T, Uyeda S. ULF geomagnetic field measurements in Japan and some recent results associated with Iwateken Nairiku Hokubu earthquakes in 1998. *Phys Chem Earth* 29: 481–494. 2004.
- [5.] Uyeda S, Kamogawa M, Tanaka H. Analysis of electrical activity and seismicity in the natural time domain for the volcanic-seismic swarm activity in 2000 in the Izu Island region, Japan. *J Geophys Res* 114: B02310, 2009.