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Signal Discrimination of ULF (Periods T < 1,000 s) External Source Field with the Use of Interstation Method with Wavelet Transform

M. HARADA[1], K. HATTORI[2], I. TAKAHASHI[1], C. YOSHINO[2], and N. ISEZAKI[3]

[1]*Graduate School of Science and Technology, Chiba University, Japan*
[2]*Marine Biosystems Research Center, Chiba University, Japan*
[3]*Department of Earth Sciences, Faculty of Science, Chiba University, Japan*

Electromagnetic phenomena preceding large earthquakes have been reported in various frequency ranges. Ground-based observation of ULF geomagnetic field change is one of the most promising methods to monitor the seismic and volcanic activities due to the skin depth. Additionally, the precursory geoelectric potential changes called as "Seismic Electric Signals (SES)", have been reported by the VAN group. In order to verify earthquake-related electromagnetic phenomena and clarify the possible physical mechanisms, a network observation has been established in Japan.

The observed ULF magnetic and electric potential data are superposition of some possible signals in the periods of 1 – 1000 sec. The most intense signal is the external source field associated with the solar-terrestrial interactions such as the geomagnetic pulsations and geomagnetic storms, and their inductive field, which appear simultaneously in the global (hundreds km) scale. The signals associated with the crustal activity are very weak in general, and therefore the signal separation is of significant importance.

As for ULF geomagnetic data, we have already developed an effective method for elimination of the external source fields, which is based on the interstation transfer function (ISTF) method with wavelet transform [1]. The performance of the designed filter is found to be quite well and geomagnetic pulsations are effectively reduced.

In this paper, we extend the ISTF approach with wavelet transform to the geoelectric potential data with the aim of reducing the inductive fields due to geomagnetic field changes in the frequency range of 0.001 to 1 Hz. The proposed method was applied to the data observed at the electromagnetic sensor array in the Boso Peninsula, Japan. The data obtained at Kakioka Magnetic Observatory, Japan Meteorological Agency has been used as the remote reference. In order to verify the possibility of the global electromagnetic field reduction and the detectability of possible SES related with the earthquakes, we adopted to the virtual data, which means that the simulated earthquake-related signals added to the observed electric data in the active geomagnetic storm period. The results indicate that almost whole of the inductive field was eliminated successfully, while the additive simulated signals were detected with keeping their waveforms. This implies that the discrimination of desired electromagnetic phenomena will be possible even in the period of high geomagnetic activity, when SES signals masked completely and it is impossible to be recognized by eyes.

Reference

[1] M. Harada, K. Hattori, and N. Isezaki : "Transfer function apporach to signal discrimination of ULF geomagnetic data", *Phys. Chem. Earth*, 2004, *in press*