E059-P002 Time: May 29 17:00-18:30

An Application of Principal Component Analysis to Multiple ULF Geomagnetic Data Associated with 2000 Izu Islands Earthquake Swarm

Katsumi Hattori[1], Shintaro Miyazaki[2], Chie Yoshino[3], Kaoru Gotoh[4], Nobuhiro Isezaki[5], Masashi Hayakawa[6]

[1] MBRC, Chiba University, [2] Dept. of Earth Sci., Fac. of Sci., Chiba Univ., [3] MBRC, Chiba Univ., [4] ECU, [5] Dep. Earth Sci,Chiba Univ., [6] Univ. Electro-Comms.

Electromagnetic phenomena are recently considered as a promising candidate for short-term earthquake prediction. There have been accumulated a lot of evidence of precursory signatures in a wide frequency range (DC-VHF). The ULF range is one of the most promising phenomena. The purpose of this report is to find out any ULF geomagnetic signature for Izu Islands Earthquakes in July, 2000.

On June 26, 2000, an official alarm was issued for imminent volcanic activity of volcano Oyama, Miyake-jima Island by JMA based on increased occurrences of small earthquakes under the island. In the next morning, at several km west of the island, there was an indication of undersea eruption and the seismic swarm activity started almost simultaneously. Earthquake epicenters also migrated from the island first westward and then northwestward. There are five large earthquakes (M larger than 6) during this activity.

The ULF geomagnetic data observed at Izu and Boso Peninsulas in Japan have been investigated. Three stations are closely distributed in both peninsulas (three for Izu peninsula, three for Boso peninsula). The inter sensor distance is about 5 km. Torsion type magnetometers with three components are in operation at 50 Hz and 12.5 Hz sampling rate there. The rough epicentral distances are about 80-100 km for Izu stations and about 130-150 km for Boso stations.

In order to extract any ULF signature of Izu Islands Earthquakes, the principal component analysis (PCA) has been performed. We analyzed data of NS component from February, 2000 to February, 2001 to investigate the long-term variation. The procedure of PCA is as follows. First, the ULF waveform data are down sampled and they are fed to numerical narrow-band pass filters without delay. We adopt PCA to the time series data of 30 minutes observed at closely distributed stations. Consider that data are given by yi = [yi(t1), yi(t2),.., yi(t1800)]T, Then, the data matrix Y = [y1, y2, y3]T is obtained, where T means transpose. Then, we calculate the variance matrix R = YYT. After that eigenvalue decomposition of R have been done, R = VLV T where L is eigenvalue matrix with l1, l2 and l3 and V is the eigenvectors matrix.

In this paper, we discuss the temporal evolution of the amplitude of each eigenvalue at a particular frequency of 10 mHz. The result of Izu group showed that the largest component sqrt (l1) had a clear correlation with the geomagnetic activity described in Ap index. Therefore, the first principal component is reasonably considered to be the effect of geomagnetic variation. The second largest component sqrt (l2) showed a clear daily variation reminiscent of human activity: high at work hours, low at lunch time, night time and weekends. sqrt (l3), which was about an order of magnitude smaller than the first, is the third possible noise candidate. Earthquake related ULF emissions are possibly included in this component. Because of the low contamination of man-made noises, the variation of midnight time has been paid attention. The level of sqrt (l3) begins to increase from the end of March, 2000. A sharp decrease of in the intensity of sqrt (l3) about 10 days before the first large earthquake on July 1, followed by an abrupt increase a few days before the first large earthquake. Very Similar behaviors are noticed for both the second and third earthquakes on July 9 and July 15. This kind of variation cannot be seen with the geomagnetic variation. Therefore, the temporal evolution in sqrt (l3) at night time is highly suggestive of the ULF emissions related with Izu Islands earthquake swarm. On the other hand, the variation of sqrt (l3) in nighttime at Boso peninsula indicates decrease of level from the middle of April to before the earthquake. It is the inverse of the Izu peninsula variation. We cannot find the remarkable anomalous changes a few days before the earthquakes with M6 class either.