

A new system for measuring EM waves in the deep under the ground and detection of electric pulses related to the Taiwan Earthquake

Minoru Tsutsui[1]

[1] Inst. Computer Sci. Kyoto Sangyo Univ

A new system for measuring electromagnetic waves in the deep under the ground has been developed in Kyoto Sangyo University. The main part of the system is borehole of 100m in depth. The sensitivity of an electric field sensor inserted into the hole is about $0.01 \text{ micro-V/m}/\sqrt{\text{Hz}}$. We started its test observation since September 1999. Many groups of electric pulses began to appear from around Sep.14. When the pulse intensity was on the way reaching its maximum value, Taiwan Earthquake occurred at 02:45 JST Sep.21.

This system which is able to detect precise value of electric field in the deep under the ground would be useful tool for studying the earthquake and its related wave phenomena in the earth.

In order to study the mechanisms of excitation and propagation of EM waves in the earth, a new system for measuring EM waves in the deep under the ground has been developed in Kyoto Sangyo University. This system mainly consists of three parts. One is the borehole for inserting sensors, which is 10 cm in diameter and 100 m in depth (see Figure). In order not to disturb the wave fields in the earth, the hole structure was made up from non-conducting materials, and the hole inside is waterproof. The second is a new type of electric field sensor inserted into the borehole. Since the noise level of the sensor is -135 dBV/ $\sqrt{\text{Hz}}$, its sensitivity of electric field is about $0.01 \text{ micro-V/m}/\sqrt{\text{Hz}}$. The third is the data analysis and display system. The noise detected in the deep under the ground is AD converted and analyzed by FFT routine and displayed on a CRT of the computer as a frequency color dynamic spectra (f-t diagram), in which the color indicates the field intensity. This display provides us a strong impression on the wave property and its behavior.

Using the sensor, we obtained a depth dependence under the ground of the field intensity. Intensities which is related to the antenna impedance at every level under the ground, suggests that the electric conductivity of the medium at levels to 50m under the ground is larger than that of the deeper levels. This suggests that electromagnetic waves in the earth could propagate as a waveguided mode below the conductive layer.

A continuous measurement using the sensor fixed at 90 m under the ground has been started since September, 1999. Many groups of electric pulses began to appear from Sep. 14, and their intensities increased from 17:00 JST Sep. 20, and at 02:45 JST Sep. 21, Taiwan earthquake occurred.

Although the intensity of the electric pulses dropped about 6 dB during about 10 min just after the earthquake, after that it began to increase again reaching its maximum value ($0.1 \text{ micro V/m}/\sqrt{\text{Hz}}$) at one hour after the earthquake. The frequency dynamic spectra represents lower cutoff frequency (below few hundreds of Hz) of the pulse spectra. This suggests that the detected pulses might have been propagating as a waveguided mode below the conductive layer under the ground.

The newly developed measuring system has manifested to be useful tool for the future study of the electromagnetic phenomena related earthquakes.

