

Propagation of earth-originating electromagnetic pulses

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In order to clarify the validity of electromagnetic (EM) pulse generations in the earth when stress impacts were imposed to the earth-crust at a stage prior to earthquakes, we have been conducting EM measurements, using sensor systems installed at the bottom of a 100 m-deep borehole and on the seashore in Shirahama-Cho, Wakayama prefecture, Japan. The sensor system was composed of three directional magnetic search coils and a vertical electric linear dipole antenna. The magnetic and electric field data detected by the sensor system were used for obtaining arrival directions of the EM pulses. Through 16-bit analogue-to-digital (AD) converters with a sampling period of 30 micro-second, signal waveforms of detected electric and magnetic fields were acquired simultaneously into observation computers whose clock was synchronized with GPS time. Through continuous monitoring of waveforms at the vertically different levels, we finally discovered earth-originating EM pulses, distinguishing up-propagating waves in the earth, amongst a great amount of incident pulses from the sky including pulses generated by lightning discharges, in which a large time-delay of about 30 micro-second were found in waveforms detected on the seashore against those detected at the bottom of the borehole. This long time-delay was supposed to be caused by the electrically high conductivity of the medium of the land layer.

We surveyed entire EM pulses over a continuous observation period of 115 days from 28 April to 20 August, 2009. During this period, several hundred were counted even on calm days and several thousand on stormy days in the rainy season. Their counts are presumed to be mainly due to lightning discharges. Of these, earth-originating EM pulses numbered several tens per day on average. The resultant variation in the histogram of the earth-originating EM pulses has no correlation with that of all detected EM pulses.

We also found that almost of all detected earth-originating EM pulses were far field mode, judging from the in-phase relation between waveforms of electric and magnetic fields of EM pulses. This fact suggests that earth-originating EM pulses had been propagating for long distances in the earth. For clarifying propagation distances of earth-originating EM pulses in the earth, we are going to identify source locations of earth-originating EM pulses using their arrival directions measured at short-separated two observation points. For this purpose, we are planning to construct the third observation point near the Shirahama site.

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