FDTD analysis of ELF/VLF wave field induced by underground source

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We have been analyzing the propagation mechanism of the ELF/VLF waves from the underground source via FDTD method. As a result, the magnetic field intensity on the ground surface induced by the underground electric dipole is in an observable range especially in the ELF band. The lower the frequency is, the larger polarization is found on the ground surface nearby the wave source. In case that the ground consists of two different media regarding the vertical boundary as a fault, the large polarization can be seen along the fault on the ground surface. The polarization analysis is one of the important approaches to identify the seismic electromagnetic signals in ELF/VLF band.

In recent years, many papers report electromagnetic events related to earthquakes. The anomalous propagation due to the ionospheric perturbation is detected before and after the earthquakes. The electromagnetic pulses, which are deduced to be originated to the crack of rocks in the ground, are observed around the epicenter

in ELF/VLF band. The increase in the polarization (ratio of the vertical magnetic field component to the horizontal) is also reported in lower frequencies.

We have been analyzing the propagation mechanism of the ELF/VLF waves from the underground source via finite difference time domain (FDTD) method. The FDTD method has the advantage of calculation of transient wave field in arbitrary inhomogeneous media.

According to our simulations with the homogeneous ground, the magnetic field intensity on the ground surface induced by the underground electric dipole is in an observable range especially in the ELF band. The lower the frequency is, the larger polarization is found on the ground surface nearby the wave source. The vertical component of the magnetic field exceeds the horizontal one in the ELF band. In case that the ground consists of two different media regarding the vertical boundary as a fault, the large polarization can be seen along the fault on the ground surface. The propagation of the ELF pulse using sinusoidal wave with Gaussian amplitude is also evaluated, and it is confirmed that the results are essentially same as the dipole case.

The polarization analysis is one of the important approaches to identify the seismic electromagnetic signals in ELF/VLF band.