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Seismic waves radiated from nonlinear vibration source and prevision of earthquakes

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This study describes the vibration characteristics of hypocenters using actual data and methods used in sound vibration analysis. Recent earthquakes near Mt. Fuji are used to analyze the earthquake hypocenter vibrations. Earthquakes larger than M5.0 occurred four times between 2009 and 2012 in this area. Earthquake signals were processed using the time-reversal method and simulated to obtain the time-reversal pulse. The frequency of the time-reversal pulse depends on the azimuth. The peak frequency is the frequency of the maximum frequency spectrum; it too depends on the azimuth. These dependencies are caused by nonlinear acoustic radiation in active faults. Such phenomena suggest that the vibration source moves at a high speed similar to a parametric source, which suggests the existence of points with unique spectra along the radiation direction, owing to parametric effects, i.e., the so-called parametric spots.

Further, these observations were common in the precursor earthquakes, the main shock, and the aftershocks. Hence, a dynamic model for the nonlinear vibration of the hypocenter is proposed. The model is verified by using actual earthquake data and is expected to find application in earthquake prediction by observing the waveforms of weak earthquakes.

Pavlov et al. examined nonlinear vibrations in an inhomogeneous medium and derived the equation for the Cerenkov radiation and transition radiation. The Cerenkov radiation is generated in a narrow angular range of the traveling direction near the source and the waveform is pulse-like. The transition radiation depends on the angle. The narrow beam at the radiation end has the same characteristic as the Cerenkov radiation. The peak frequency is also a function of the angle at the radiation end. On the other hand, the inhomogeneous medium structure constants are not well known. However, because the peak frequency patterns with respect to azimuth are similar for the earthquakes, the abovementioned phenomena are considered specific to the hypocenter vibrations. The earthquake data are from the Hi-net of National Research Institute for Disaster Prevention.

Keywords: Hypocenter vibration, Time reversal, Waveform of seismic wave, Transition radiation, Seismic wave propagation, Prevision of earthquakes