Random media effects on acoustic seismic coda waves in elastic solids earth

Akira Ishimaru* [(1)], Yasuo Kuga[(1)], Max Bright[(1)], and Benjamin Walborn[(1)]
(1) University of Washington, Department of Electrical Engineering, Seattle, WA 98195

Seismic waves are acoustic waves excited and propagated in the elastic solids earth. Seismic waves on the homogeneous half-space representing the earth have been studied extensively in the past. The initial short-term pulse is important and the magnitude scales are mostly based on the short term pulse. However, the seismic pulses include both coherent and incoherent components. The coherent pulse is short and produces an incoherent wave train, called the coda, due to the heterogeneous medium and multiple scattering that may last much longer than the initial pulse. The coda includes important information on the total earthquake energy and medium characteristics, and therefore careful attention to the coda waves is needed. The coda waves have attracted considerable attention in recent years. This paper is a continuation of our work that was presented at APS-URSI 2017 in San Diego, and emphasizes Rayleigh surface wave excitation and attempts to present analytical expressions of coda waves.

Seismic waves include three major components: The P (pressure) wave, the S (shear) wave, and the Rayleigh surface wave. In general, an acoustic wave in elastic solids can be expressed in terms of the scalar potential and the vector potential. This paper deals with the two-dimensional case where the scalar potential and one component of the vector potential are used. They satisfy the space-time wave equation, and for half-space earth, they must satisfy the boundary condition that normal stress and tangential stress are zero on the solid-air interface. The total wave consists of the body wave (P and S components) and the Rayleigh surface wave, and the total energy is the sum of the coherent and incoherent waves.

The complete time-space solution consists of the three components of the seismic wave: The P-wave, the S-wave, and the Rayleigh wave. The Rayleigh surface wave is expressed by the residue at the pole and is the surface wave traveling close to the surface, attenuating exponentially away from the surface. Expressions for the body wave components, P and S, can be obtained by the saddle point technique. Expressions for the coda for the wave can be obtained by using a two-frequency mutual coherence function and its approximate expression. The body waves diminish as the cylindrical wave, while the Rayleigh surface wave maintains its magnitude over a long distance and may become dominant at a long distance.