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Power-Law Decay of Direct- and Coda-Wave Amplitudes and the Fractal Distribution of Intrinsic Absorbers and Scatterers

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The maximum amplitude of seismic waves of a local earthquake decreases according to some power of distance for a wide range of distance. The coda amplitude of a local earthquake decreases according to some power of lapse time measured from the earthquake origin time. When intrinsic absorbers and scatterers are randomly and homogeneously distributed in space; however, the conventional theory predicts that the direct-wave amplitude exponential decreases with distance increasing and the coda amplitude also exponentially decreases with lapse time increasing in addition to the geometrical decay. The exponential decay of the direct-wave amplitude is inevitable in the case of homogeneous distribution.

This paper presents a theoretical model that leads to the power law decay of the direct-wave amplitude with distance and that of the coda amplitude with lapse time. We can formulate the scattering process in the framework of the radiative transfer theory when the spatial distribution of intrinsic absorbers and isotropic scatterers are fractally random and homogeneous. In the case that their fractal dimension is two, the theory exactly predicts power law decay for both the direct-wave amplitude with distance and coda-wave amplitude with lapse time. An exponential decay term for the fractal dimension 3 changes into a power law decay term for the fractal dimension 2. The difference between the direct- and coda-wave amplitudes and that between their powers are controlled by intrinsic absorption and scattering strength. It will be interesting to measure regional variation and depth dependence in those parameters from the analysis of seismogram envelopes of local earthquakes on the basis of the fractal model in relation with seismotectonic conditions.

Keywords: coda, attenuation, scattering, radiative trasnfer theory, body waves