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Earthquake Amplitudes and Crustal Attenuation in Asia and the Globe

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Seismic amplitudes are routinely measured for the estimation of earthquake magnitude. These data can also be used to interrogate the Earth's attenuation structure using seismic amplitude tomography. Amplitude tomography produces maps of crustal attenuation and is similar to conventional seismic travel time tomography, which maps velocity variations. Seismic amplitudes are influenced by source size, geometrical raypath spreading, attenuation due to intrinsic absorption and scattering, and station site gain. These effects are all included in the tomographic inverse problem and applied to data from Asia and the Globe. Data are from the Chinese National Seismic Network and one international data set from the International Seismological Center. The Chinese data cover most of China. They are measurements for the ML and MS magnitude scales and represent the amplitudes of body-waves traveling through the crust and short-period surface waves guided through the top five to ten kilometers of crust. The body-waves geometrically spread at a super-spherical rate rather than the expected cylindrical spreading. The high rate of geometric spreading is due to the effects of dispersion and leakage from the crust into the uppermost mantle. Surface waves spread in a cylindrical manner as predicted by theory. Dispersion has little effect on their amplitudes. Station site gains and corrections to the event magnitudes are small for both the inversions. Regional seismic attenuation variations are associated with the ocean-continent transition and surface rock type. The water layer creates high attenuation. Crystalline intrusive or volcanic rocks show little attenuation while active basin and fold belts show high attenuation. Data from the International Seismological Centre are from long-period surface waves that cover most of the planet. They are primarily influenced by attenuation structure in the crust but little affected by crustal thickness. As with the Chinese surface wave data, they show nearly perfect cylindrical spreading and relatively small station site gains. High seismic attenuation occurs in subduction zones, ocean ridges, and sediments. Cratons and igneous terrains have little attenuation.