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Three-dimensional attenuation models for P and S waves of the crust in southern California

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At higher frequencies ($f > 1$ Hz), amplitude variations due to anelastic attenuation and elastic scattering in the crust become more important for the accurate simulation of seismic wavefields. Southern California is an excellent natural laboratory for studying crustal attenuation, owing to its high seismicity and the dense coverage of Southern California Seismic Network (SCSN). From our 1-D frequency-dependent crustal model (Lin & Jordan, *JGR*, 2018), the depth averages of both Q_P and Q_S can be described by the same function of wavenumber k, $Q(k)$ = (240 $\pm$ 20) $k^{0.40 \pm 0.05}$ (1 km$^{-1} \leq k \leq$ 17 km^{-1}). The results are consistent with attenuation dominated by first-order Born scattering from a stochastic model of elastic heterogeneities with a root-mean-square relative amplitude of $\sim$8%, an outer scale of $\sim$10 km, a fractal dimension of $\sim$3.8, and the cutoff scattering angle of $\sim$40°. To investigate the 3-D variation of attenuation in Southern California, we analyzed P and S waveforms from 660 regional earthquakes (3 $\leq M \leq$ 5.7) recorded from 1998 to 2017 at 281 broadband stations of the SCSN. The geometrical spreading and the source parameters were accounted for by referencing the spectral amplitudes to values computed from 1-D synthetic seismograms. We used synthetic seismograms computed from our frequency-dependent 1-D model to correct the spectral amplitudes in the 1-10 Hz band, and we inverted the residuals for 3-D attenuation structure. The P-wave and S-wave data were inverted separately. Q_P and Q_S models display the similar lateral variations that are well-correlated with 3-D velocity structure. For example, there is stronger attenuation in the Los Angeles region and Salton Trough and weaker attenuation in the Peninsular Ranges and Mojave block.

Reference: Lin, Y.-P., & Jordan, T. H. (2018). Frequency-dependent attenuation of P and Swaves in Southern California. *Journal of Geophysical Research: Solid Earth*, 123, 5814–5830. https://doi.org/10.1029/2018JB015448