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Measurement of apparent attenuation in seismic sections by using waveform synthetics

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Summary

Measurement of attenuation effects on seismic waveforms is a critical part of correcting reflection seismic sections for attenuation effects. However, it is rarely noted that the reduction of spectral amplitudes and the associated phase shifts (dispersion) in a seismic record are "apparent" quantities that may not be simply related to an integral of some "material *Q*" along the ray paths. For some physical mechanisms of attenuation, no *Q* can be attributed to the subsurface, and for some other, the *Q* would be frequency-dependent. Regardless of the mechanisms, the effects of attenuation and dispersion on seismic records can be denoted by a complex-valued t^*. This parameter can be different for different attenuation mechanisms, and also for propagating P and S waves, reflections, effects thin layering, or multiples. Because such detailed t^* within a seismic section cannot be modeled directly, we propose measuring it by comparing two synthetic sections modeled in identical geometries and subsurface structures. In one of these sections, we only model the elastic wavefield, and the second section contains all desired effects of attenuation by using the appropriate attenuation mechanisms, such as viscoelastic, pore-fluid flows, solid viscosity, or wave front focusing. In order to produce the apparent t^* including the dispersion (phase shift) effects, we measure the spectral ratios between the attenuated and elastic synthetic sections, evaluated within series of overlapping time windows. The resulting "section" of t^* is utilized in two ways. First, it is compared to the attenuation model (viscoelastic *Q* in the present example) used for forward modeling. Second, attenuation-compensation of the synthetic and real data is carried out by using the detailed t^* section.