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Analysis of fracture-related seismic attenuation and scattering: insights gained through numerical modeling

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The orientation, geometry, and fill attributes of subsurface fracture networks can be characterized by seismic surveying through the study of seismic energy attenuation, wavefield scattering, and directional phase velocities. This method of understanding in-situ reservoir features is an indirect approach, however, and requires an in-depth understanding of the seismic response to each property and how the signatures of these properties combine to form what we see in seismic data. To properly control any characteristics of a fracture network for study, a model must be implemented to represent the subsurface and predict the outcome of changes in individual fracture attributes. Previous studies using finite difference modeling techniques have correlated these properties to differing patterns in energy attenuation and scattering for transversely isotropic media. For more complex media, such as orthorhombic symmetry or fracture clustering, this technique is incapable of overcoming wavefield interference and cancellation. To advance this study, I propose the use of finite element wave propagation techniques which give more freedom to modeling parameters. This freedom allows for better contouring of the discontinuous fracture interface and, therefore, can more accurately represent the reflection and diffraction off these surfaces. Through the application of this better suited method of modeling, I will be able to more accurately identify the presence of and characterize complex fracture networks.

Keywords: finite element modeling, fracture modeling, seismic attenuation, wavefield scattering