Application of Pre-Stack Kirchhoff Migration on Earthquake Source Data: Theory

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Abstract

The pre-stack diffraction stack (PreSDS) migration, also called Kirchhoff migration, is used for structure imaging on seismic data. The migration procedure can be divided into two primary steps. First of all, the migration algorithm maps the arrival waveform of each trace back to depth domain along the corresponding migration trajectories. The shape of migration trajectories, as well as the imaging condition, is controlled principally by the total travel time T which consists of the delay times between source-to-scatter, τS, and scatter-to-receiver, τR. The delay time, τS and τR, are strongly affected by the laterally varying propagation wave speed. Therefore, the shape and size of a migration impulse response in heterogeneous material corresponds to a fat ellipsoid in 3D, connecting source and receiver. The resolution depends on the pre-defined propagating velocity, frequency bandwidth of propagating waves and spatial coverage between source-receiver pair. Next step is the diffraction stacks (DS) of all partially migrated images. By stacking all migrated section together, depth imaging is then promoted by constructive interference.

Currently, several synthetic data are tested with the PreSDS migration procedures to clarify the different imaging conditions for both active- (explosive) and passive- (earthquake) source data. Making it clear helps us improve on pre-processing and processing stage. Primary concerns are the waveform contribution of direct, primaries and multiples waves, as well as the effect of focal mechanism associate with earthquake event. Different type of radiation patterns will produce variety of spatial energy distribution and phase changes from the corresponding waveform arrivals.

The goal of this research is to apply PreSDS migration to both active- (explosion) and passive- (earthquake) source seismic data with referenced velocity model. By taking the benefit of densely-occurring and depth-varying earthquake data with sufficient penetration depth, the imaged area originally limited by having poor ray coverage through utilization of active-source data could be enhanced through integrated approach.

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