Acoustic Full Waveform Inversion and Elastic Pre-Stack Inversion of the Yakutat Terrane, Gulf of Alaska

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ABSTRACT

The Yakutat-North America collision zone in the Gulf of Alaska has developed a complex subduction zone followed by major deformations such as the Chugach-St Elias mountain range creation and erosion, intensified exhumation and fold and thrust-fault formation. I utilize marine seismic reflection and refraction data from the STEEP project (ST. Elias Erosion/tectonics Project) in order to generate a compressional velocity model of the Yakutat microplate using 2D acoustic, isotropic time-domain full waveform seismic inversion (FWI). FWI is a non-linear data-fitting algorithm that aims to recover subsurface parameters using the recorded seismic wavefield. This technique consists of iteratively minimizing the misfit between the recorded and the predicted seismic data. The predicted seismic data are generated through the forward problem as the numerical solutions of the wave equation based on direct methods (gridding techniques). In this study, a 2D time-domain staggered-grid finite difference acoustic modeling scheme is implemented in order to simulate the seismic wave propagation along the Yakutat terrane. Drawbacks associated with FWI is cycle skipping during the minimization process, which results in converging to the wrong velocity model. Starting with good initial model which contains the low-frequency information can help mitigate this issue. The starting velocity model input to FWI in this case is a traveltime tomographic inversion of OBS and streamer seismic data. Data preconditioning includes muting, filtering, noise removal and amplitude rescaling of the field seismic data to match the corresponding amplitudes of the synthetic traces. The forward model is able to produce a good match between the observed and the modeled wavefiled within half the propagated wavelength. FWI results, show good correlation with the industry well. The model from FWI is used as an input to pre-stack seismic inversion in order to recover shear impedance and density along the seismic line. Extending the problem to the elastic medium is important to support more advanced seismic interpretation.

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