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Elastic parameter estimation in full waveform well-to-well tomography

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Seismic full-waveform inversion (FWI) method has been used to estimate velocity and density structures in the subsurface. The waveform analysis is a powerful tool to investigate the properties in the areas of interest, and the importance to use the waveform is widely recognized in the seismic explorations. As the wave propagation is influenced by elastic parameters, Vp, Vs, density, it is necessary to include these parameters in FWI (Virieux and Operto 2009). However, there are few previous studies dealing with density as a parameter in the application of elastic FWI. Density is usually estimated using an empirical formula such as Gardner's relationship (Gardner et al., 1974), or is fixed to a constant value. Almost all elastic FWI studies have neglected the influence of approaches how density parameter is estimated. The objective of this study is to investigate how difficult the estimation of density structure is, and propose a new approach to overcome the problem. We employ 2D numerical simulations in order to investigate the important factor in the inversion of density structure. Our results show that it is difficult to estimate density structure because density structure is less sensitive to waveform than Vp and Vs. Therefore, we hypothesize that the simultaneous inversion of Vp and density structures, using a selected dataset can improve the accuracy of the FWI. For testing this hypothesis, various ways for estimation of Vp, Vs and density using different datasets and approaches. We conclude that Vp and density structures should be estimated simultaneously in the elastic FWI, in which P-wave data separated from the seismic records is used as the input data.

Keywords: full-waveform, tomography, density