Adjoint-state Method Based Strategy for Non-linear Seismic AVO Inversion

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Seismic amplitude versus offset inversion has gained increased attention over the years and is a pragmatic tool applied to retrieve the seismic and petrophysical properties of the geological layers. The prediction of these petro-elastic properties plays an important role in litho-fluids identification and quantitative seismic reservoir characterization. However, imaging of these subsurface variables from the pre-stack seismic data requires minimizing the objective function and is generally solved by using a gradient-descent based optimization method. We have introduced a model-based non-linear AVO inversion strategy that is based on the computation of the adjoint-state gradients. The forward seismic modelling is carried out by convolving the seismic wavelet with the reflectivity series modelled by using the linearized AVO approximation. The optimization method known as L-BFGS is implemented to attain the best optimal model. The novelty of this work is the adjoint-state solution of the linearized AVO equation. This inversion method has been successfully applied on single and multi-traced seismic data simulated with different seismic noise levels. The modelled examples show that the presented non-linear inversion method accurately extract the seismic properties including seismic (P and S) wave velocities and bulk density. Even at some realistic seismic noise levels, the true and extracted model show good agreement which demonstrates the wide application to solve the AVO inverse modelling problems.