Geophysical Research Abstracts
Vol. 20, EGU2018-5440, 2018
EGU General Assembly 2018

Challenges for on-shore multi-parameter subsurface full waveform inversion

Phuong-Thu Trinh (1,2), Romain Brossier (1), Ludovic Métivier (3,1), Laure Tavard (4,1), Jean Virieux (1), and Pengliang Yang (1)

(1) Univ. Grenoble Alpes, ISTerre, Grenoble, France, (2) TOTAL EP, Pau, France, (3) CNRS, LJK, Grenoble, France, (4) Univ. Grenoble Alpes, GRICAD, Grenoble, France

Full Waveform Inversion offers the possibility to build high-resolution images of the subsurface seen by seismic waves. Reconstructed parameters are those involved in the wave propagation honored by seismic data. For on-shore acquisition usually deployed at the free surface, the influence of the highly variable shallow part (including topography effects) is quite drastic: efficient strategies are required for 3D visco-elastic anisotropic inversion.

For such purpose of crustal imaging, a time-domain approach based on spectral element methods is designed on deformed cartesian-based meshes. This workflow integrates an automatic and accurate cartesian-based mesh building with high-order shape functions to capture rapid topography variations, as well as an efficient workflow for the incident and adjoint fields computation when considering attenuation. This simple mesh design makes this finite-element approach frugal on computer resources as for finite-difference methods. Explicit detailed expressions for model parameter gradients are given for anisotropic stiffness coefficients, isotropic attenuation Q_p and Q_S parameters and density (hereafter called classes). Better understanding the different contributions on sensitivity kernels for these gradients is crucial for mitigating possible leakages between parameters of same class or of different classes.

Moreover, a nonstationary and anisotropic structure-oriented smoothing filter expressed as a partial differential equations of modified Bessel functions is implemented directly on the spectral element mesh, for model preconditioning after the computation of the data gradient. Prior geological information such as coherent lengths, dip and azimuth angles are integrated by this efficient filtering operation over the computed data gradient (regularization based on a model gradient could be handled the same way). Such information are key points for mitigating cross-talks between parameters with different impacts on seismic data and with different resolution expectation.

Numerical illustrations on Marmousi and SEAM II benchmarks illustrate the importance of each ingredient we have developed for making efficient and flexible elastic FWI for land applications.