ANISOTROPIC REVERSE-TIME MIGRATION IN TTI MEDIA

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There is increasing need in the hydrocarbon industry for reverse-time migration in TTI media. Anisotropic reverse-time migration requires more computer resources compared to isotropic migration, which is based on the acoustic wave equation. The solutions are usually obtained by finite-difference or pseudo-spectral modelling methods. Since anisotropic modelling is more demanding in terms of CPU-time and memory resources, various attempts have been made to develop so-called pseudo-acoustic wave equations for TTI media. These methods allow to propagate mainly the qP-wavefield. Besides the qP-waves some lower amplitude artifacts with considerably smaller propagation speeds are propagated too. All of these pseudo-acoustic wave equations work well if the orientation of the media's symmetry axes are aligned throughout the computational domain. However, in the general case of spatially varying symmetry axes numerical instabilities occur. These instabilities are not due to contrasts in the velocity field. They are solely due to differences in the orientations of symmetry axes. Some authors claimed to be able to avoid these instabilities. Stability could in some cases be achieved only by applying extensive smoothing of the angles of symmetry axis orientation or by using certain staggered grids which inherently apply some averaging. However, when smoothing, the advantages of grid based forward modelling schemes disappear, e.g. sharp velocity contrasts at interfaces or sharp changes of the symmetry axes. Modification of the elasticity matrix in the stress-strain relation for the elastodynamic equations of motion for anisotropic media aiming for the pseudo-acoustic case leads to numerically stable results using the pseudo-spectral Fourier-method. Since the modelling algorithm is based on the full elastodynamic equations it is computationally more costly than pseudo-acoustic methods. Also in this case the above mentioned wavefield artifact are present. The migration algorithm based on the pseudo-acoustic elasticity matrix can only image the qP-wavefield. With the same computational effort images using both, the qP-and the qS-wavefields can be obtained with a pseudo-spectral algorithm with the unmodified elasticity matrix. However, due to the fact that the qP-and qS-waves cannot be imaged independently some energy is undesirably imaged by mixed mode correlations.

References

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