Analyse de vitesse par inversion dans le domaine des données (Inversion velocity analysis in the data domain)

Yubing LI

Migration Velocity Analysis (MVA) is a technique to determine the background velocity model representing the macro structure of the subsurface. It is supposed to be a powerful tomographic imaging tool but in practice, only limited number of applications on real data have been reported. Recent studies (ten Kroode, 2012; Hou and Symes, 2015) proposed to replace migration, adjoint of Born modeling, by the asymptotic inverse in the context of extended subsurface offset domain. Following the same strategy, we develop a wave-equation based Inversion Velocity Analysis approach in the original surface-oriented shot domain and then extend it to the data domain. We derive the gradient of the modified objective function in both image- and data-domain. We aim at figuring out advantages and limitations through applications on 2D synthetic data sets by comparing both cases. The main advantage of inversion over classical migration velocity analysis is an automatic compensation for geometrical spreading and illumination, leading to more stable velocity gradient, especially after Gaussian smoothing over a wavelength distance. The image-domain method present spurious oscillations around model imprints. Consequently, a correction on objective function is necessary to get rid of such artefacts. The data-domain method shows superiority since its objective function is originally free of such artefacts.

In a correct background velocity model, conventional migration methods accurately position reflectors but generally fail to recover amplitudes, typically small scale velocity perturbations. The reason is that migration, adjoint of the modeling operator, does not compensate for geometrical spreading, uneven illumination nor limited acquisition geometry. We provide a wave-equation-based shot-profile constant density true-amplitude migration formula. This is a variant conventional approach, that better behaves in the presence of heterogeneities close to the source position. The formula is derived from the asymptotic ray- based approach, but the final expression only contains wave-equation-based operators. This pseudo-inverse produces velocity variations with correct amplitudes and phases, in the sense that Born modeling reproduces the data with good accuracy. Coupling the true amplitude migration method, that is, inversion, with velocity analysis will produce more accurate gradient for updating the background velocity.

The mission of my thesis is to take advantage of true amplitude migration method in velocity analysis to develop Inversion Velocity Analysis (IVA) and subsequently extend IVA in data domain to better retrieve the background velocity model of subsurface.

References:
- ten Kroode, F. [2012] A wave-equation-based Kirchhoff operator. *Inverse Problems*, **28**(11), 115013.
- Hou, J. and Symes, W.W. [2015] An approximate inverse to the extended Born modeling operator. *Geophysics*, **80**(6), R331–R349.