2D Visco-acoustic Wave Equation Modelling and Inversion

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For fluid detection, attenuation (or quality factor Q) is more sensitive than velocity changes. Based on Q model, it can help detect fluid and increase the quality of migration image in exploration geophysics. Classical approaches consist of analysing seismic amplitude and spectrum based on travel time method. Recently, full waveform inversion of Q and velocity becomes realistic due to increasing computation ability, while it suffers from the coupling of attenuation and velocity. Our objective is to develop a new method to estimate attenuation and velocity in image domain. To apply this method, the first step is to develop visco-acoustic wave equation simulation based on constant Q theory. The second step is to obtain common image gathers in subsurface offset in attenuation medium. The final solution is to obtain the gradient of image difference and optimized velocity and Q models.

Because the attenuation effect, visco-acoustic seismic waves have less energy and phase shift compared to acoustic waves. As the figure 1(a) shows, visco-acoutic waves are weaker and travel faster because of dispersion. Due to these features, the migrated session is not accurate. Therefore, we apply the image domain method to retrieve the velocity and Q model. As the figure 1(b) shows, the common image gather (CIG) in subsurface offset is obtained by migrated image through adding a subsurface horizontal shift. If the velocity and Q models are accurate, the CIG is focused and at the right position. Here the energy of CIG is dispersed and upshift because of wrong velocity and Q model. As this criteria, we apply the visco inversion in this image domain to update the macro velocity and Q model.
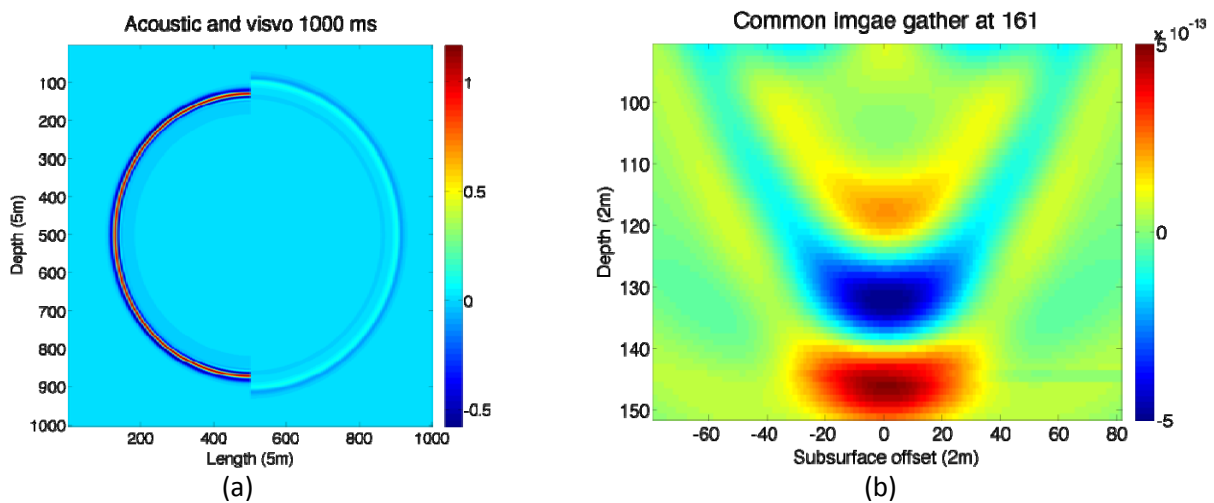

(a)   (b)

Figure 1: (a) One snapshot of visco-acoustic and acoustic waves. The left half circle represents acoustic waves and the right half circle represents visco-acoustic waves. (b) Common image gather in subsurface offset with a dispersed energy for inaccurate background velocity and Q model.

References:

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