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Full Broadband Processing Including Total Q Compensation

X.S. Wang (CGG), B. Hung* (CGG), Y.P. Phan (CGG) & R. Alai (PETRONAS Carigali Sdn. Bhd.)

SUMMARY

We present a broadband processing workflow that is purely data driven and applicable to conventional towed and variable depth towed marine streamer data. Three important ingredients of our workflow are highlighted: (1) deghosting; (2) Q-Tomography; (3) prestack depth Q migration (Q-PSDM). For the first component, 3D deghosting method that can handle the spatial aliasing issue in the crossline direction is applied. For Q-Tomography, two schemes are employed to address background and anomalous Q effects separately. Background Q estimation involves adaptively extracting dissipation time information from the change of spectral features of the seismic data; whereas, anomalous Q estimation makes use of the amplitude ratio between affected and unaffected areas for tomographic inversion to obtain the Q field due to gas. For Q-PSDM, the estimated Q fields are used in the migration process to compensate for the frequency dependent dissipation effects. We apply our workflow on a field data example with a unique geological complexity that has been affecting the exploration and production activities in the region for the past few decades, and demonstrate its capability of attenuating the ghost and recovering the loss in frequency bandwidth caused by attenuation due to the subsurface.

Recent efforts on broadband processing have largely been focusing on source and receiver deghosting. Nevertheless, to fully recover the frequency bandwidth of seismic data, the attenuation effect of the earth needs to be taken into account. This is more so if strong localised absorptive bodies are present in the subsurface. In Malaysia and other parts of Southeast Asia, shallow gas pockets are frequent geological features that represent this kind of absorptive bodies. Its effect can be expressed as anomalous quality factor Q .

Besides this localised effect, the intrinsic nature of earth's absorption also causes the degradation of resolution in seismic data. This can be represented by background Q . Hence, in the presence of gas, both background and anomalous Q effects need to be compensated to recover frequency dependent amplitude loss and phase rotation for full broadband processing.

We present a broadband processing workflow that is purely data driven and applicable to conventional towed and variable depth towed marine streamer data. Three important ingredients of our workflow are highlighted: (1) deghosting; (2) Q -Tomography; (3) prestack depth Q migration (Q -PSDM). For the first component, 3D deghosting method that can handle the spatial aliasing issue in the crossline direction is applied. For Q -Tomography, two schemes are employed to address background and anomalous Q effects separately. Background Q estimation involves adaptively extracting dissipation time information from the change of spectral features of the seismic data; whereas, anomalous Q estimation makes use of the amplitude ratio between affected and unaffected areas for tomographic inversion to obtain the Q field due to gas. For Q -PSDM, the estimated Q fields are used in the migration process to compensate for the frequency dependent dissipation effects.

We apply our workflow on a field data example with a unique geological complexity that has been affecting the exploration and production activities in the region for the past few decades, and demonstrate its capability of attenuating the ghost and recovering the loss in frequency bandwidth caused by attenuation due to the subsurface. We suggest that our proposed workflow should be considered as the main skeleton for amplitude preserving processing that is important for AVO analysis.

Figure. (a) Previous PSDM result without our workflow. (b) Q -PSDM result with our workflow.