Compensating for Seismic Absorption Anomalies with 3-D Q-Tomography and Q-compensating PSDM

Yi Xie [2], Kefeng Xin [2], James Sun [2], Carl Notfors [2], Barry Hung [2], and Roger Taylor [1]
[1] *CGGVeritas, Crawley, United Kingdom.*
[2] *CGGVeritas, Singapore, Singapore.*

Spatial variations and anomalies in the transmission properties of the overburden cause seismic amplitude attenuation, wavelet phase distortion and seismic resolution reduction on deeper horizons. Gas trapped in shallow sediments is a classic example of such an absorption anomaly. This poses problems for the seismic interpretation, tying of migration images with well-log data and AVO analysis.

In this paper, we present a ray based tomographic method that builds on previous work on amplitude tomography (Hung et al., 2008) for estimating a 3D Q depth model. The method is not restricted to attenuation anomalies that originate in the near surface. It takes into account the actual dips of the anomalies because the analysis is performed on pre-stack depth migrated data.

Early attempts to treat dissipation were directed towards the elimination of its effects from the data by inverse Q-filters. Since the effects of dissipation increase with the length of wavepath, the filters are time-variant. Rather than compensating for the effects of absorptions in a separate preprocessing step, it is more rigorous to do it during the migration itself. Seismic energy is attenuated during the propagation in the earth; the frequency-dependent loss must be compensated for according to the actual wavepath in the migration process to give a reflector with correct phase, magnitude and resolution.

We have developed a prestack depth Q migration approach to compensate for the dissipation effects in the migration process which we have implemented in Kirchhoff, Gaussian Beam and Reverse Time Migration. We demonstrate, with synthetic and real data examples, how we include the estimated Q volume in the depth migration process to mitigate amplitude attenuation and frequency-dependent dispersion.