AAPG Datapages/Search and Discovery Article #90255 © 2016 AAPG/SEG International Conference & Exhibition, Barcelona, Spain, April 3-6, 2016

Estimation of the Quality Factor with Tomography Using the Complex Eikonal Equation

Tatiana Espinosa[1] and Carlos Piedrahita Escobar[2]

[1]Universidad de Pamplona
[2]Universidad de Medellín

Abstract

The propagation of seismic waves through viscoelastic media is affected by the attenuation, which is measured by the quality factor Q (inverse of attenuation), results in significant loss of signal strength and bandwidth. Gas trapped in sediments is an example of these media. Seismic images of geological structures underneath shallow gas often suffer from resolution degradation and the effect of amplitude reduction. This makes identification and interpretation difficult. Also this affects the ability to accurately predict reservoir properties. Thus, there is a need to compensate the attenuation due to Q, to be estimated using tomography seismic.

This work takes place in a viscoelastic medium in the frequency domain, where is incorporated the attenuation to replace the elastic real parameters by visco-elastic complex parameters, frequency dependent, consequently the equations are casted in the complex domain and thus a solution should be sought in the complex space. A complex eikonal equation is obtained from the equation of motion in a viscoelastic medium, in the frequency domain.

The objective of this work is to apply a tomographic method to estimate a model of complex velocity and a Q model to achieve an improvement in seismic imaging, in areas where there are strong attenuation factors or fractured media.

To achieve an estimate of Q, initially, a complex eikonal equation is solved in a viscoelastic medium using ray tracing. The resulting travel time is complex: its real part describes the wave propagation and its imaginary part describes the effects of attenuation. Tomography is then performed to obtain the initial estimates of complex velocities and of Q; the models are smooth and heterogeneous, with a constant gradient of the square of the slowness. For such models, an exact solution of the complex eikonal equation can be found analytically by using complex ray tracing. Given an initial complex velocity model and an initial Q, we calculate theoretical travel times and finally produce an inversion, using optimization, to fit the initial velocity model and Q, to obtain get minimal difference between the observed data and theoretical data.

The computational codes for this methodology is implemented in Python scripting.