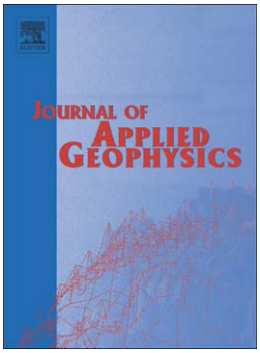

Attenuated traveltime tomography method for estimation of seismic attenuation

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PII: S0926-9851(17)30156-8
DOI: doi:10.1016/j.jappgeo.2017.02.014
Reference: APPGEO 3218

To appear in: *Journal of Applied Geophysics*

Received date: 6 March 2016
Revised date: 15 December 2016
Accepted date: 14 February 2017

Please cite this article as: Jin, Ziqi, Sun, Zandong, Attenuated traveltime tomography method for estimation of seismic attenuation, *Journal of Applied Geophysics* (2017), doi:10.1016/j.jappgeo.2017.02.014

Attenuated traveltime tomography method for estimation of seismic attenuation

Summary

Due to the viscous-elastic properties of subsurface media, seismic waves experience a loss of amplitude and distortion of phase during propagation. Compared with frequency domain methods, tomography methods are designed to calculate a set of Q values simultaneously. But we have noticed that most existing tomography inversion methods may result in inaccurate Q estimation because of many adverse factors. In addition, these methods can only calculate effective Q between layers. Improved attenuated traveltime (t*) tomography is introduced here as a more accurate and efficient method for estimation of true Q distribution, instead of effective Q values. The method updates an initial Q guess to the true Q distribution through inversion. The accuracy of t* is essential for t* tomography. Minute errors of t* can cause unreasonable Q inversion results. A stabilized method is designed to improve the accuracy of t* by statistically selecting the optimum frequency band for regression. Synthetic and field data examples demonstrate the feasibility and effectiveness of this method. Depending on the more accurate Q distribution, seismic resolution can be improved after Q compensation migration.

Introduction

The viscous-elastic properties of subsurface media causes amplitude loss and phase distortion in seismic waves. To quantify this attenuation for characterization of rock and fluid properties and to compensate the attenuation for high seismic resolution, it is necessary to estimate the amount of attenuation during propagation. Q value is used to quantify the attenuation amount and various methods have been designed for Q estimation. These methods can be grouped into two categories: time-domain Q estimation, frequency-domain Q estimation. Q tomography can be regarded as a tomographic generalization of the frequency-domain method (Rickett, 2006), rather than estimating one interval Q between layers, it estimates Q distribution through inversion methods. Time-domain methods are not recommended because they have difficulties in separating intrinsic attenuation from spherical spreading loss and transmission/reflection loss, etc. (Červený,2001). Spectral ratio method and centroid frequency shift method are two widely used Q estimation methods in the frequency domain. By transforming time domain signals into the frequency domain, the adverse effects mentioned above can be removed from intrinsic attenuation, basing on that only the