Velocity analysis in homogeneous VTI media using SVD-semblance

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Resumo

Velocity analysis in prestack reflection data on CMP gathers is traditionally perform using semblance coherence measure with hyperbolic moveout curves. However, due to the assumptions made in its development, this measure is inaccurate in estimating parameters in sections with long-spread, anisotropy, and in the presence of amplitude variation with offset (AVO), especially in the presence of polarity reversals. Nonhyperbolic moveout approximations are commonly used to approximate moveout on surveys with long offsets in anisotropic media. Among these, the shifted hyperbola approximation is considered quite valid to model traveltime reflections in CMP gather data with large offsets obtained in VTI media. Amplitude variations with offset, in the presence of reverse polarity may be introduced in velocity analysis, modifying the traditional semblance algorithm. Singular value decomposition (SVD) applied to the semblance reduces the influence of AVO even in the presence of noise. In this paper we perform velocity analysis based on semblance SVD with shifted hyperbole approximation in estimating parameters in anisotropic media VTI (transversely isotropic with a vertical symmetry axis) in data free and with noise. The results suggest the validity, accuracy and robustness, technique to estimate parameters in such media.

Introduction

Velocity analysis in seismic sections is performed using Coherence measures in general semblance. However, in seismic data with high amplitude variation along the seismic events and offset-depth ratio greater than one, the semblance loses precision in estimation of parameters. This has led to consider changes to the semblance in order to suit it to seismic sections with anisotropy, long offsets, variations in amplitude with the offset and reverse polarization. Several nonhyperbolic moveout curves in CMP sections with long offsets have been proposed to approximate traveltime in VTI media (Tsvankin and Thomsen (1994); Alkhalifah and Tsvankin (1995); Fomel (2004)). Methods for performing semblance-based velocity analysis using nonhyperbolic approximations, have been presented by Alkhalifah (1997)and Grechka and Tsvankin (1998). Using approximations by rational interpolation Douma and Calvert (2006) and Douma and Baan (2008) presented an accurate method for performing semblance-based velocity analysis in homogeneous VTI layered media. Sarkar et al. (2001) and Sarkar et al. (2002) presented AB and AK-semblance algorithms in order to make the semblance, sensitive to variations in phase and amplitude with offset. Their experiments showed that the new measures were robust to deal with AVO anomalies and reverse polarity. Yan and Tsvankin (2008) extended the AK-semblance algorithm for VTI media and large offsets using nonhyperbolic moveout equation of Alkhalifah and Tsvankin (1995). Using singular value decomposition of the matrix formed by the windowed data in semblance, citeursin2014signal showed an adaptation to semblance, precise and robust enough to handle data with large amplitude variations with the offset. In this paper, we present the velocity analysis based on SVD-semblance algorithm with nonhyperbolic moveout aproximation shifted hyperbola in order to measure the accuracy and robustness in the parameter estimation in homogeneous VTI media.

Wave propagation in VTI media

TI media are characterized by five elastic parameters, density-normalized: $a_{11}, a_{13}, a_{33}, a_{44}$ and a_{66}. The P-wave propagation in VTI media has phase velocity equation, as a function of the phase angle θ given by Gassmann (1964); Thomsen (1986):

Results and Conclusions

At present, the fluid percolation theory based on Darcy's law means that we can ignore stress-strain state in solids. Besides that, percolation theory contains porosity, but do not contain specific surface, that creates forces to stop percolation. Instead of Darcy's law we need predict stress-strain in solid and the rupture of pressure between phases. This rupture depends on structure of pore space, and not on porosity only.

There is no necessity to use Darcy's law for determination of permeability, since it is a geometric property of porous medium. Permeability value is directly proportional to porosity, and inversely proportional to the square of the specific surface for a specimen.

The porosity and specific surface give a possibility to use alternative methods for measuring of permeability.

Equation of motion with long waves compared to the structure does result in the wave equation, but in the telegraph equation, that describes the propagation and diffusion of waves.

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