A Study of PS Wave AVO

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Abstract

Amplitude variation with offset (AVO) is a technique used in petroleum exploration to estimate the lithology and pore fluids underground for a direct prediction of oil and gas. Recently, due to the rapid development in the multicomponent surveying, P to S converted wave (PS-wave) exploration becomes an important technique to augment the ability of seismology exploration. PS-wave AVO is used to estimate the S-wave velocity and density contrasts of strata at the same time. However, P- and PS-wave AVOs are two independent methods for obtaining strata's P- and S-wave velocities and their responses to strata's densities. Their expenses, difficulties, and efficiencies in data acquisition, processing, correction, and analysis are quite different, therefore it is not easy to estimate which one is better. Nevertheless, the sensitivities of the above methods to the oil or gas reservoir (shale-gas sand interface) must be classified and addressed. Therefore, in this study, the incident angles dependent reflection coefficients of P- and PS-wave which reflected from a shale-gas sand interface were calculated and compared to evaluate their performances.

A commonly used two-layer model for P-wave AVO analysis was adopted. The P- and S-wave velocities and densities of shale and sand used in this study were based on Young and LoPiccolo's (2003; 2004) five classes for the classification of P-wave AVO. Then Aki and Richards's (1980) matrix form of Zoeppritz equations was used to calculate the exact reflection coefficients of P- and PS-wave reflected from the shale-gas sand interface. Study results show that the PS-wave reflection coefficients are larger than those of P-wave at far offsets for the classes of high impedance sands and class 5, which is a case of low impedance sand with a decreasing amplitude for increasing offset. For the other classes, P-wave reflection coefficients are greater than those of S-wave. These two techniques are not to compete with each other, but the PS-wave AVO provides added information for the velocity and density. Therefore, our results provide a general guideline for using the PS-wave AVO in the seismic data analyzing for an oil or gas reservoir.