Geophysical Research Abstracts
Vol. 17, EGU2015-7804, 2015
EGU General Assembly 2015

PS wave image enhancement using polarity reversal correction in the wavenumber domain

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Polarities of the S waves are reversed at all reflection points, therefore these reversals should be considered in elastic imaging of multicomponent seismic data. If the polarity reversals of S wave are not corrected properly, the final PS image generated by summing over every shot domain migration may deteriorate. If the underground structure is horizontally layered, then the polarities of the S wave are reversed at the zero offset. However, in heterogeneous media, such as real Earth's interior, defining where the S wave polarities are reversed is complex. Many elastic migration methods correct polarity reversals in the angle domain by reversing the sign of the negative angle data or by calculating the sign factor using the energy flux density vector to correct the polarity reversal. These are all implemented in the spatial domain.

In this study, the reversed S wave polarities are corrected in the wavenumber domain using simple equation then imaged in the frequency-spatial domain using elastic generalized-screen migration algorithm. The reflection angle at the underground reflector is represented using the wavenumber basis according to the expressions as tan γ = -k_h/k_z, where γ is the reflection angle and k_h and k_z are offset wavenumber and depth wavenumber, respectively. According to the Equation, the sign of the reflection angle can be expressed as -1$\times$(sign of horizontal wavenumber); therefore, the S wave polarities can be easily corrected in the wavenumber domain by reversing the sign of the extrapolated wave on one side of the position at k_x = 0. Subsequently, the wavefields are inverse Fourier transformed to the frequency-spatial domain, and then, the imaging condition is applied. This method is very efficient in thin-slab way migration algorithm such as phase-screen or generalized-screen migration. For the verification, simple horizontal 2-layer and tilted model were tested using the elastic generalized-screen migration algorithm. Furthermore, the effect of the S wave polarity corrections on the more realistic complex model is also tested using the SEG/EAGE salt model. All PS wave images after polarity reversal corrections using our method show clearer events with exact positions.