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Seismic wavefield distortion due to anisotropic anomalies near surface

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Reservoir rocks and near surface materials are estimated to be strongly anisotropic for elastic wave propagation (e.g., Sone, 2012). Therefore, it is important to take anisotropy properties into account for estimating accurate geological structure using seismic exploration methods. There are many previous studies of elastic anisotropy, for example, azimuthal anisotropy of qP- and qSV-wave, S-wave splitting, etc. Most of these studies are based on the assumption that media is ”weakly” anisotropic (Thomsen, 1986). When the anisotropy of media is not ”weak”, the assumption may not be applicable. However, the effect of ”strong” anisotropy on the behavior of seismic wave propagation is still not well understood. In this study, we investigate the influence of strong anisotropy on received seismic waveforms using three-dimensional numerical models, and verified capability of detecting subsurface anisotropy. We assumed one model that contains a block of horizontally stratified isotropic layers (transversal isotropy with vertical axis of symmetry), while the other contains an isotropic inhomogeneity sharing the same block. We took the difference in the received waveforms of two models to see how the anisotropy of the medium influences the wavefield based on the orbital analysis of particle motion of the residual wavefield. Our results show that there are meaningful changes in the received waveform mainly due to P-wave and converted-wave (P-to-S) that might be generated by the anisotropy of the materials as secondary seismic sources. Since the anisotropy of the material behaves as secondary sources for incoming seismic waves, we concluded that seismic exploration method is applicable to estimate the anisotropic properties.