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Anisotropic crosshole seismic tomography

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The crosshole seismic tomography used in seismic exploration can be applied to map a velocity section of strata between two holes. Therefore the targets, such as geologic structure, fault, fracture zones, low velocity zone, between two holes can be accurately estimated. The strata in the crustal usually possess anisotropic characteristics of velocity. For the crosshole seismic tomography to resolve the anisotropic strata, the anisotropic characteristics of the velocity of the grids in the velocity section are usually assumed as a transversely isotropic medium with a vertical symmetry axis (VTI) or horizontal symmetry axis (HTI), thus the anisotropies of the strata can be evaluated. However, the velocity anisotropy of strata is not always VTI (or HTI), and multi-azimuth fractures can be found in strata. Thus, in this study, a non-restricted azimuthally dependent velocity of the grids in the velocity section is used for the crosshole seismic tomography.
An algebraic reconstruction technique for the crosshole seismic tomography incorporating with non-restricted azimuthally dependent velocity of the grids in the velocity section is developed. Results of the numerical testing show that when the coverage of the ray paths of the seismic waves is sufficient, the number of the grids and the number of azimuths of the velocities in each grid are insensitive to this technique. In addition, the anisotropies in a low velocity zone are easier to detect than those in a high velocity zone. Because the seismic wave propagation through a low velocity zone can produce more anisotropic information in the travel time than those through a high velocity zone. In conclusion, the azimuthally dependent velocity of each grid in the velocity section can be successfully resolved by this technique.