Geophysical Research Abstracts
Vol. 19, EGU2017-6341, 2017
EGU General Assembly 2017

S wave propagation in acoustic anisotropic media

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The acoustic anisotropic medium can be defined in two ways. The first one is known as a pseudo-acoustic approximation (Alkhalifah, 1998) that is based on the fact that in TI media, P wave propagation is weakly dependent on parameter known as "vertical S-wave velocity" (Thomsen, 1986). The standard way to define the pseudo-acoustic approximation is to set this parameter to zero. However, as it was shown later (Grechka et al., 2004), there is "S wave artifact" in such a medium. Another way is to define the stack of horizontal solid-fluid layers and perform an upscaling based on the Backus (1962) averaging. The stiffness coefficient that responds to "vertical S wave velocity" turns to zero if any of layers has zero vertical S wave velocity.

In this abstract, I analyze the S wave propagation is acoustic anisotropic medium and define important kinematic properties such as the group velocity surface and Dix-type equations.

The kinematic properties can easily be defined from the slowness surface. In elastic transversely isotropic medium, the equations for P and SV wave slowness surfaces are coupled. Setting "vertical S wave velocity" to zero, results in decoupling of equations. I show that the S wave group velocity surface is given by quasi-astroidal form with the reference astroid defined by vertical and horizontal projections of group velocity. I show that there are cusps attached to both vertical and horizontal symmetry axes. The new S wave parameters include vertical, horizontal and normal moveout velocities. With the help of new parameterization, suitable for S wave, I also derived the Dix-type of equations to define the effective kinematical properties of S waves in multi-layered acoustic anisotropic medium. I have shown that effective media defined from P and S waves have different parameters. I also show that there are certain symmetries between P and S waves parameters and equations. The proposed method can be used for analysis of S waves in acoustic anisotropic media.

References

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