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S wave propagation in acoustic orthothombic media

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The orthorhombic medium (ORT) is defined by Schoenberg and Helbig (1997) and Tsvankin (1997). In order to reduce the number of parameters for P wave, the acoustic orthorhombic medium was proposed by Alkhalifah (2003) by setting all on-axis shear wave velocities to zero. Stovas (2015) defined the kinematic properties of acoustic ORT medium. Grechka et al. (2004) and Stovas (2017) analyzed so-called "S wave artifact" in acoustic transversely isotropic (VTI) medium. In this abstract, I analyze the S wave propagation is acoustic ORT medium and show that there are two S waves propagating in such a medium. One of these waves is very similar to the one propagating in VTI medium, while another one has a very complicated shape.

The kinematic properties can easily be defined from the slowness surface. In elastic ORT medium, the equations for P, S1 and S2 wave slowness surfaces are coupled. Setting "on-axis S wave velocities" to zero, results in decoupling of equations,

$$q\left(p_x, p_y\right) = \frac{1}{v_0}\sqrt{\frac{f_1}{f_2}}, \tag{1}$$

where v_0 is the vertical velocity, and functions f_1 and f_2 are given by

$$\begin{array}{l} f_1\left(p_x, p_y\right) = 1 - \left(1 + 2\eta_1\right) p_x^2 v_1^2 - \left(1 + 2\eta_2\right) p_y^2 v_2^2 + \left(\left(1 + 2\eta_1\right)\left(1 + 2\eta_2\right) - \left(1 + \eta_{xy}\right)^2\right) p_x^2 p_y^2 v_1^2 v_2^2 \\ f_2\left(p_x, p_y\right) = 1 - 2\eta_1 p_x^2 v_1^2 - 2\eta_2 p_y^2 v_2^2 + \left(4\eta_1\eta_2 - \eta_{xy}^2\right) p_x^2 p_y^2 v_1^2 v_2^2 \end{array}, \tag{2}$$

where v_1 and v_2 are NMO velocities in [x,z] and [y,z] symmetry planes, respectively, and η_1, η_2, η_{xy} are anelliptic parameters (Stovas, 2015).

I show the slowness branches corresponding to P and two S waves. There are two specific points on these branches that correspond to caustics for S1 and S2 waves. It is also shown that S2 wave has a quasi-astroidal shape and exists only in between the symmetry planes. The S1 wave group velocity surface consists of two mutually crossing sub-surfaces.

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