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On singularity point for acoustic orthorhombic model

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The singularity points are very important for elastic waves propagation in low-symmetry anisotropic media (Stovas et al., 2021a). Being converted into the group velocity domain, they result in internal refraction cone with anomalous amplitudes and very complicated polarization fields. I analyze the conditional singularity point in acoustic orthorhombic (ORT) model which is very popular in processing and analysis of 3D seismic data. The elliptic ORT model has one singularity point in one of the symmetry planes (Stovas et al., 2021b). The elastic ORT model has 1 to 6 singularity points. It is shown that for acoustic ORT model the only one S1-S2 wave singularity point (per quadrant) can conditionally be defined in-between the symmetry planes. The required conditions and position of singularity point are computed. The projection of the slowness vector $\mathbf{p}_s = \left(p_{1s}, p_{2s}, p_{3s}\right)^T$ for singularity point are given by

$$p_{1s}^2 = \left(c_{11} - \frac{c_{12}c_{13}}{c_{23}}\right)^{-1}, \quad p_{2s}^2 = \left(c_{22} - \frac{c_{12}c_{23}}{c_{13}}\right)^{-1}, \quad p_{3s}^2 = \left(c_{33} - \frac{c_{13}c_{23}}{c_{12}}\right)^{-1},$$

where c_{ij} are the elements of the stiffness coefficients matrix. I show that the singularity point for this model has the stable conical type of degeneracy (Shuvalov, 1998), which means that the internal refraction cone is always represented by ellipse in 3D space. The slowness surface for acoustic orthorhombic model that consists of three sheets corresponding to P (the inner one) and S1-S2 waves. The image of singularity point in the group domain and its three projections on the symmetry planes can be computed analytically.

References

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