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A vertical fracture cluster embedded into thinly layered medium

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The linear slip theory is gradually being used to characterize seismic anisotropy. If the transversely isotropic medium embeds vertical fractures (VFTI medium, according to Schoenberg and Helbig, 1997), the effective medium becomes orthorhombic. The vertical fractures may exist in any azimuth angle which leads the effective medium to be monoclinic. We apply the linear slip theory to create a monoclinic medium by only introducing three more physical meaning parameters: the fracture preferred azimuth angle, the fracture azimuth angle and the angular standard deviation. First, we summarize the effective compliance of a rock as the sum of the background matrix compliance and the fracture excess compliance. Then, we apply the Bond transformation to rotate the fractures to be azimuth dependent, introduce a Gaussian function to describe the fractures' azimuth distribution assuming that the fractures are statistically distributed around the preferred azimuth angle, and average each fracture excess compliance over azimuth. The numerical examples investigate the influence of the fracture azimuth distribution domain and angular standard deviation on the effective stiffness coefficients, elastic wave velocities, and anisotropy parameters. Our results show that the fracture cluster parameters have a significant influence on the elastic wave velocities. The fracture azimuth distribution domain and angular standard deviation have a bigger influence on the orthorhombic anisotropy parameters in the (x_2; x_3) plane than that in the (x_1; x_3) plane. The fracture azimuth distribution domain and angular standard deviation have little influence on the monoclinic anisotropy parameters responsible for the P-wave NMO ellipse and have a significant influence on the monoclinic anisotropy parameters responsible for the S1- and S2-wave NMO ellipse. The effective monoclinic can be degenerated into the VFTI medium. Assuming that the fracture cluster has a preferred azimuth angle and other fractures are statistically distributed around it, we define the effective compliance matrix by a Gaussian function, the Bond transformation matrix and the excess compliance matrix of the vertical fractures in the eigen-coordinate system. The resulting effective medium possess the monoclinic symmetry. The monoclinic anisotropy parameters (Stovas, 2021) can easily be defined from the effective stiffness coefficients.

Schoenberg, M. and Helbig K., 1997, Orthorhombic media: Modeling elastic wave behavior in a vertically fractured earth, Geophysics, **62**(6), 1954-1974.

Stovas, A., 2021, On parameterization in monoclinic media with a horizontal symmetry plane, Geophysics (early online).