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Calculating the anisotropic seismic properties of a polycrystalline aggregate using self-consistent approximation with a MATLAB software

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We present a MATLAB-based software (AnisEulerSC; Anisotropy Euler angle Self-Consistent) for calculating the anisotropic seismic properties of a polycrystalline aggregate using the self-consistent (SC) approximation. AnisEulerSC was based on the algorithm that is originally written in FORTRAN77 by Mainprice (1997) using the SC formulation of Willis (1977), which was developed to make models of polycrystalline multi-mineral rocks with variable shapes. The shape becomes more important when the elastic contrast is large between inclusions and background medium. If included cracks are empty, their shapes have strong influence on the seismic anisotropy of rocks. For fluid-filled cracks, the influence of shape decreases with increasing fluid bulk modulus. If cracks are filled with a background mineral, there is almost no influence of the shape (e.g. Anderson et al., 1974). AnisEulerSC can be used to model the effects of empty cracks on the seismic properties of the aggregate. For the AnisEulerSC program, single crystal elastic constants, density, volume fraction of each component, and orientation data in Bunge, Roe or Matthies Euler angles (e.g., EBSD; electron backscatter diffraction or U-stage; universal stage) are required as input data; grain (crystal) orientations and modal mineral composition as well as single crystal elastic tensors. Using EBSD data with grains their areas, mean crystal orientations, and shape (long and short axes) orientations will be determined by a MTEX script. The elastic tensors will be imported directly via the script from a database. Based on the script input parameters, which are crystal orientation, area, shape, and elastic tensors, are used to define the initial aggregate as Voigt, Reuss or Hill average. Options exist to define the grain shape in specimen coordinates for each mineral for modeling. The initial aggregate (e.g., Voigt) is chosen as the starting aggregate for the SC method replacing the unknown background medium, and the procedure is repeated for all inclusions (grains) and repeated iteratively until the solution converges. The convergence of the elastic constants can be plotted. After the SC loop converges, the 21 elastic constants of a SC aggregate and the phase velocities of compressional (Vp), fast shear (Vs1), and slow shear (Vs2) waves are obtained as outputs.