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Anisotropy and Heterogeneity Interaction in Shear Zones

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Rocks are heterogeneous on many different scales and deformation may introduce a coexistence of heterogeneity and anisotropy in shear zones. A competent inclusion embedded in a laminated matrix is a typical example. Indisputably, the presence of a mechanical heterogeneity leads to a flow perturbation and consequently to a deflection of the lamination in its vicinity. Assuming a passive response of the matrix phase, the pattern formation around rigid objects has been modeled in two and three dimensions using analytical solutions. Yet, the laminas may be mechanically distinct, leading to an effectively anisotropic rheology of the matrix. The feedback of an evolving matrix structure on the inclusion motion cannot be precluded in this case.
In our study elliptical inclusions of varying aspect ratios are embedded in a laminated linear viscous host and subject to a large simple shear deformation in finite element numerical simulations. Increasing the viscosity ratio of the weak and strong lamina significantly changes the pattern characteristics in the matrix. The structural evolution around an inclusion proves to have a major impact on the inclusion motion, leading to the stabilization of elongated inclusions at antithetic orientations. We provide a comparison of two different modeling approaches. In the first approach discrete layers are introduced in the matrix and the large strain evolution of individual minute layers is resolved. Next, the matrix is modeled as an anisotropic medium using an evolving director field that locally describes the anisotropy direction. The length scale of layering can be restored in this model using the micropolar medium formulation.