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Deformation of two-phase aggregates using standard numerical methods

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Geodynamic problems often involve the large deformation of material encompassing material boundaries. In geophysical fluids, such boundaries often coincide with a discontinuity in the viscosity (or effective viscosity) field and subsequently in the pressure field.

Here, we employ popular implementations of the finite difference and finite element methods for solving viscous flow problems. On one hand, we implemented finite difference method coupled with a Lagrangian marker-in-cell technique to represent the deforming fluid. Thanks to it Eulerian nature, this method has a limited geometric flexibility but is characterized by a light and stable discretization. On the other hand, we employ the Lagrangian finite element method which offers full geometric flexibility at the cost of relatively heavier discretization.

In order to test the accuracy of the finite difference scheme, we ran large strain simple shear deformation of aggregates containing either weak of strong circular inclusion (1e6 viscosity ratio). The results, obtained for different grid resolutions, are compared to Lagrangian finite element results which are considered as reference solution. The comparison is then used to establish up to which strain can finite difference simulations be run given the nature of the inclusions (dimensions, viscosity) and the resolution of the Eulerian mesh.