A new 3D finite strain elastoviscoplastic code for lithospheric scale modeling

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Modeling of coupled viscous deformation in the asthenosphere, viscoelastic deformation in the deep parts of the lithosphere and brittle failure in the upper crust requires an advanced treatment of elastic and plastic rheological mechanisms in finite deformation regime. Our approach is based on the implicit time integration of rate-type elastoviscoplastic constitutive equation in displacements variables using an objective corotational kinematical formulation. The code is called SLIM3D which stands for Semi-Lagrangian Implicit Modeler. The term Semi denotes the capability to overcome the restriction of purely Lagrangian formulations by means of particle-based remeshing procedure when the mesh becomes excessively distorted. The locking-free hexahedral finite element with hourglass control is adopted to maintain robustness and efficiency of computation. The notion of consistent linearization of stress update algorithm and derivation of tangent modulus tensor is used to achieve optimal convergence rate of global Newton-Raphson equilibrium iteration at a large time step.

Currently incorporated in SLIM3D elastoviscoplastic rheology assumes stress-independent shear modulus and shear viscosity and Von Mises plasticity with linear softening rule. To introduce more adequate description of the mechanical behavior of geological materials, we are currently working on the implementation of nonlinear creep law and non-associative two-invariant smooth-cup plasticity model. Details of finite element formulation and numerical procedures implemented in SLIM3D as well as results of numerous tests will be demonstrated.