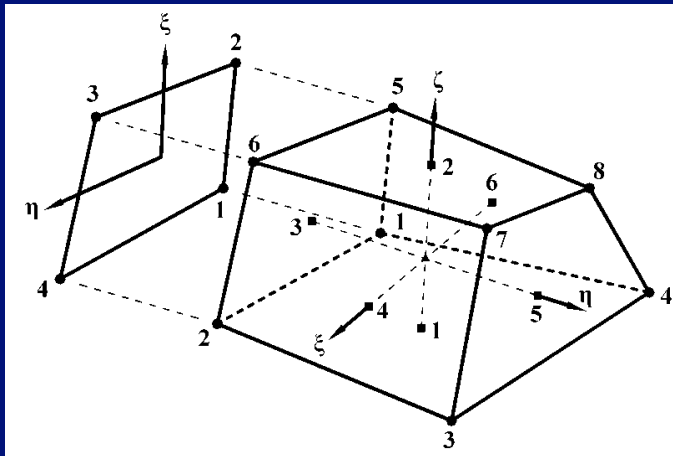


Section on Geodynamic Modeling at GFZ

We use advanced numerical methods to quantify and understand geological processes

Discretization by Finite Element Method



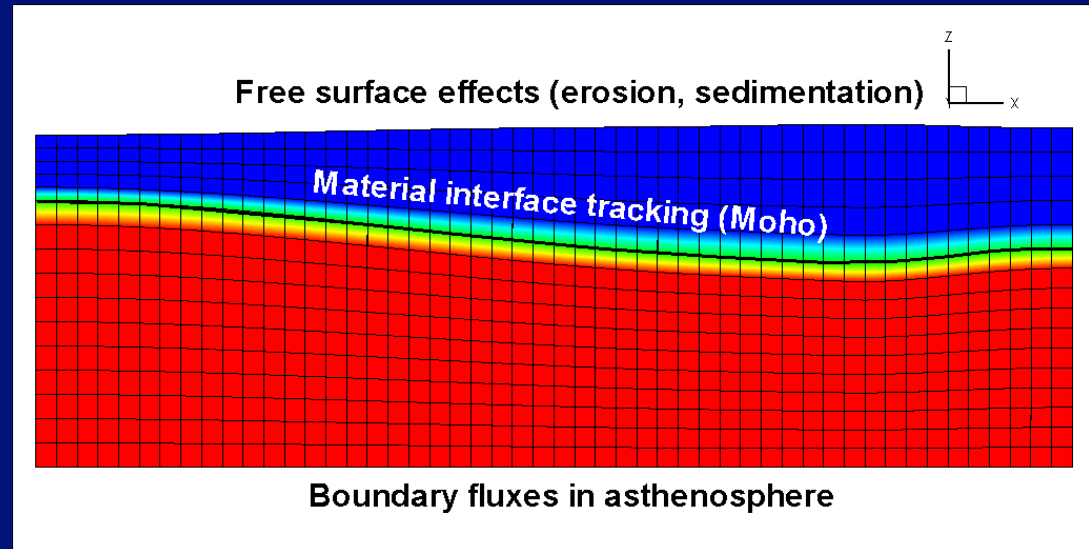
Fast implicit time stepping
+ Newton-Raphson solver

$$\mathbf{u}_{k+1} = \mathbf{u}_k - \mathbf{K}_k^{-1} \mathbf{r}_k$$

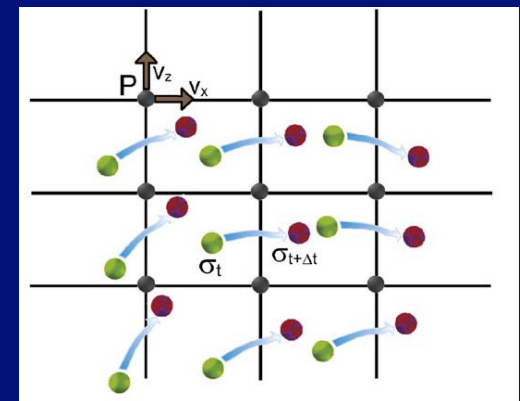
\mathbf{r} – Residual Vector

$$\mathbf{K} = \frac{\partial \mathbf{r}}{\partial \Delta \mathbf{u}} \quad \text{– Tangent Matrix}$$

Arbitrary Lagrangian-Eulerian kinematical formulation

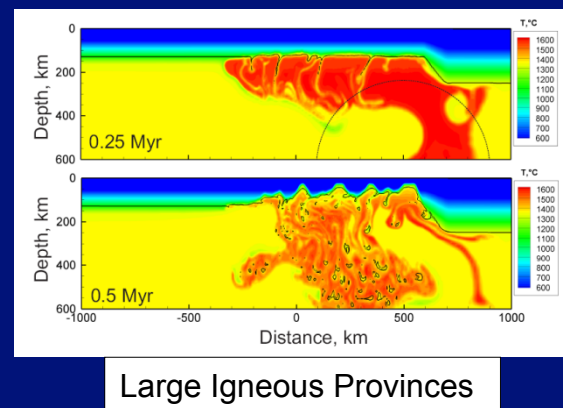
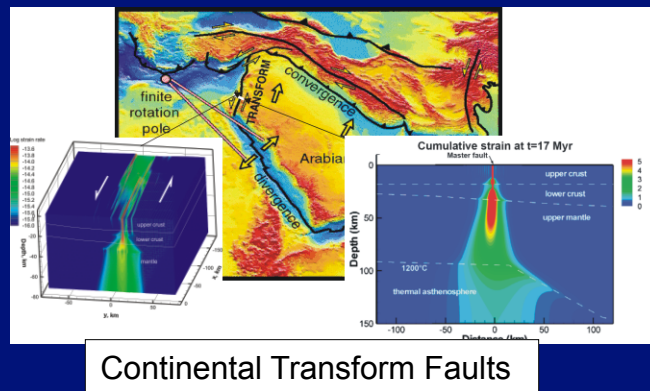
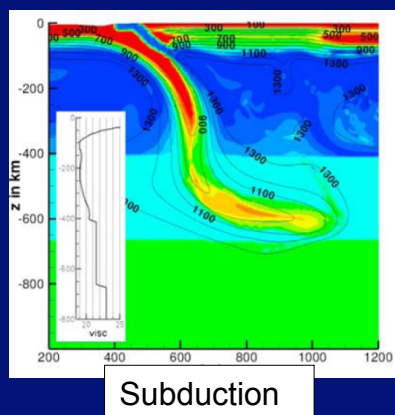
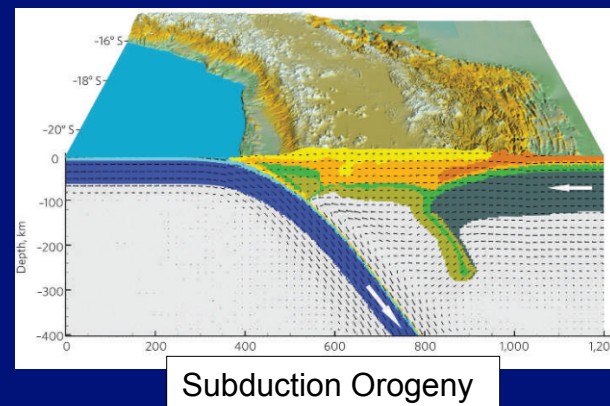
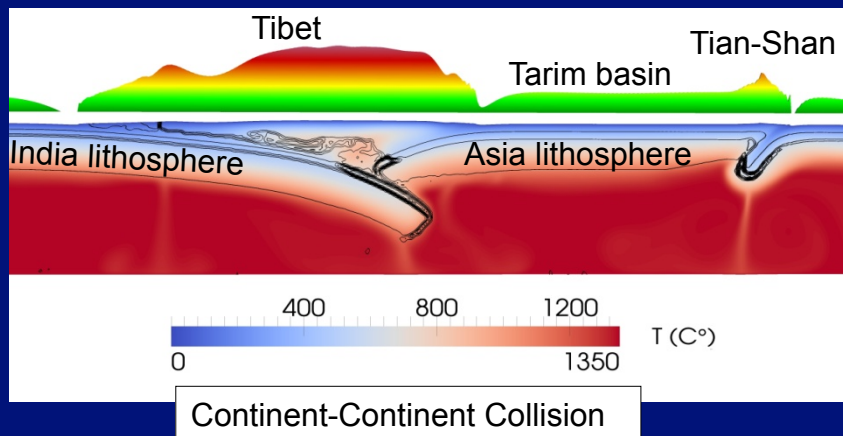


Remapping of entire fields by Particle-In-Cell technique



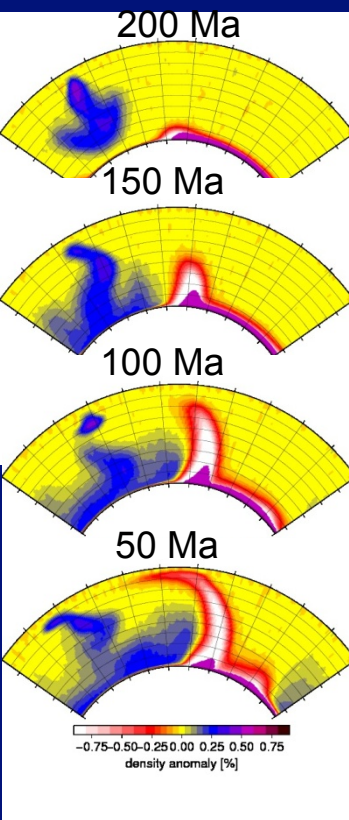
Lithospheric-scale modeling

Modeling key geodynamic processes constrained by observations

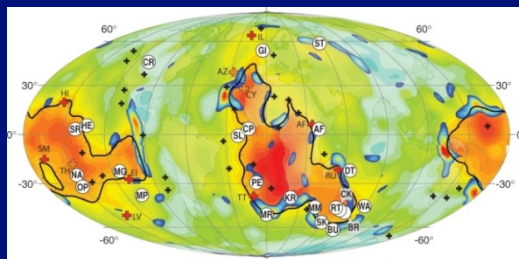
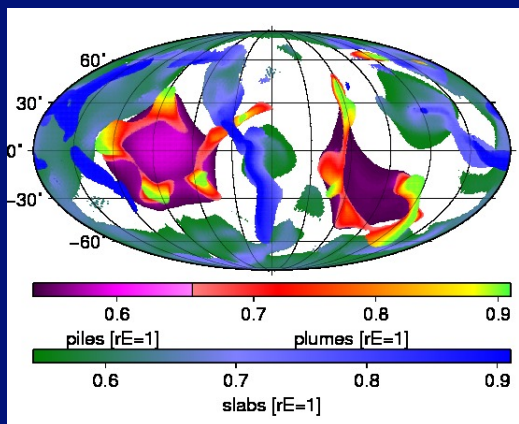


Global-scale modeling

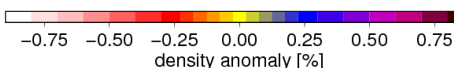
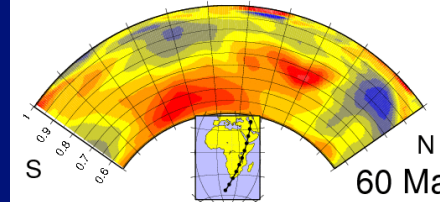
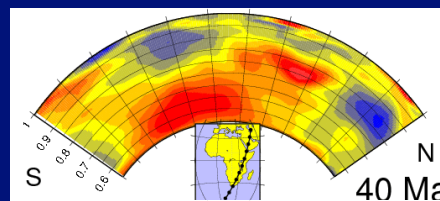
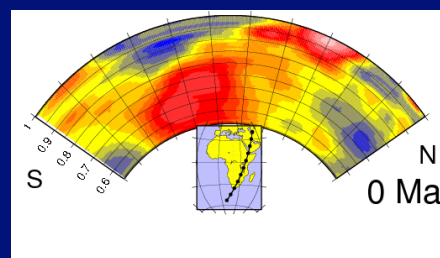
Reconstructing Earth's mantle through geologic time



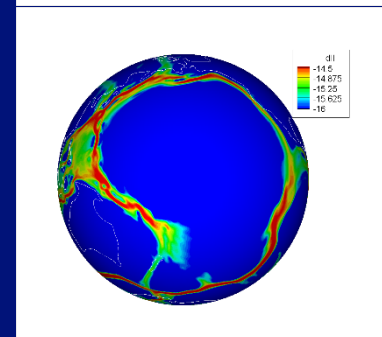
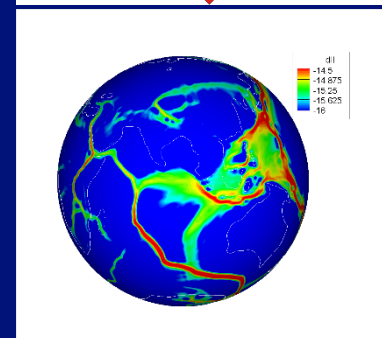
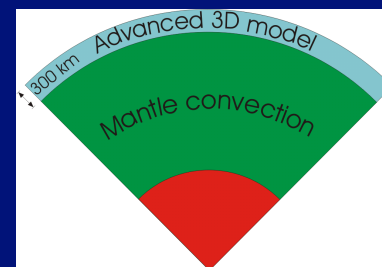
Forward modeling based on subduction history



Backward models based on seismic tomography

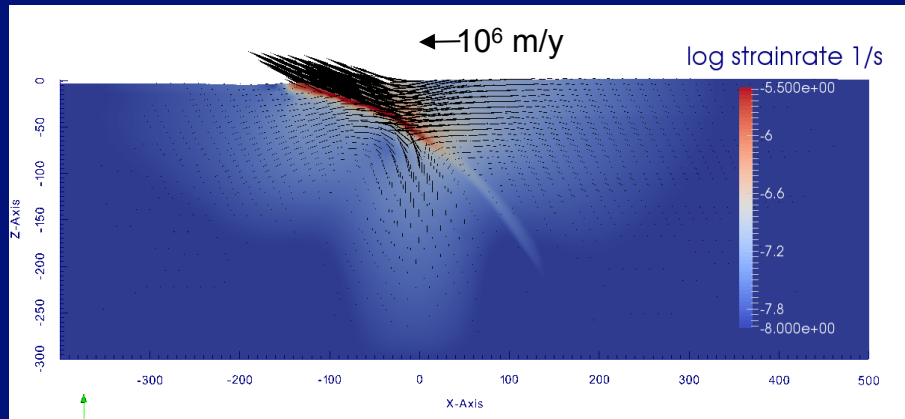


Modeling plate tectonics

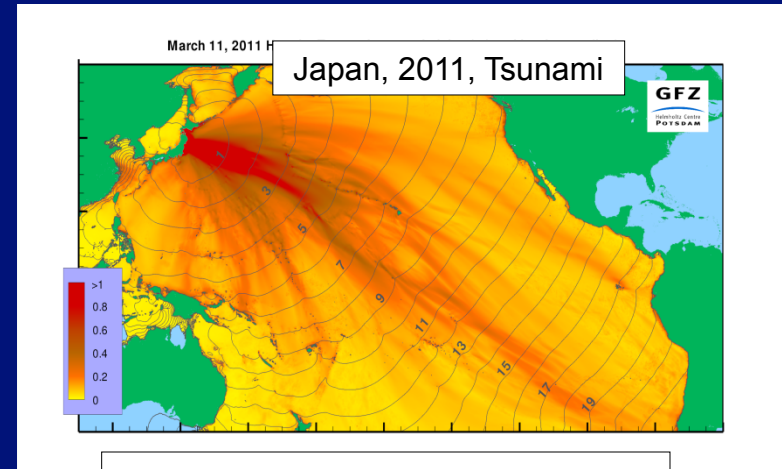


Model and observations: Plumes generated at the margins of thermo-chemical piles

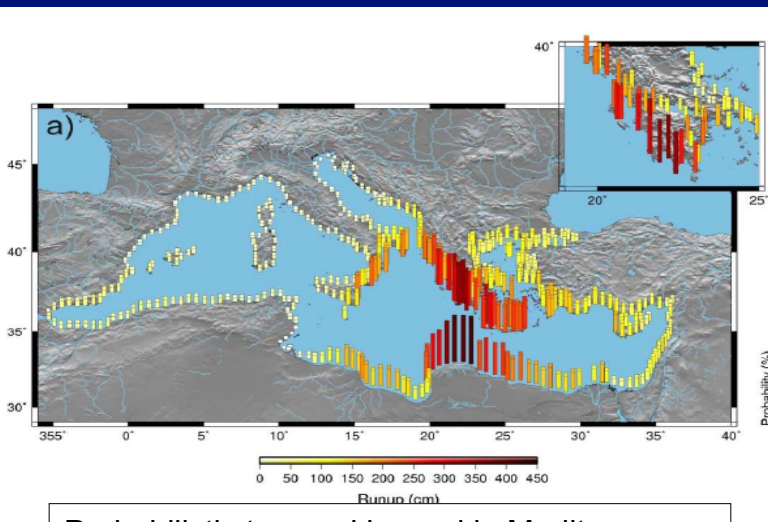
Link to surface processes



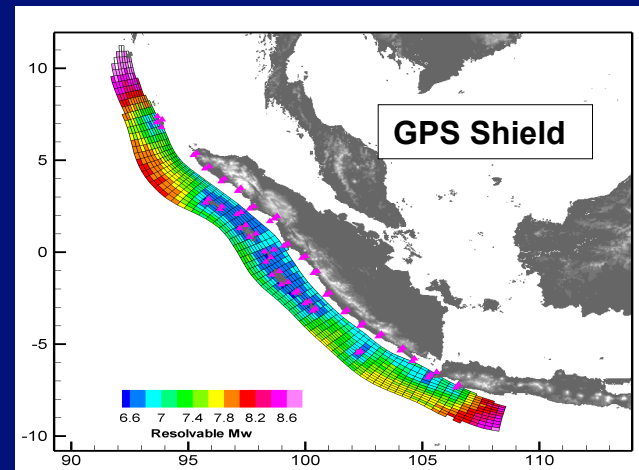
Modeling earthquake cycle



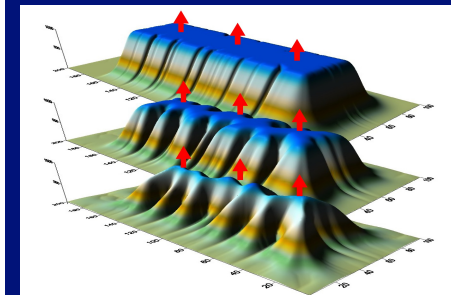
Tsunami and source modeling



Probabilistic tsunami hazard in Mediterranean



GPS arrays for quick source inversion



3D Tectonics and erosion

Future: Cross-scale thermomechanical models

Coupling of global mantle convection and lithospheric deformation

Coupling of global and regional scale plate-tectonic models

Coupling of geological (1-100 Myr) and seismic cycle (1 min- 0.1 Tyr) time scales