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Slab detachment – 3-D versus 1-D & 2-D

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Slab detachment is a geodynamic process that may affect subduction zones on Earth. This process is characterized by the detachment of a subducting slab fragment and results in a dramatic decrease of the slab pull force magnitude. As a result, slab detachment has many potential consequences for the dynamics of convergent zones such as orogens. We study three-dimensional (3-D) lateral propagation of slab detachment due to a laterally varying initial slab length with numerical simulations based on the finite element method (FEM). The slab detachment is simulatedby buoyancy-driven necking in a layer of power-law fluid embedded in a linear viscous medium. Our 3-D FEM code combines a numerical contour-line technique and a deformable Lagrangian mesh with re-meshing. With this combined method it is possible to accurately follow the initial material contours with the FEM mesh and to accurately resolve the geometrical instabilities. We are able to follow the material contour and therefore, to study the accurate slab geometry at any time.
We provide a detailed description of the evolution of the slab morphology and evaluate the rates of lateral propagation of slab detachment.We compare the 3D results with the 1-D analytical solution for slab detachment of Schmalholz (2011). We further compare the 3-D results with 2-D numerical simulationsthat can be described reasonably well with the 1-D analytical solution. The fundamental differences between the3-D and 2-D slab detachment are identified and quantified.

REFERENCES
Schmalholz, S., 2011, A simple analytical solution for slab detachment, Earth and Planetary Science Letters 304, 45-54