Shear Heating and Subduction Initiation

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Shear Heating?

$$\eta = A^{-1/n}\dot{\varepsilon}_{II}^{\,1/n-1}\exp\frac{H}{nRT} \quad \rightarrow \quad \tau_{ij} = 2\eta\dot{\varepsilon}_{ij}$$

$$\rho c_p\left(\frac{\partial T}{\partial t} + v_i\frac{\partial T}{\partial x_i}\right) = \frac{\partial}{\partial x_j}\left(k\frac{\partial T}{\partial x_j}\right) + H_r + F\tau_{ij}\left(\dot{\varepsilon}_{ij}^{v} + \dot{\varepsilon}_{ij}^{p}\right)$$

Why Shear Heating?

- Has been suggested as a potential mechanism to initiate subduction [Regenauer-Lieb et al. (2001)].
- Leads to clear localization for a certain range of parameters [Crameri & Kaus (2010)].

BUT: Does shear localisation necessarily lead to subduction?

How ?

- numerical modelling
- visco-elasto-plastic rheology
- extend model used in Crameri & Kaus to a depth of 660 km

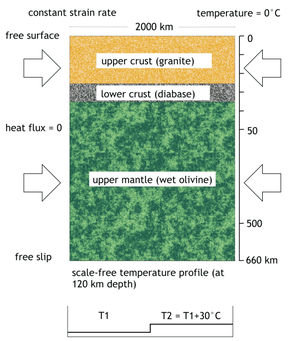

Figure 1: modified model setup from Crameri & Kaus

Conclusions

- Extension of the model to greater depths results in faster localization.
- Not every localized shear zone evolves into a subduction zone.
- Delamination, slab breakoff and subduction are competing processes.

Preliminary Results

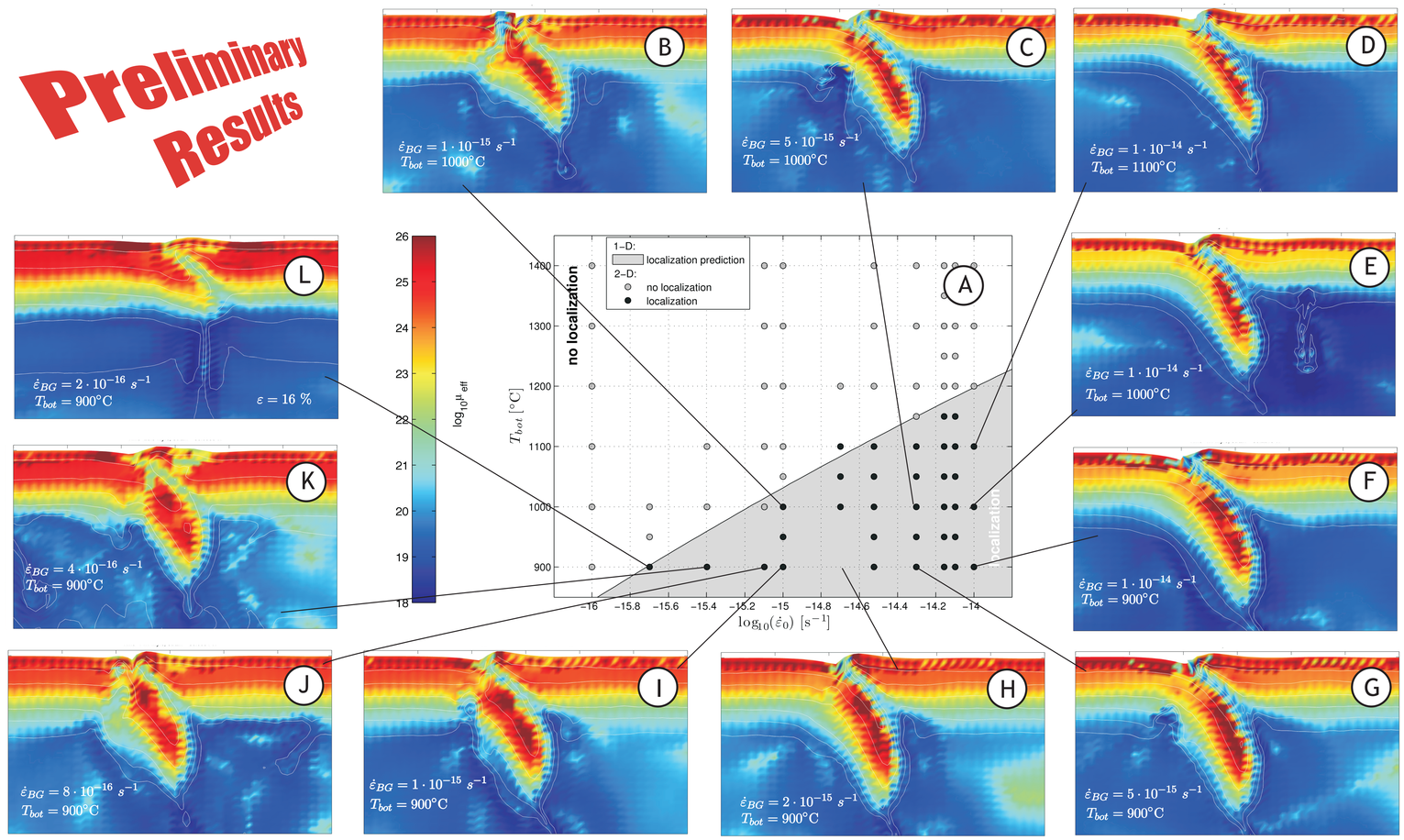

Figure 2: Comparison of model results to the results of Crameri & Kaus that were obtained using a model depth of 120 km. A: One-dimensional predicted onset of shear localization (black curve, *Lo* = 1) versus finite strain 2-D simulations that resulted in either localization (dark dots) or no localization (light dots). T_{bot} denotes the temperature at 120 km depth. B-L: Snapshots of the viscosity field (temperature is shown as contour lines) of different runs with the extended model at 30 % strain. Shown (zoomed in) model width is 1200 km and model depth is 660 km.

Outlook

- Are the generated subduction zones gravity-driven or do the boundary conditions drive them?
- Is it possible to generate the needed stresses/strain rates from mantle convection?

References

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The research leading to these results has received funding from Crystal2Plate, an FP7-funded Marie Curie Action under grant agreement number PITN-GA-2008-215353.