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Upper-plate shortening and Andean-type mountain-building in the context of mantle-driven oceanic subduction

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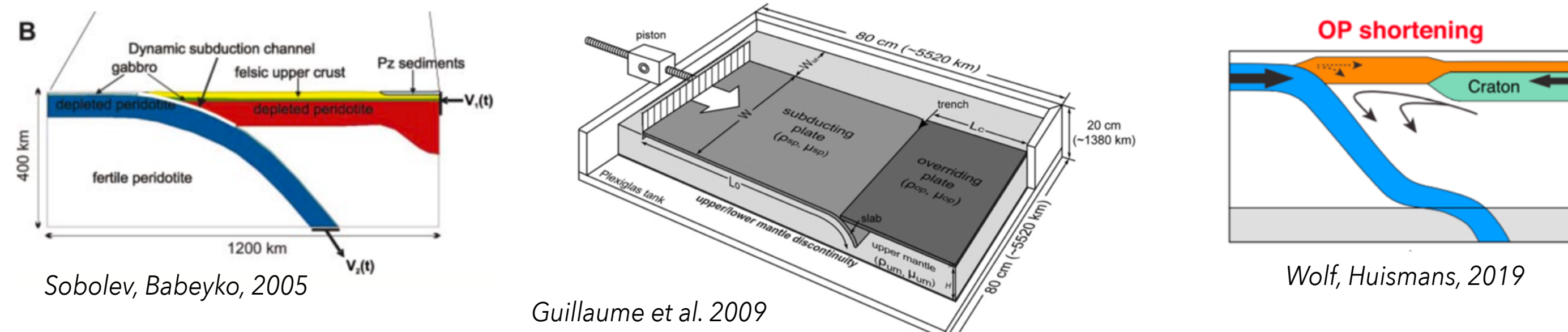
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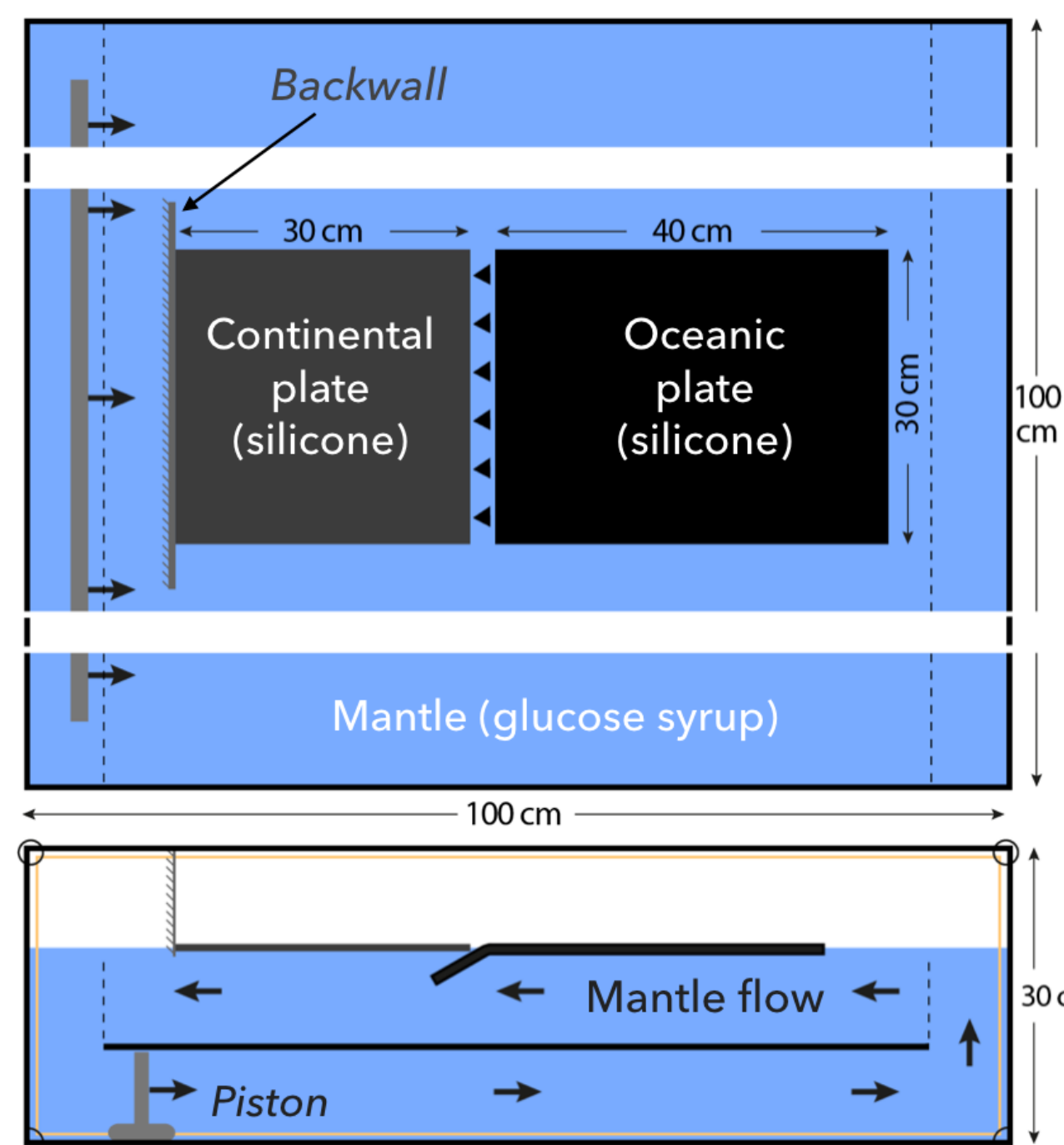
Tania Habel, Anne Replumaz, Benjamin Guillaume, Martine Simoes, Thomas Geffroy, and Jean-Jacques Kermarrec, Robin Lacassin, *TEKTONIKA* 2023



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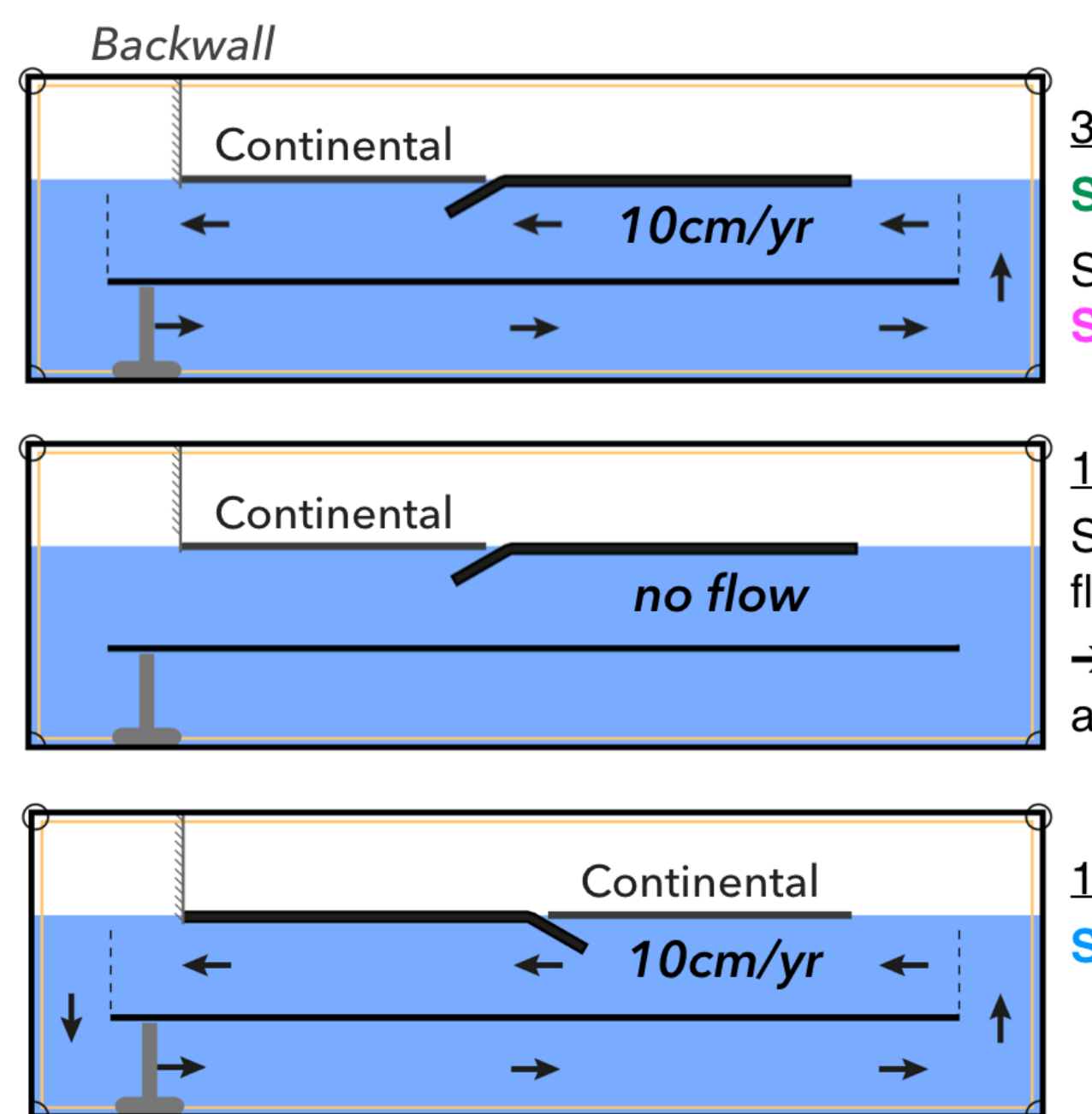
Most published experiments made with constant plate velocities obtained by pushing the plates. They cannot fully reproduce a natural system where plate kinematics adjusts to the force equilibrium.



3D analogue models at the scale of the lithosphere and upper mantle. Driven by imposed horizontal mantle flow and slab pull.

Plate velocities are not imposed as in most models, but rather adjust to the balance of forces in the system.

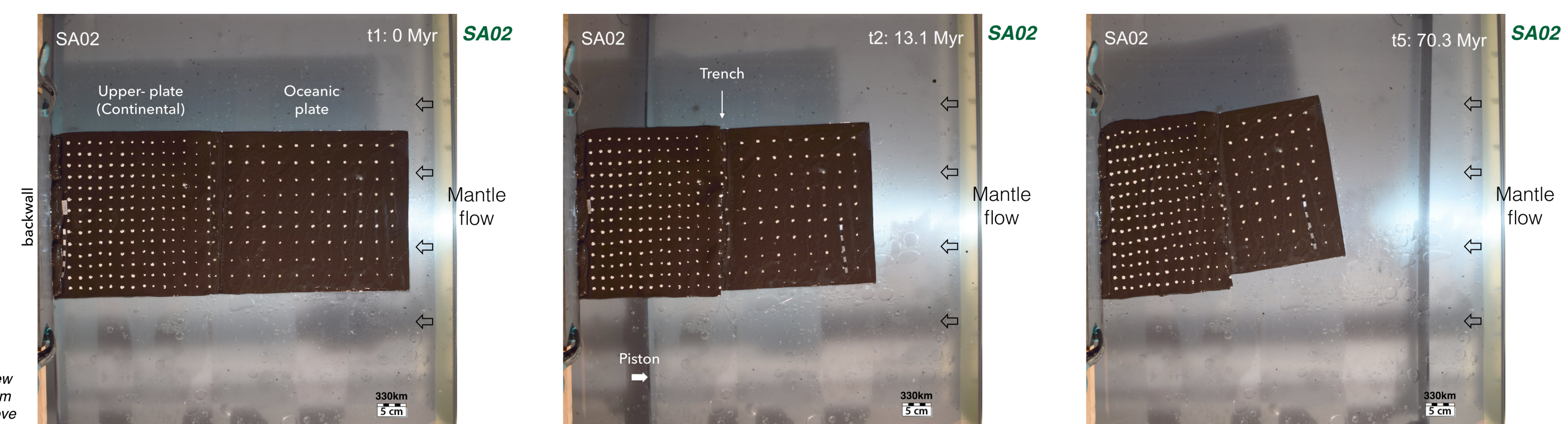
Materials with linear viscous rheology. Experiments scaled following Guillaume et al. 2021



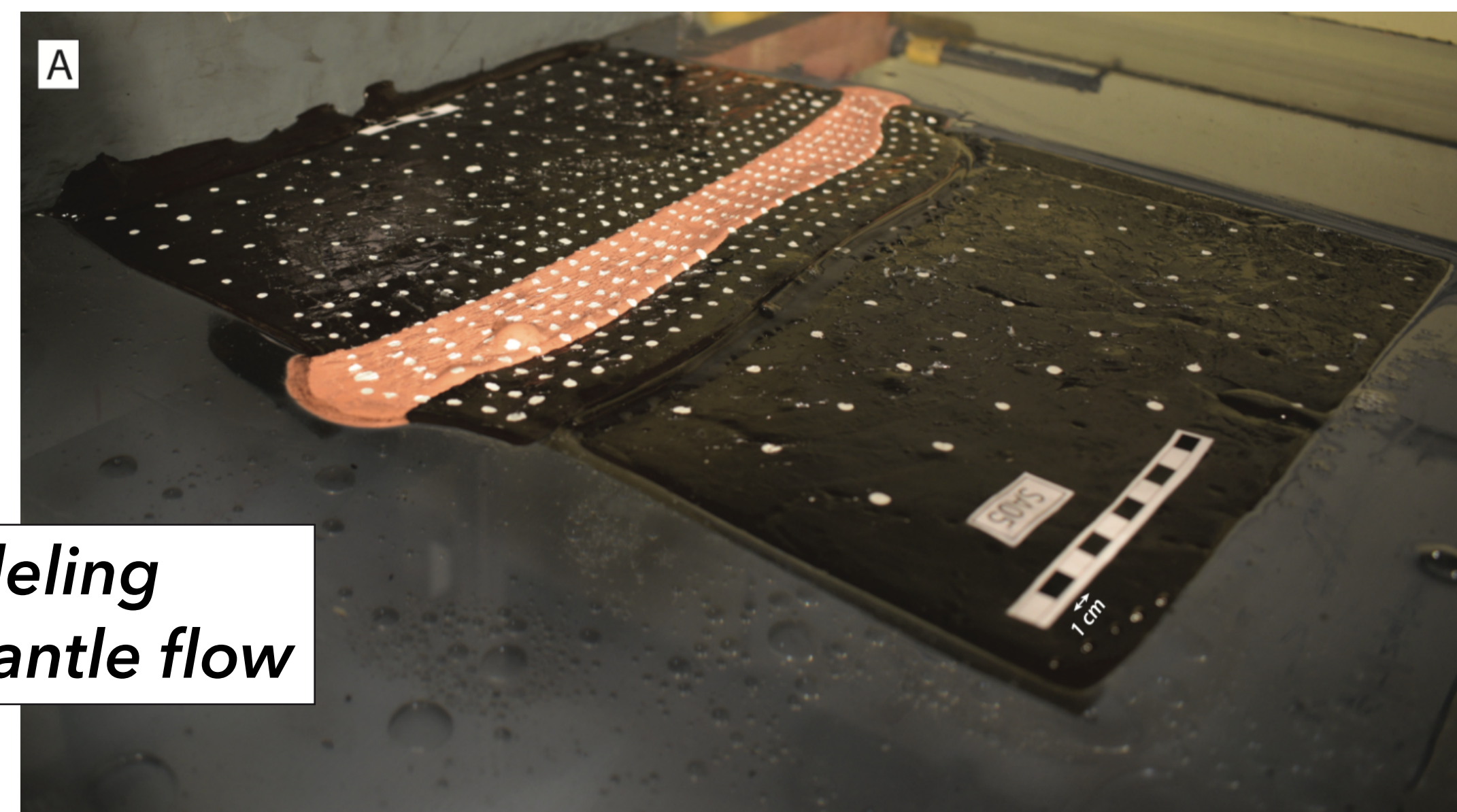
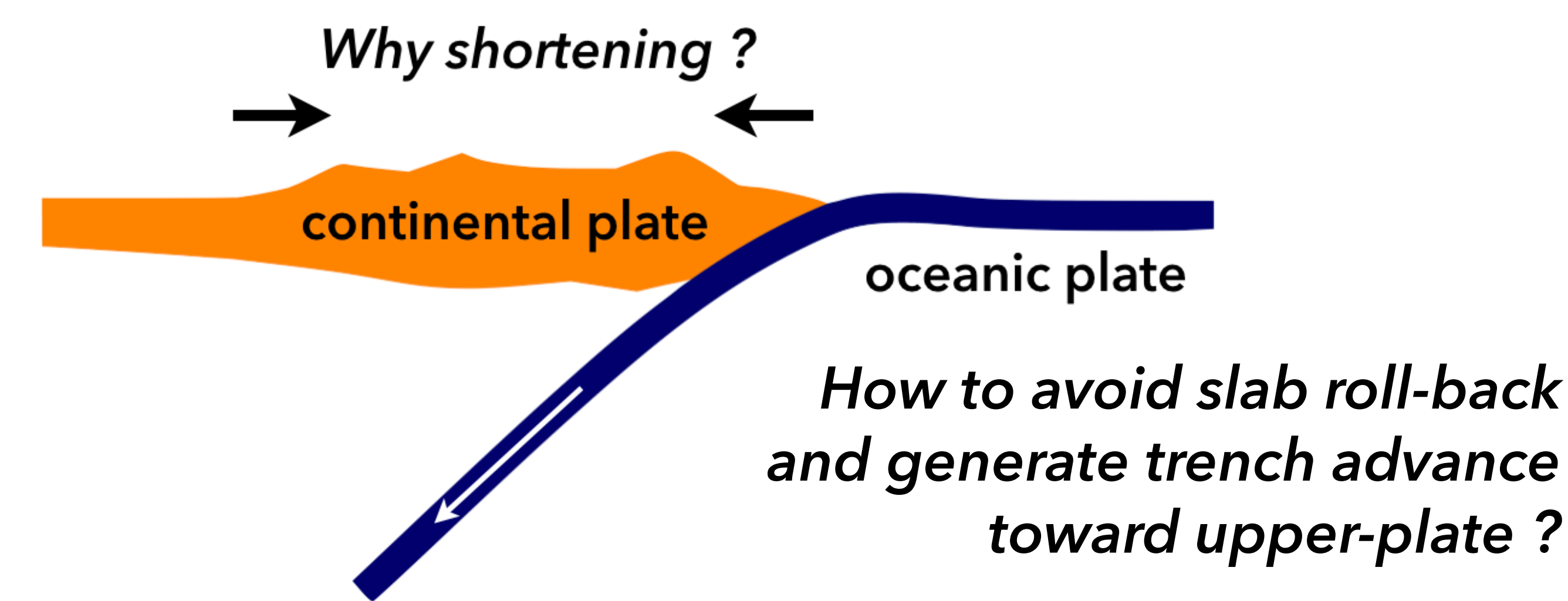
3 experiments
SA02
SA04 | heterogeneous upper plate
SA05 | heterogeneous upper plate

1 reference exp.
SA03, no mantle flow, only slab pull
→ Trench retreat and no shortening

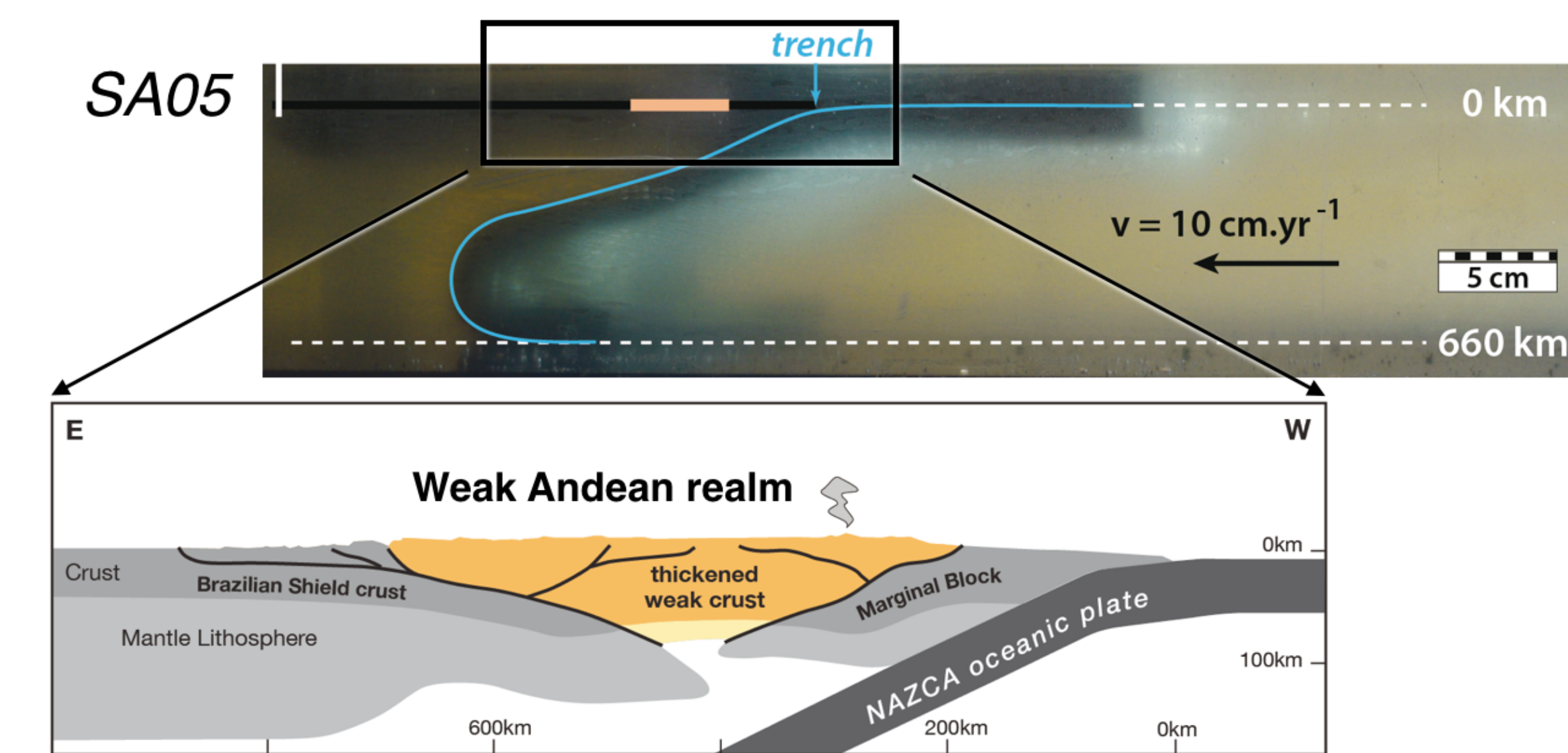
1 experiment
SA01



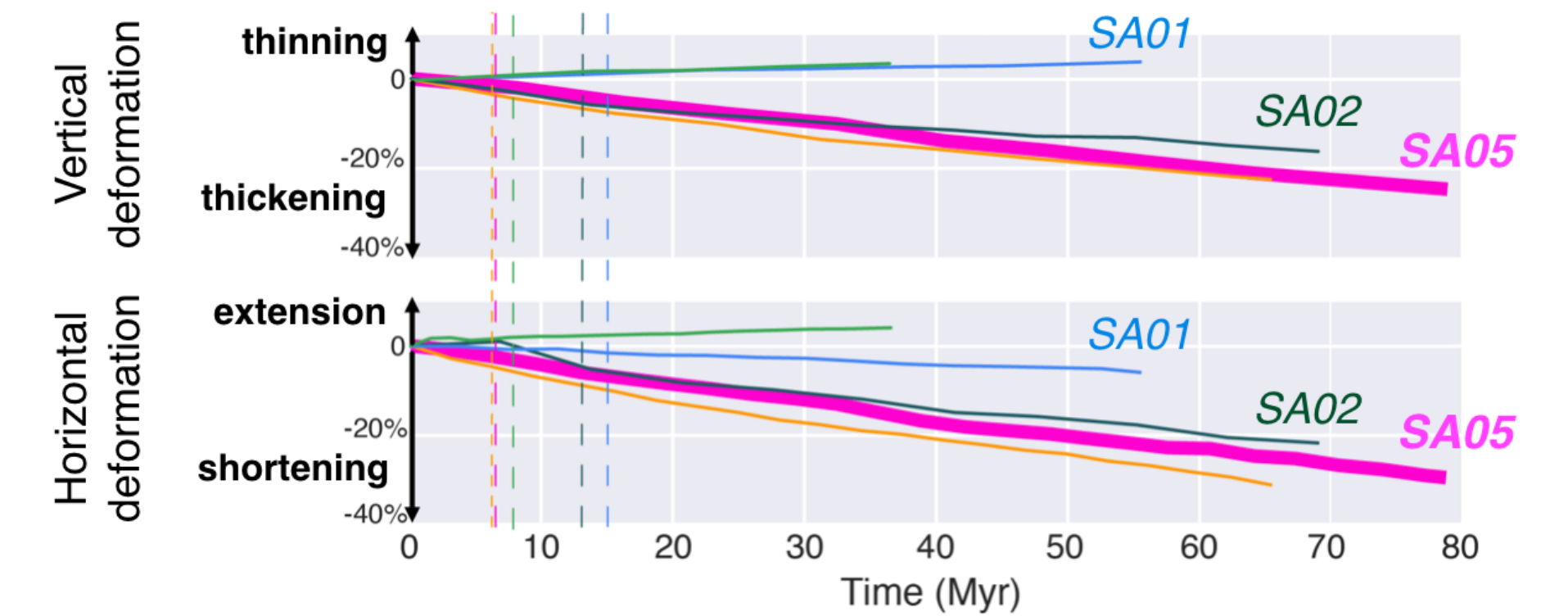
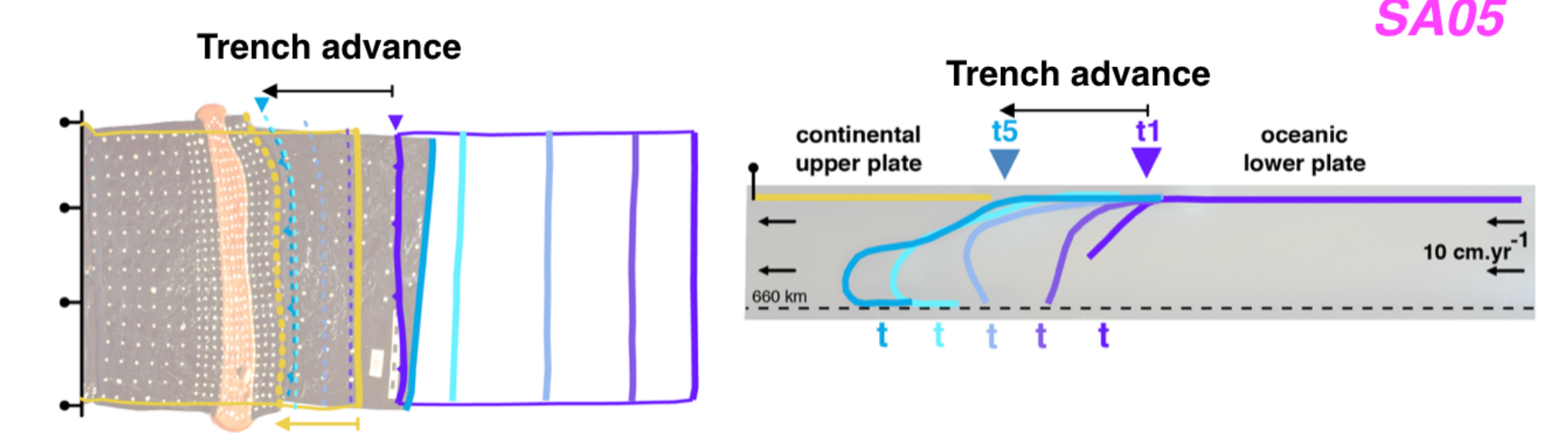
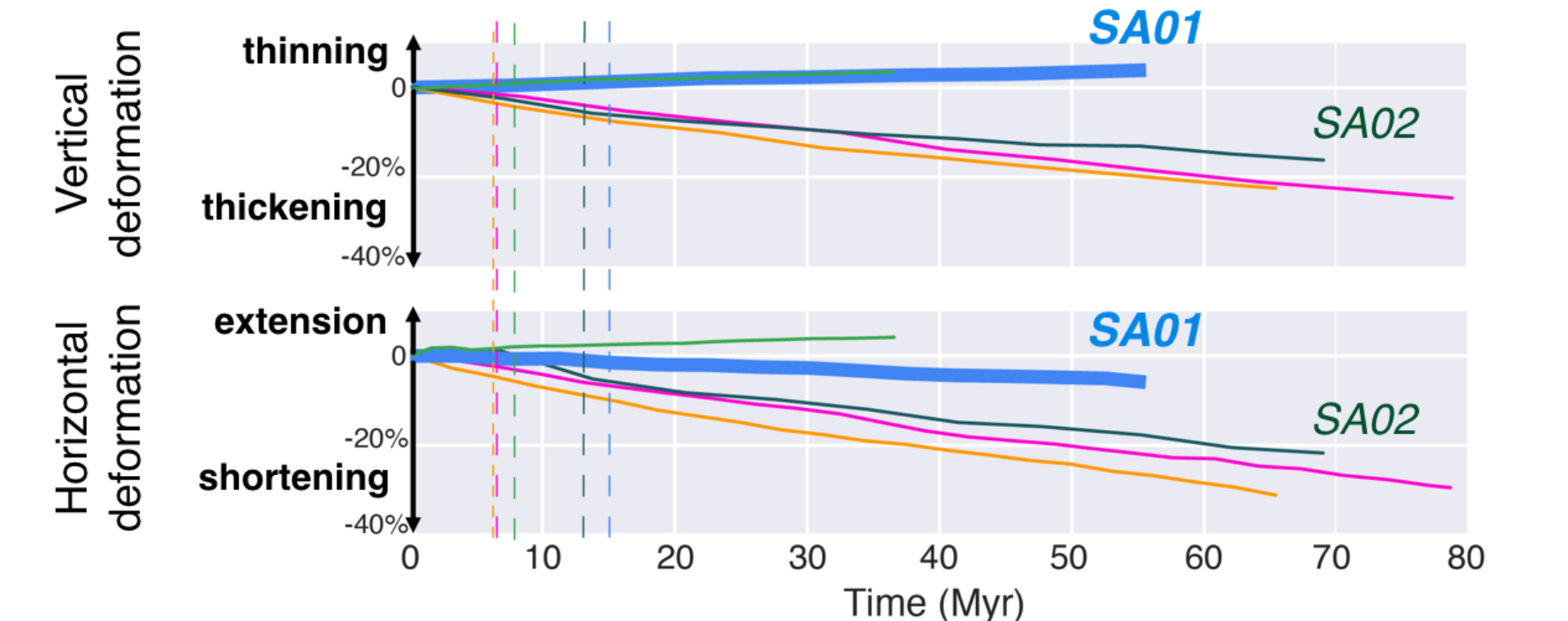
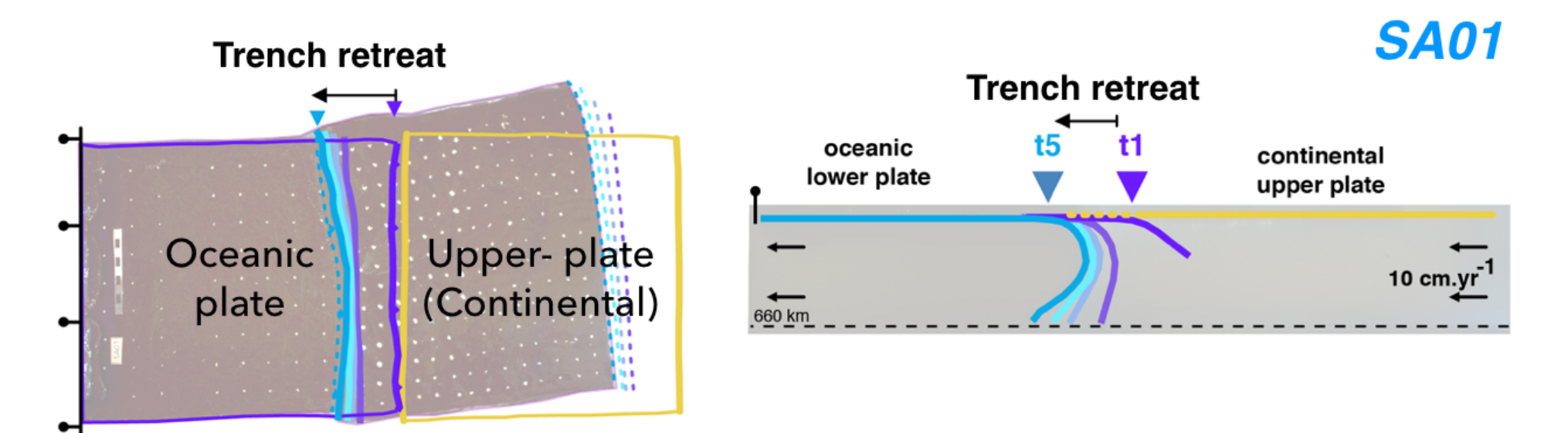
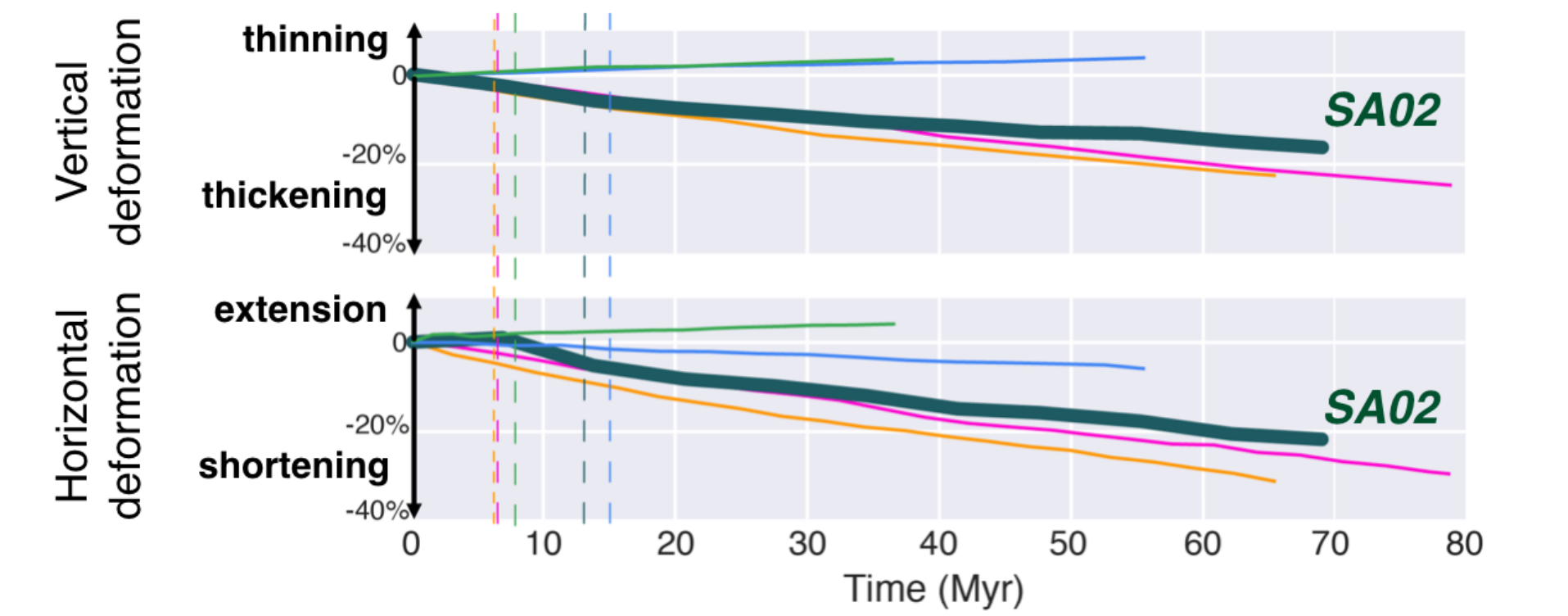
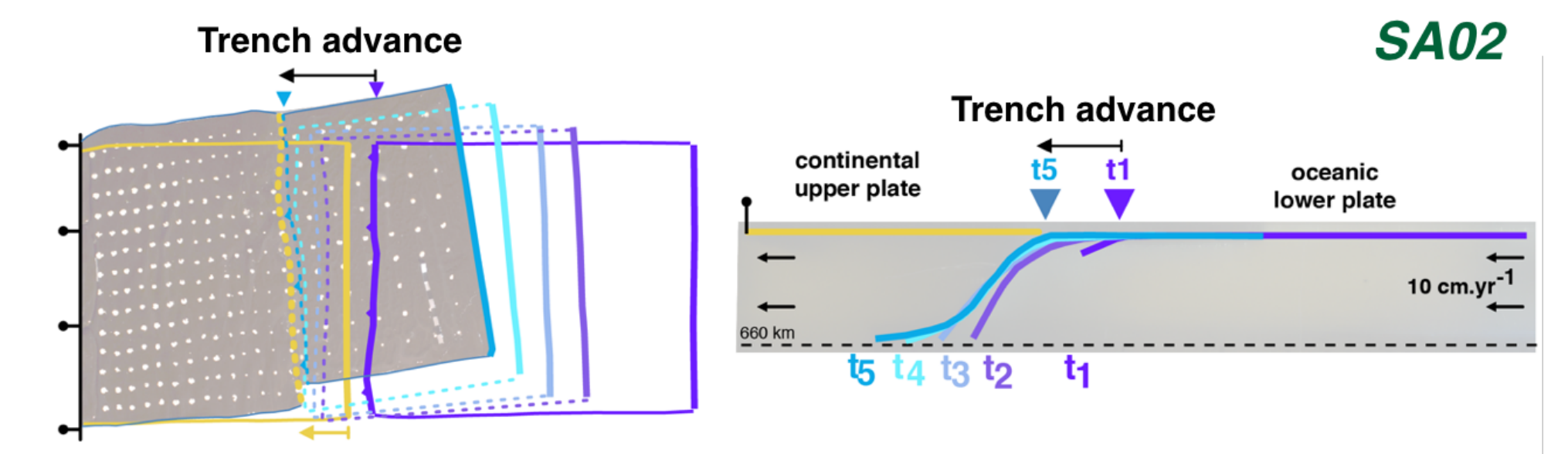
Mountain building in ocean-continent subduction context ?



Analog modeling driven by mantle flow



- Mantle flow directed toward fixed overriding continental plate promotes trench advance, and upper plate shortening / thickening.
- Backwall exerts a resisting force equivalent to upper-plate trenchward motion.
- The amount of deformation increases with decreasing upper-plate bulk strength.
- Deformation is preferentially localized in the weakest block of upper plate.



see video



see video

Next Step : exploring parameters (geometry, mantle flow rate)

Geffroy et al., Role of mantle drag on the tectonics of subduction zones: insights from laboratory models, *Tectonics*, 2023.



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Further Steps : using non-newtonian localizing material

Ongoing project aiming to test new material able to localize deformation in the analog lithospheric plates.

TH, MS, RL: Université Paris Cité, Institut de physique du globe de Paris, CNRS
AR: Institut des Sciences de la Terre (ISTerre), Université Grenoble Alpes, CNRS
BG, TG, JJK: Université de Rennes, CNRS, Geosciences Rennes

