Oceanic plateau accretion for young oceanic plates: Geodynamic models of Siletzia

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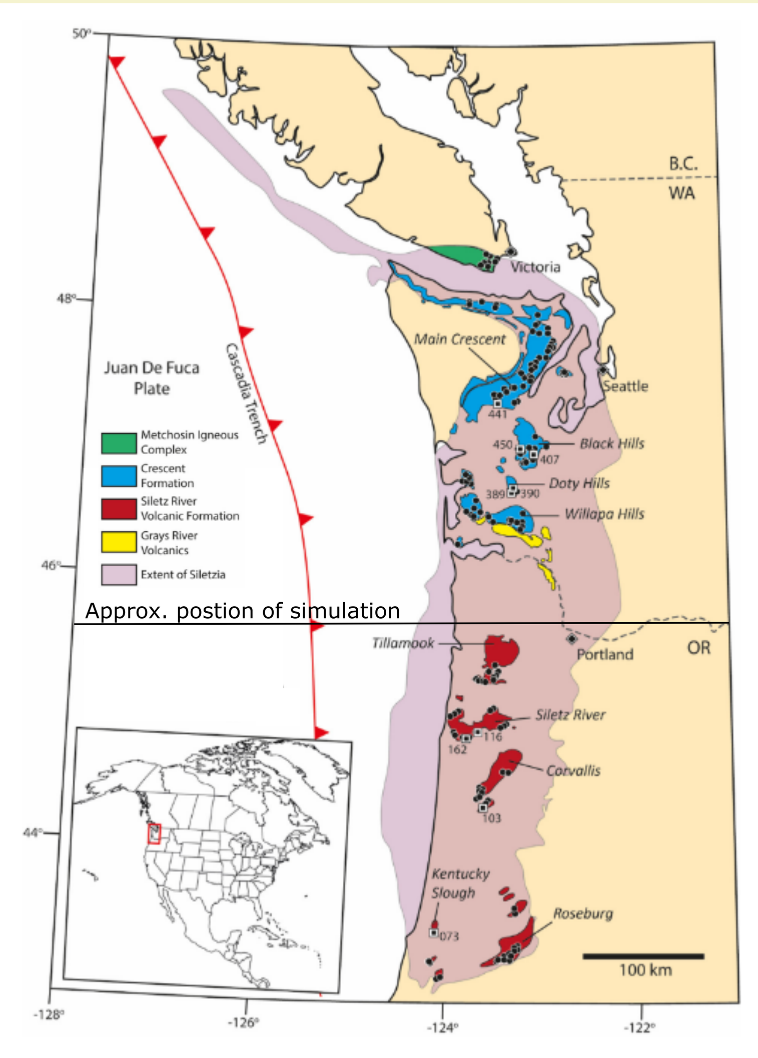
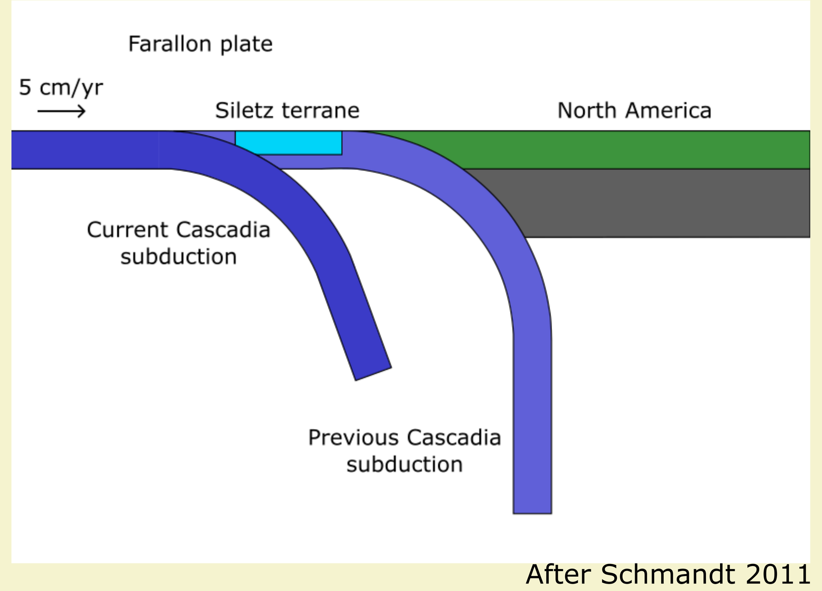
Introduction



Modified from Ciborowski 2020

Siletzia formed as an oceanic plateau (large island) between 48 and 52 Ma on the Farallon plate. The most common hypothesis for its origin is formation at the mid oceanic ridge between Farallon plate and the Pacific plate. The geochemistry of the Siletz basalts indicates association with the Yellowstone hot spot. Around 50 Ma the plateau reaches the continental margin of north America, where it acreted to the continent. The closeness to the mid oceanic ridge and the recent formation of the plate around 10 Ma before subduction mean that it is hot and thin which makes the plate more buoyant than typical for oceanic plates during subduction. Since there is an overlap of formation of plateau and accretion the material close to the plateau is thermally weakened.[1,2]

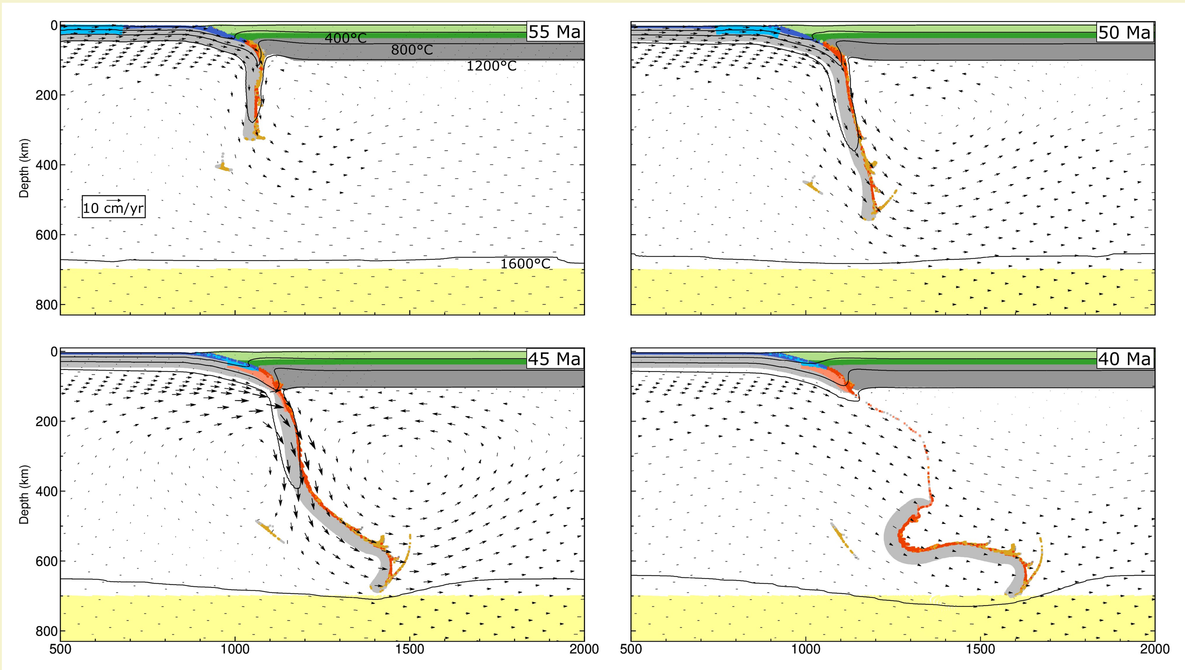
Seismic tomography finds fast seismic anomalies east of the currently subducting plate that are interpreted as the oceanic slab still attached to Siletzia.[3]



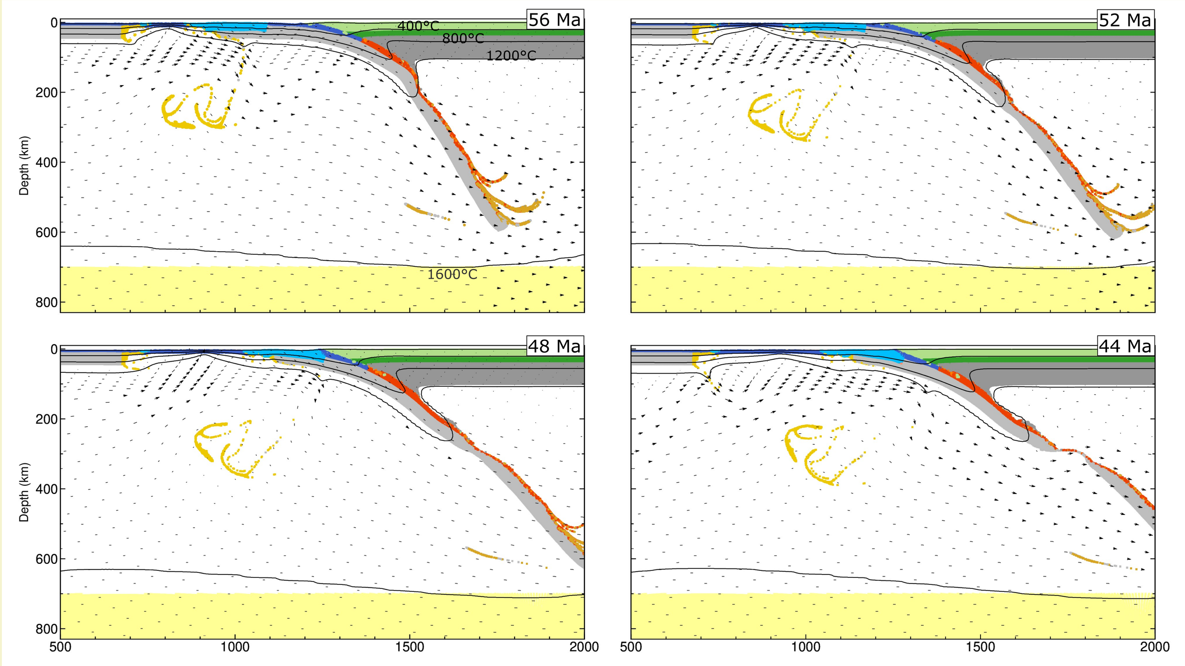
After Schmandt 2011

Simulation results

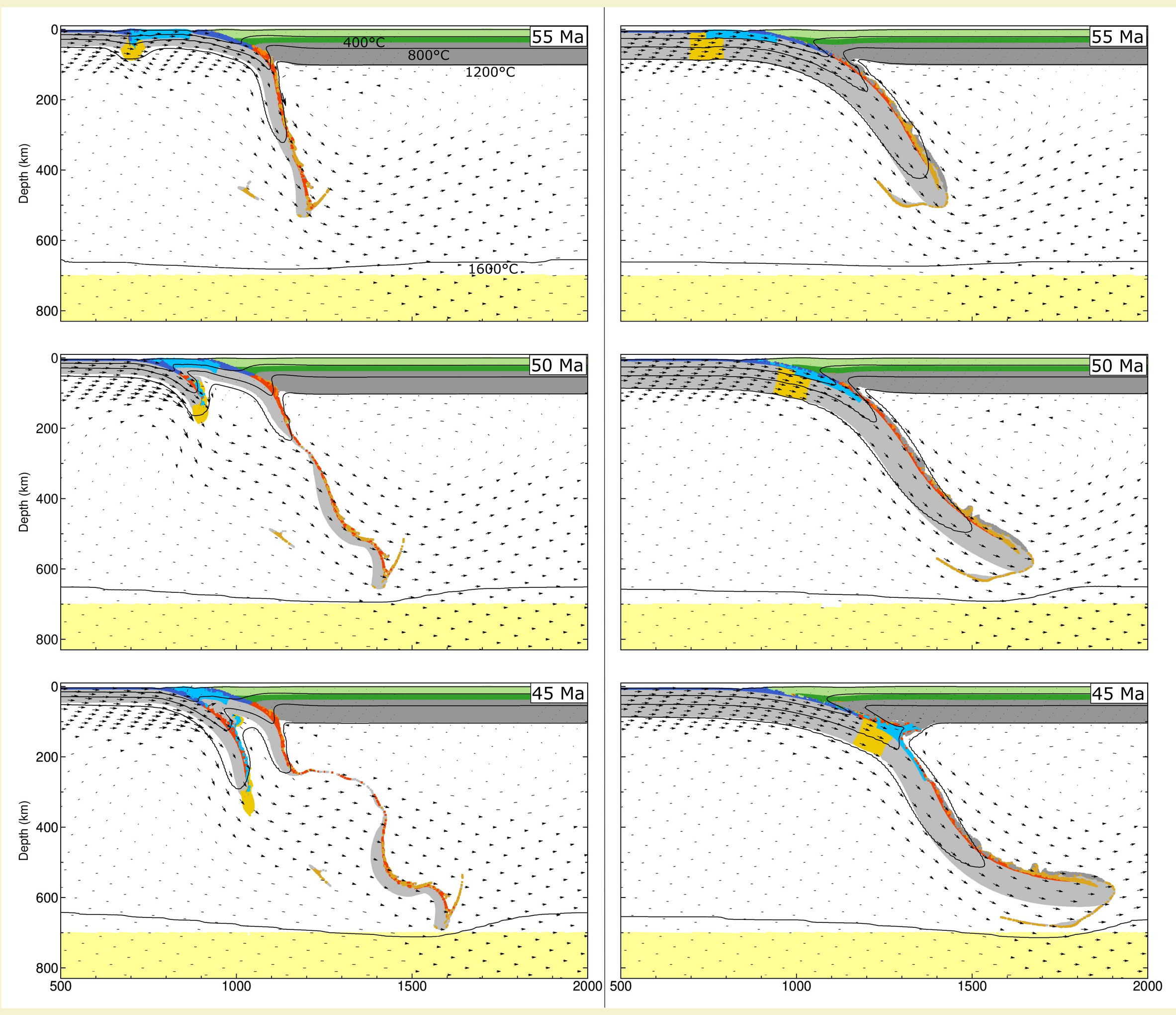
Plateau on young plate



Free Subduction



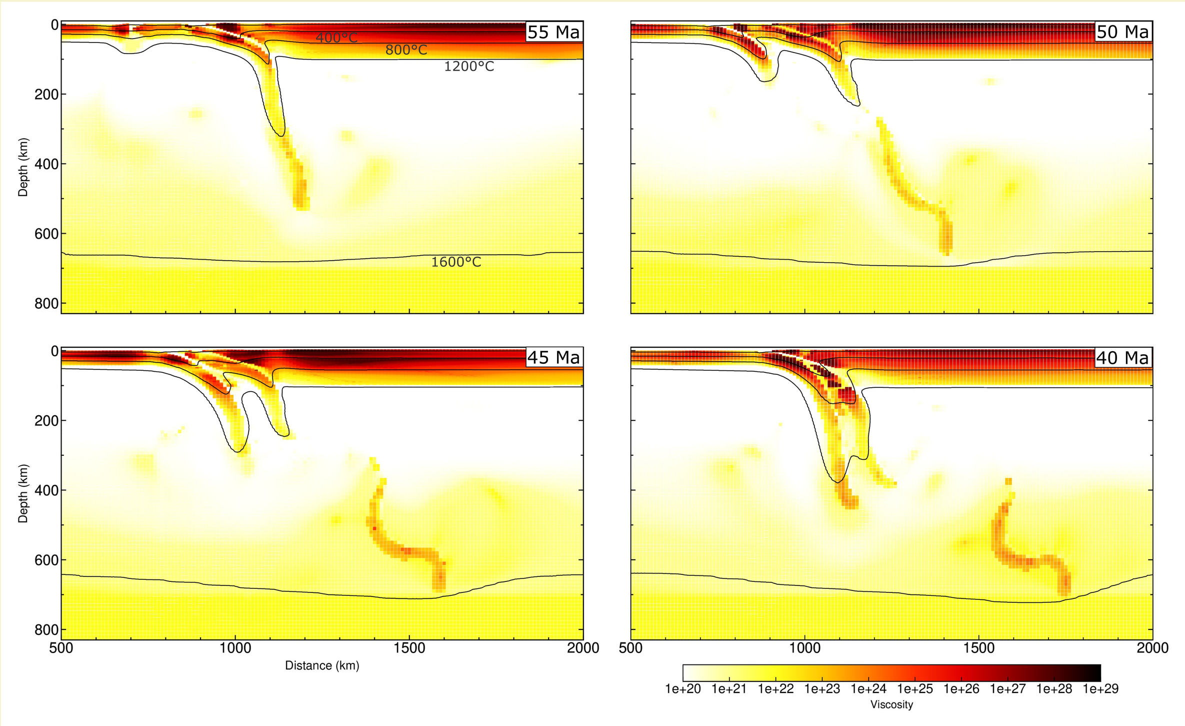
Comparison young vs old plate



Oceanic plateau on young plate (without conduit)**:** Plateau's buoyancy prevents subduction and all plate motion seizes leading to slab break off.

Free subduction: 0 velocity at left boundary. Plateau entering trench halts subduction. Challenge to achieve enough slab pull without causing slab break-off on young plate.

Viscosity



Comparison young vs old plate: On young plate(left) a new subduction zone is created behind plateau. Slab break-off of previous slab leads to (temporary) accretion of plateau.
On thicker oceanic plate (right), subduction continues when plateau arrives at trench. No accretion even with vertical weak zone.

Viscosity: Same simulation as young plate model in comparison. Conduit has similar viscosity to subduction channel. Both subduction channels have similar viscosities leading to no preference in localization for the deformation.

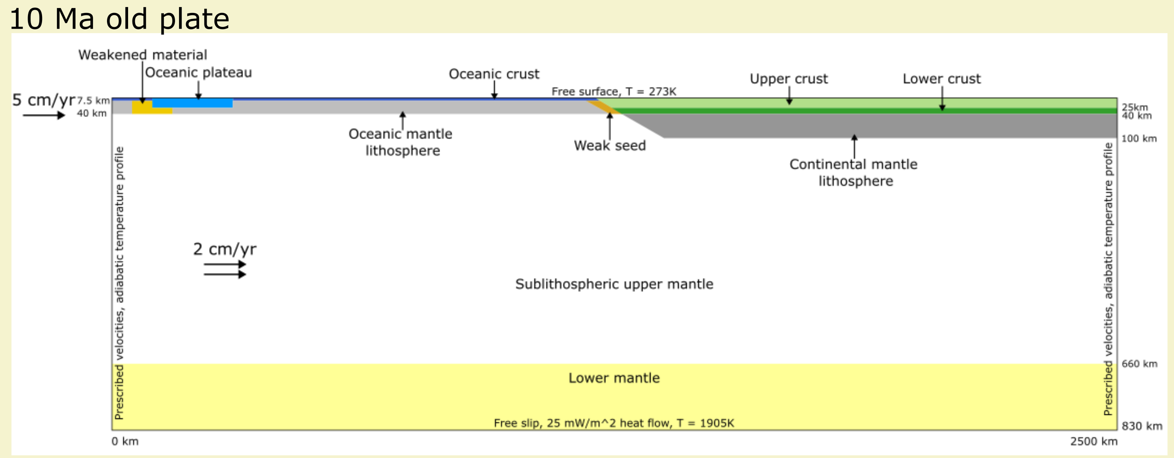
Questions to investigate

> What parameters affect the accretion of the plateau on a young oceanic plate?

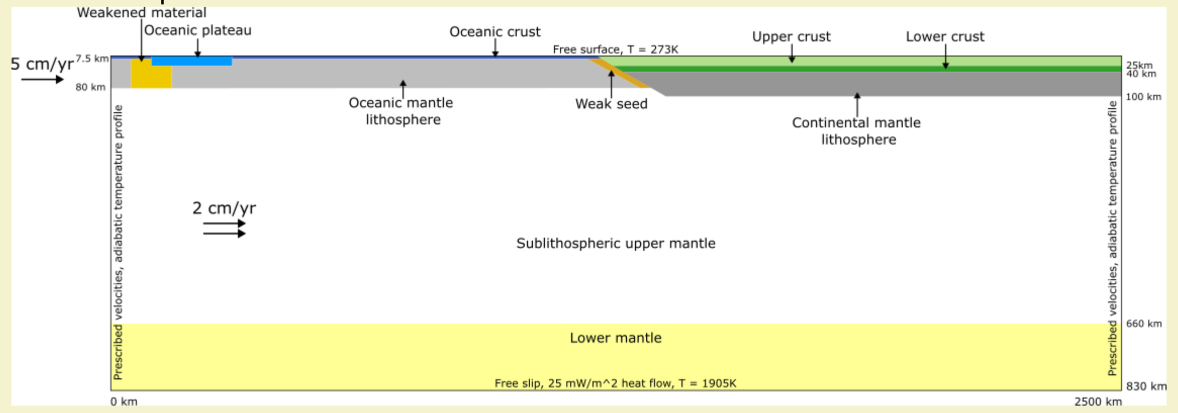
> How does the subduction dynamic differ in comparison to a 10 Ma oceanic plate?

> Does the oceanic slab stay connected to the Siletzia plateau during accretion?

10 Ma old plate



50 Ma old plate



Initial models

- 2D numeric simulation run using SOPALE code.[4]
- Structure of oceanic plate based on the age of the plate during subduction
- Zone of weaker material (gold) behind plateau approximates the weakening of the plate from conduit of plateau with constant viscosity
- A phase transition ocurres from basalt to denser eclogite (red in simulation results).

Key points

> Adding a plateau stops subduction for young oceanic plate and requires forced convergence to be compensated elsewhere

> Weakened material of substantial extent related to the creation of the plateau can lead to creation of new subduction zone outboard of previous subduction zone

> Both plateau and vertical weak zone only have marginal effects on older oceanic plates as no accretion or formation of new subduction is observed

Literature

[1] Ciborowski, T. Jake R., Bethan A. Phillips, Andrew C. Kerr, Dan N. Barfod, and Darren F. Mark. "Petrogenesis of Siletzia: The World's Youngest Oceanic Plateau." Results in Geochemistry 1 (September 1, 2020): 100004.

[2] Wright, Nicky M., Maria Seton, Simon E. Williams, and R. Dietmar Müller. "The Late Cretaceous to Recent Tectonic History of the Pacific Ocean Basin." Earth-Science Reviews 154 (March 1, 2016): 138–73.

[3] Schmandt, B., and E. Humphreys. "Seismically Imaged Relict Slab from the 55 Ma Siletzia Accretion to the Northwest United States." Geology 39, no. 2 (February 1, 2011): 175–78.

[4] Fullsack, Philippe. "An Arbitrary Lagrangian-Eulerian Formulation for Creeping Flows and Its Application in Tectonic Models." Geophysical Journal International 120, no. 1 (January 1995): 1–23.

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