Contributions to dynamic topography from shear-driven mantle flow at lithospheric edges

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In collaboration with:
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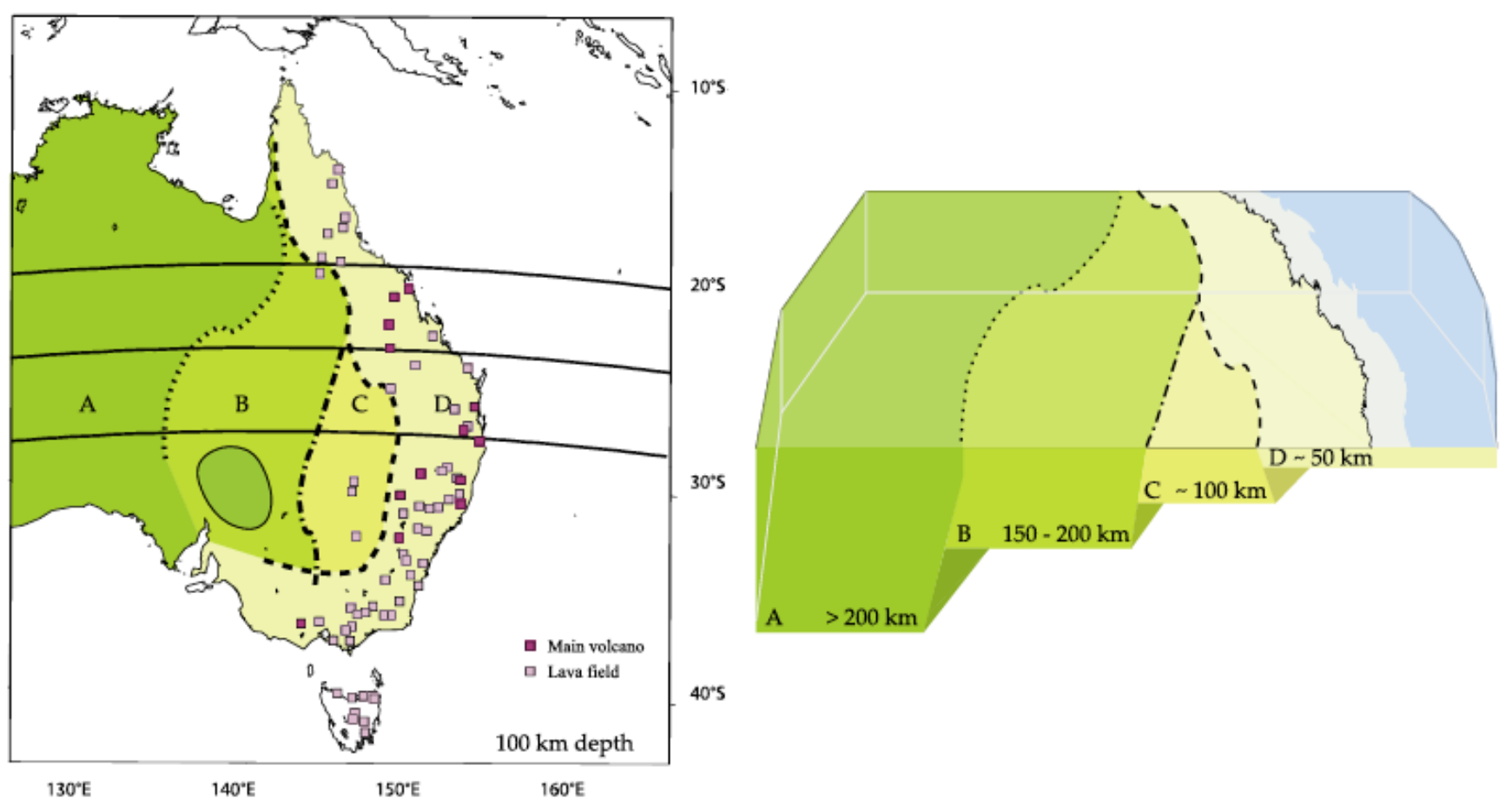
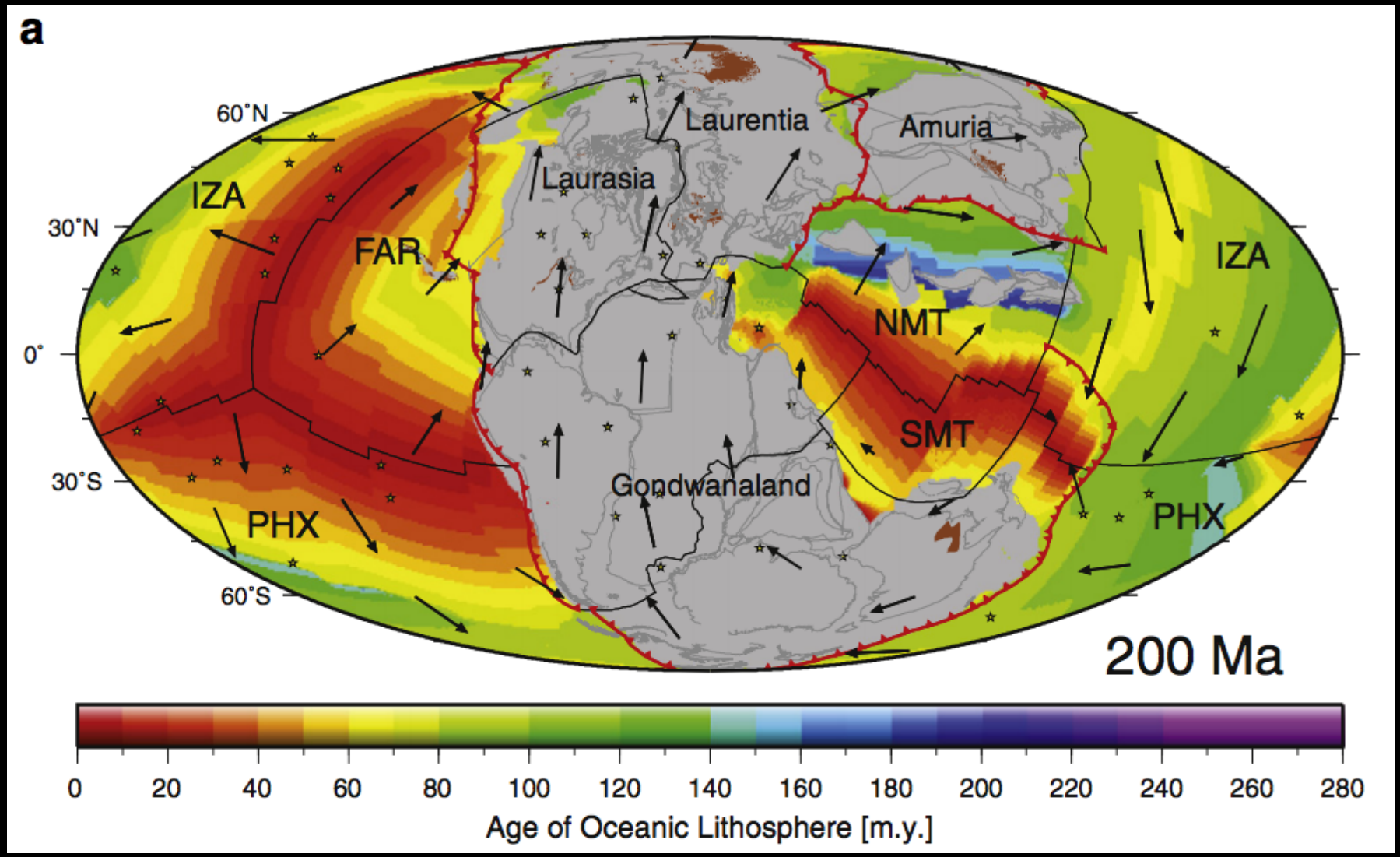
and Dave Stegman (Scripps)

1) 3D structure of continents



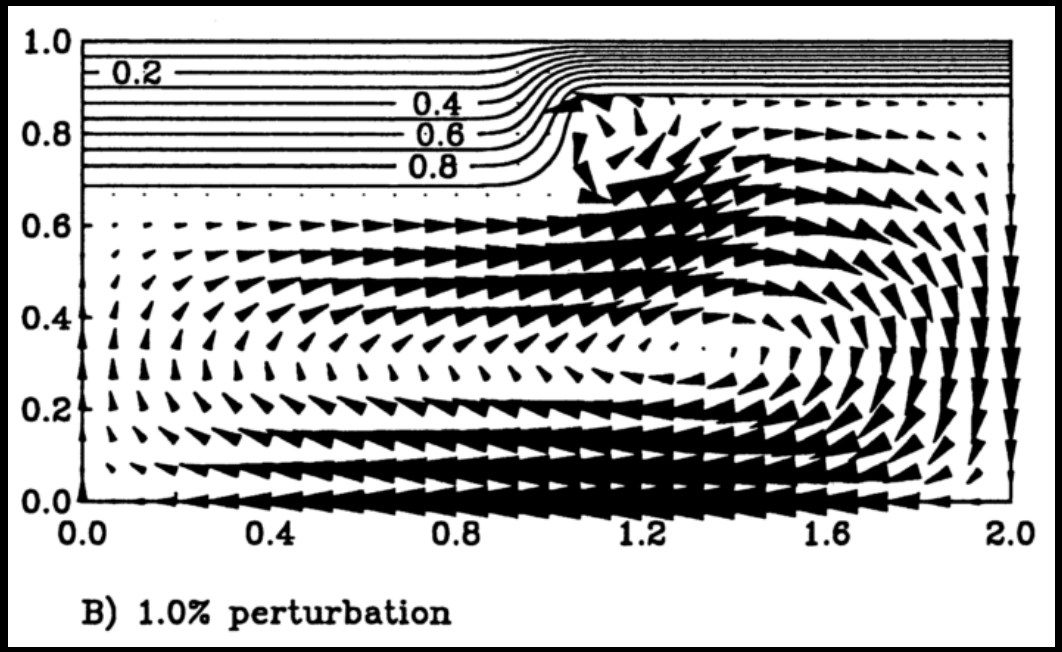
Fishwick et al (2008)

2) Plate Motions



Seton et al (2012)

Edge-driven Convection:



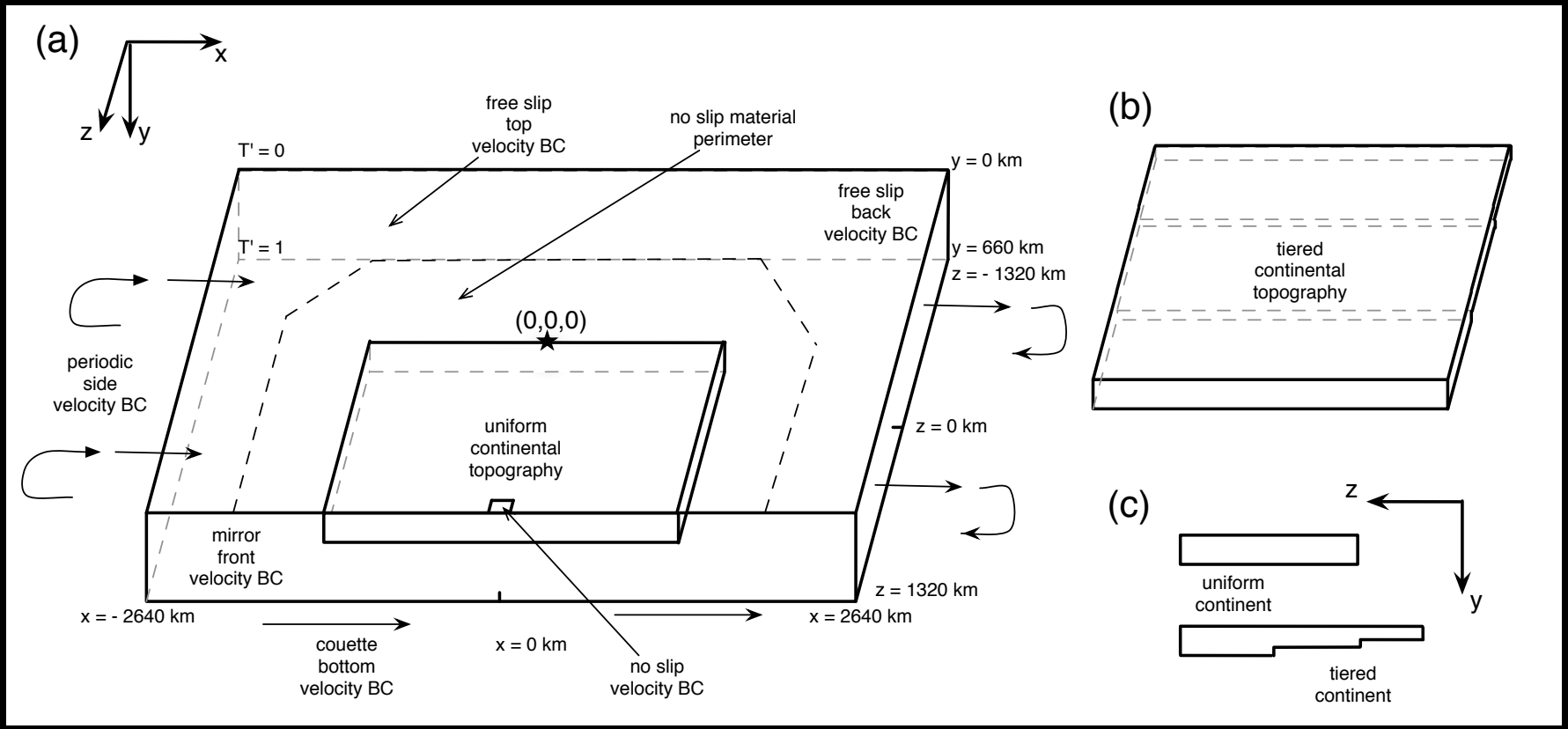
Demonstrated relationship between continental morphology & plate motion

King & Anderson (1998)

Model Setup

1) Continent morphology (2D and 3D)

2) Plate Velocity

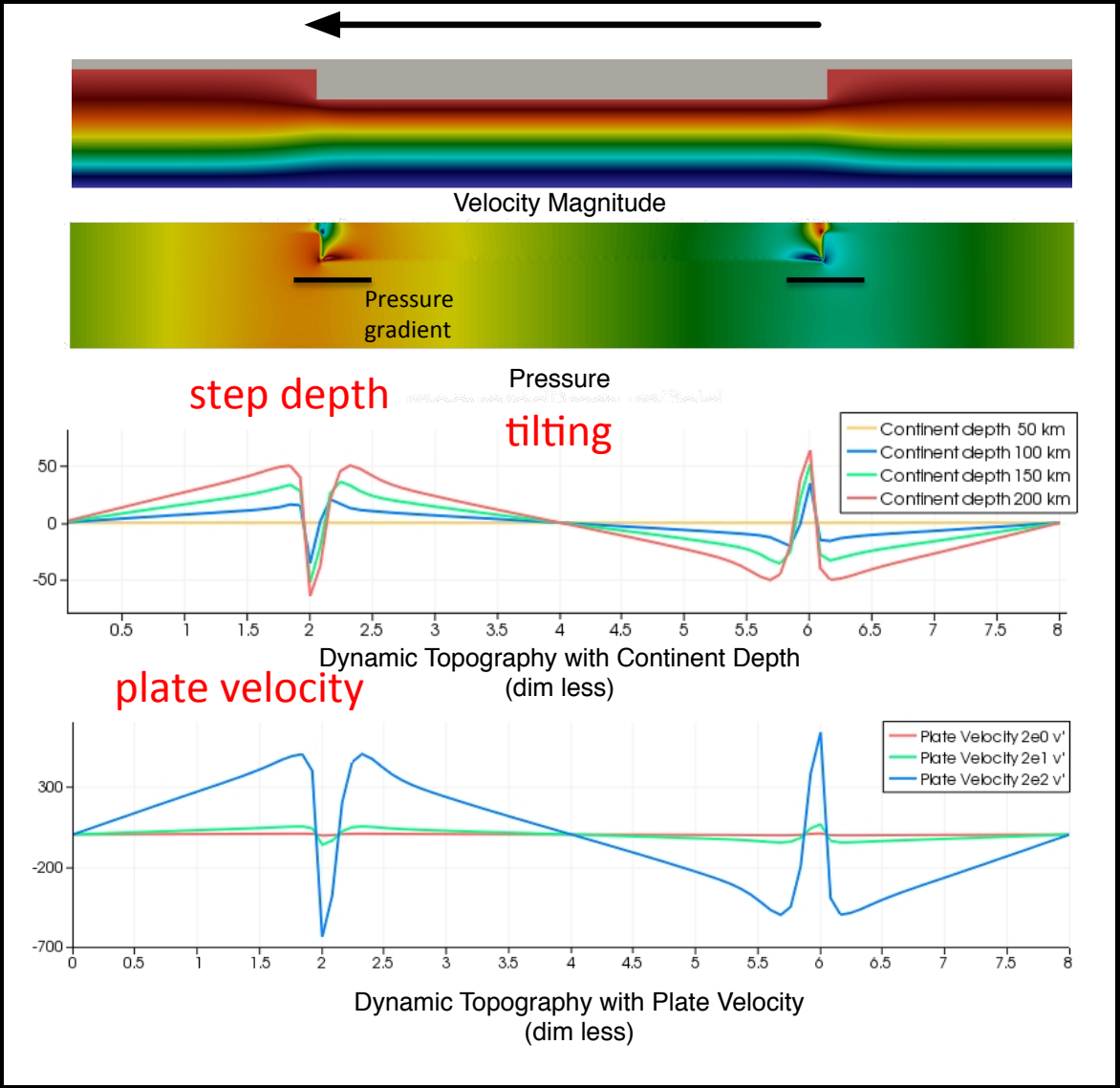


Thermal IC: quasi steady state, insulating continent & hot sub continental mantle. Upper mantle $\eta(T,\dot{\varepsilon})$
model run time: for continent to move 2640 km (x/2)

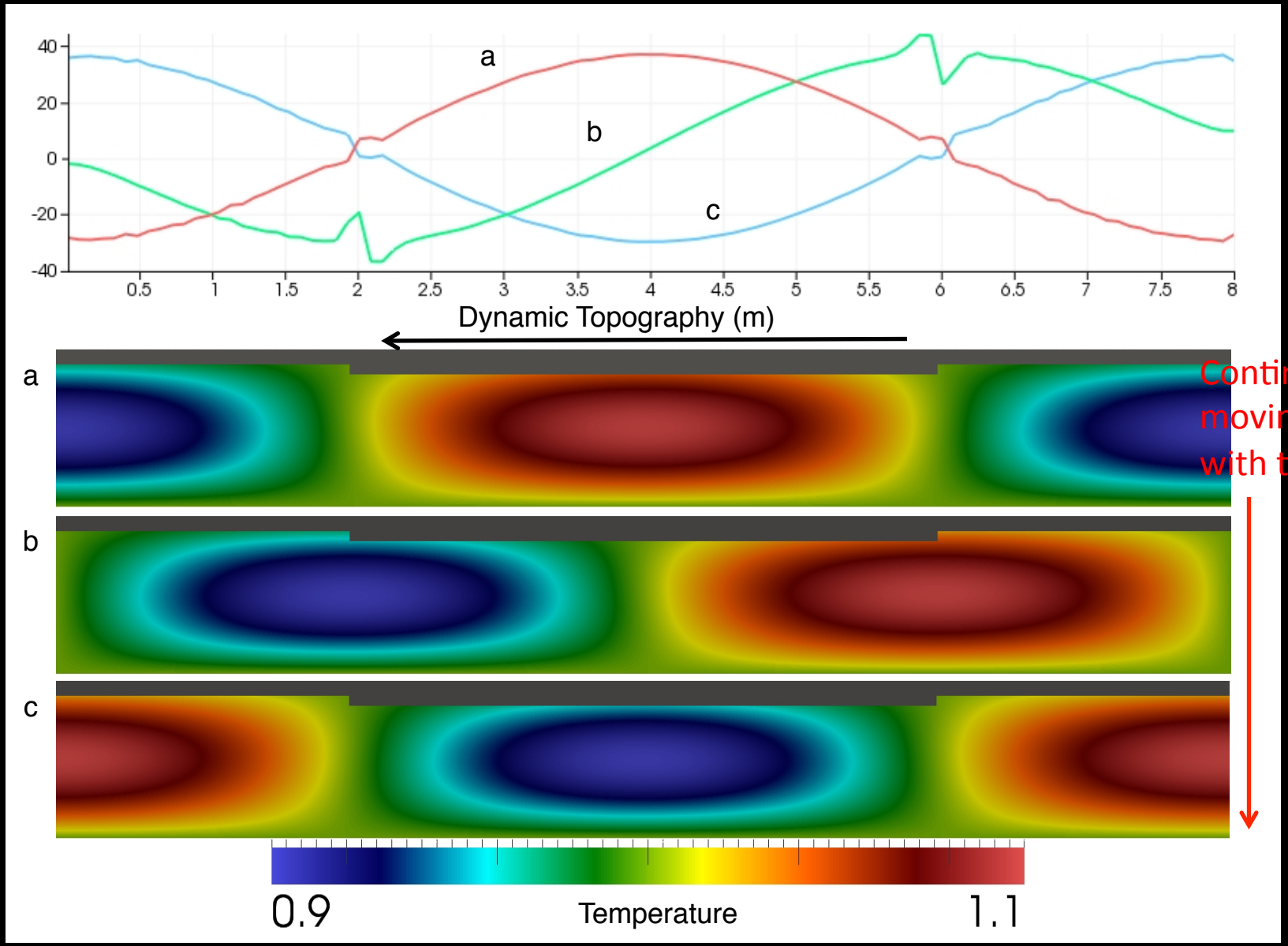
Underworld: Moresi et al (2007)

... stepping back

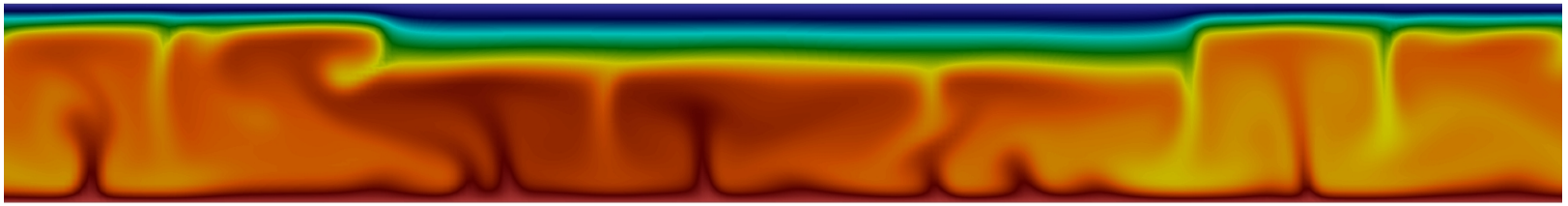
Lithospheric step + plate velocity = Continent Tilting



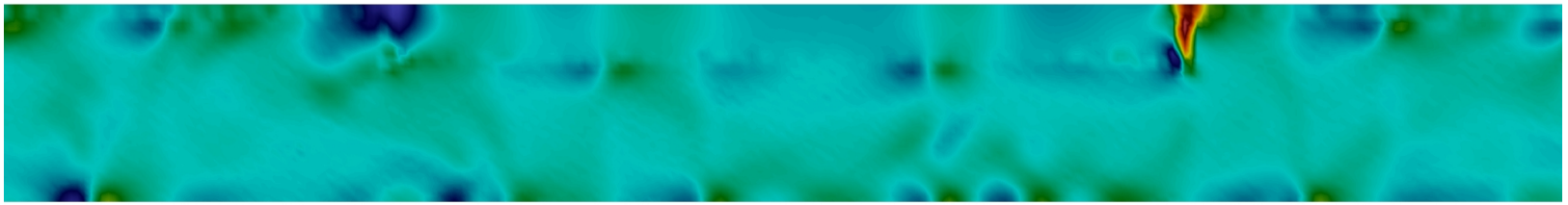
+ thermal anomaly



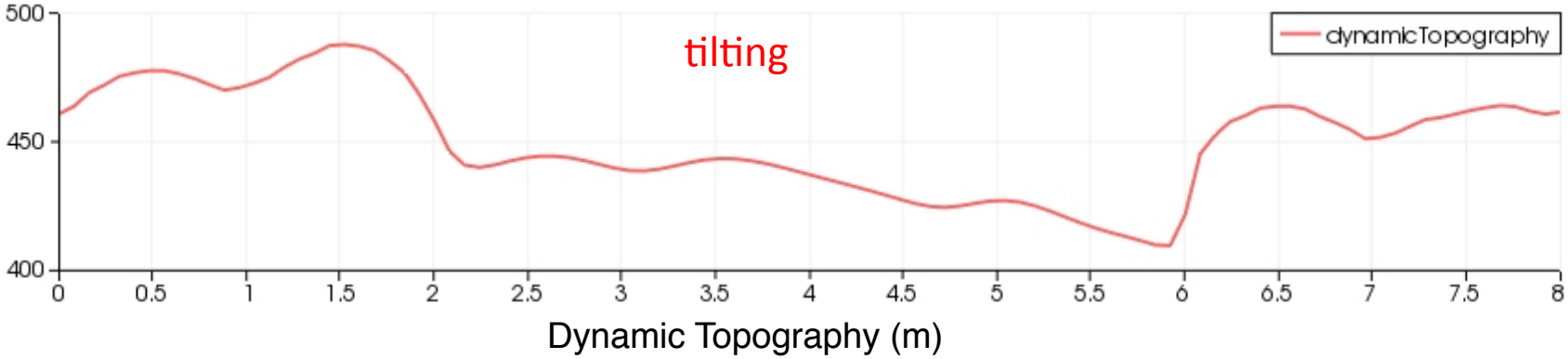
Insulating continent + mantle convection = thermal anomaly



Temperature



Pressure Gradient in X

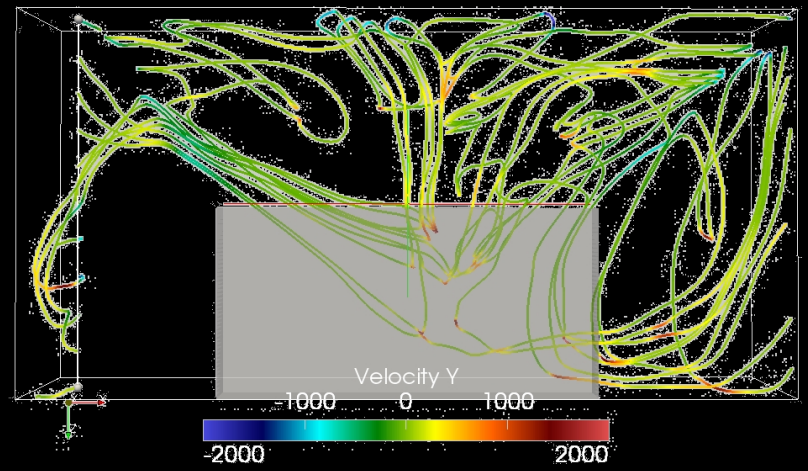


- No plate motion
- Dynamic topography on the scale of convection cells size

Flow Field

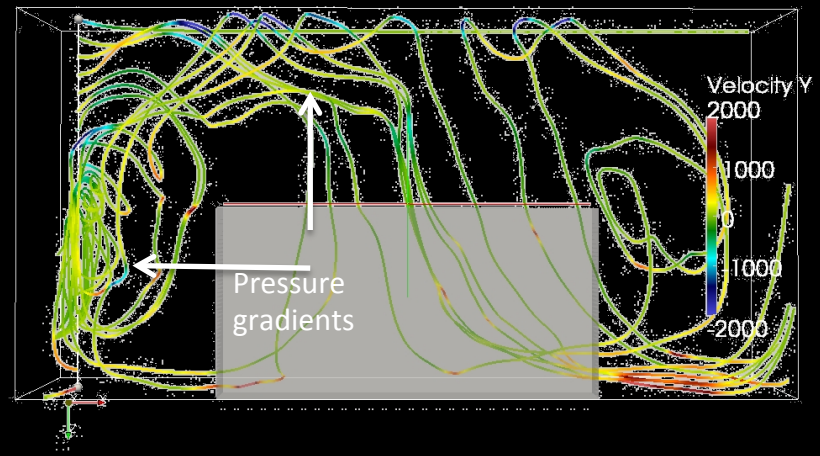
Uniform Continent

0 cm/yr
Thermal
model



Thermal
Convection-
controlled

2 cm/yr
Thermal + Plate
shearing model



Continent
morphology
-controlled
(3D)

20 cm /yr
Plate shearing model

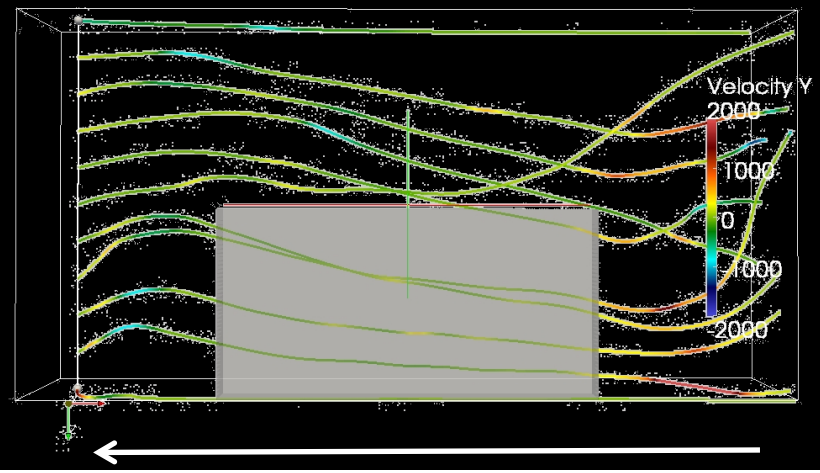
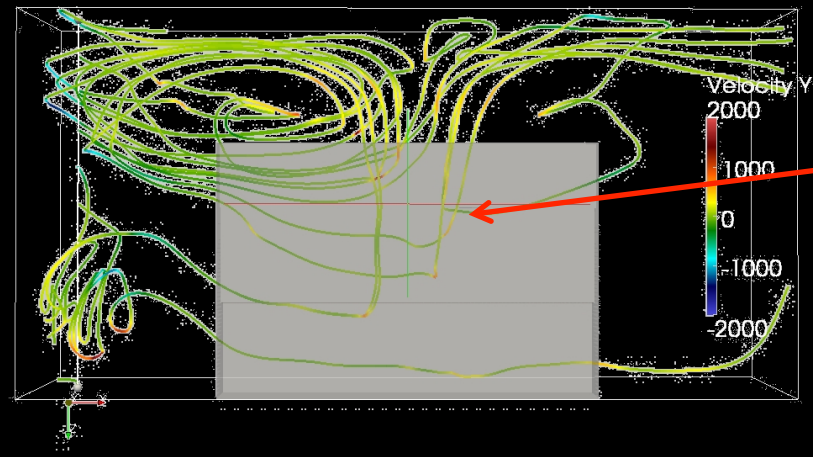


Plate
motions-
controlled
(2D)

Flow Field

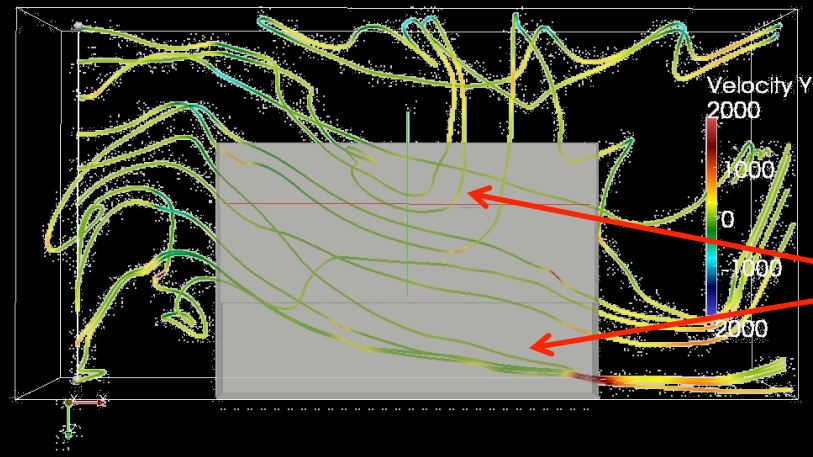
Tiered Continent

0 cm/yr
Thermal
model



Continent
morphology
-controlled
(3D)

2 cm/yr
Thermal + Plate
shearing model



Continent
morphology
-controlled
(3D)

20 cm /yr
Plate shearing model

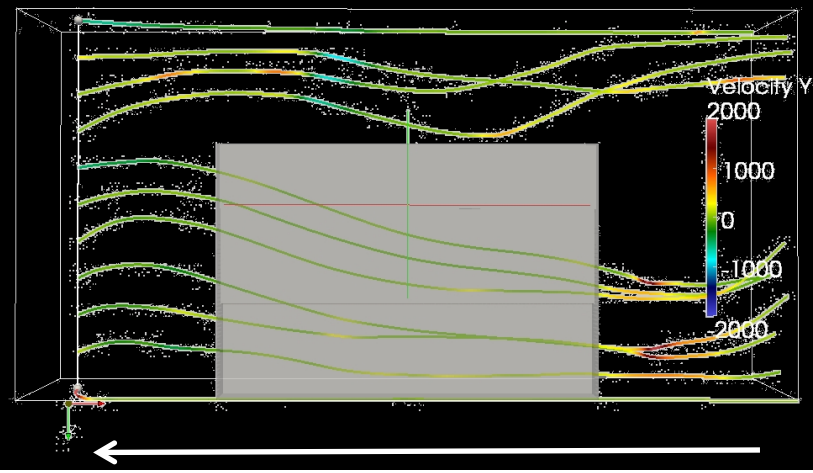
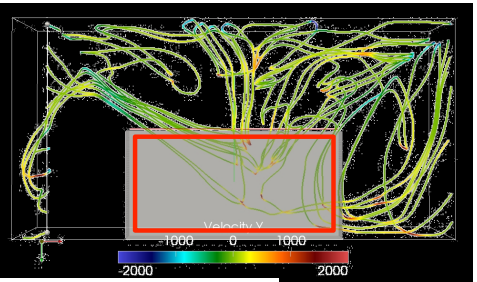


Plate
motions-
controlled
(2D)

Dynamic Topography



Uniform

Tiered

0 cm/yr
Thermal
model

2 cm/yr
Thermal + Plate
shearing model

20 cm /yr
Plate shearing
model

Basins form
continental
edges

Deep
basins

-500 -250 0 250 500

-600 Dynamic Topography (m) 600

Conclusions

- Morphology is important
  - (whether you have a plate velocity or not)
- 2D v 3D
  - Mantle can move normal to plate motions
- Deep continental basins may be formed as a consequence of continental basal morphology