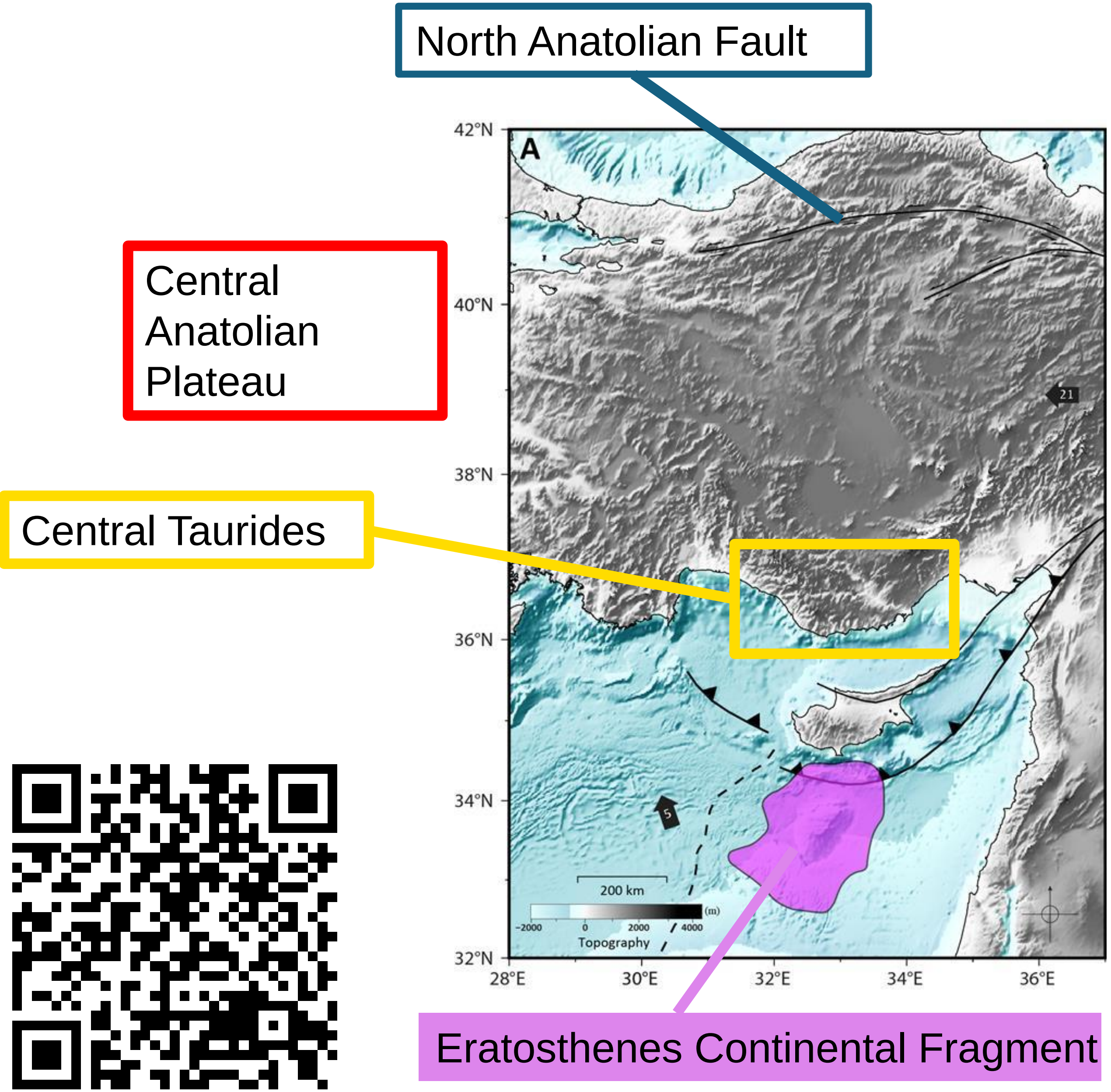
Continental fragment collision in subduction and the dramatic uplift acceleration in the Eastern Anatolian region



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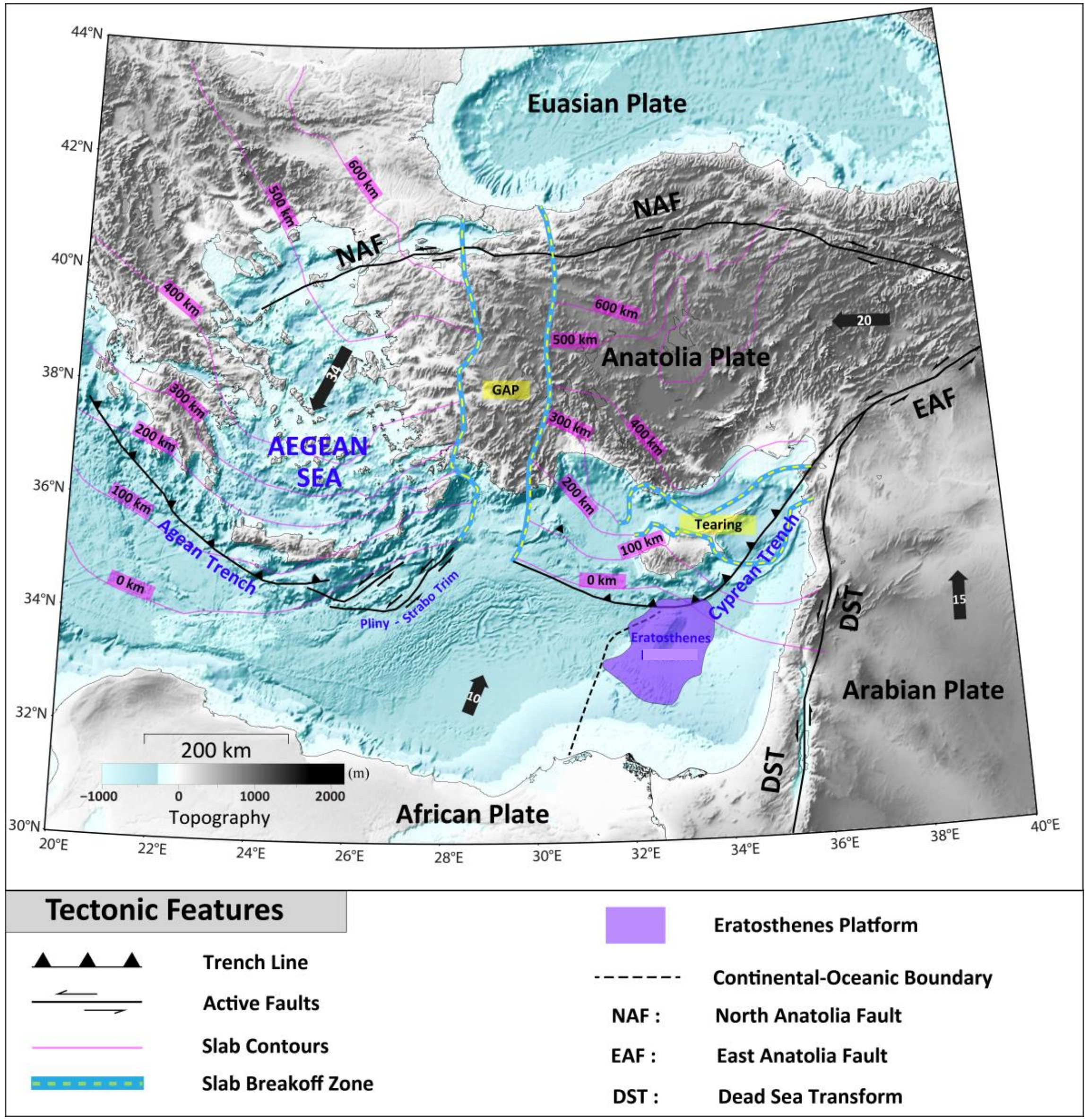
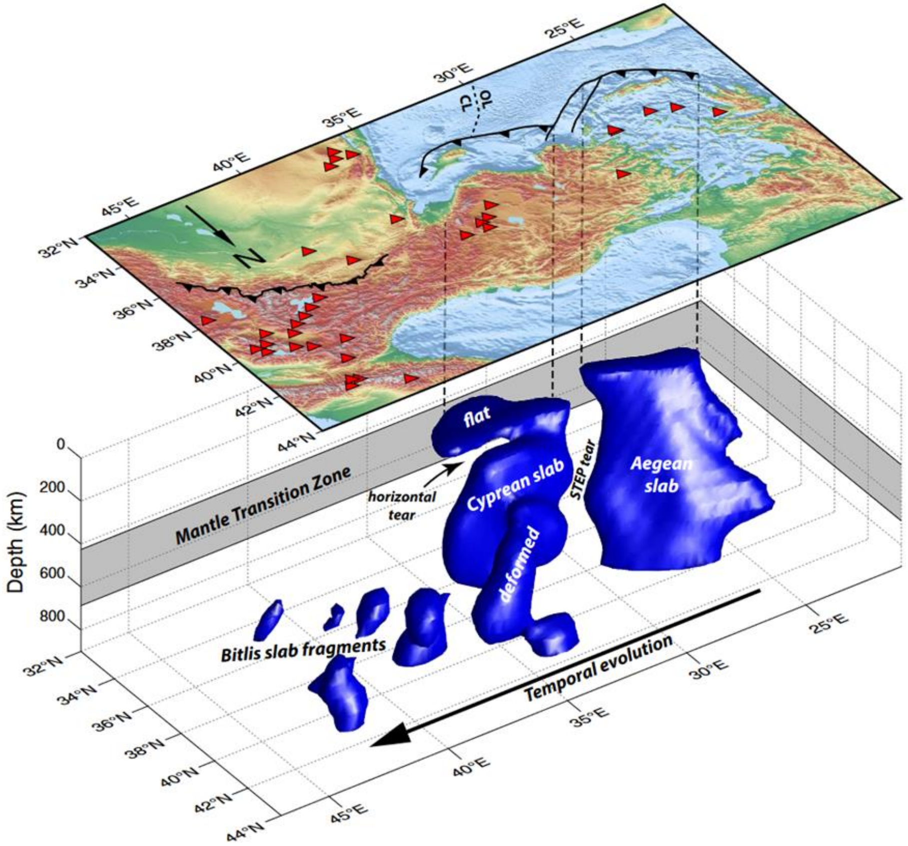
In this region, there are multiple trench segments and subducting slabs

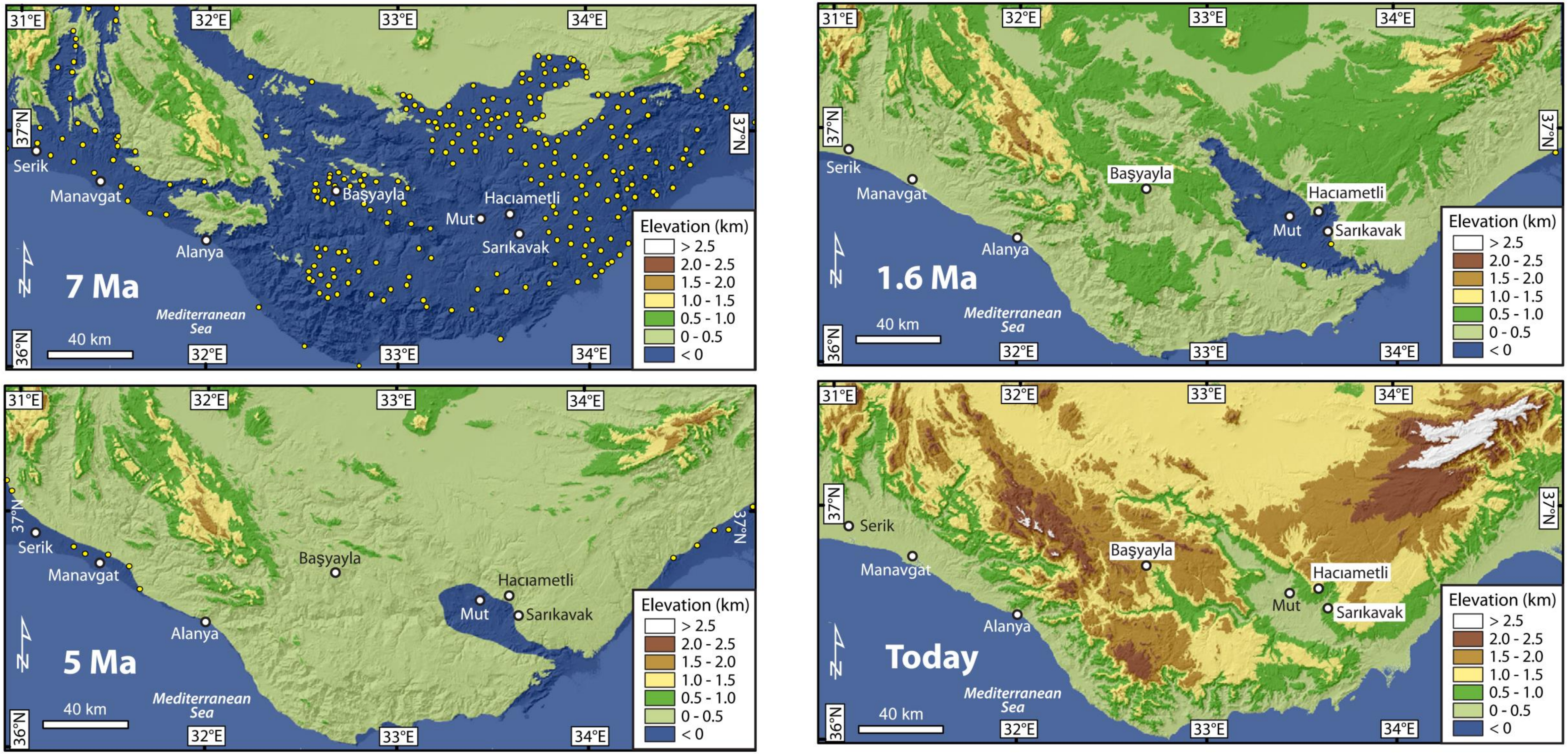




(Portner et al., 2018), *Geosphere*

Luo et al., *in prep.*

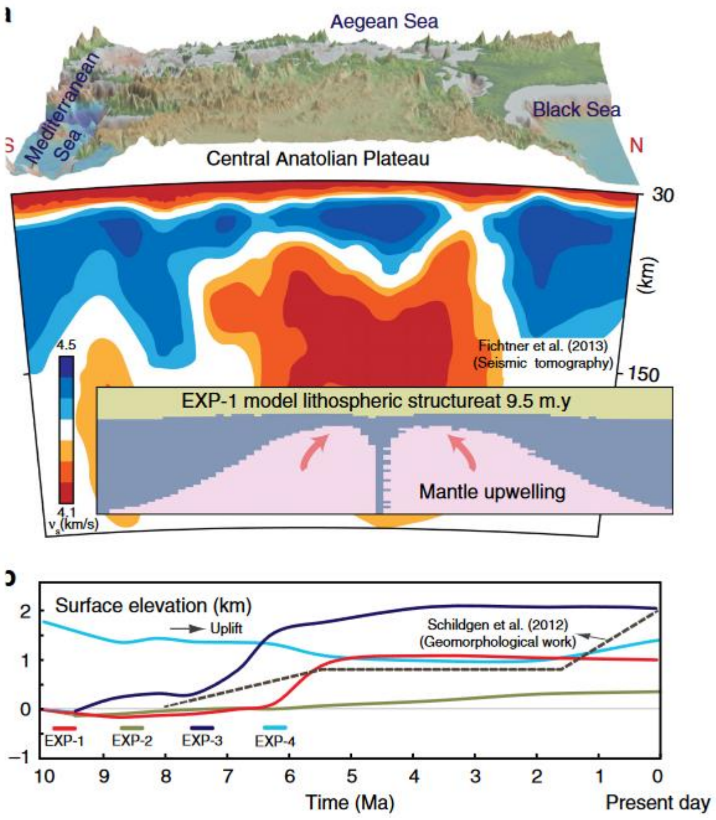
The Central Taurides has experienced significant uplift since 7 Ma



Schidgen et al., 2014. (Earth-Sci. Rev.)

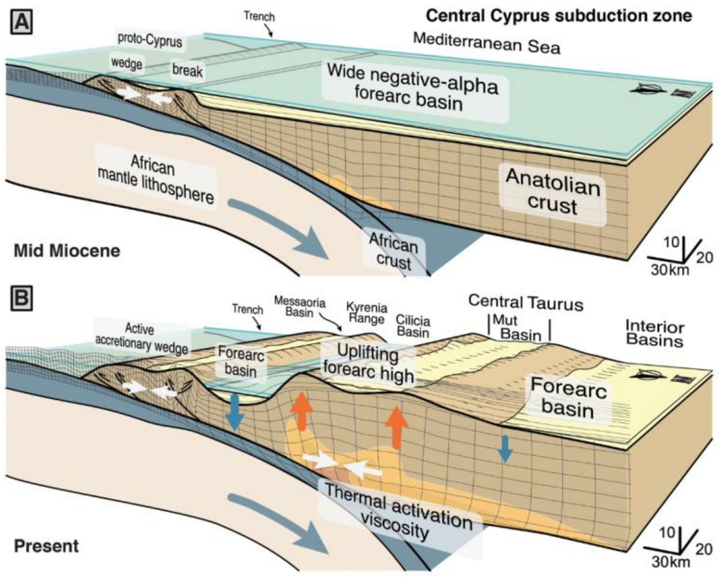
Slow progressive uplift since 7 Ma can be explained by different mechanisms

Lithospheric Drip



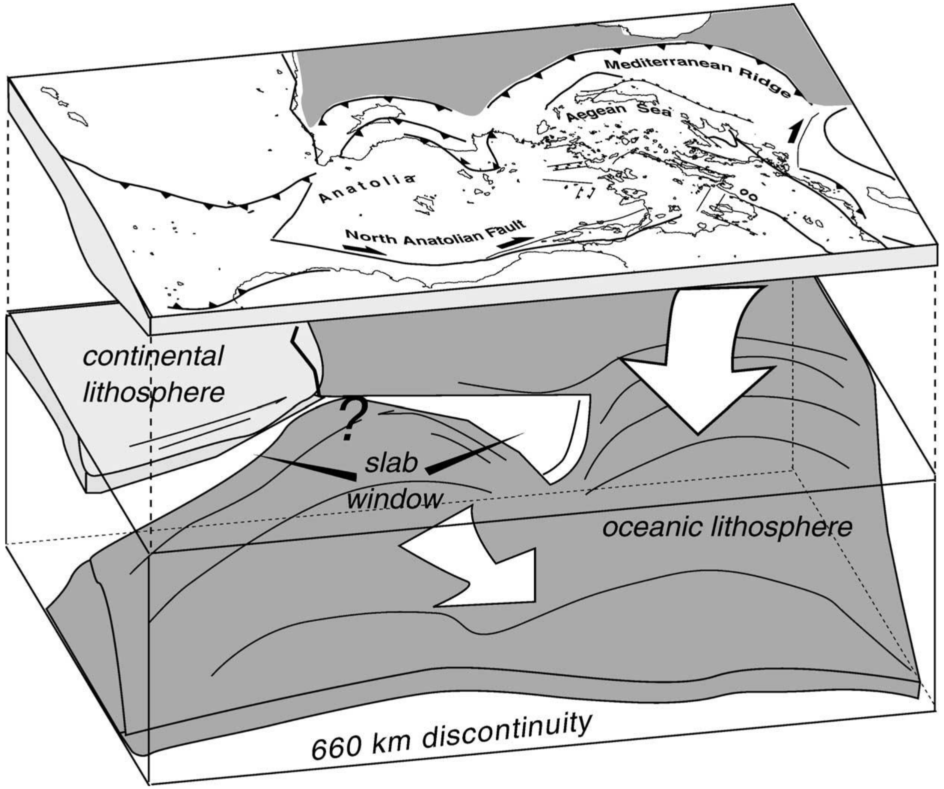
(Göğüş et al., 2017) *Nat. Comm.*

Deep-Seated Flow



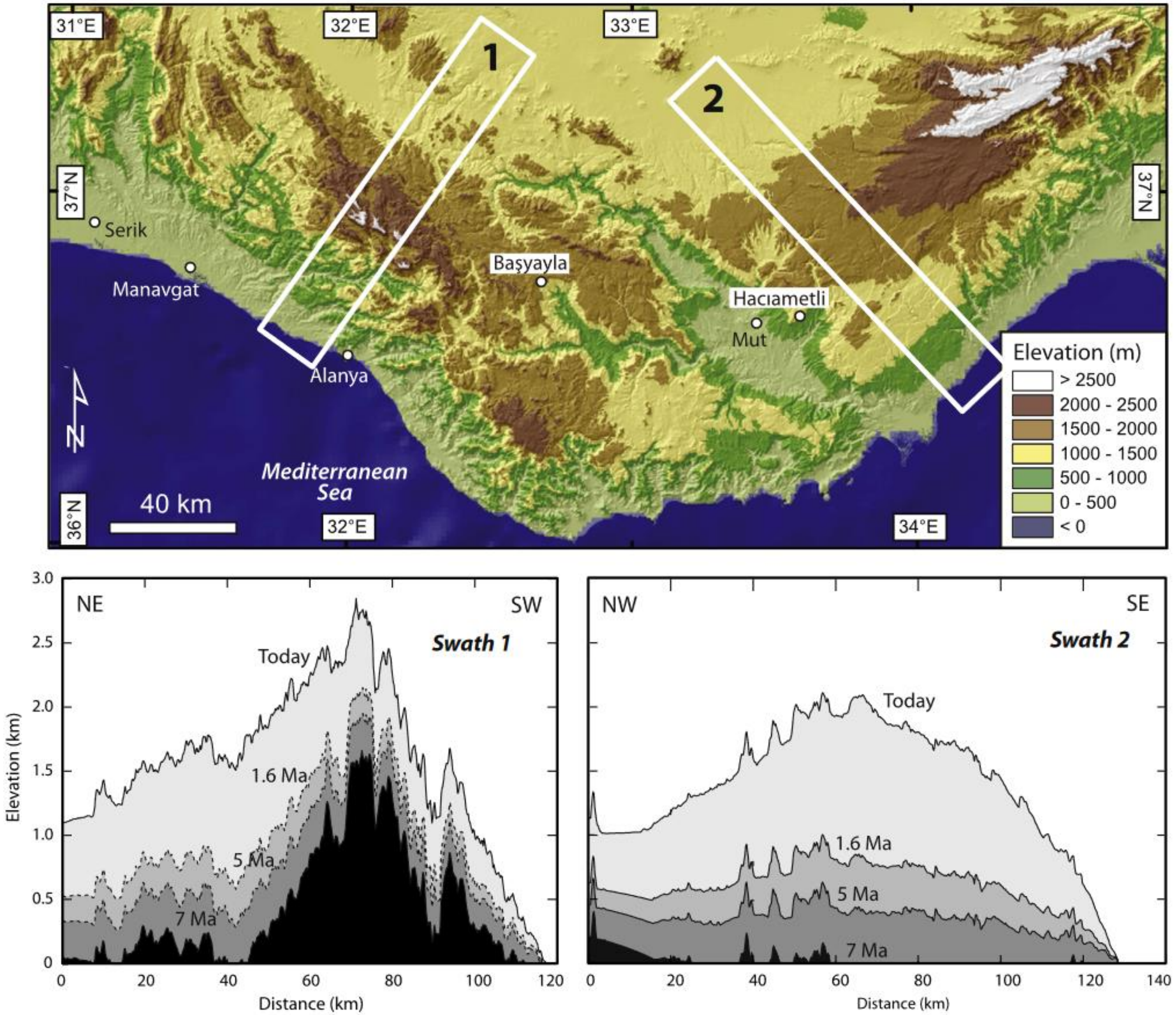
(Fernández-Blanco et al., 2020) *EPSL*

Slab Detachment

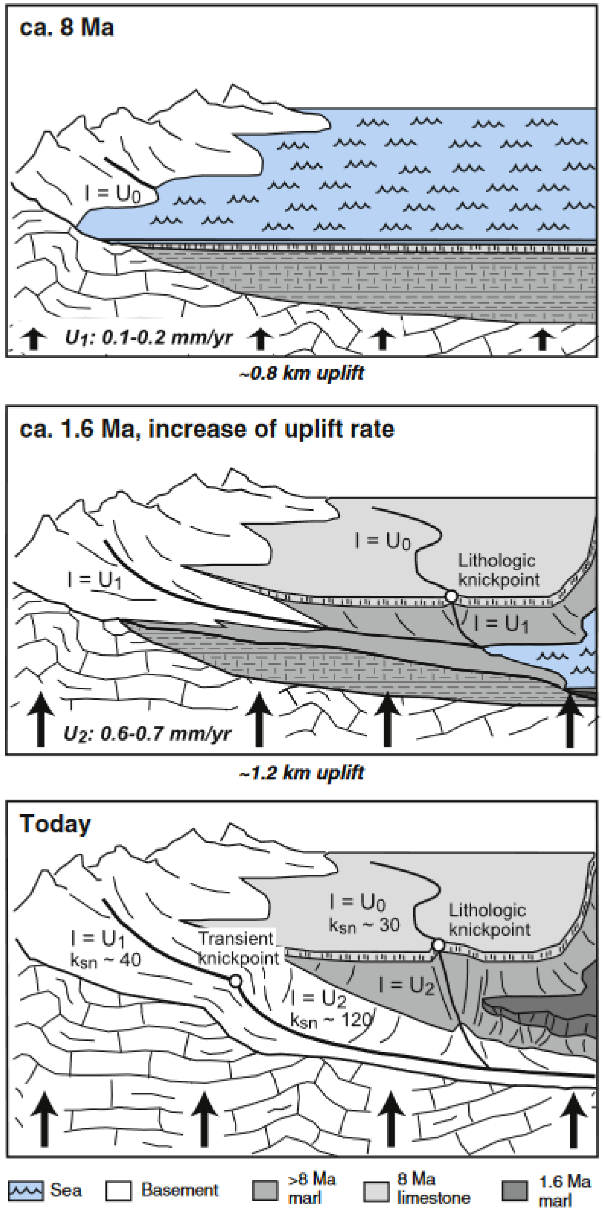


(Faccenna et al., 2006) *EPSL*

River profiles in the region suggest multiphase uplift since 7 Ma

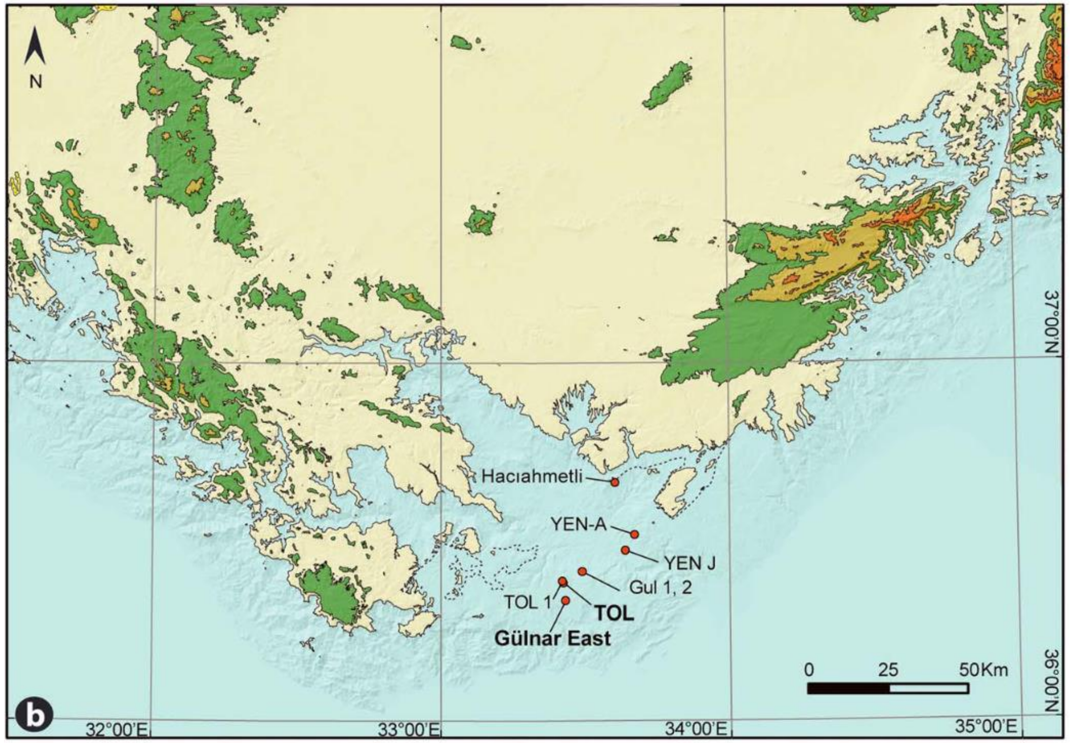


Schidgen et al., 2014. (Earth-Sci. Rev.)

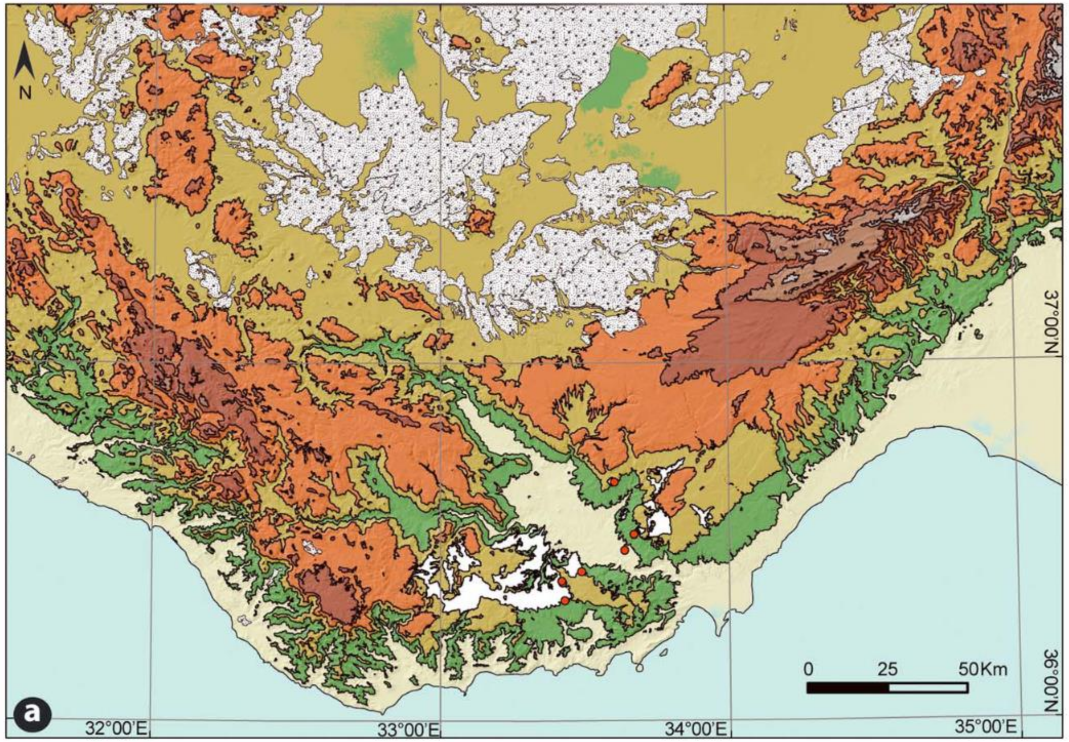


(Schildgen et al., 2012) EPSL

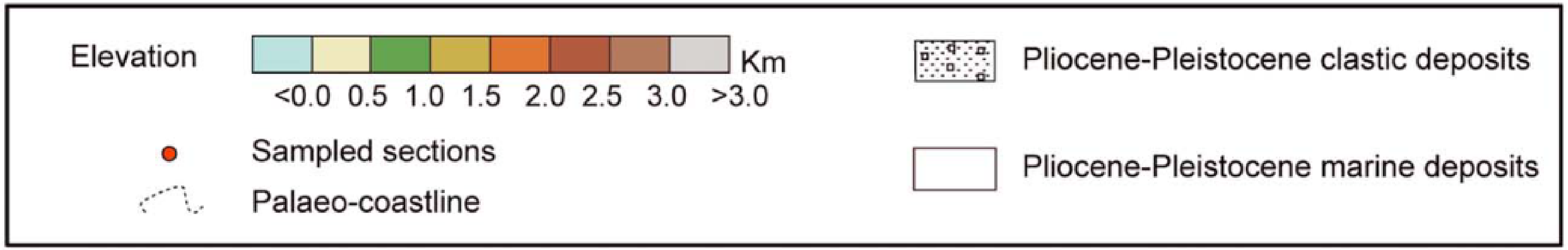
Recent finding suggest that a major pulse of uplift occurred at 450 ka



450 ka

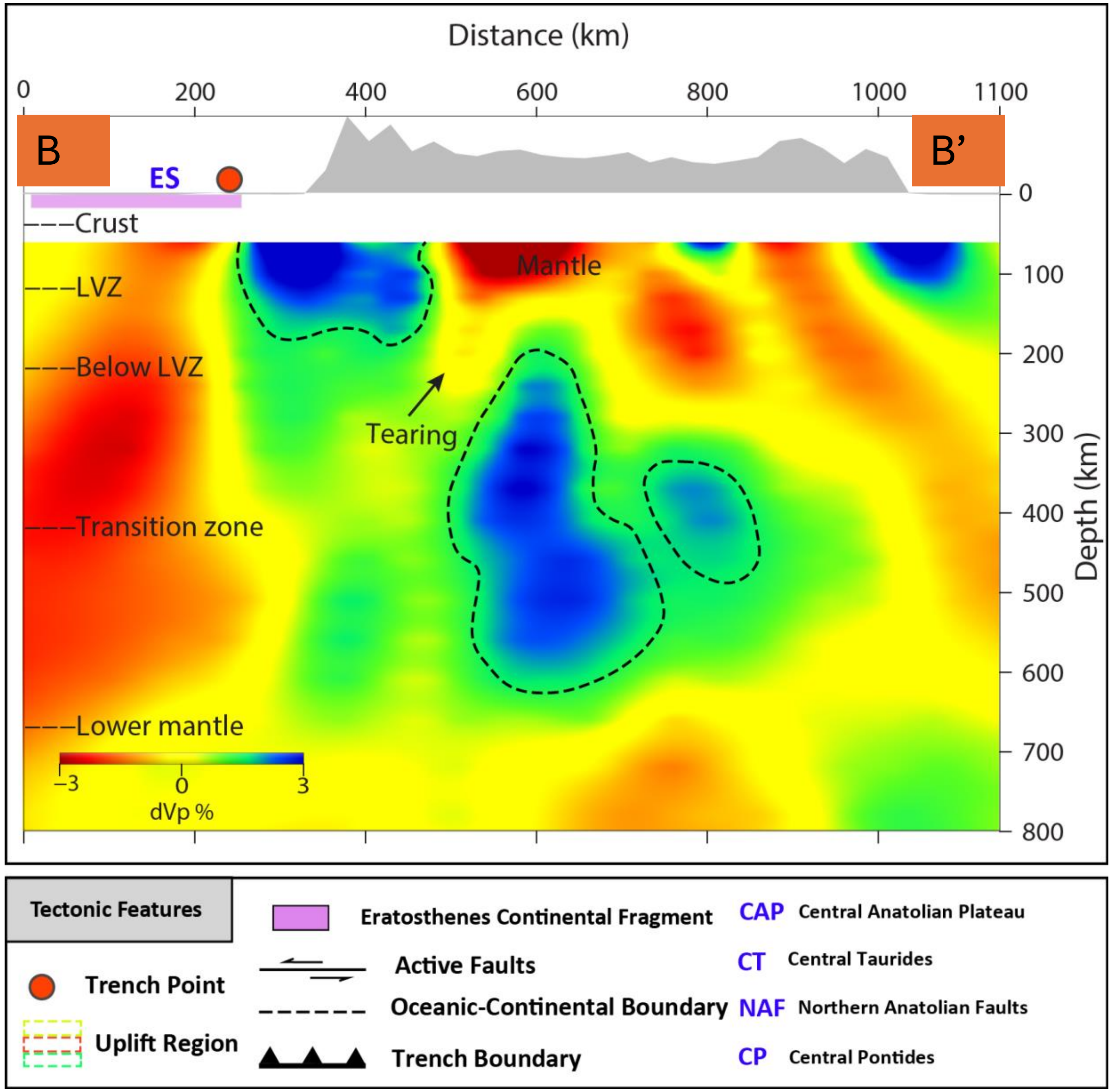


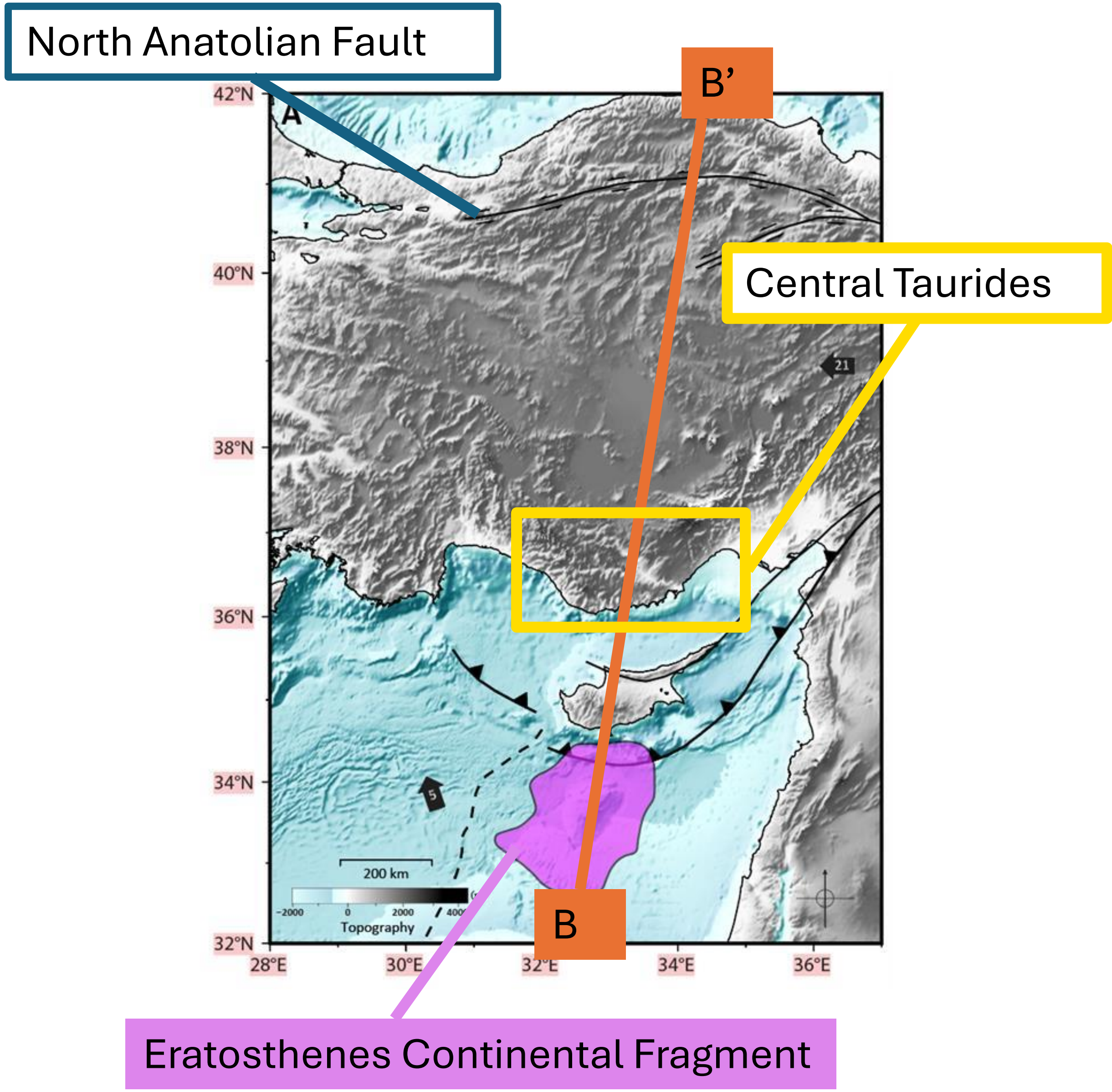
Present



(Öğretmen et al., 2018)
Tectonics

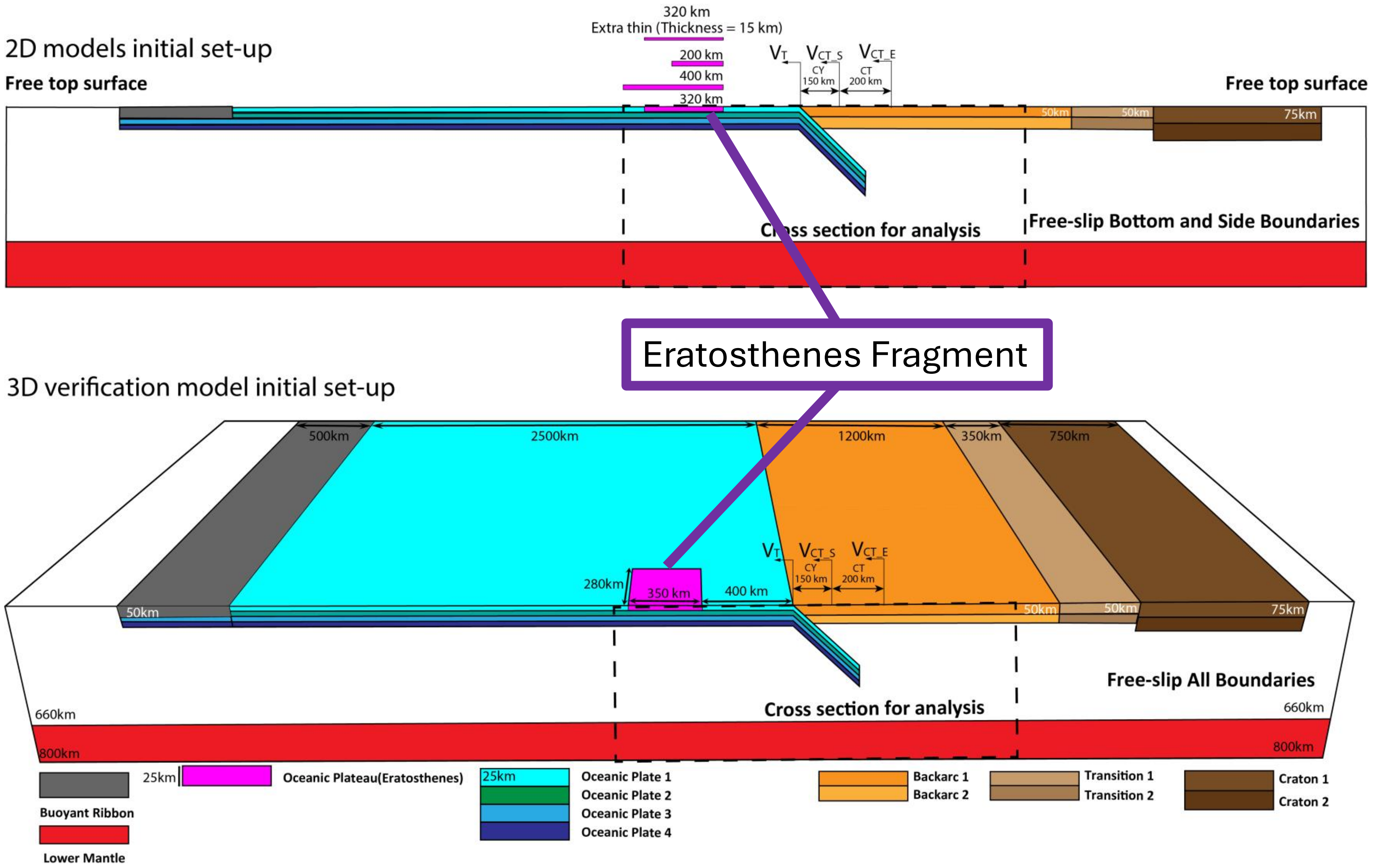
Tomographic images suggest a slab gap in the mantle





Luo et al., *in prep.*

We tested the slab-gap model with Underworld2.0 using an oceanic plate and a continental fragment representing Eratosthenes



2D setup

3D setup

Underworldproject.org

Luo et al., *in prep.*

We ran a variety of 2D and 3D models of varying lengths and thicknesses to estimate uplift in the Central Taurides

Model Name	Continental fragment length	Continental fragment thickness	Continental fragment width	Slab breakoff
Model 200	200 km	25 km	0 km	Yes
Model 320	320 km	25 km	0 km	Yes
Model 400	400 km	25 km	0 km	Yes
Model Nobreakoff	320 km	15 km	0 km	No
Model 3D	320 km	25 km	280 km	Yes

Luo et al., *in prep.*

The equation of motion is solved with incompressibility with the viscosity reduced for regions undergoing high stress

$$\nabla p - \nabla \cdot \boldsymbol{\tau} = \Delta \rho g \hat{\mathbf{z}}$$

Equation of motion

$$\nabla \cdot \boldsymbol{u} = 0$$

Incompressibility

$$\boldsymbol{\tau}_{ij} = \eta \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right)$$

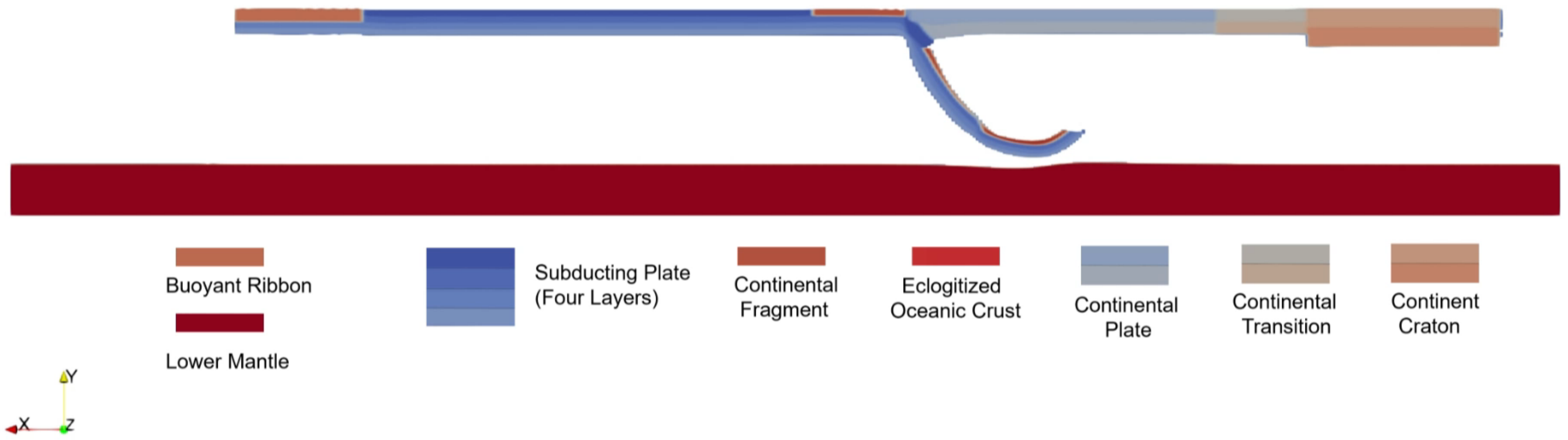
Deviatoric stress

Symbol	Meaning
p	Dynamic pressure
$\boldsymbol{\tau}$	Deviatoric stress tensor
ρ	Density
g	Gravity
η	Dynamic viscosity
$\boldsymbol{u}$	Velocity vector
$\hat{\mathbf{z}}$	Vertical vector

(Stegman et al., 2006)

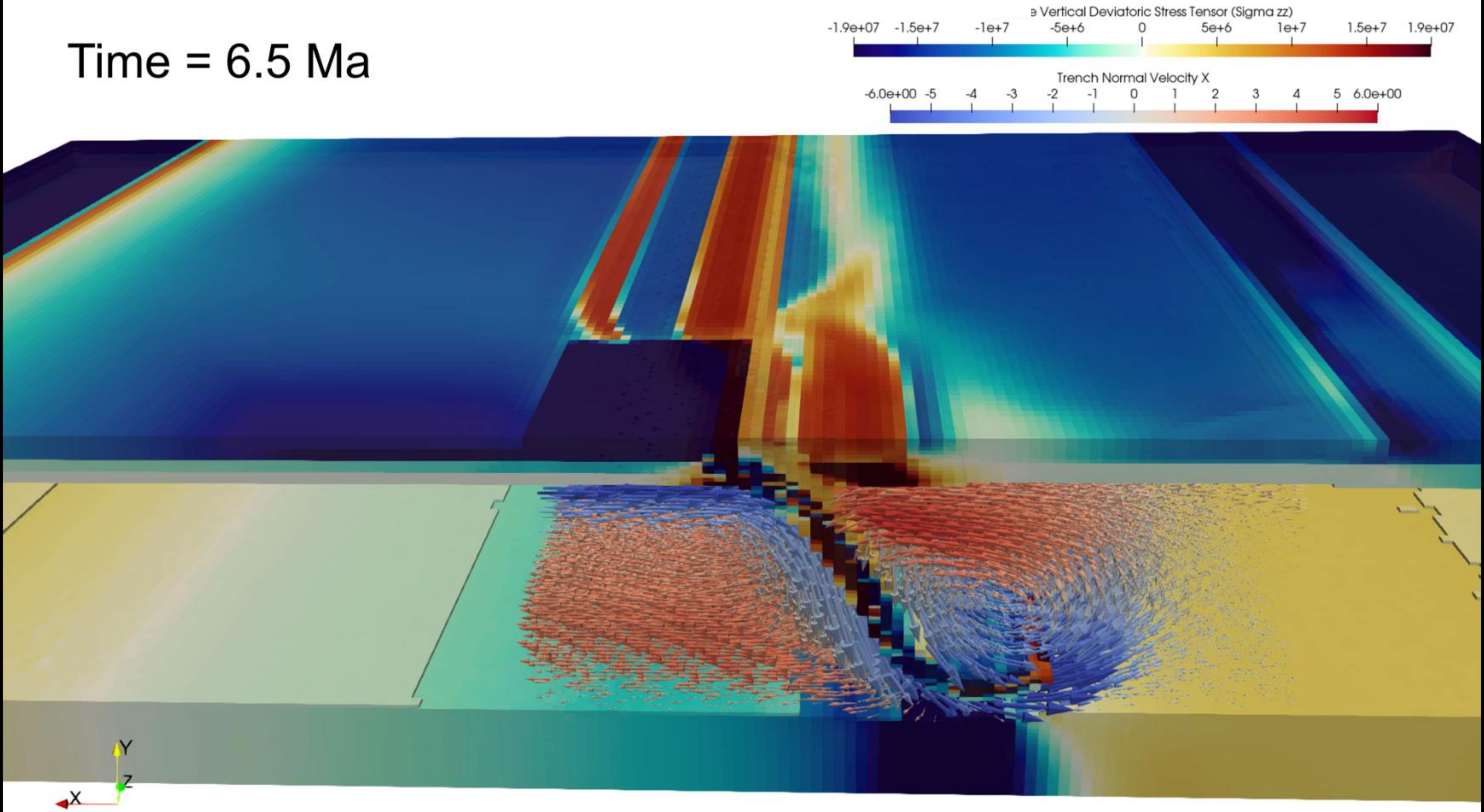
Time = 6.5 Ma

Model 320



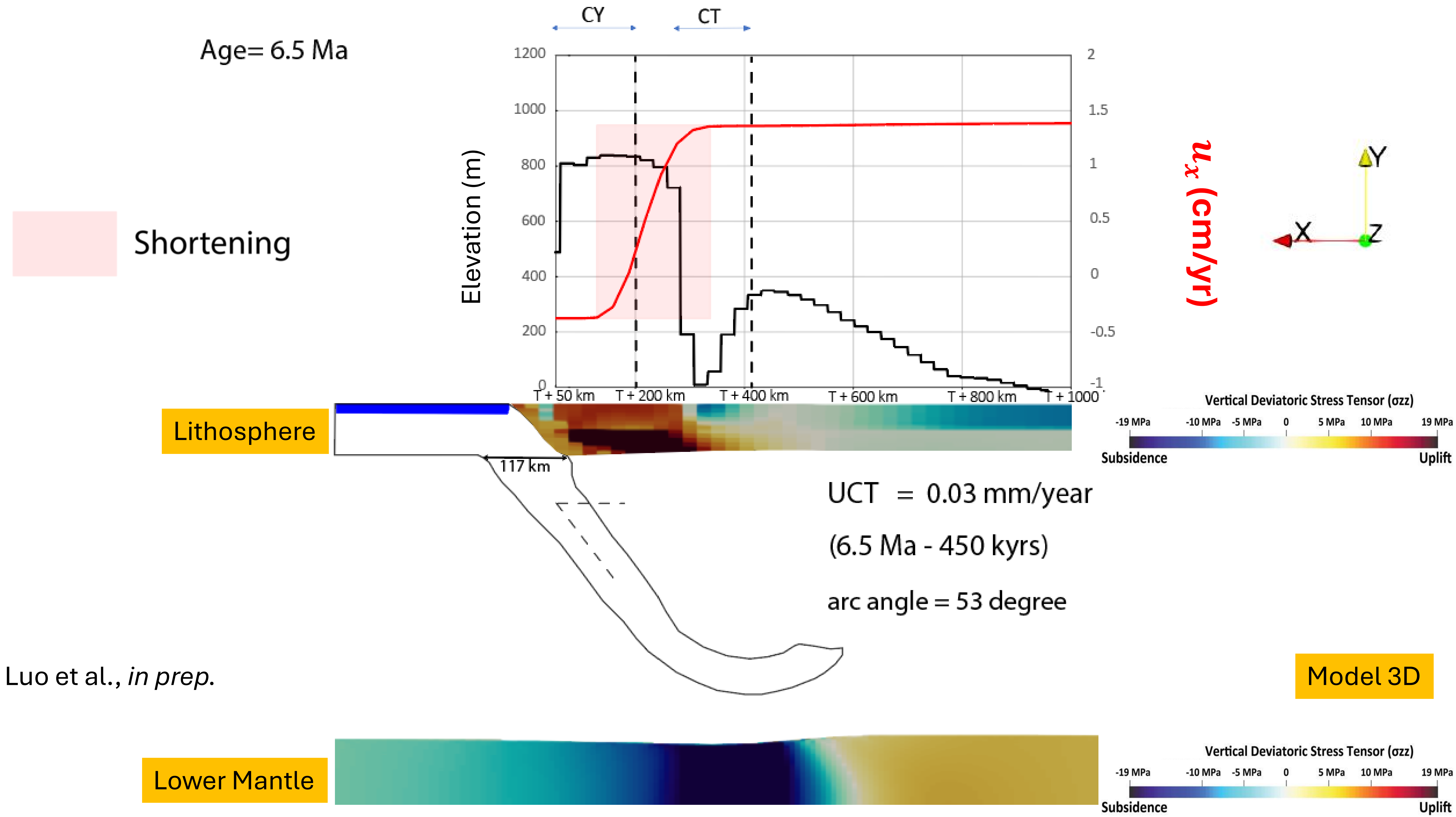
Luo et al., *in prep.*

Time = 6.5 Ma



Model 3D

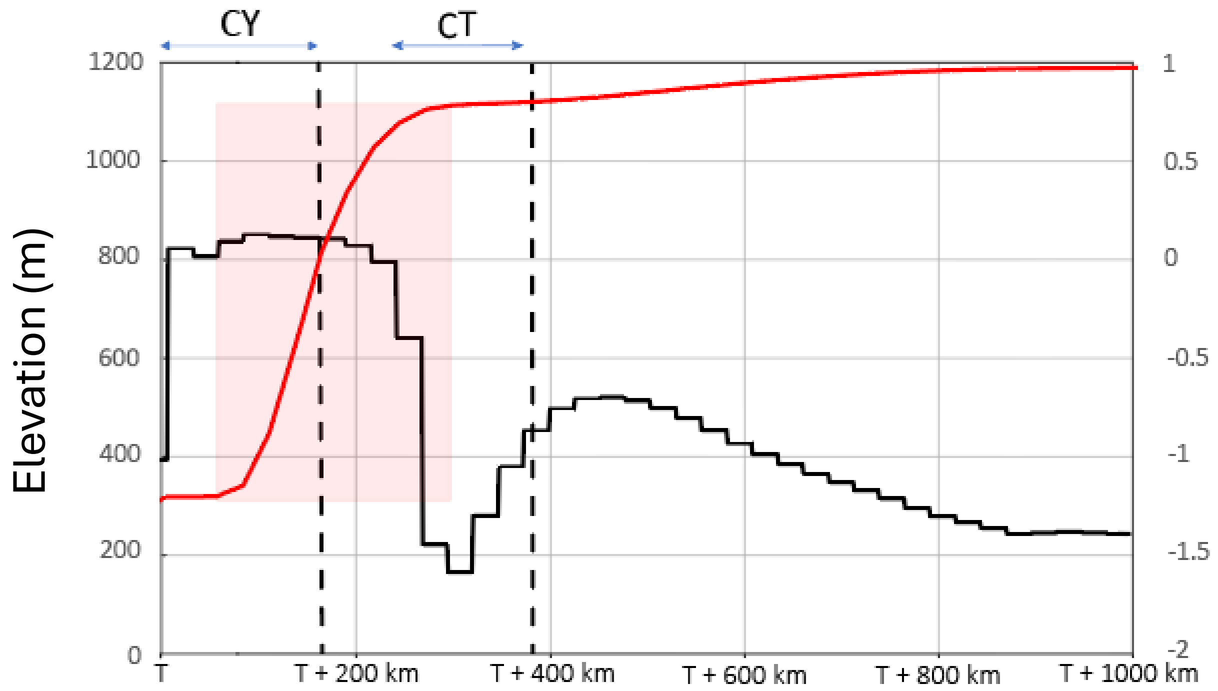
Luo et al., *in prep.*

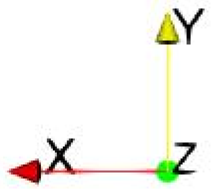


Age= 6.5 Ma
Shortening
CY
CT
Elevation (m)
1200
1000
800
600
400
200
0
2
1.5
1
0.5
0
-0.5
-1
u_x (cm/yr)
T + 50 km
T + 200 km
T + 400 km
T + 600 km
T + 800 km
T + 1000
Y
X
Z
Lithosphere
117 km
Vertical Deviatoric Stress Tensor (σzz)
-19 MPa
-10 MPa
-5 MPa
0
5 MPa
10 MPa
19 MPa
Subsidence
Uplift
UCT = 0.03 mm/year
(6.5 Ma - 450 kyrs)
arc angle = 53 degree
Luo et al., *in prep.*
Model 3D
Lower Mantle
Vertical Deviatoric Stress Tensor (σzz)
-19 MPa
-10 MPa
-5 MPa
0
5 MPa
10 MPa
19 MPa
Subsidence
Uplift

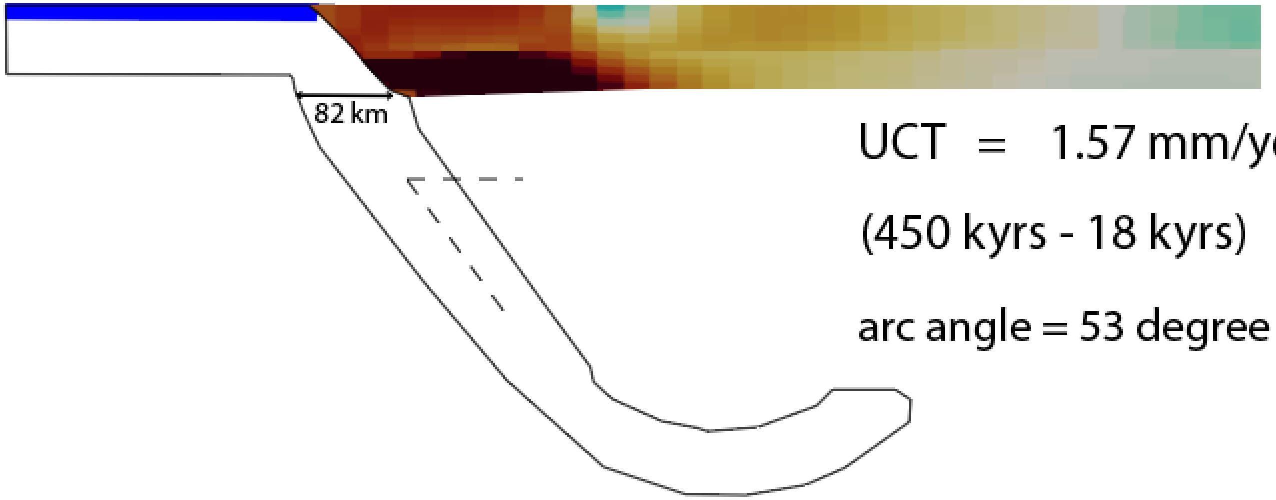
Age= 450 ka

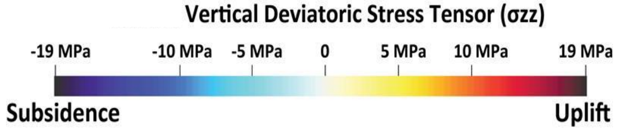
Shortening





Lithosphere





UCT = 1.57 mm/year

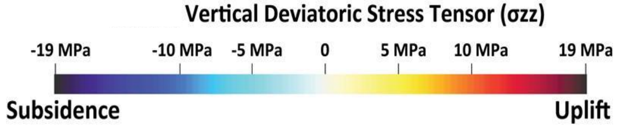
(450 kyrs - 18 kyrs)

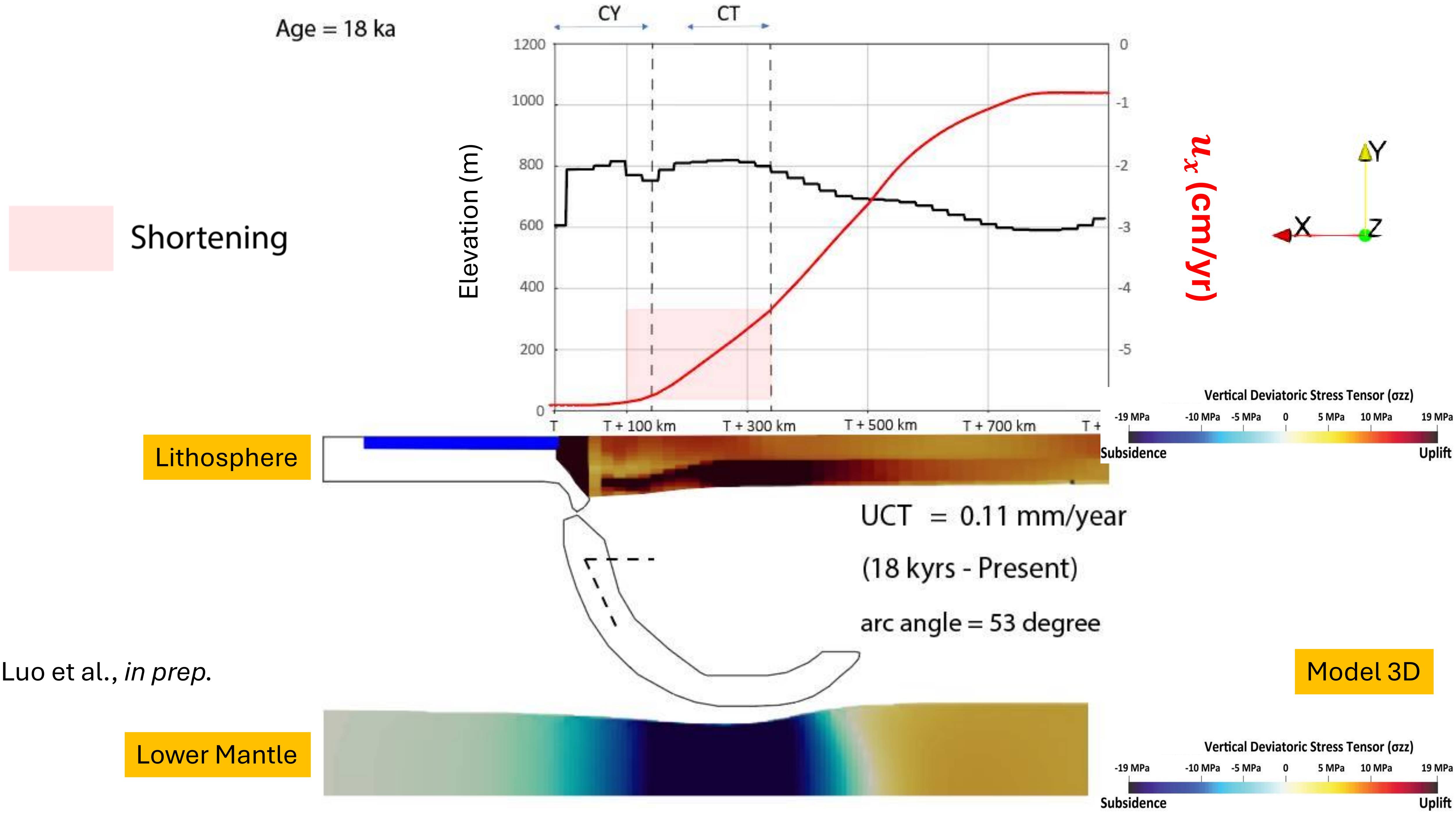
arc angle = 53 degree

Luo et al., *in prep.*

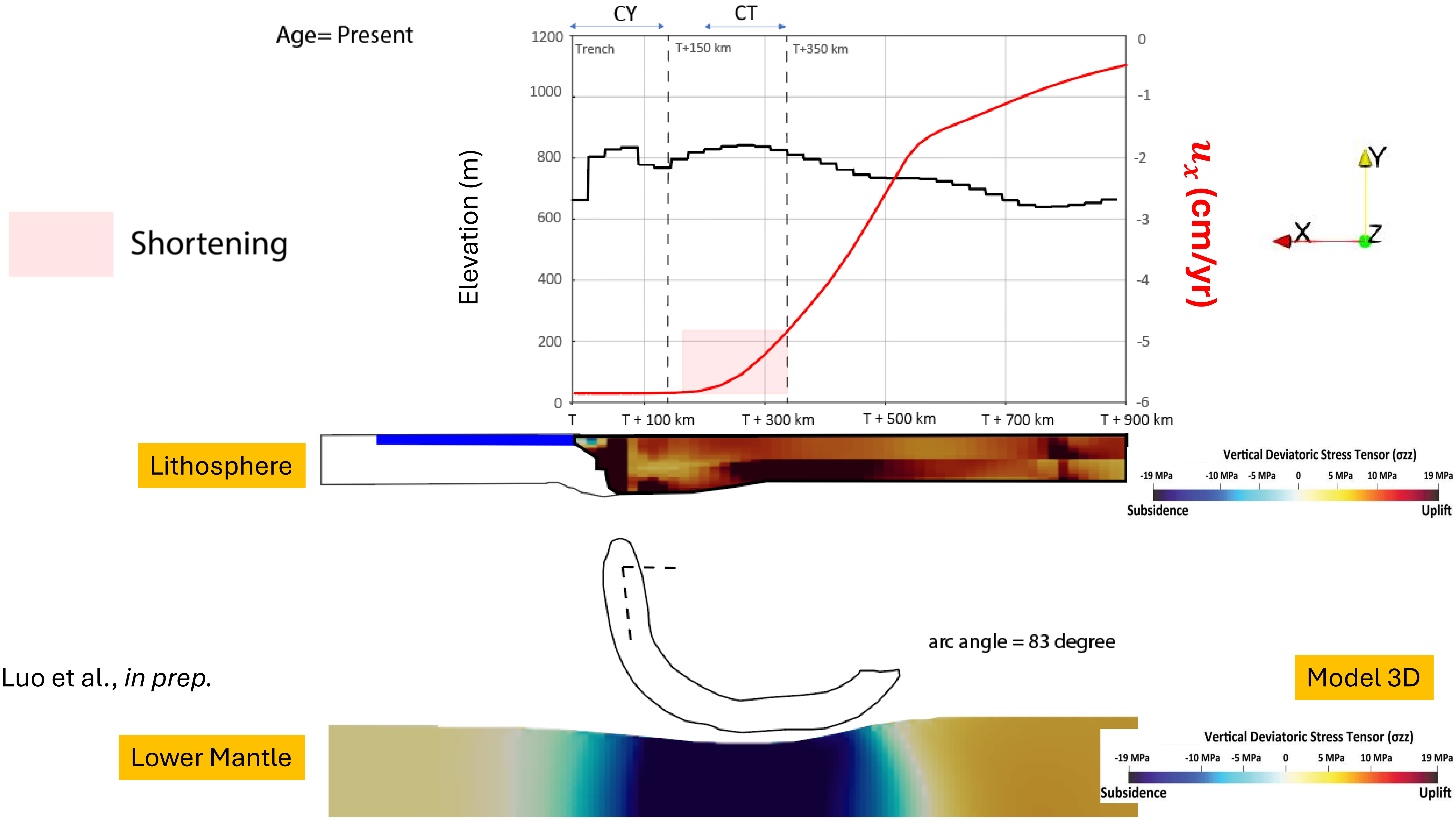
Model 3D

Lower Mantle





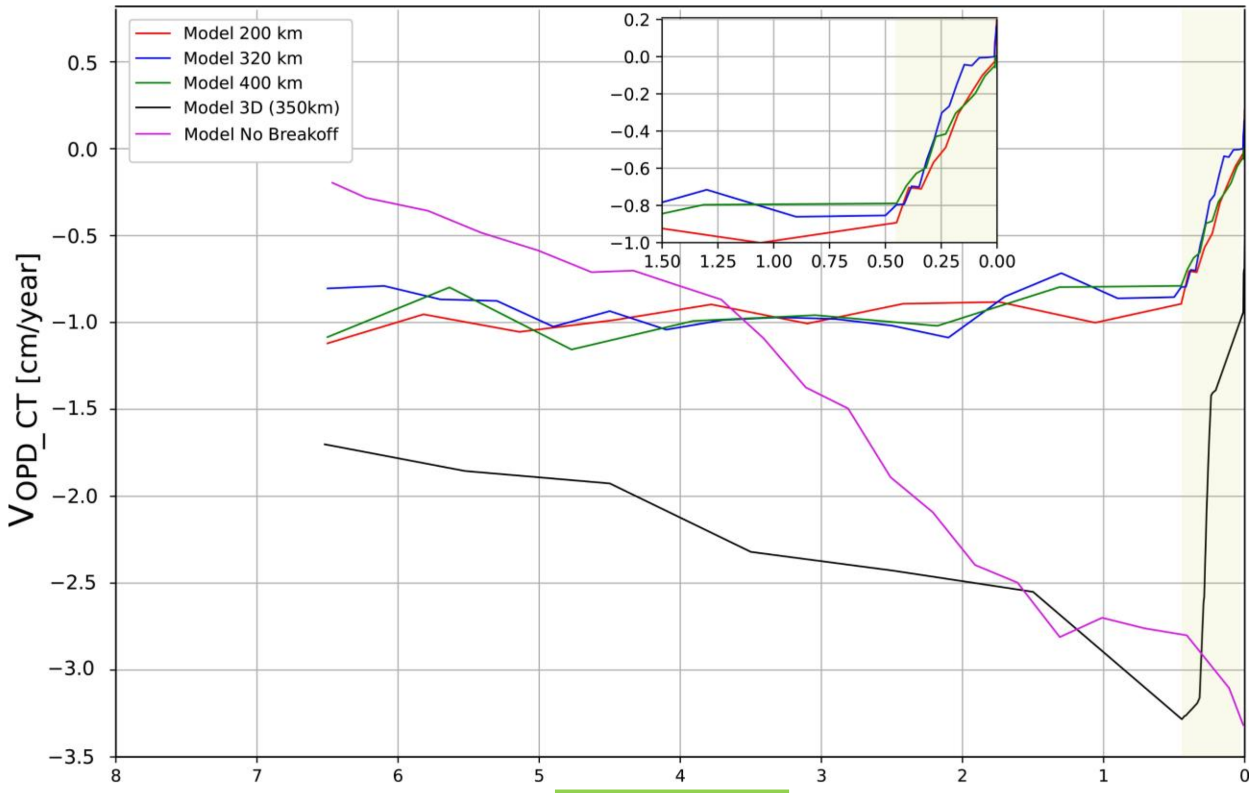
Luo et al., *in prep.*



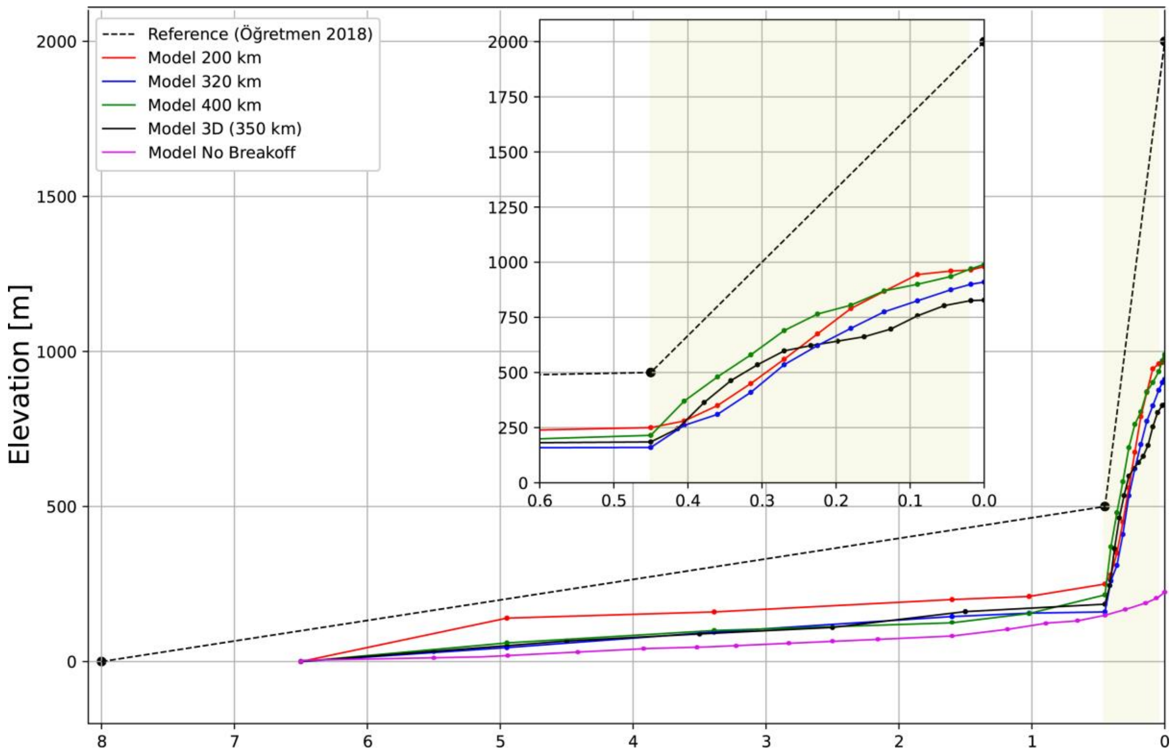
Luo et al., *in prep.*

Shortening ceases around 450 ka as is associated with rapid uplift in the CT region

8 Ma - Present



Ma



Ma

$$V_{OPD\_CT} = u_{T+200\ km} - u_{T+350\ km}$$

(-ve => shortening)

(Schellart and Moresi, 2013), *JGR*

Luo et al., *in prep.*

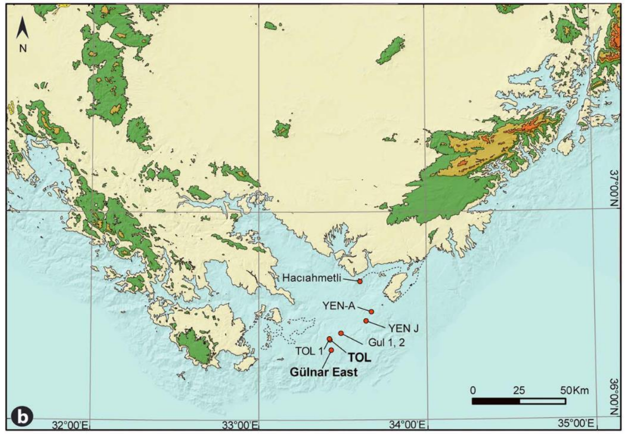
Actual uplift (since 450 ka) is 3.3 mm/yr, which is best explained by Model 400 and Model 3D

Model Name	Continental fragment length	Continental fragment thickness	Continental fragment width	Slab breakoff	Maximum Uplift Rate (mm/yr)
Model 200	200 km	25 km	0 km	Yes	2.6
Model 320	320 km	25 km	0 km	Yes	2.8
Model 400	400 km	25 km	0 km	Yes	3.4
Model Nobreakoff	320 km	15 km	0 km	No	0.2
Model 3D	320 km	25 km	280 km	Yes	3.3

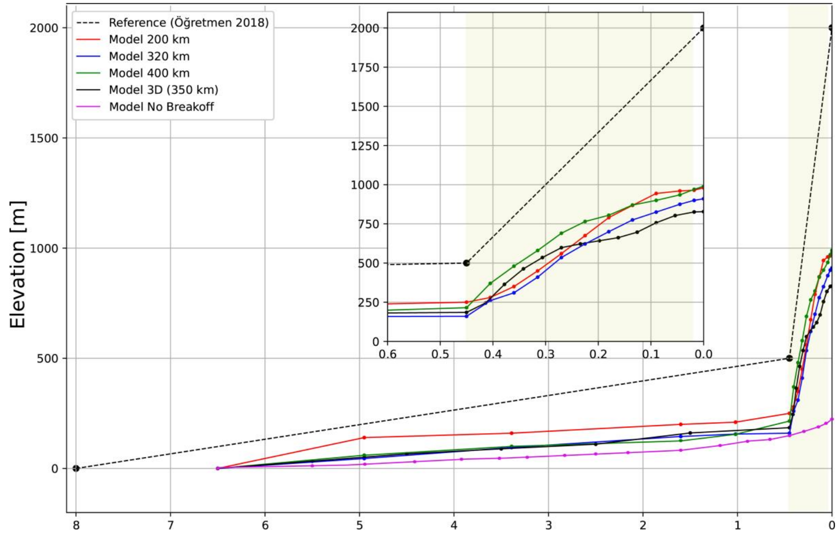
The 2D model underpredicts the uplift rate by 0.5 mm/yr compared to 3D

Luo et al., *in prep.*

Recent uplift can be explained by the rebound associated with the slab tearing and breakoff



(Öğretmen et al., 2018) *Tectonics*



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