The formation of corona structures and evidence for a hotspot Venus

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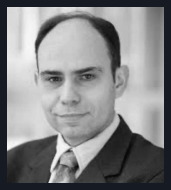
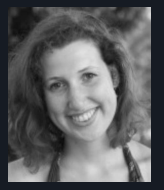
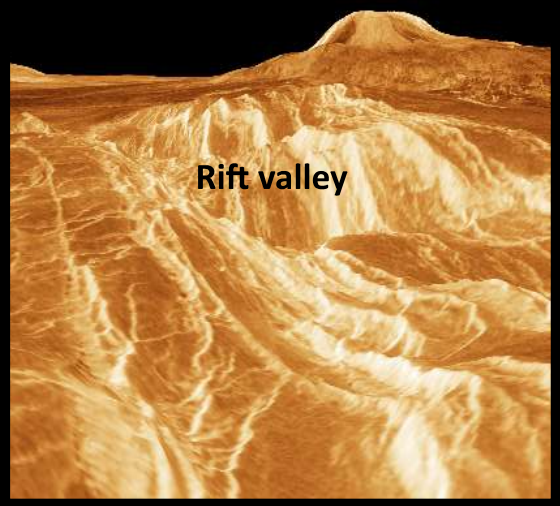
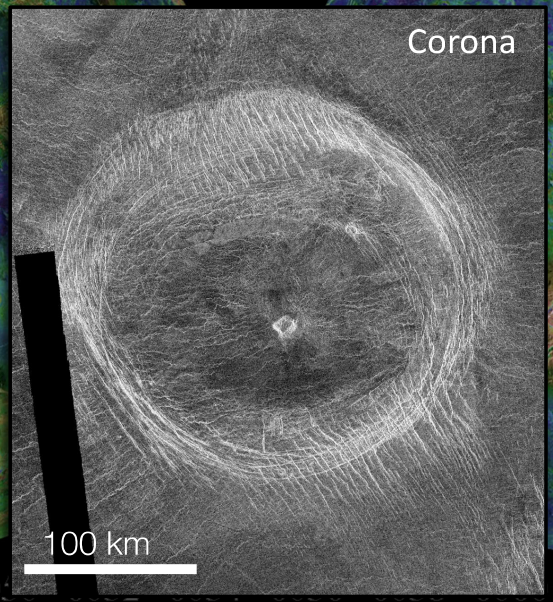
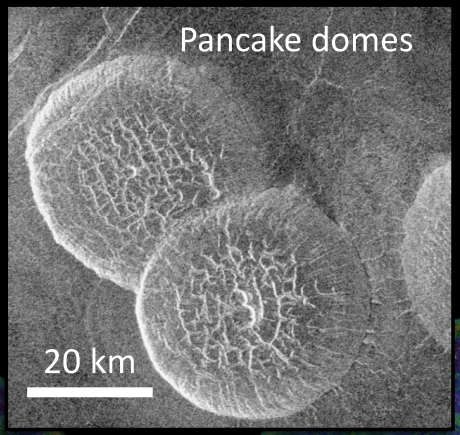



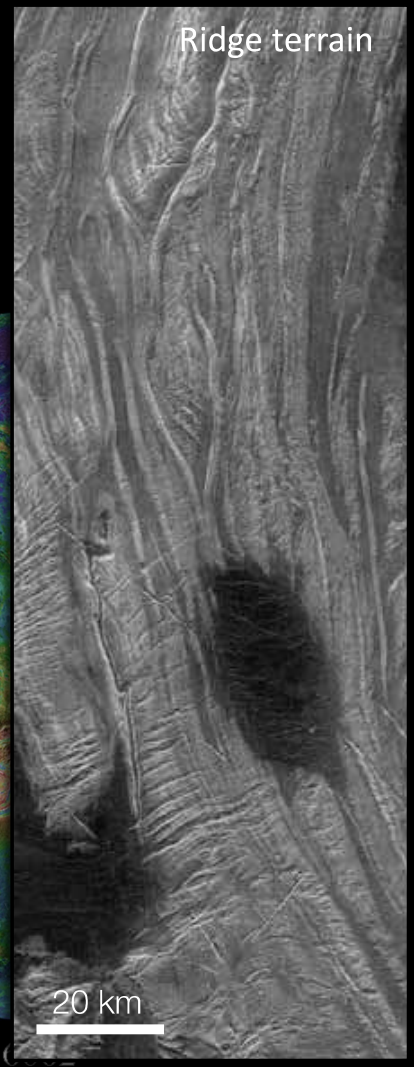
The Venusian surface

- No plate tectonics; minimal horizontal motion
- Widespread **tectonic and volcanic structures**









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The Venusian surface

To what extend do **surface structures** reflect Venus' **current interior state**?

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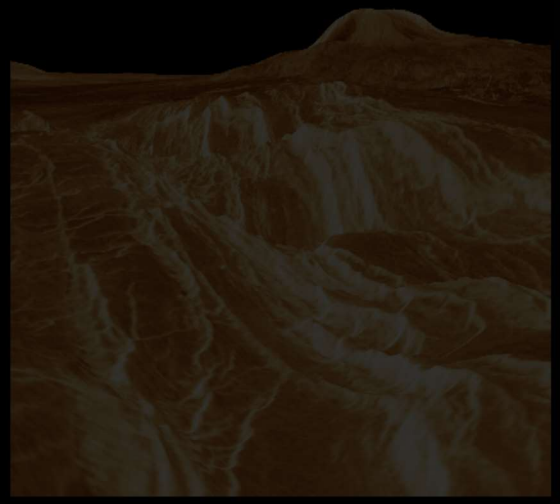
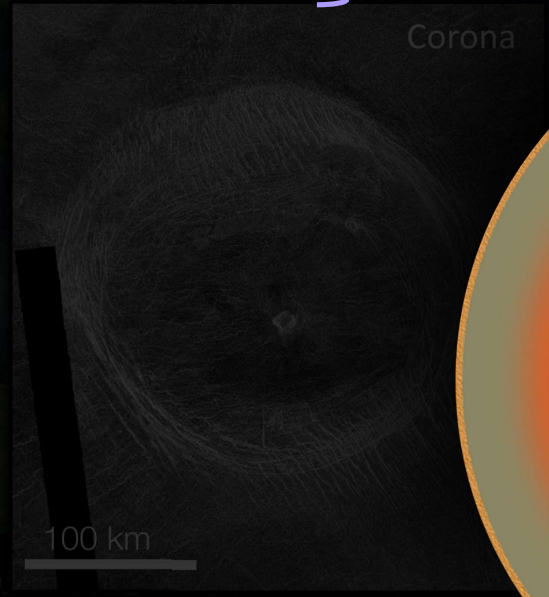
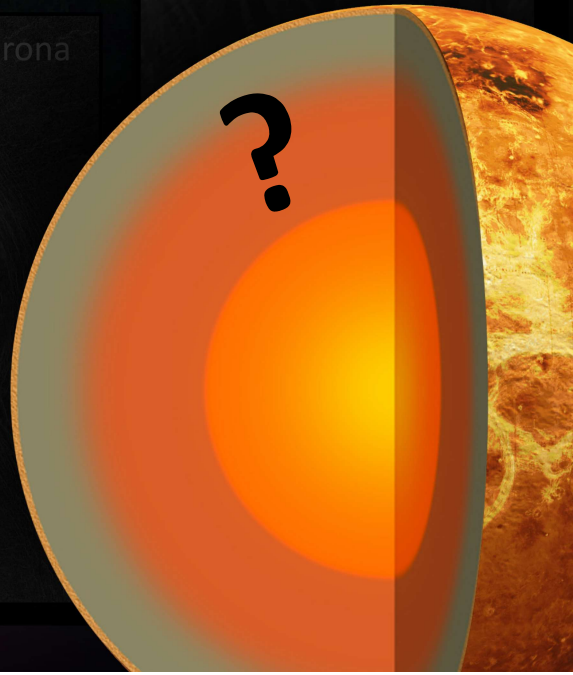
- **Catastrophic** resurfacing? (e.g. Turcotte, 1993; Strom et al., 1994)
- **Equilibrium** resurfacing? (e.g. Herrick et al., 2011; Bjonnes et al., 2012)

Apparent young & uniform surface age (~0.5 Ga)







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AGU **Journal of Geophysical Research: Planets**

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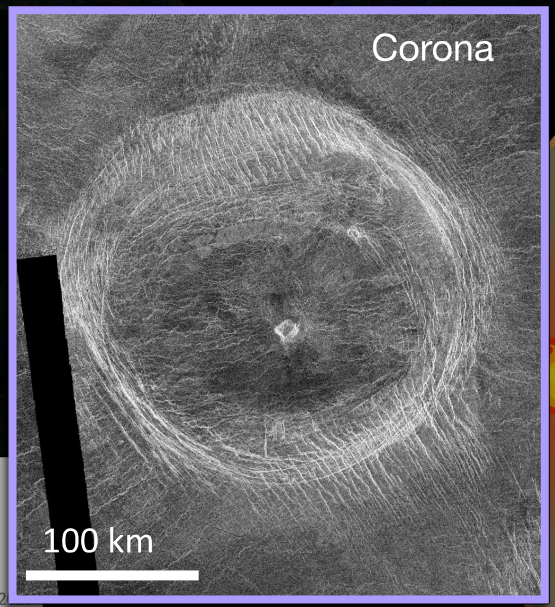
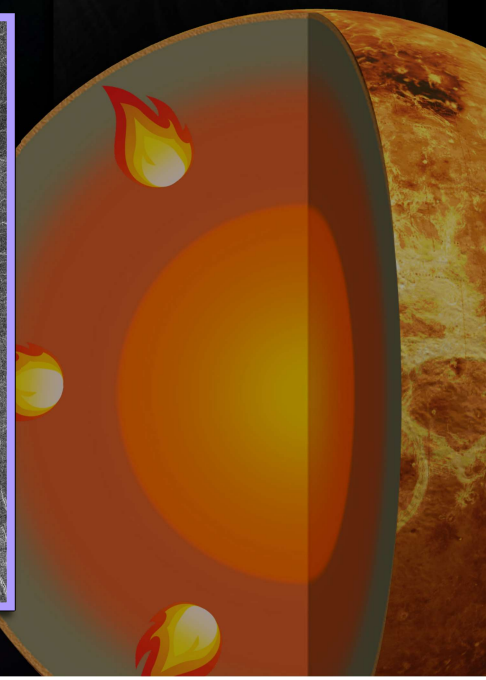
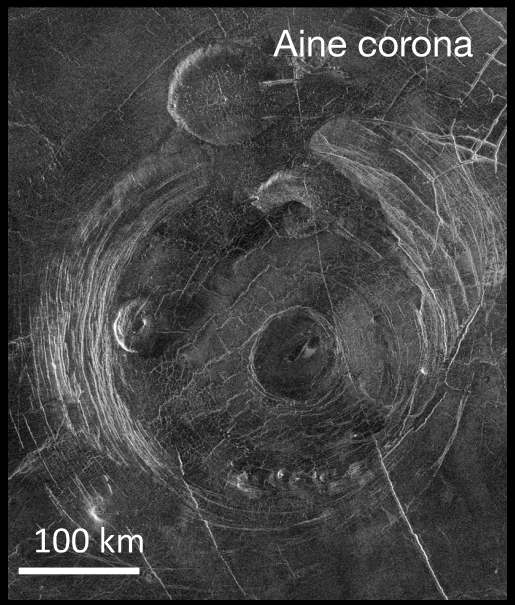
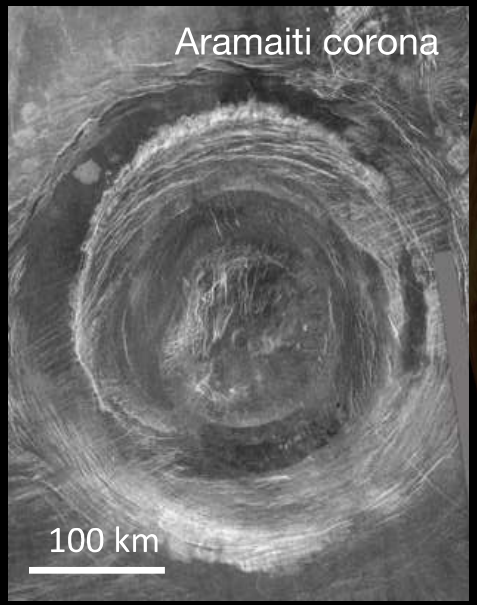


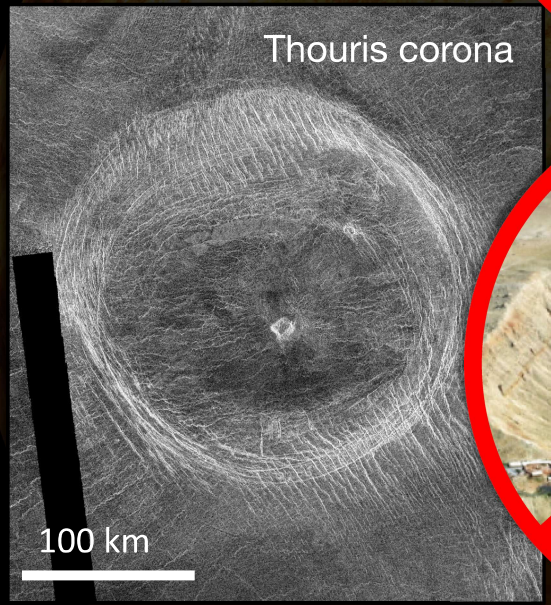


Coronae (“crowns”)

- Large (quasi-)circular volcano-tectonic features
- Various dimensions (60 to over 1000 km wide)
- Various morphologies







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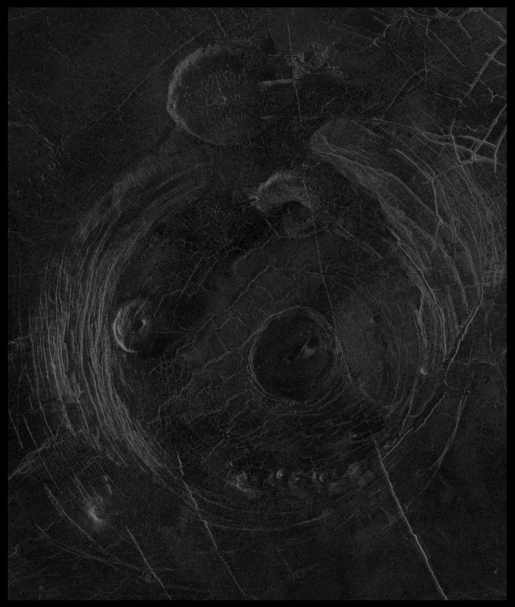
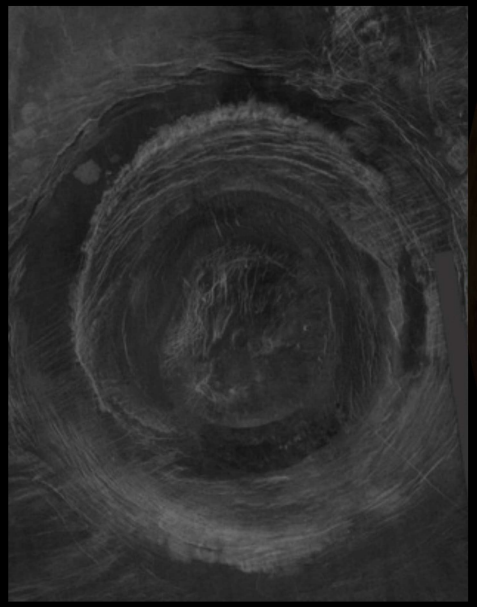
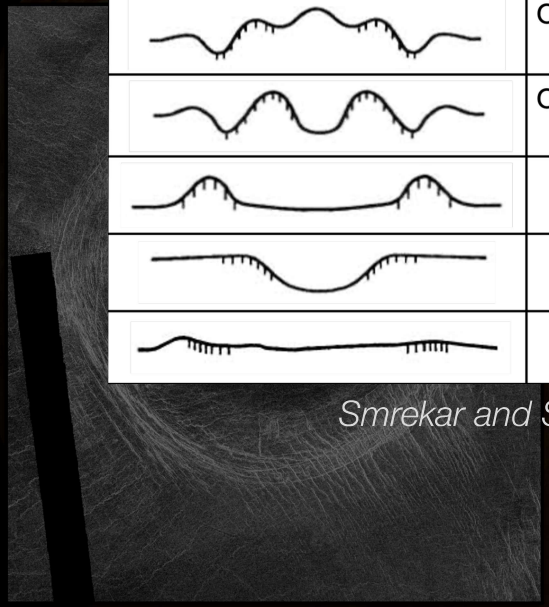






Topographic profile	Description	% of coronae
	Dome	10
	Plateau	10
	Rim surroundig interior high	21
	Rim surrounding interior dome	
	Rim surrounding depression	25
	Outer rise, trough, rim, inner high	5
	Outer rise, trough, rim, inner low	1
	Rim only	7
	Depression	7
	No discernible signature	14

Smrekar and Stofan, 1997

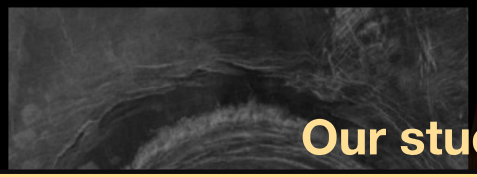
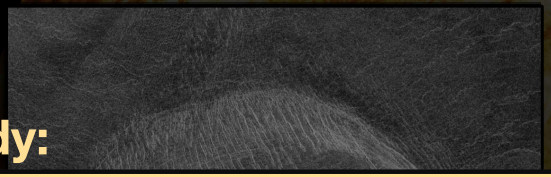
Gülcher et al. anna.guelcher@erdw.ethz.ch

Coronae: formation

- Crustal stresses above an (upwelling?) **mantle plume**
- Plume-bounding **retreating subduction** and/or **lithospheric delamination**?

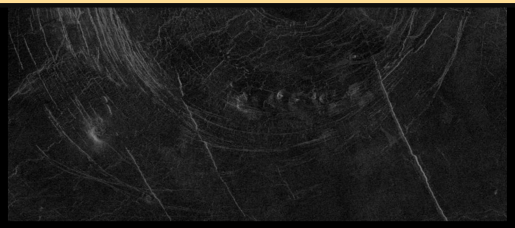
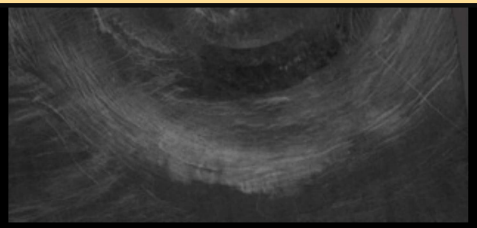
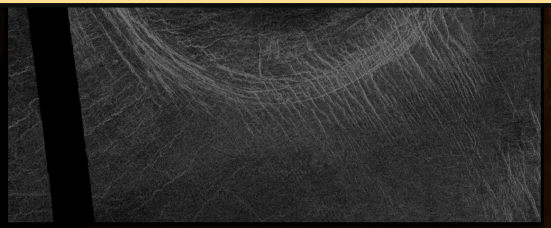
(e.g. Sandwell & Schubert, 1992; Davaille et al., 2017)

(Stofan et al., 1991; Smrekar and Stofan, 1997)

Our study:

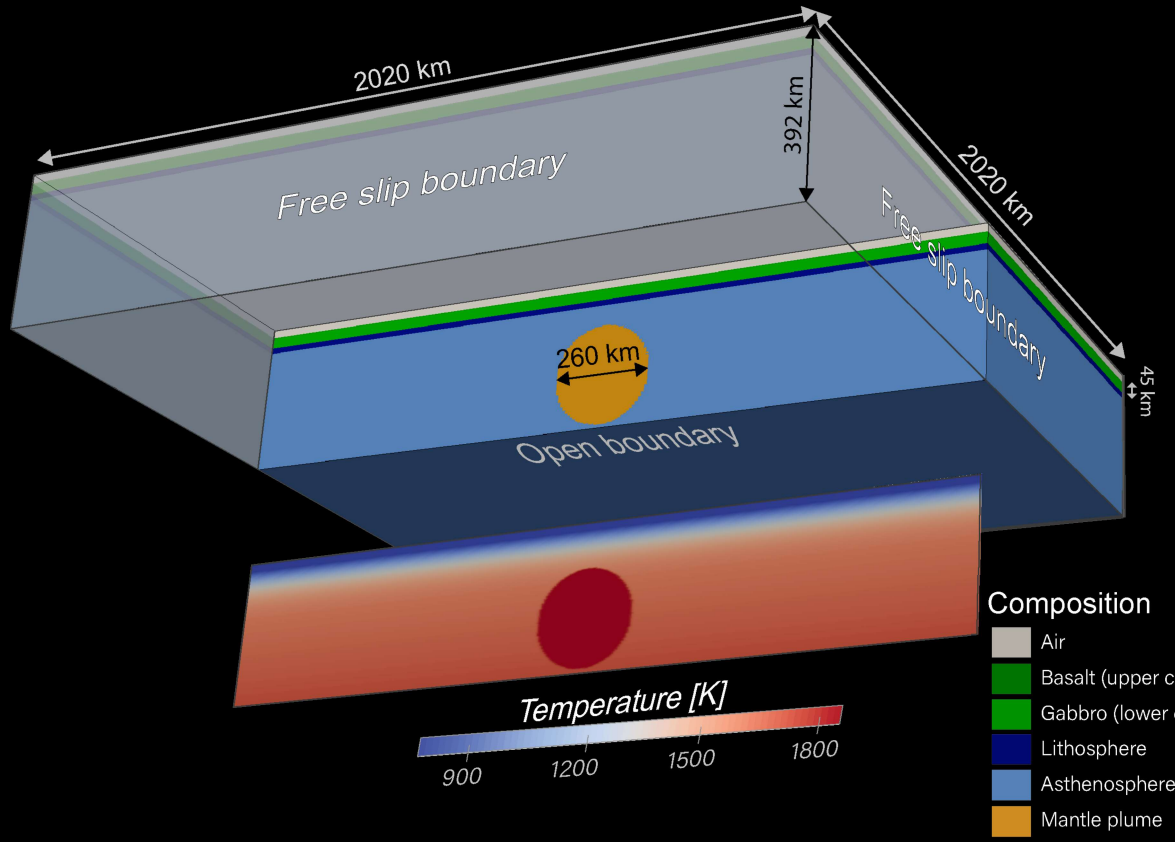
3D modelling of **coronae formation** by plume-lithosphere interactions, and assess the **reason** behind their **morphological diversity**

3D models – I3ELVIS (Gerya, 2010)

- *See Gülcher et al. (2020) for details*
- Melting, crustal accretion and phase change (eclogitization) implemented
- Visco-plastic rheology

g = 8.87 ms^{-2}
water-depleted
Eulerian grid resolution: 5 · 2 · 5 km
256 million Lagrangian markers



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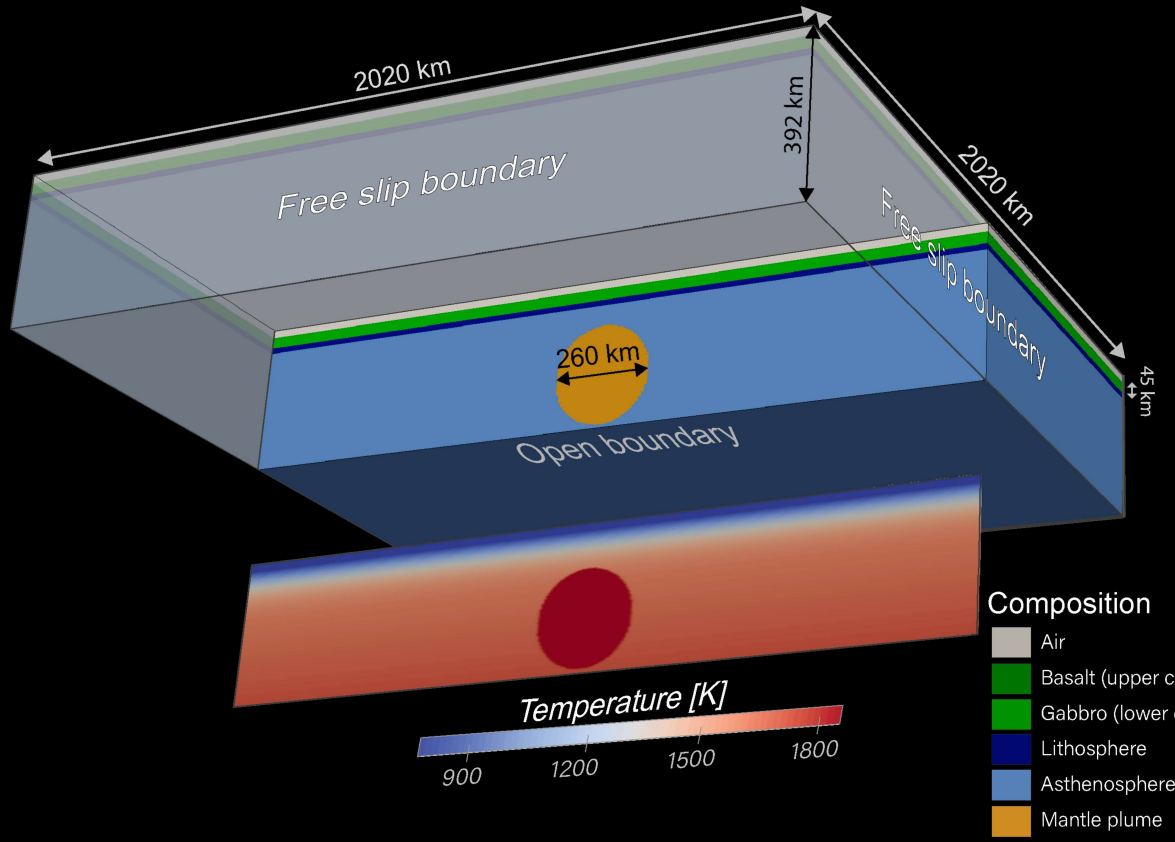
- Melting, crustal accretion and phase change (eclogitization) implemented
- Visco-plastic rheology
- 21 numerical models, varying

Plume buoyancy

plume temperature; size

Lithospheric configuration

lithospheric strength, crustal thickness



3D models - *reference model evolution*

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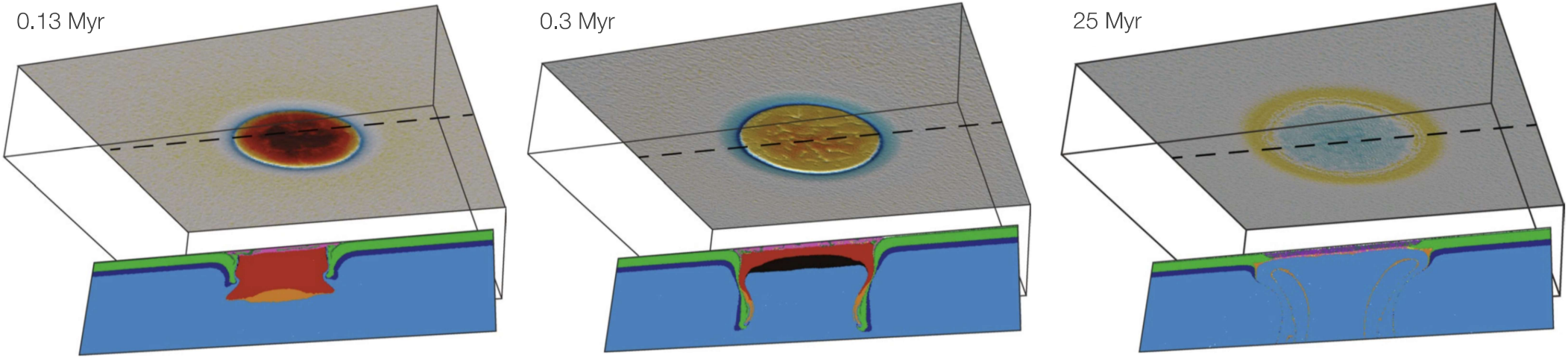
Plume penetration into lithosphere → Lithospheric dripping at plume margins → Plume cooling and topographic inversion



Composition

solid/molten
Upper crust (basalt)
Lower crust (grabbro)

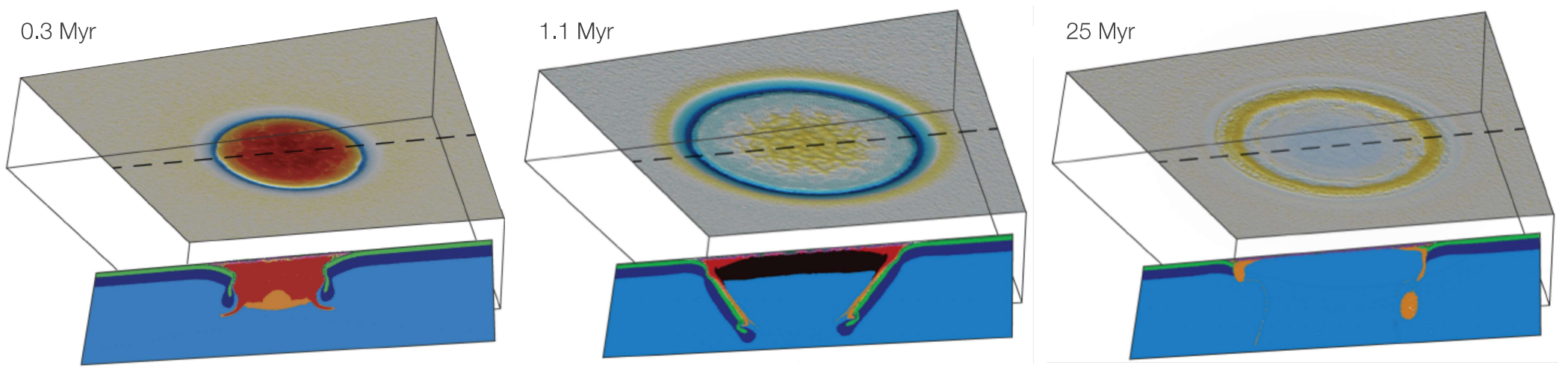
solid/molten
Newly formed crust
Lithosphere

solid/molten
Mantle
Mantle plume

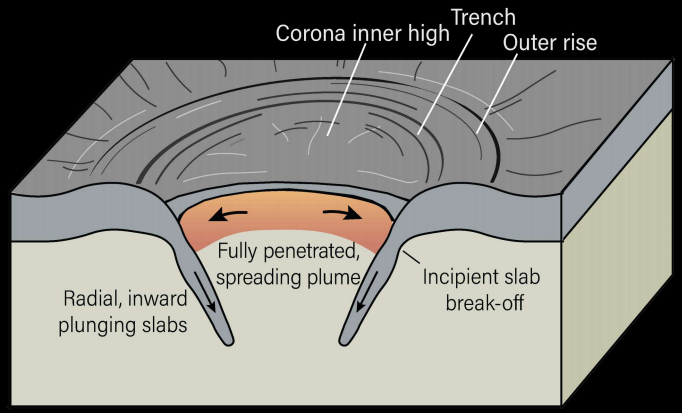
Topography [km]
-3 -2 -1 0 1 2 3

3D models - *stronger lithosphere / thinner crust*

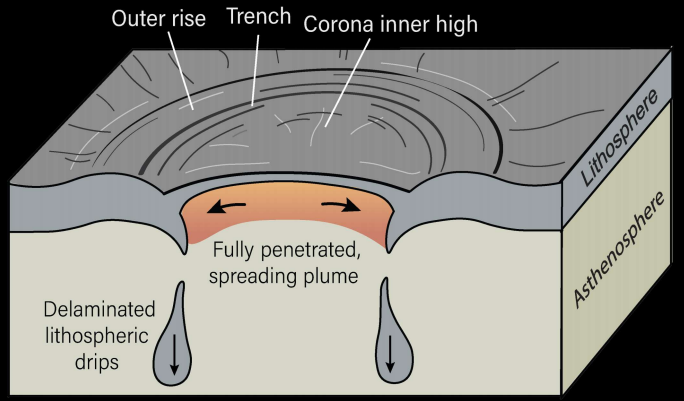
Plume penetration into lithosphere → Slab retreat at plume margins
Short-lived subduction → Plume cooling and topographic inversion



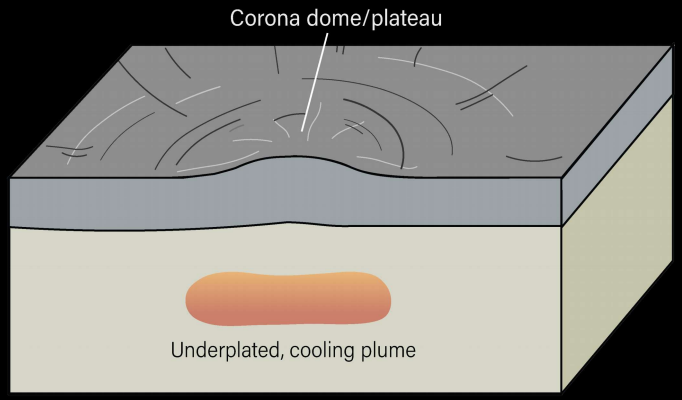
Plume-lithosphere interactions



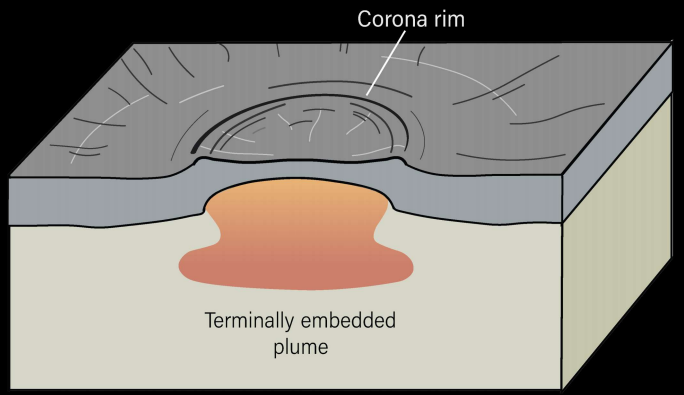
Short-lived subduction



Lithospheric dripping



Underplated plume



Embedded plume