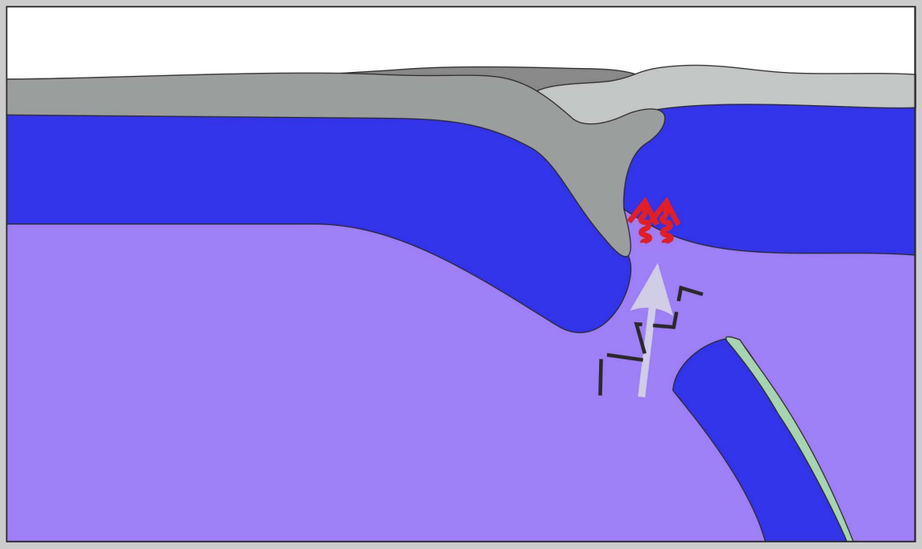
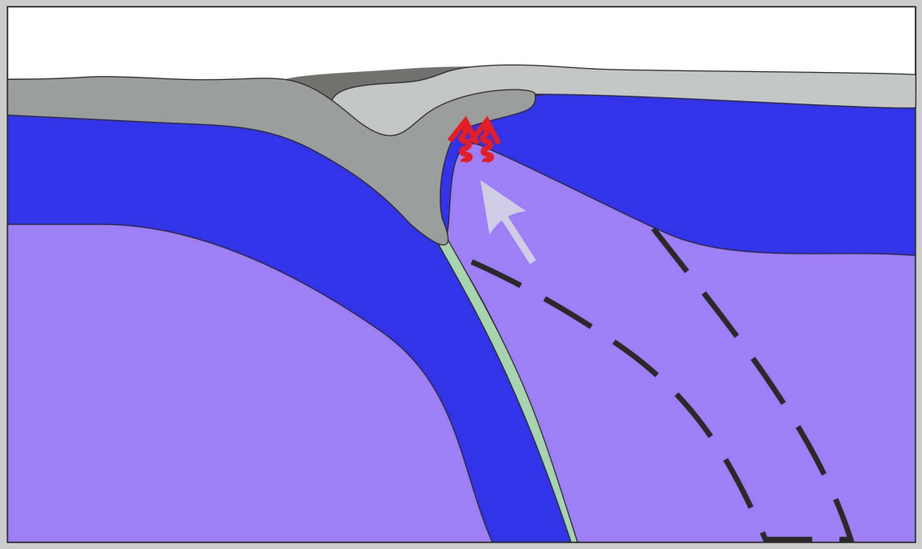
Late orogenic heating:

slab breakoff



or

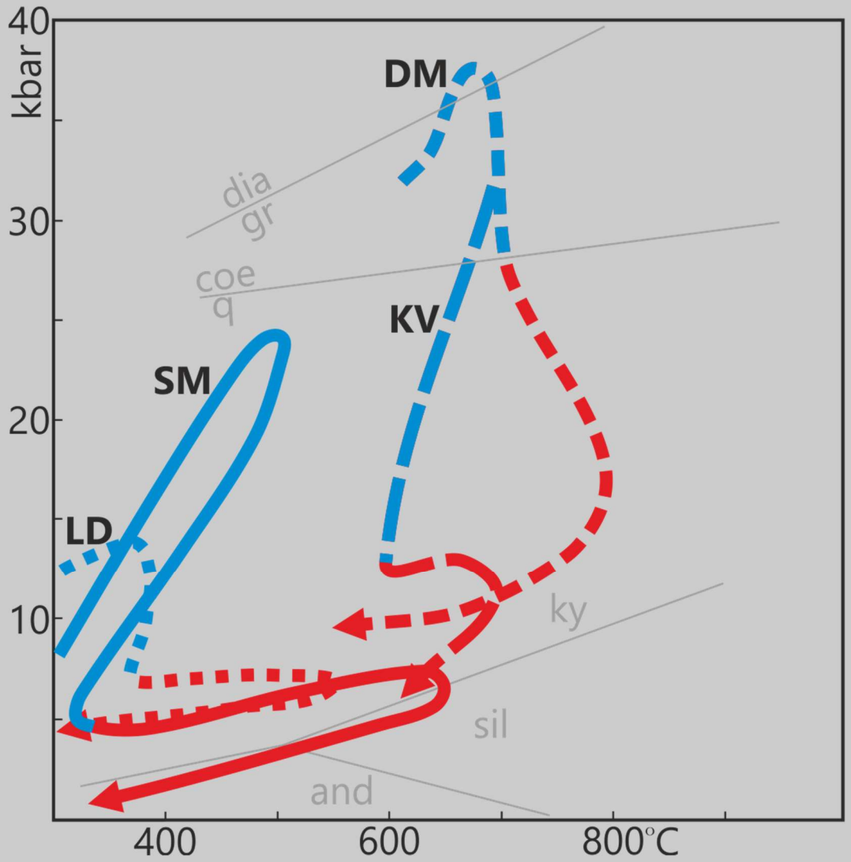
slab rollback



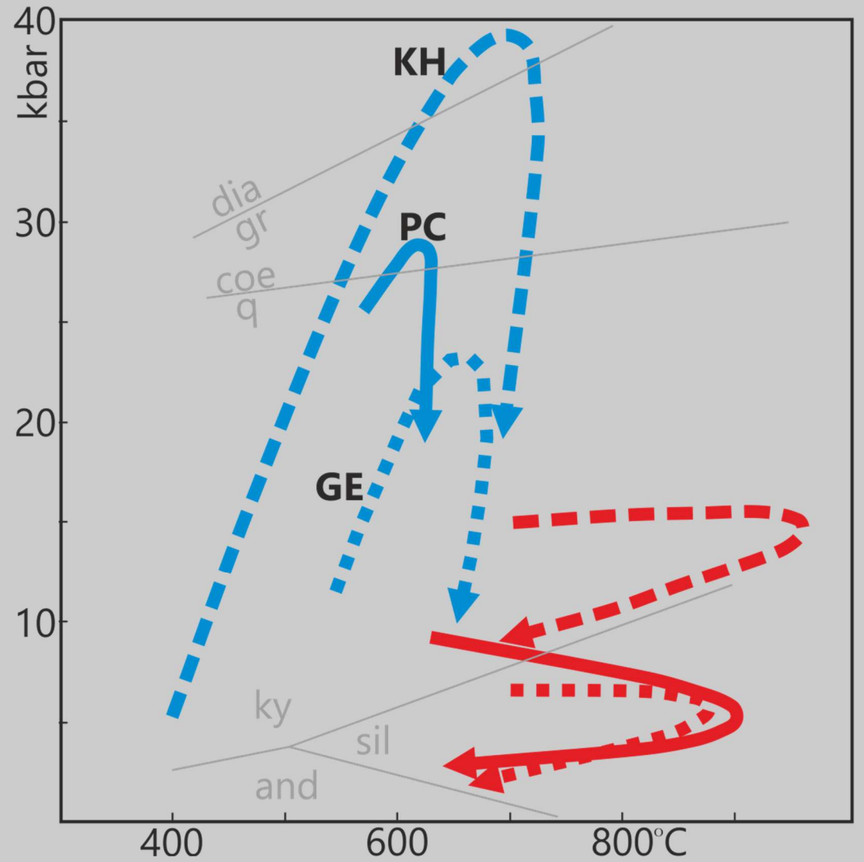
Sizova Elena, Hauzenberger, C., Fritz, H., Faryad, W.S., Gerya, T.

University of Graz
Department of Petrology and Geochemistry

Late heating in collisional orogens



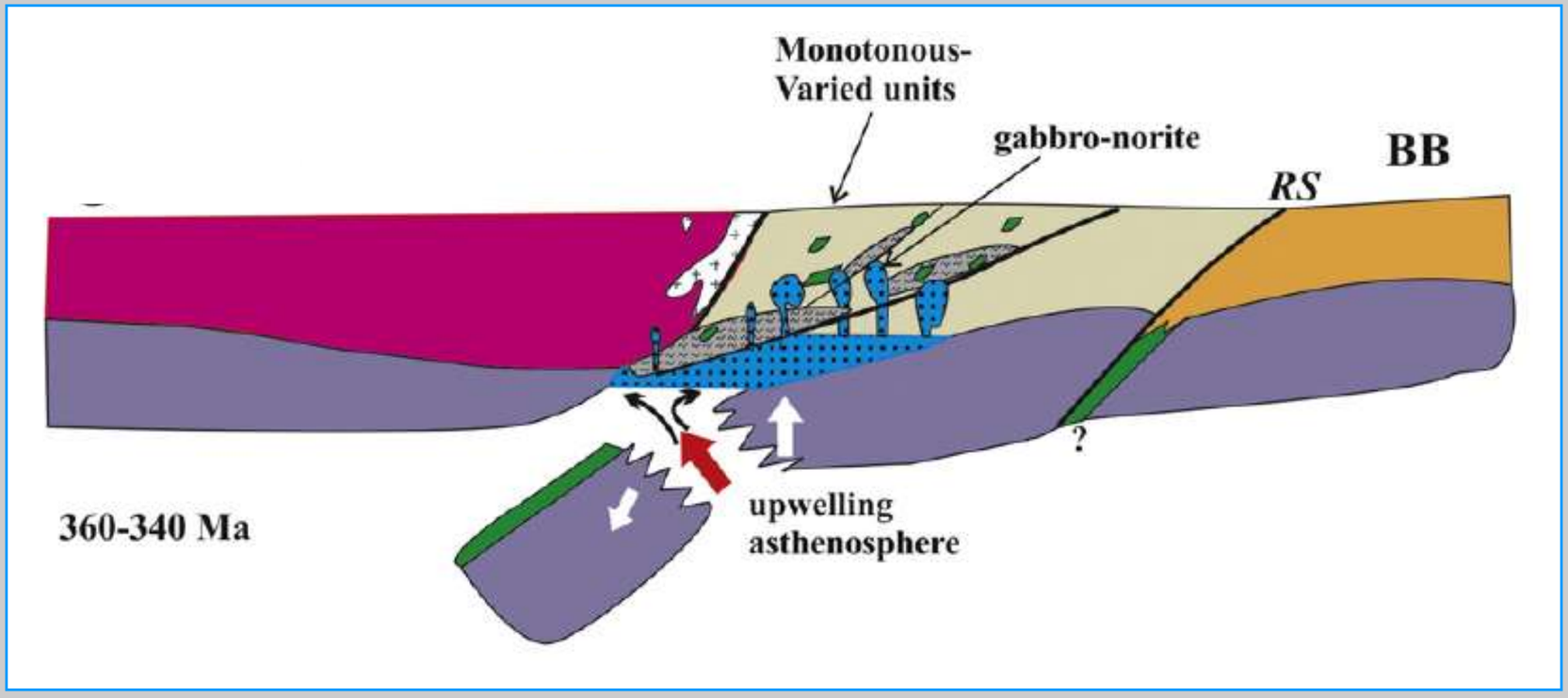
DM – Shuanghe eclogite, **D**abie **M**ountains (Liu et al., 2013)
KV – **K**aghan **V**alley eclogites, the Himalayan (Wilke et al., 2010)
SM – Sivrihisar Massif, **T**urkey (Whitney et al., 2011)
LD – Lepontine Dome, **S**wiss Alps (Wiederkehr et al., 2008)



The Bohemian Massif:
KH - **K**utná **H**ora (Perraki and Faryad, 2014)
PC - **P**odolsko **c**omplex (Faryad and Žák, 2016)
GE - Monotonous series (Faryad ad Fišera, 2015)

Common solution – slab breakoff or mantle delamination

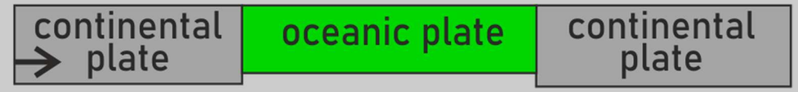
e.g. Bohemian Massif



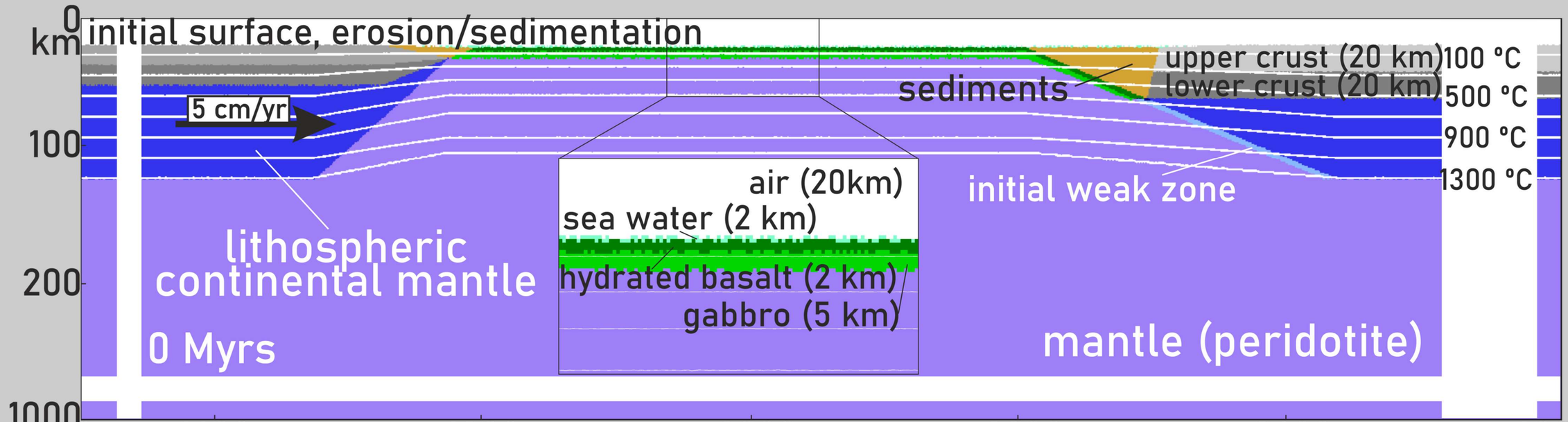
Kubínova et al., 2017

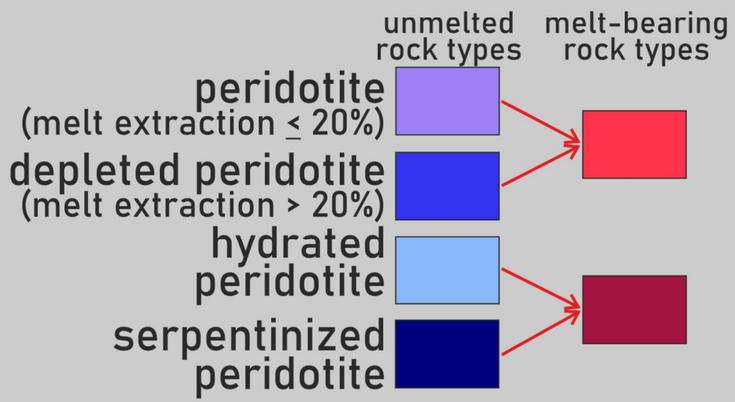
We present now an alternative...

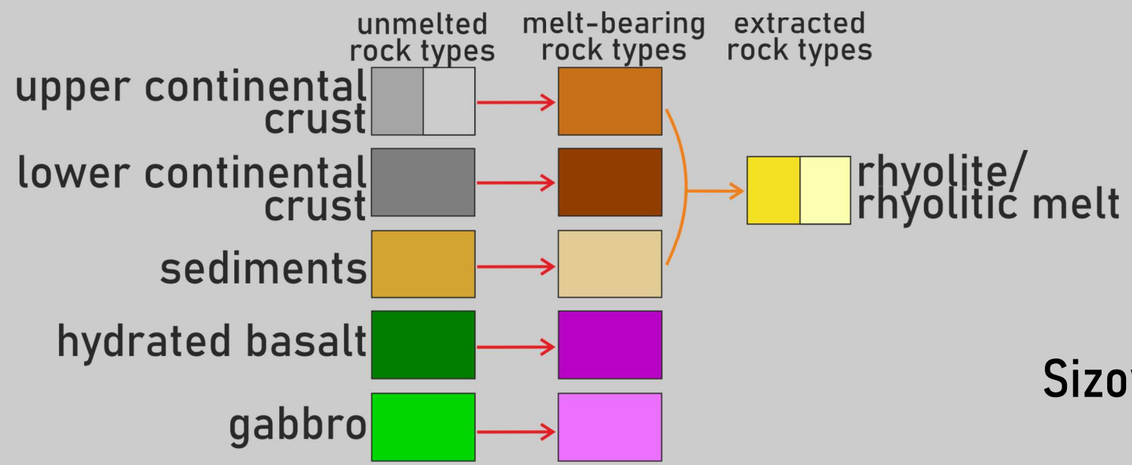
Setup of numerical model



Code: I2VIS (Gerya and Yuen, 2003) **Boundaries**: free-slip **Resolution**: 1x1 km

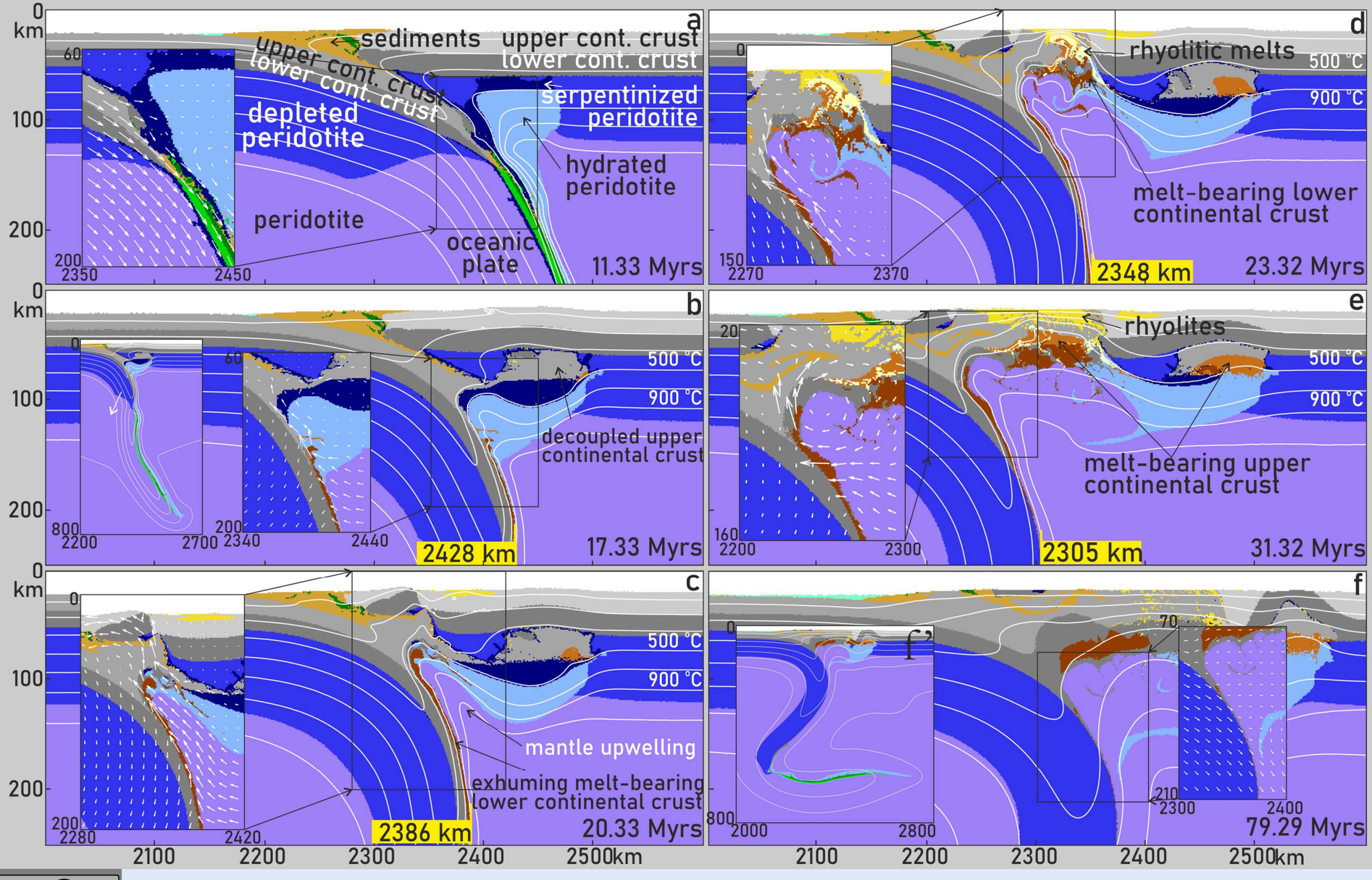






Sizova et al., 2019

Evolution of the experiment with a slab rollback



Push: 5 cm/yr, 80 Myrs

sediments

mafic crust

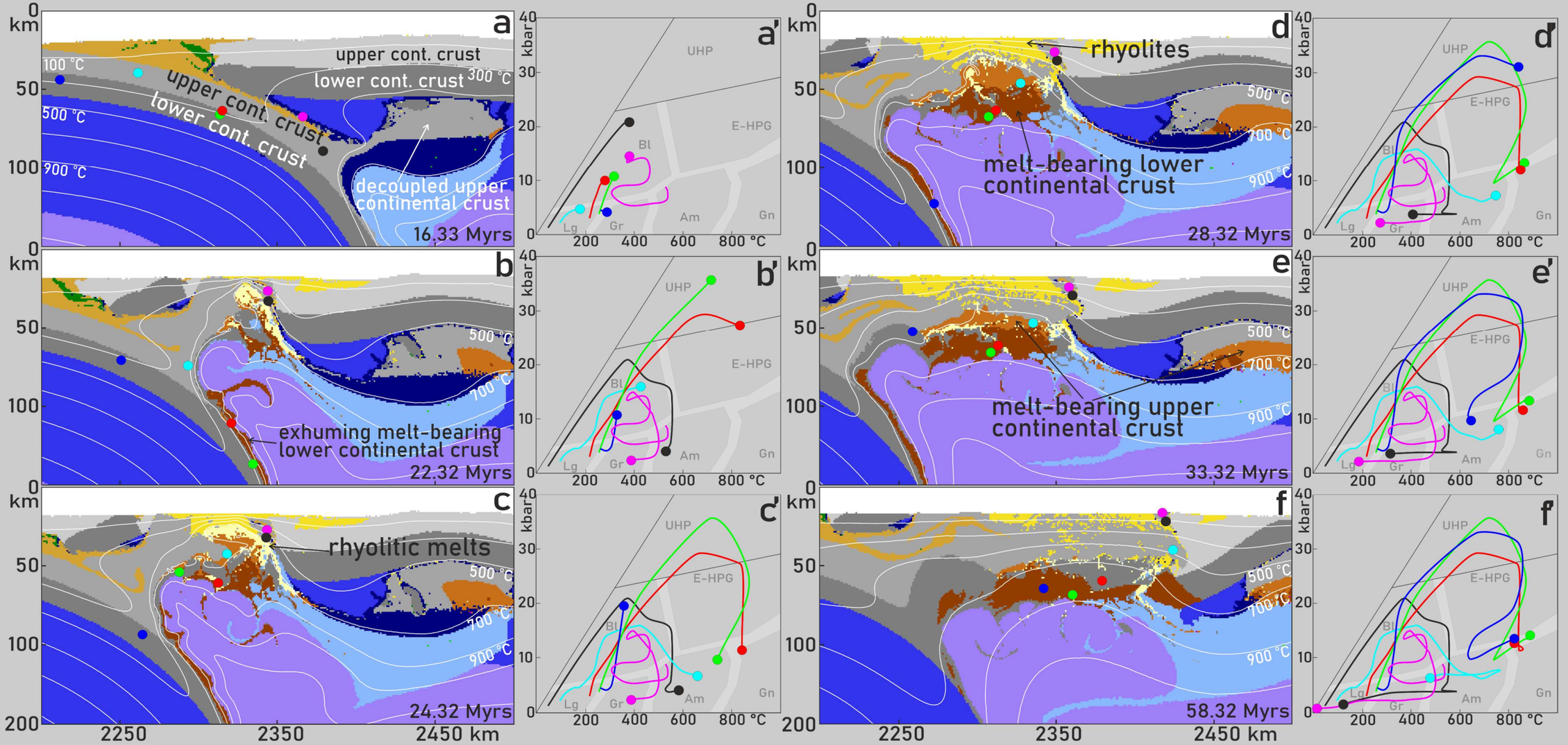
felsic crust

rhyolites

mantle

Sizova et al., 2019

Evolution of some crustal markers in the experiment with a slab rollback



sediments

mafic crust

felsic crust

rhyolites

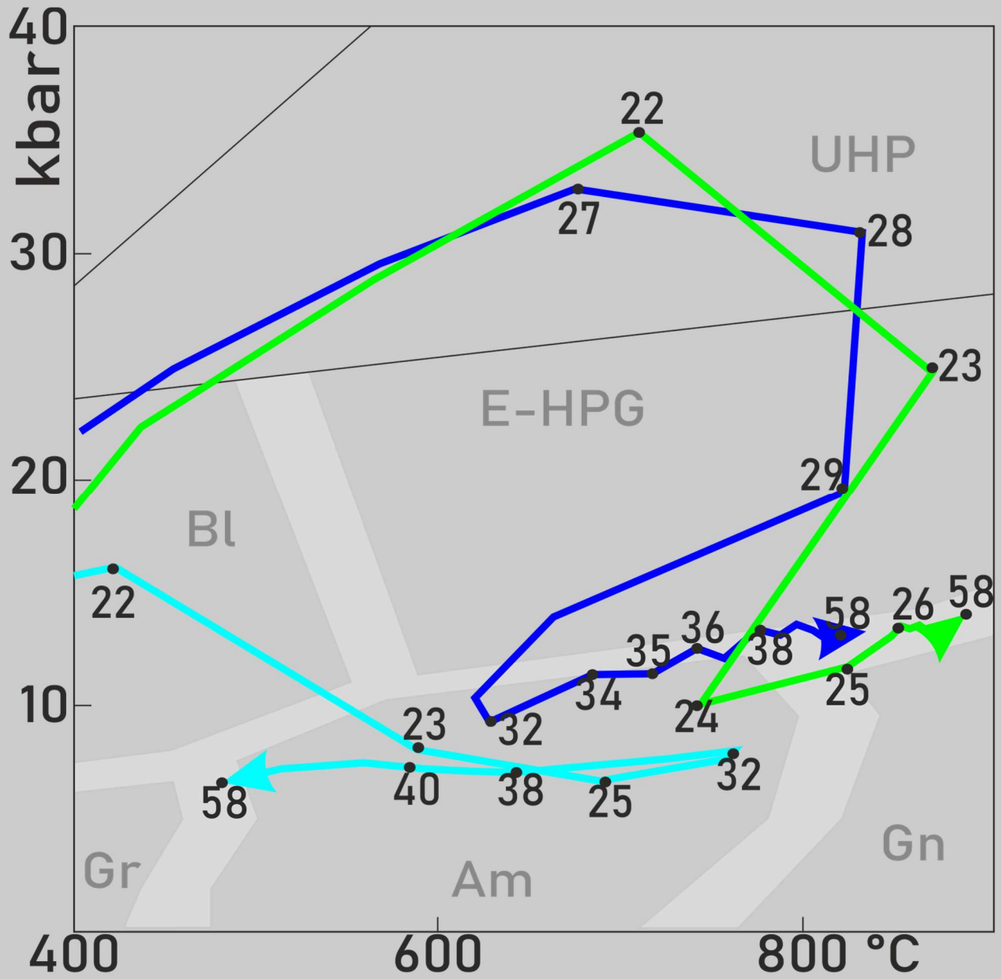
mantle

Sizova et al., 2019

Late orogenic heating: slab breakoff or slab rollback?

Sizova Elena

PT parameters of some markers that underwent heating after exhumation from (ultra)high pressure conditions



22, 34, 40 … - Myrs from the beginning of the experiment

Subduction of crustal material → slab rollback → exhumation of crustal material → asthenospheric mantle upwelling → heating of the subducted and exhumed crustal material

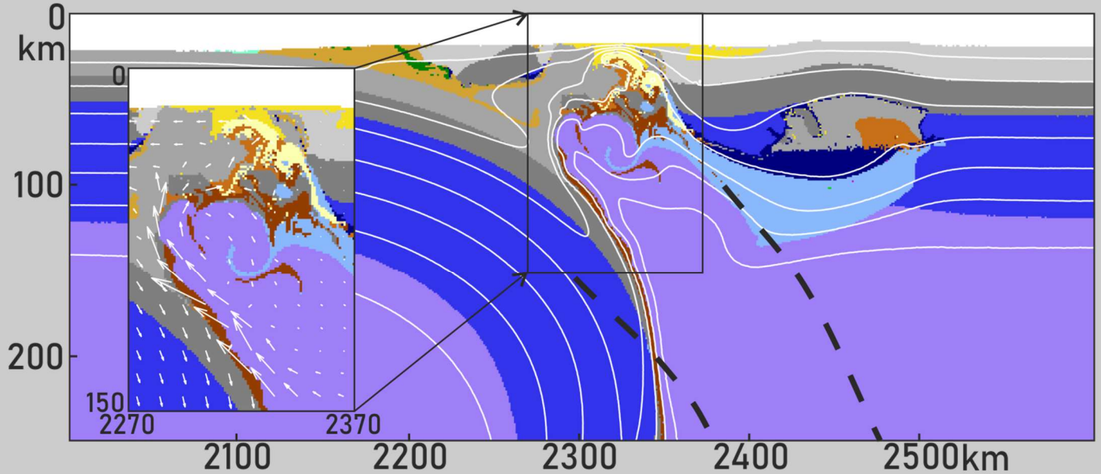
Heating due to asthenospheric mantle juxtaposition and crustal material redistribution.
Late heating by first 100 degrees – 2-4 Myrs
Late heating by another 100 degrees > 7 Myrs

Most markers showing the PTt paths with the late heating stage with some exceptions stay at depths in the experiments. They could be further exhumed by magmatic rocks or another stage of contraction.

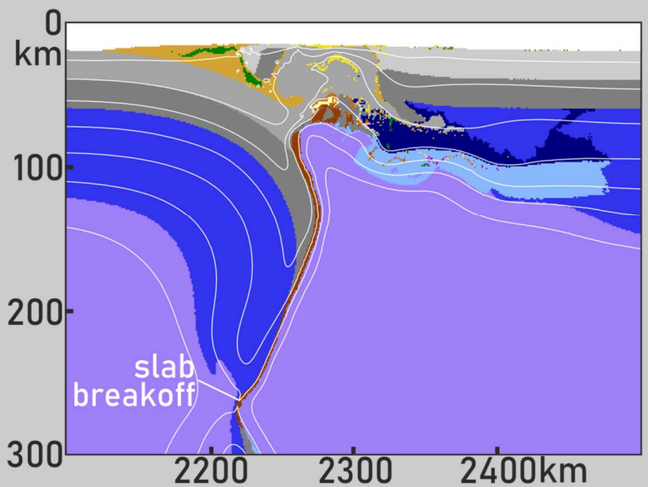
Sizova et al., 2019

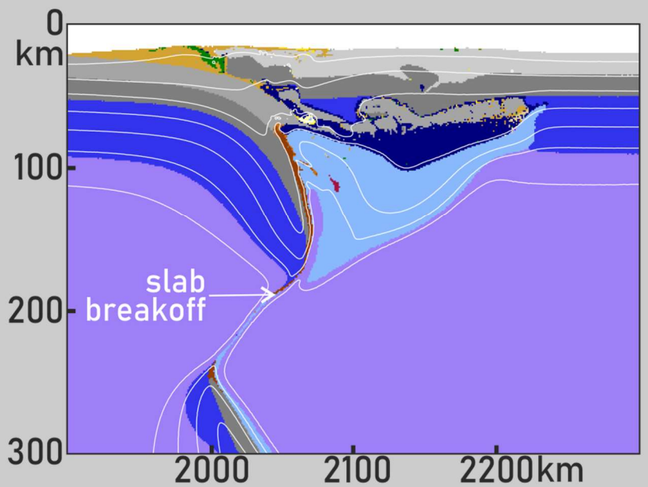
Compare with slab breakoff

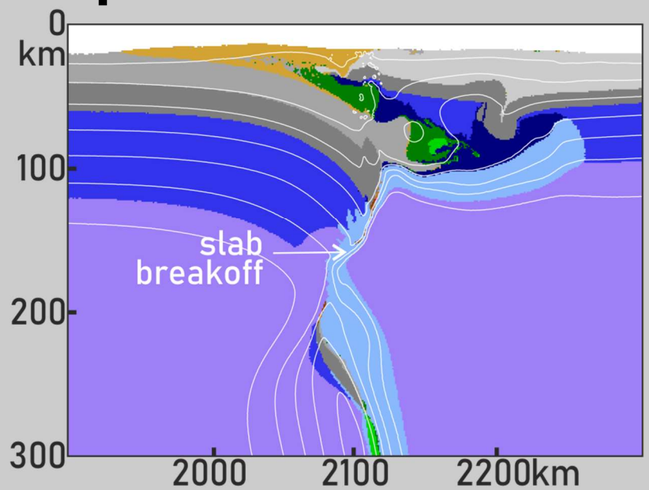
slab rollback



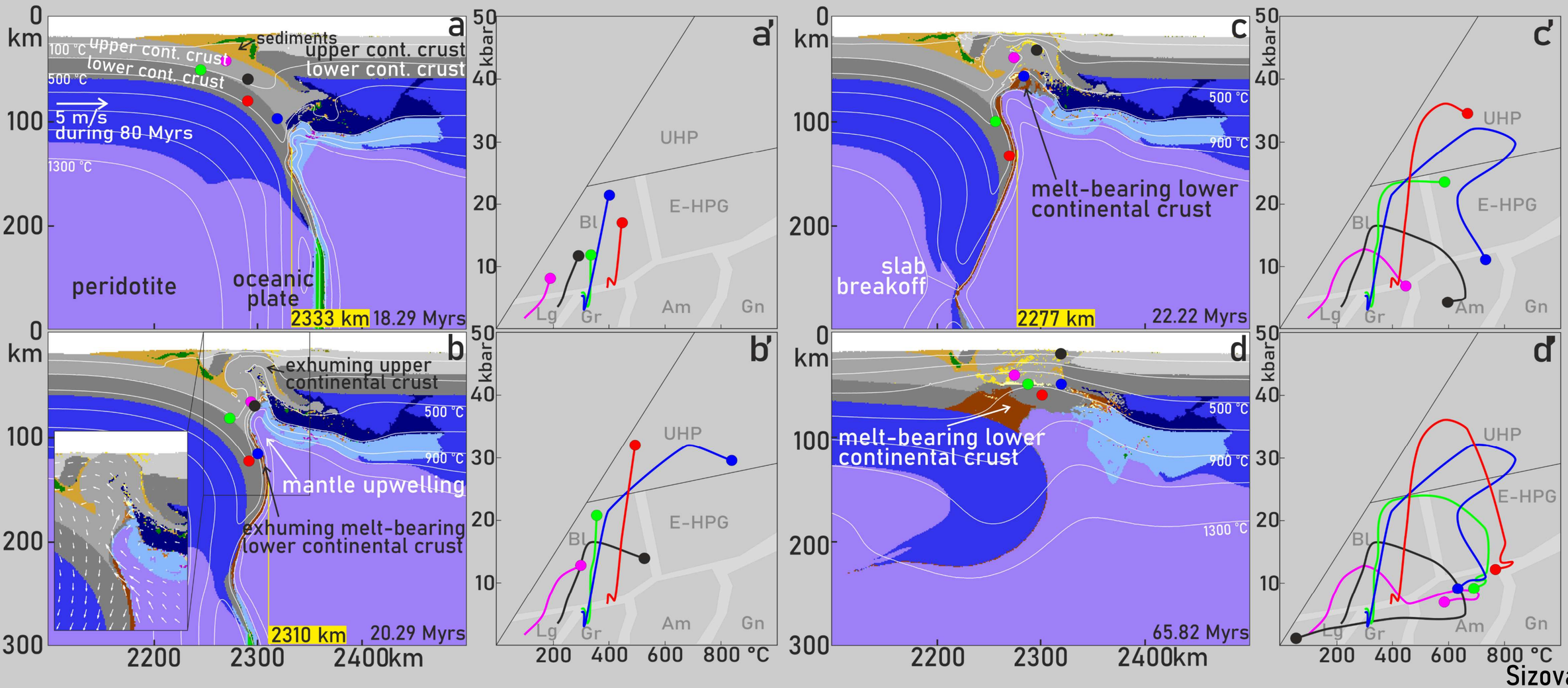
slab breakoff at different depths







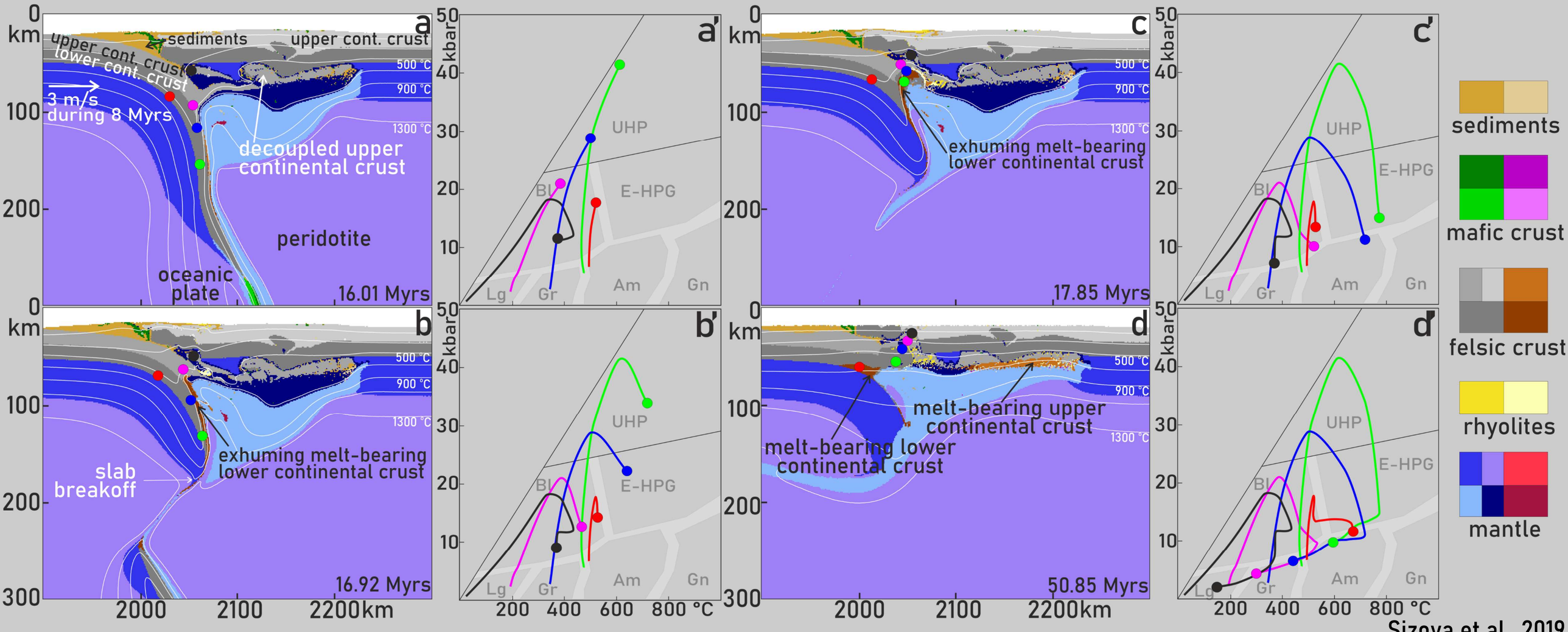
Evolution of the experiment with a deep slab breakoff



Sizova et al., 2019

Mantle upwelling occurs due to the slab bending and the subducted crust exhumation, before slab breakoff.
Slab breakoff stops the collision and causes system cooling.

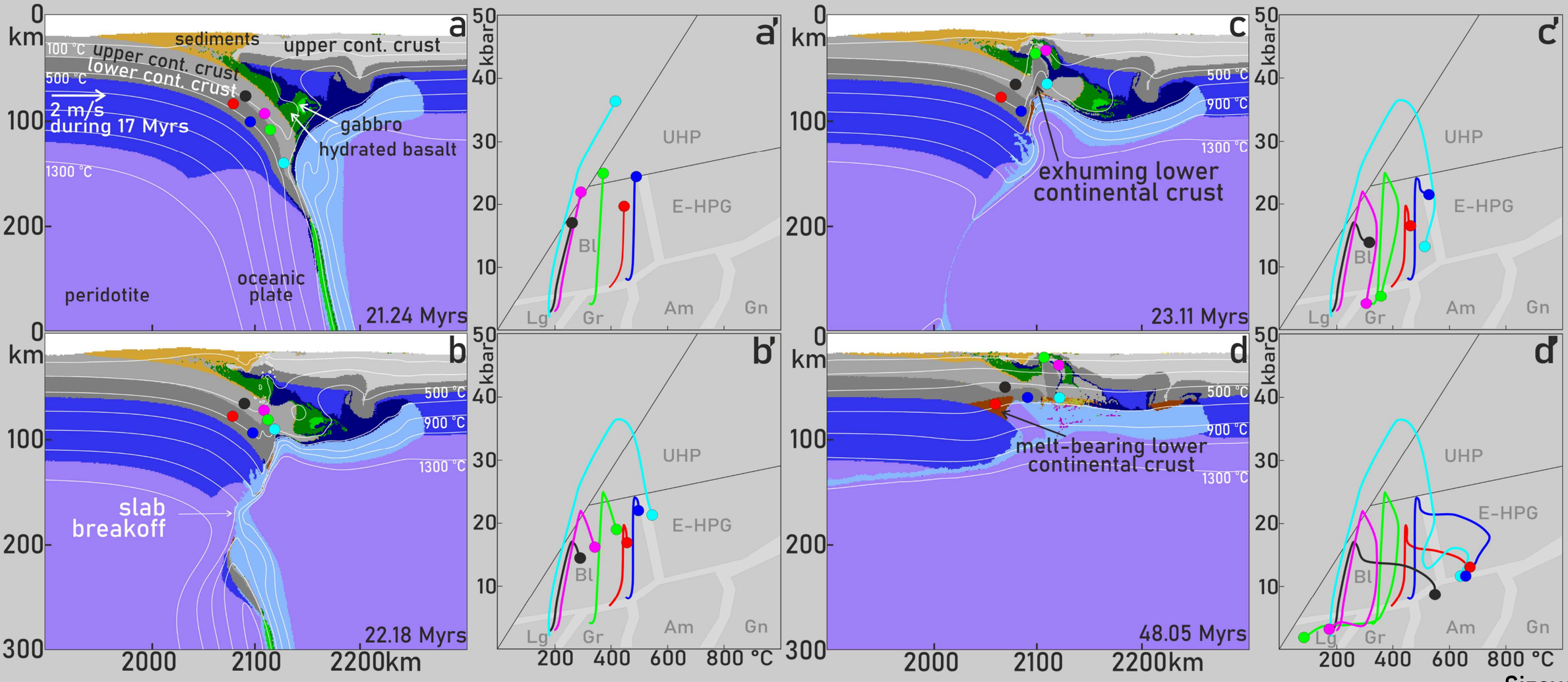
Evolution of the experiment with an intermediate slab breakoff



Sizova et al., 2019

Sligthly elevated temperatures due to the subducted crust exhumation, before slab breakoff.
Slab breakoff stops the collision and causes system cooling.

Evolution of the experiment with a shallow slab breakoff

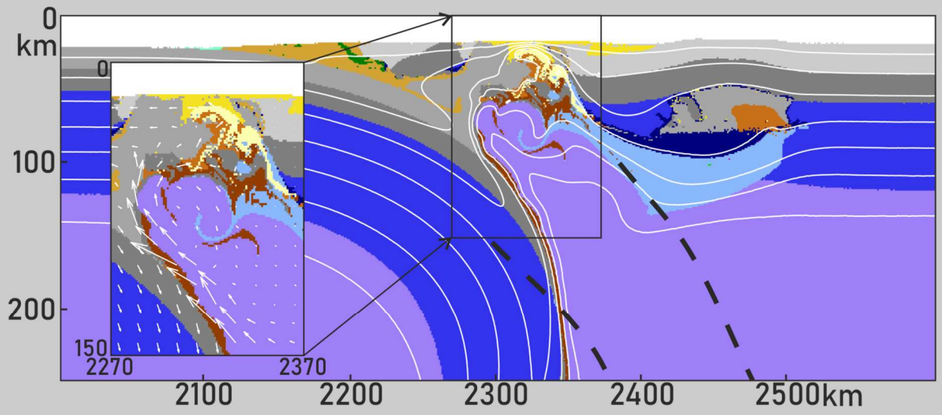


Sizova et al., 2019

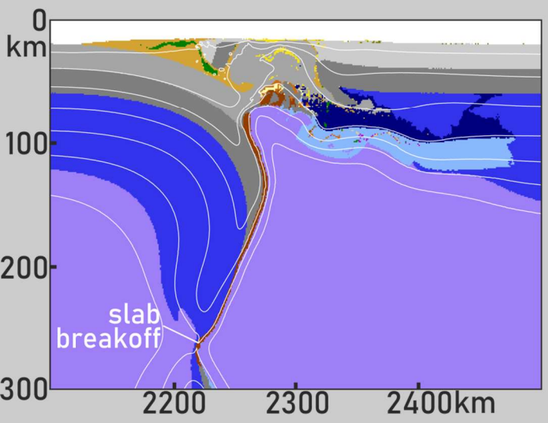
Small mantle upwelling following the exhuming crust.

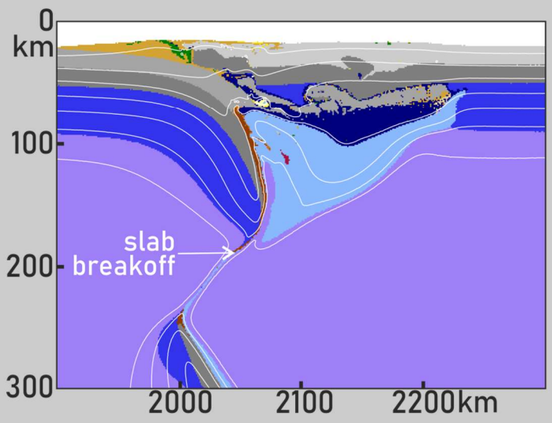
Some markers heating is caused by the late material redistribution and appearance of the markers at the Moho.

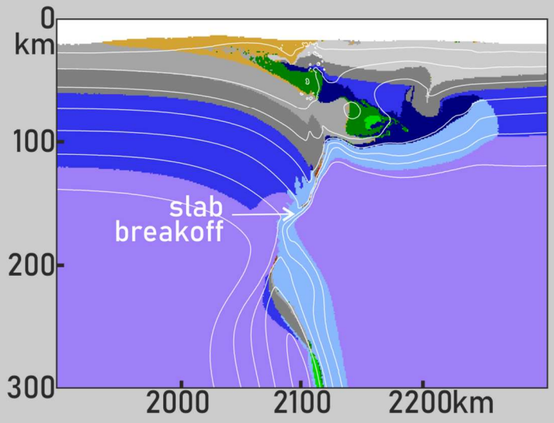
Result of comparison



Slab rollback during ongoing continental collision:
- effective extraction of (U)HP metamorphic rocks
- their later heating

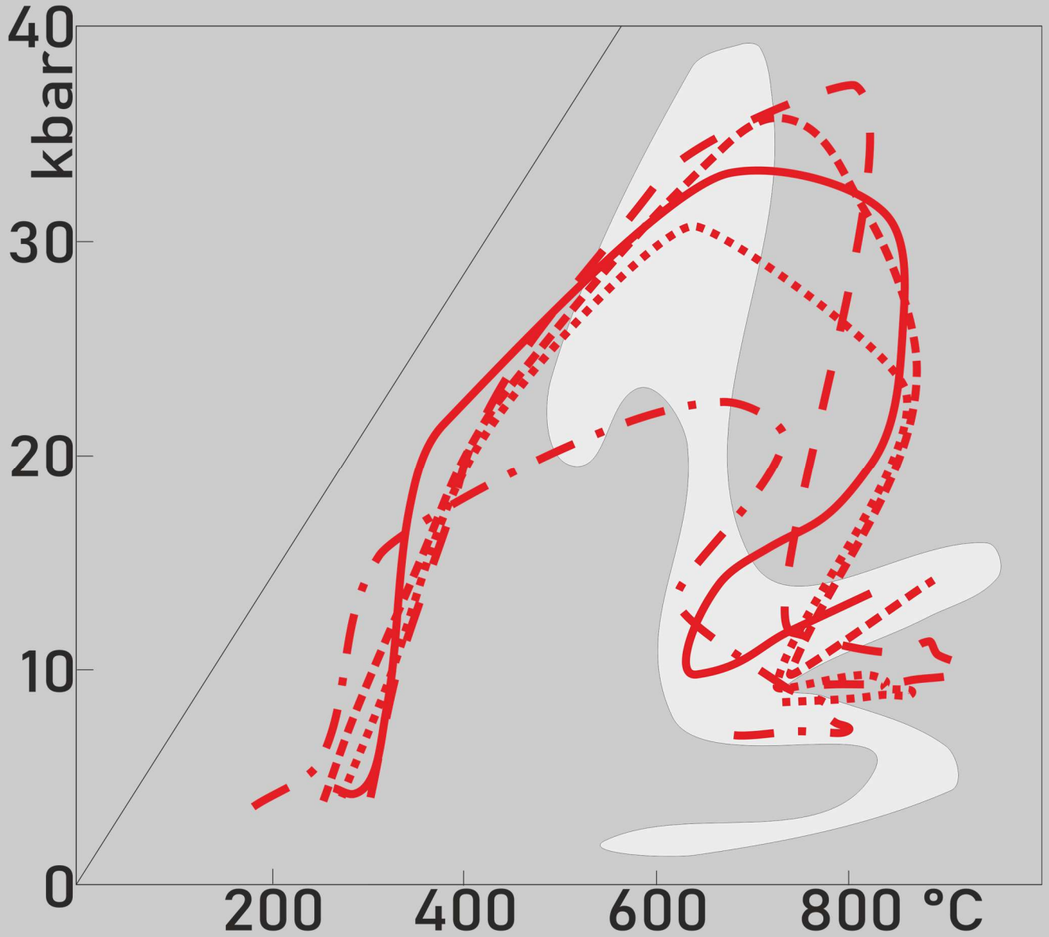






The analysed scenarios with slab breakoff do not show any slab breakoff related mantle upwellings.

Comparison of PTt paths from the slab rollback experiment with the PTt paths with late heating from the Bohemian Massif



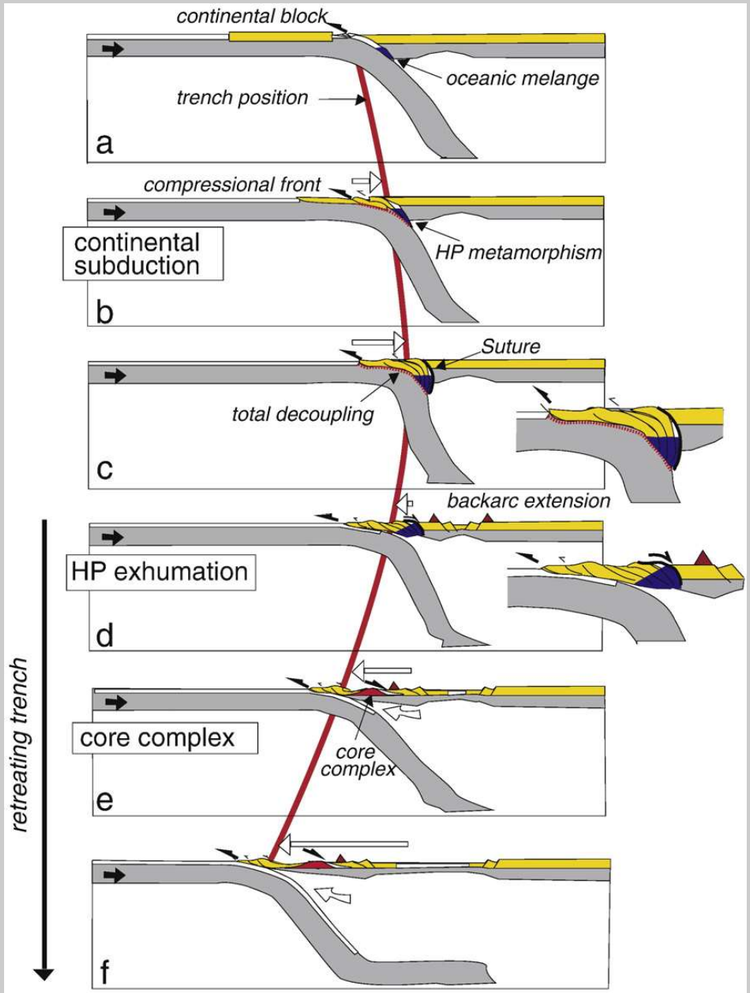
red lines – PTt paths from slab rollback experiments,
light grey field – combined PTt paths from the Bohemian massif.

The paths from the slab rollback experiments do not perfectly match the natural field, but almost cover both metamorphic peaks and repeat, in some cases, the shape.

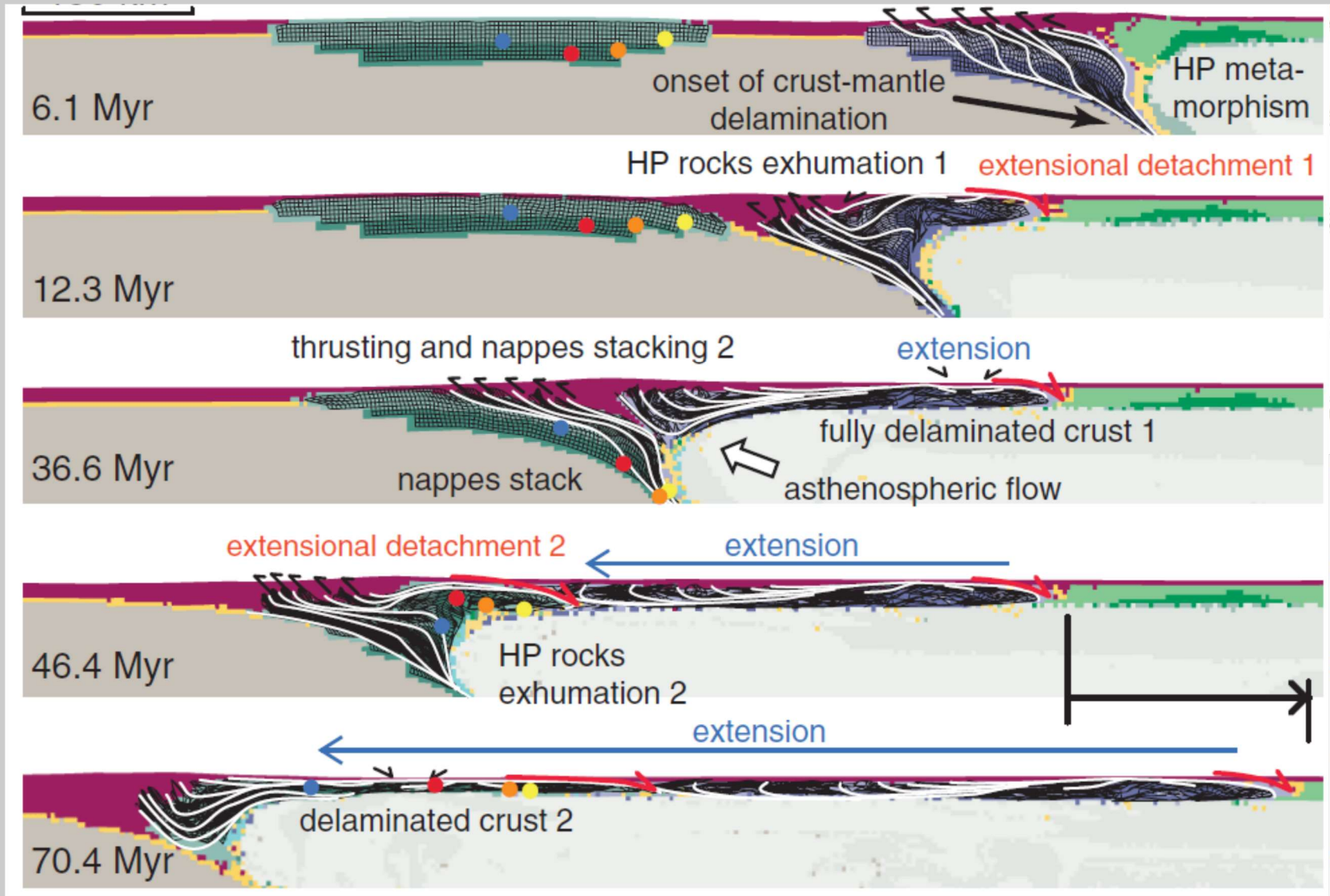
In the experiments we have tested the prolongated slab rollback scenarios, while some short-lived stages could most likely characterize the natural orogens.

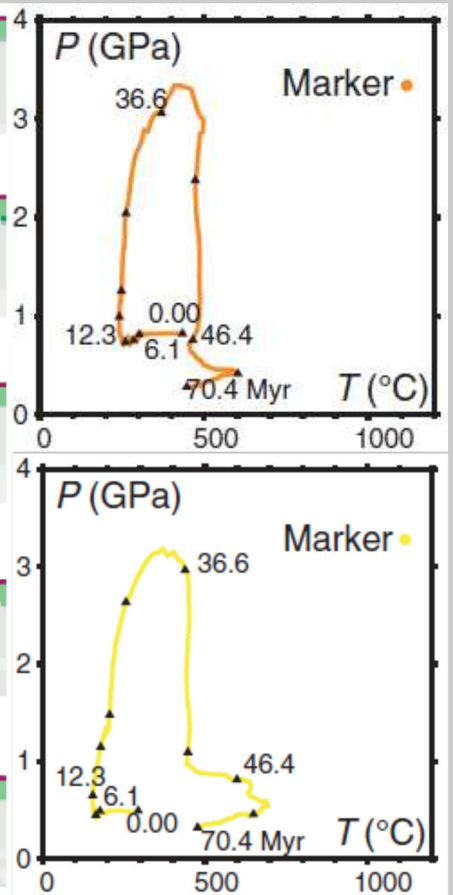
Slab rollback during oceanic-continental subduction

Slab rollback as an **exhumation-supporting** mechanism: Cloos et al, 2006 and Hacker, 2007
Application for the Mediterranean: Brun & Faccena, 2008, numerically: Tirel et al., 2013



Brun & Faccena, 2008





Tirel et al., 2013

We suggest similar idea, but for ongoing **continent-continent** collision.

Conclusions

Slab rollback during ongoing continental collision can be considered as a mechanism responsible for:
- the effective extraction of (ultra)high pressure metamorphic rocks
- their later heating.

The produced PTt paths have similar shape with some natural metamorphic rocks, like some from the Bohemian Massif.

The analysed slab breakoff scenarios do not show any slab breakoff related mantle upwellings. Further work should be done to test that conclusion.

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