

A new model of slab detachment in the Alps and its geodynamic consequences

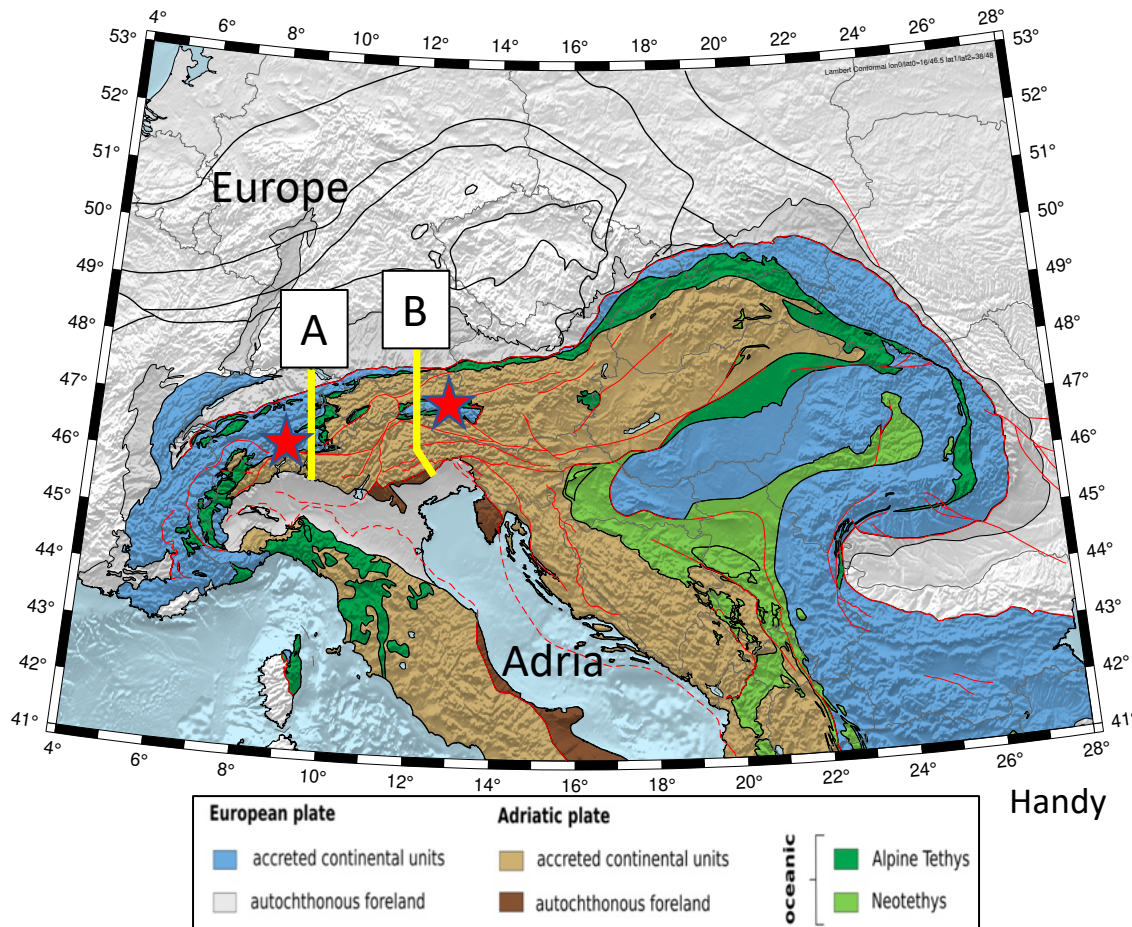


Mark R. Handy
with

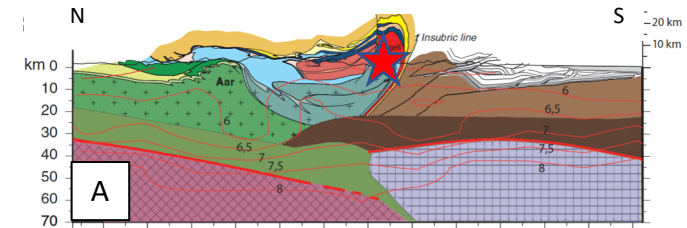
DFG Deutsche
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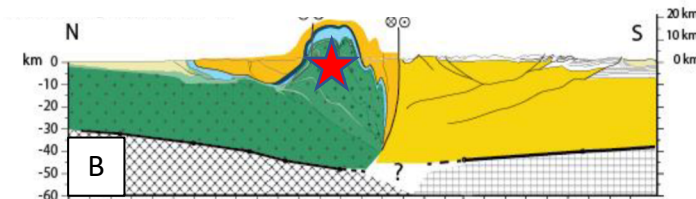
Peter McPhee, Eline Le Breton, Arthur Borzi
Anne Bernhardt, Emanuel Kaestle, Azam Jozi Najafabadi, Christian Haberland



Handy



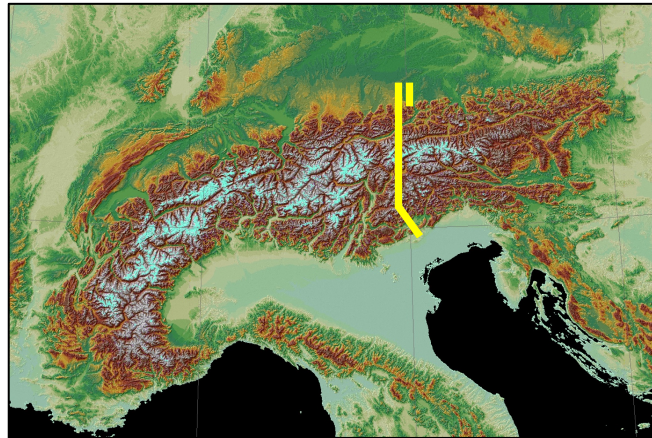
Max exhumation 30-25 Ma in retro-wedge above wedge of upper plate



Max exhumation 21-11 Ma above lower plate in centre of orogen

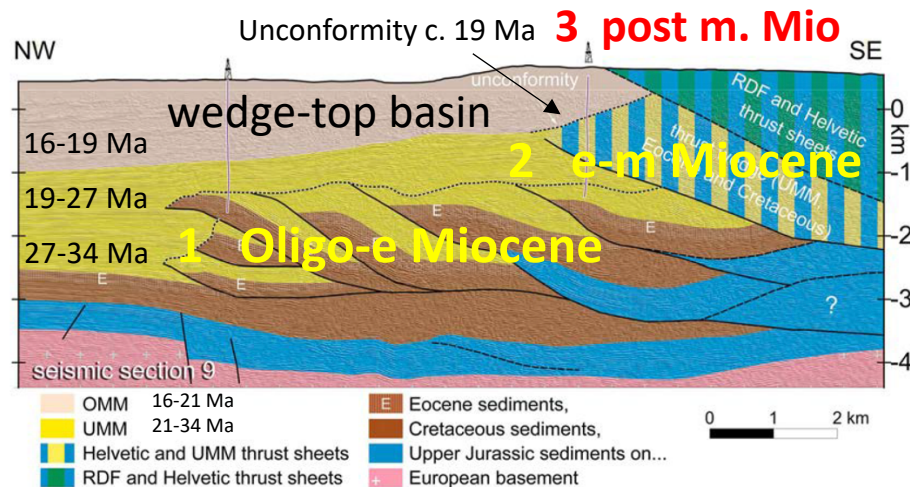
Rosenberg & Kissling 2013
Rosenberg et al. 2018

Challenge- explain switching orogenic fronts in E



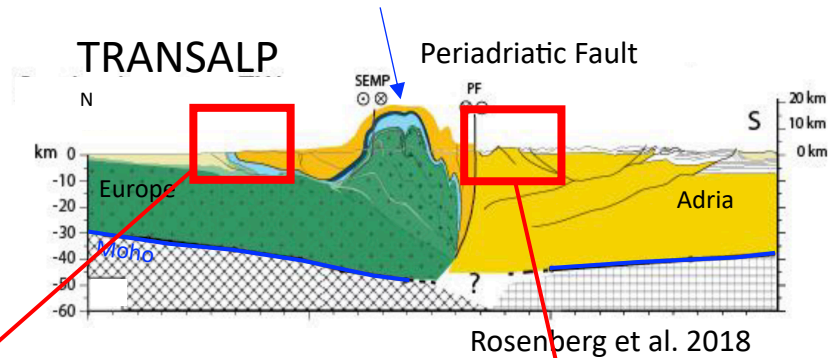
Northern Front

3 thrust events while pro-wedge retreated



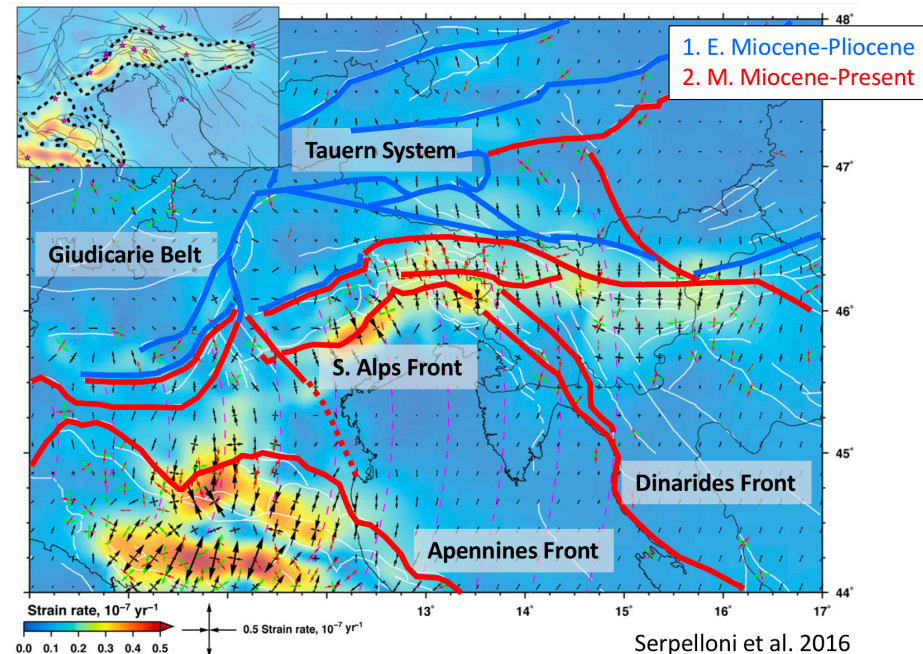
Ortner et al. 2015

Tauern - rapid exhumation & denudation from 21-11 Ma

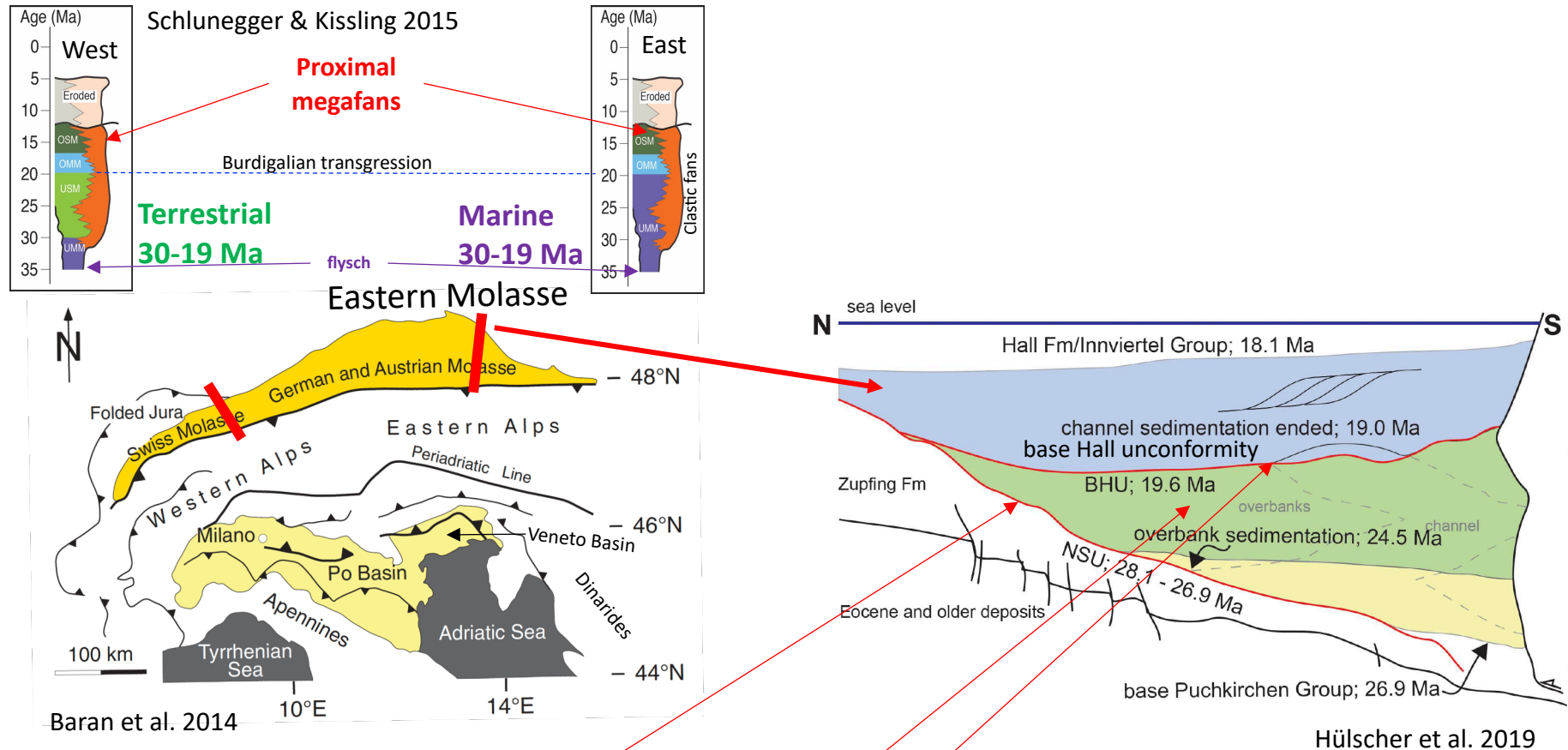


Southern Front

2 thrust events while retro-wedge advanced



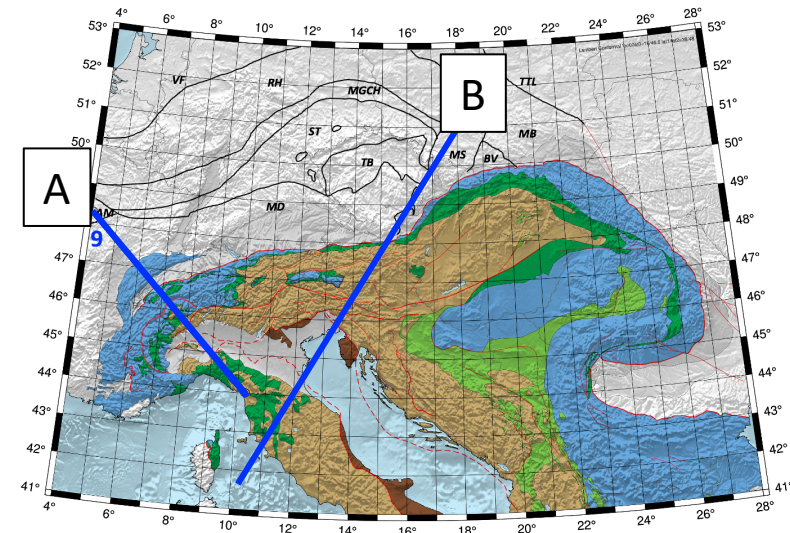
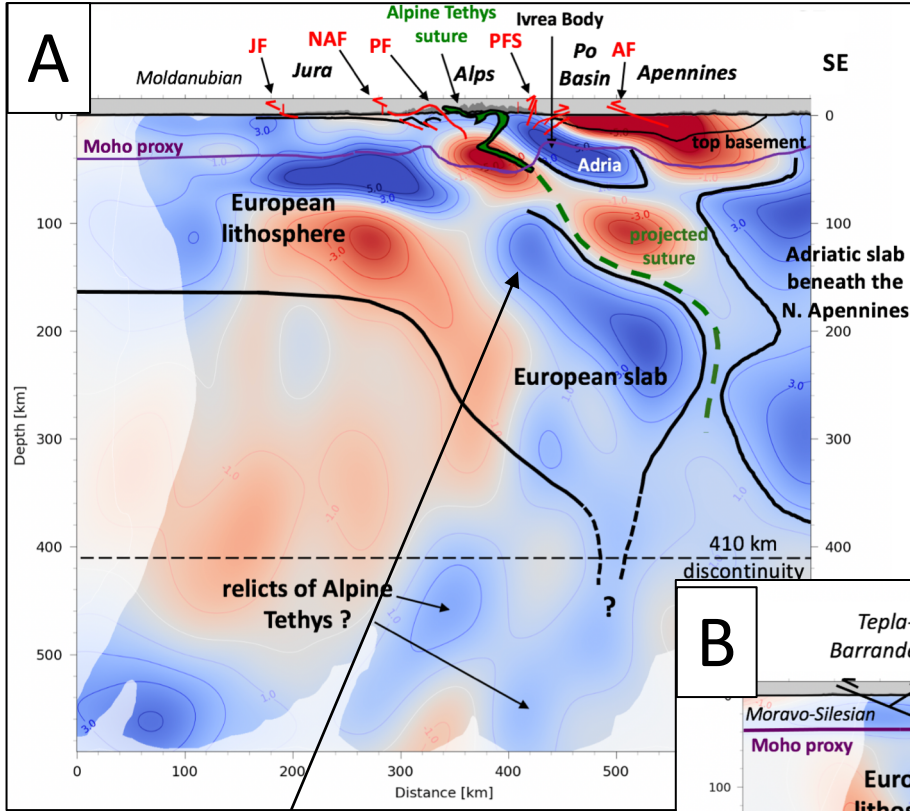
Challenge – explain differential subsidence & rapid filling of the E. Molasse Basin



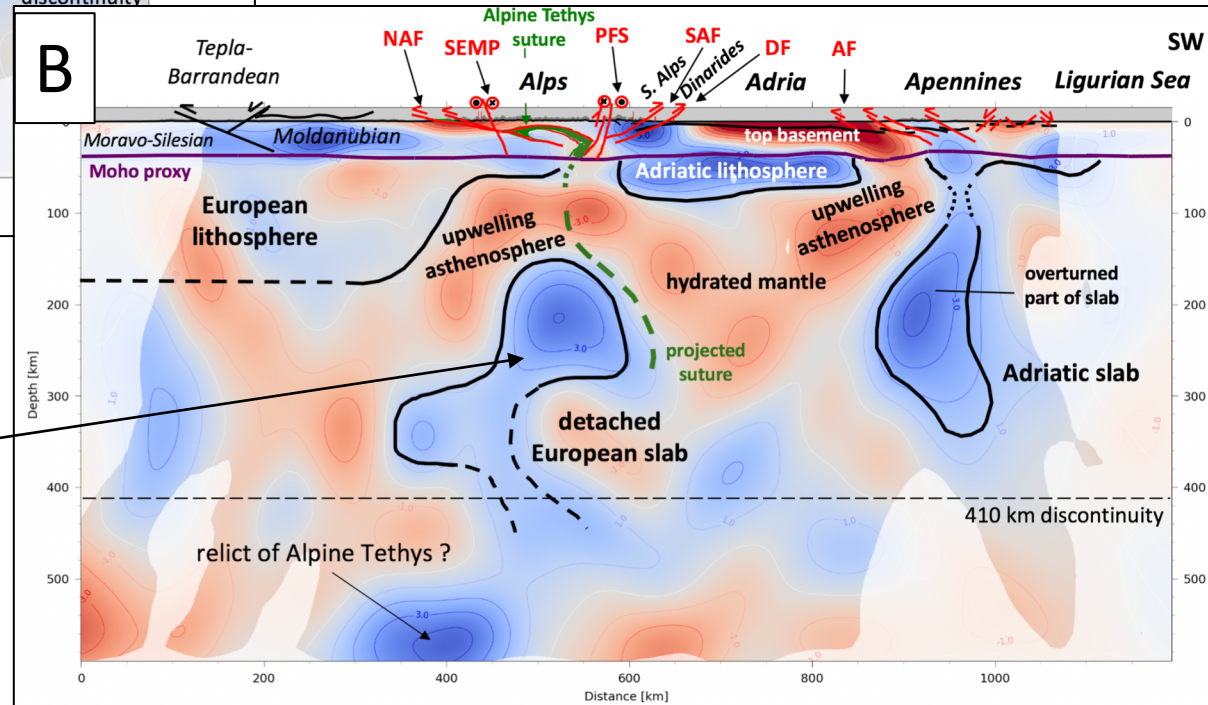
- Stratigraphic onlap; tectonic subsidence rapid
- Subsidence kept pace with sediment accumulation
- **Unconformity; basin filled rapidly**
- Basin completely filled
- **Uplift & erosion**

28-26 Ma
26-19 Ma
19-18 Ma
c. 16 Ma
≤ 6 Ma

New view- slab beneath the Alps



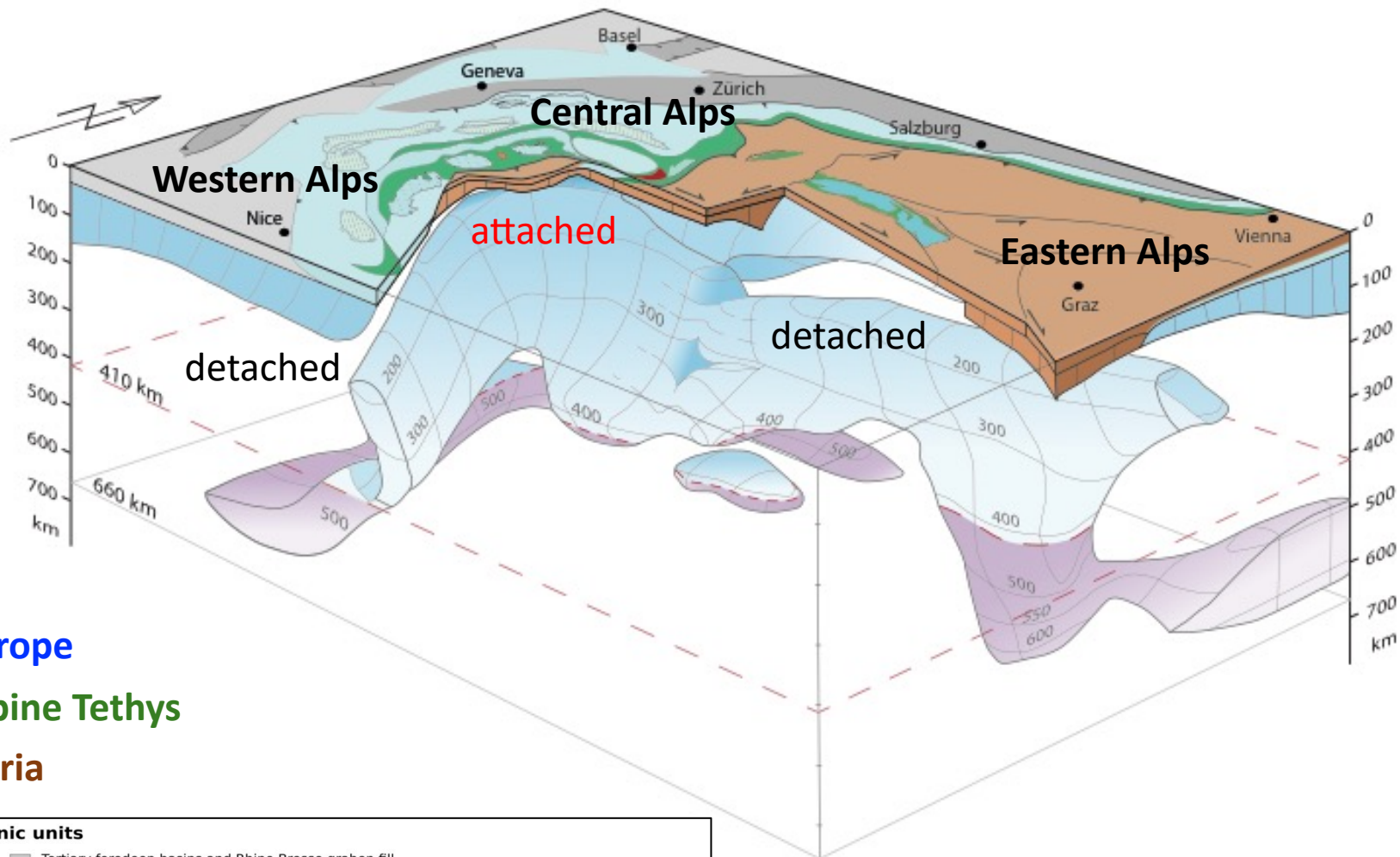
Handy et al. 2021, profiles 9 & C, based on P-wave tomography in Paffrath et al. 2021



Attached

Detached

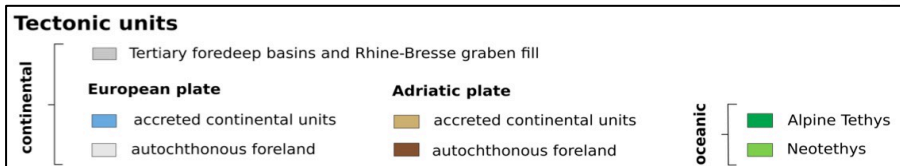
Alpine slab viewed from the SE



Europe

Alpine Tethys

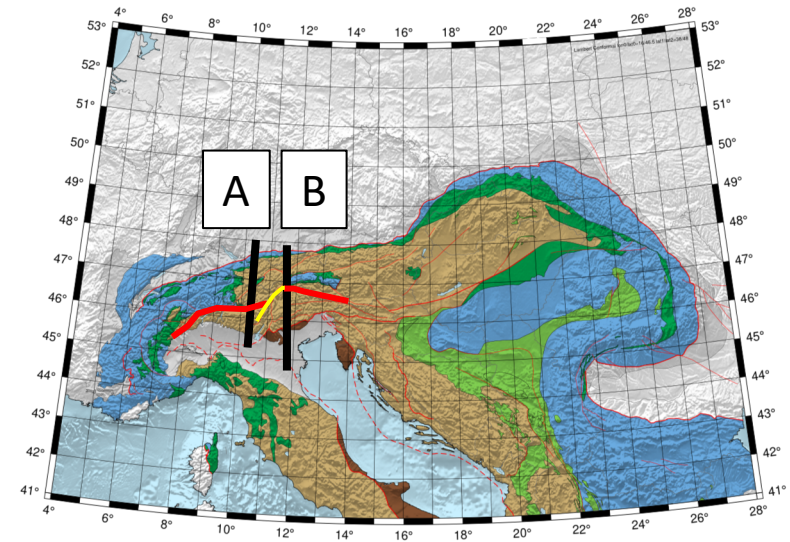
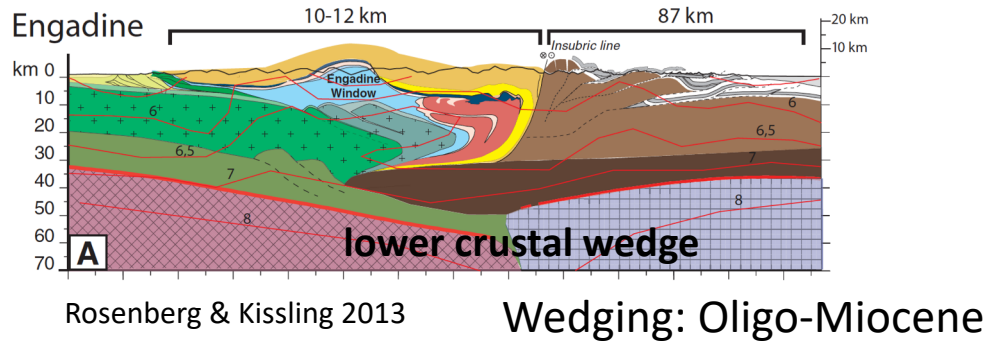
Adria



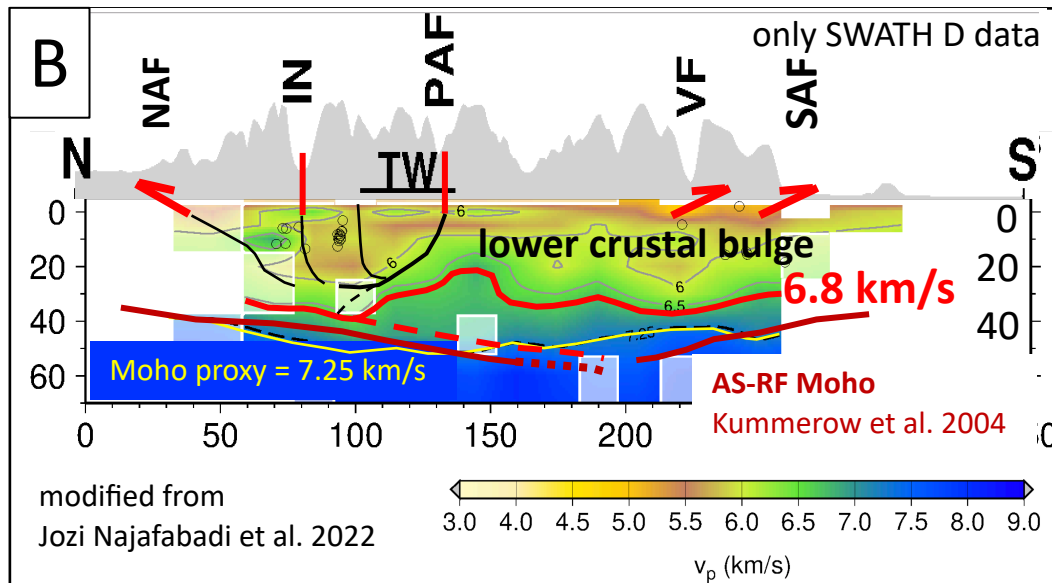
Lower crustal wedging vs. bulging

Handy, EGU 2022

A



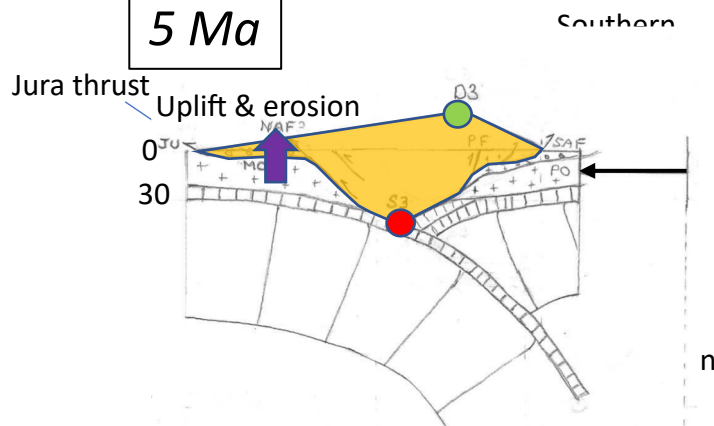
B



Bulging: probably Mio-Pliocene

Central Alps

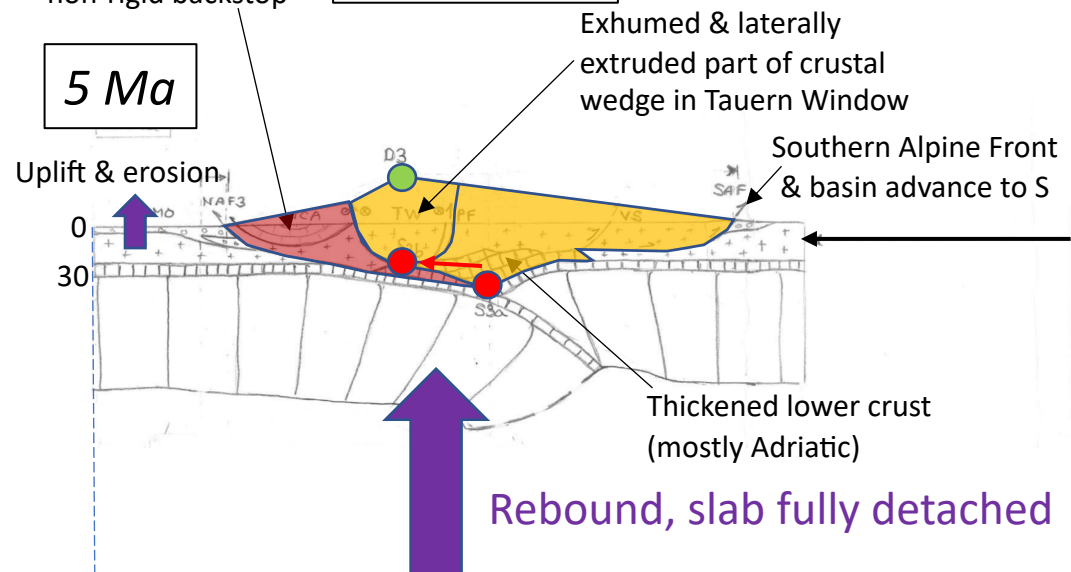
5 Ma



Slab steepens, still attached

Eastern Alps

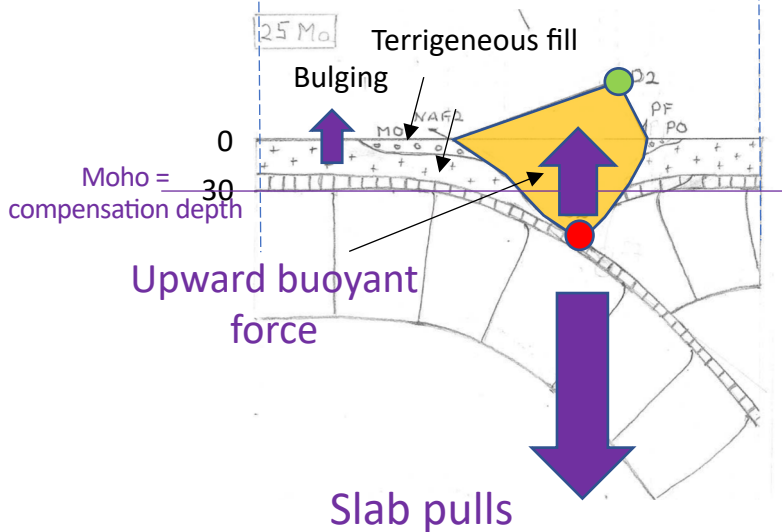
5 Ma



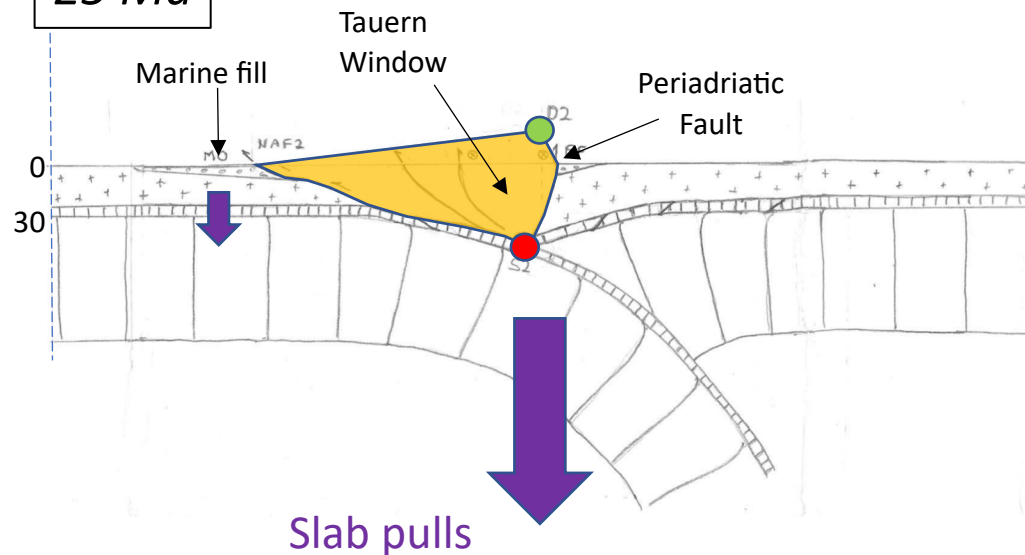
Rebound, slab fully detached

Singularity pts shift N-ward with respect to European foreland

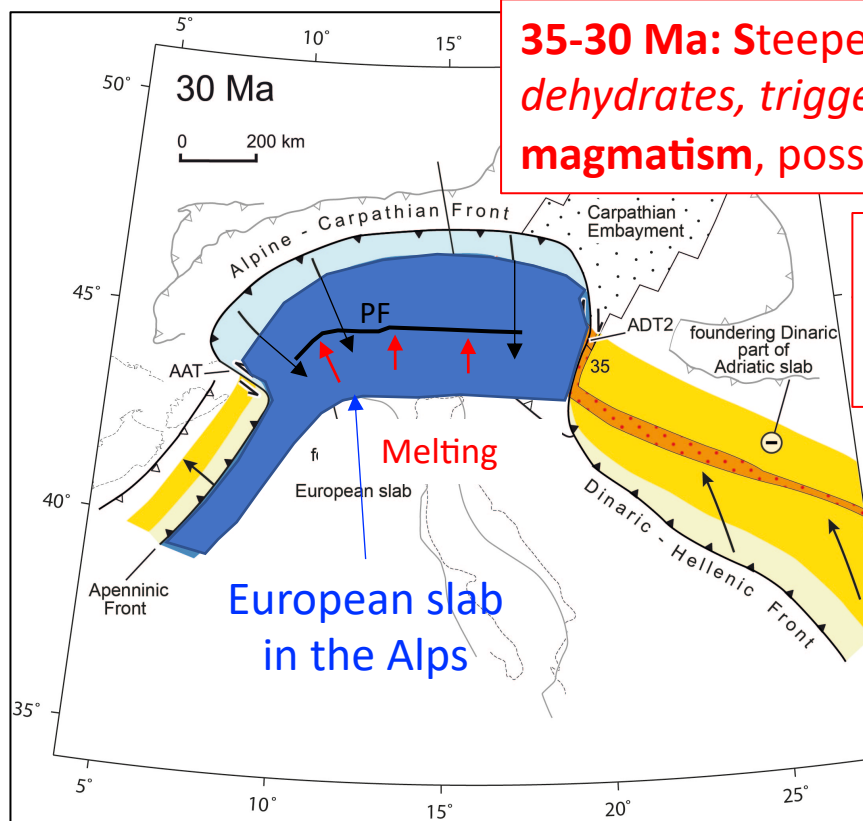
25 Ma



25 Ma

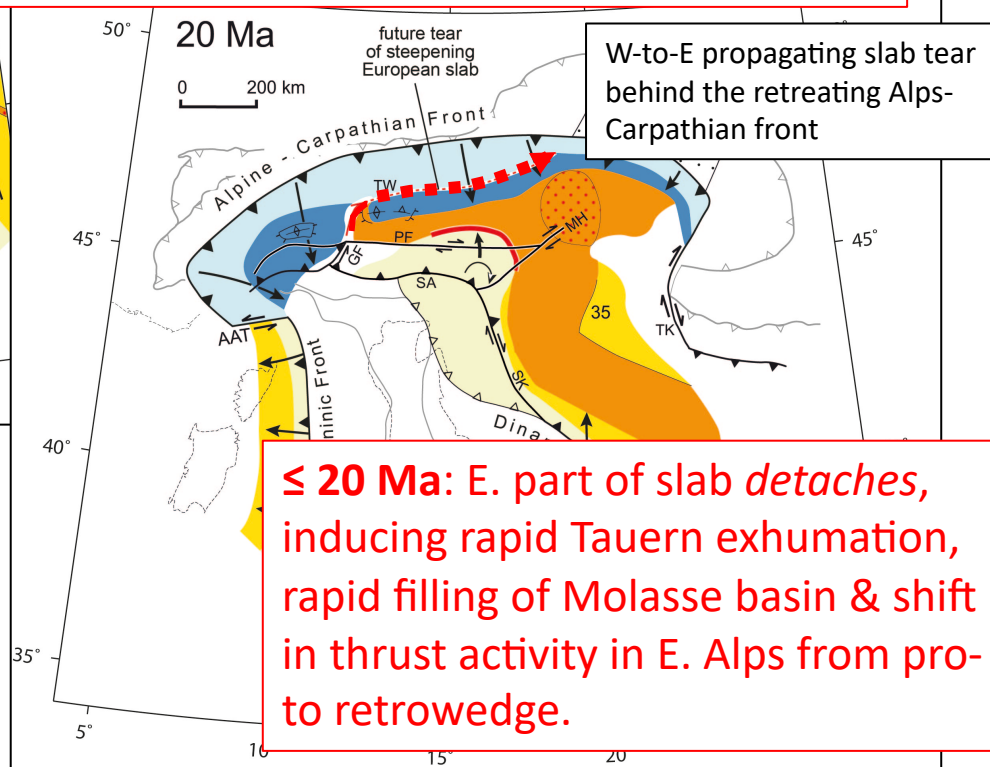


A new model for slab detachment, magmatism & basin dynamics



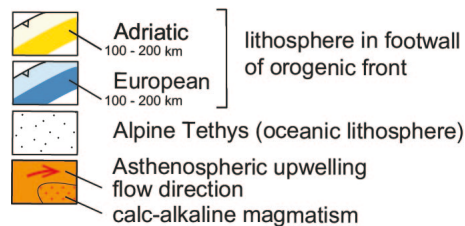
35-30 Ma: Steepening slab dehydrates, triggering Periadriatic magmatism, possible slab breakoff

25-20 Ma: Slab delaminates in E. Alps & pulls down, maintaining subsidence in the E. Molasse Basin & shifting singularity to N



Lithosphere-Asthenosphere

Handy et al. 2015, modified



1. Differing exhumation patterns & behaviour of the foreland basins in the Central and Eastern Alps reflects **shifts in the singularities of the orogenic wedges in response to partial detachment** of the European slab
 - E. Alps – slab detachment, northward & upward shift of singularity and growth of flat wedge
 - C. Alps – slab steepening, minor N-ward shift of singularity and growth of steep wedge
2. Alpine magmatism in late Oligocene time may be due to **volatile fluxing and hydration melting of a deep slab**, rather than slab breakoff.

Test – model basin response to shift in loads of orogenic wedge and of slabs

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