

# Kinematics and extent of the Liguro-Piemont Ocean

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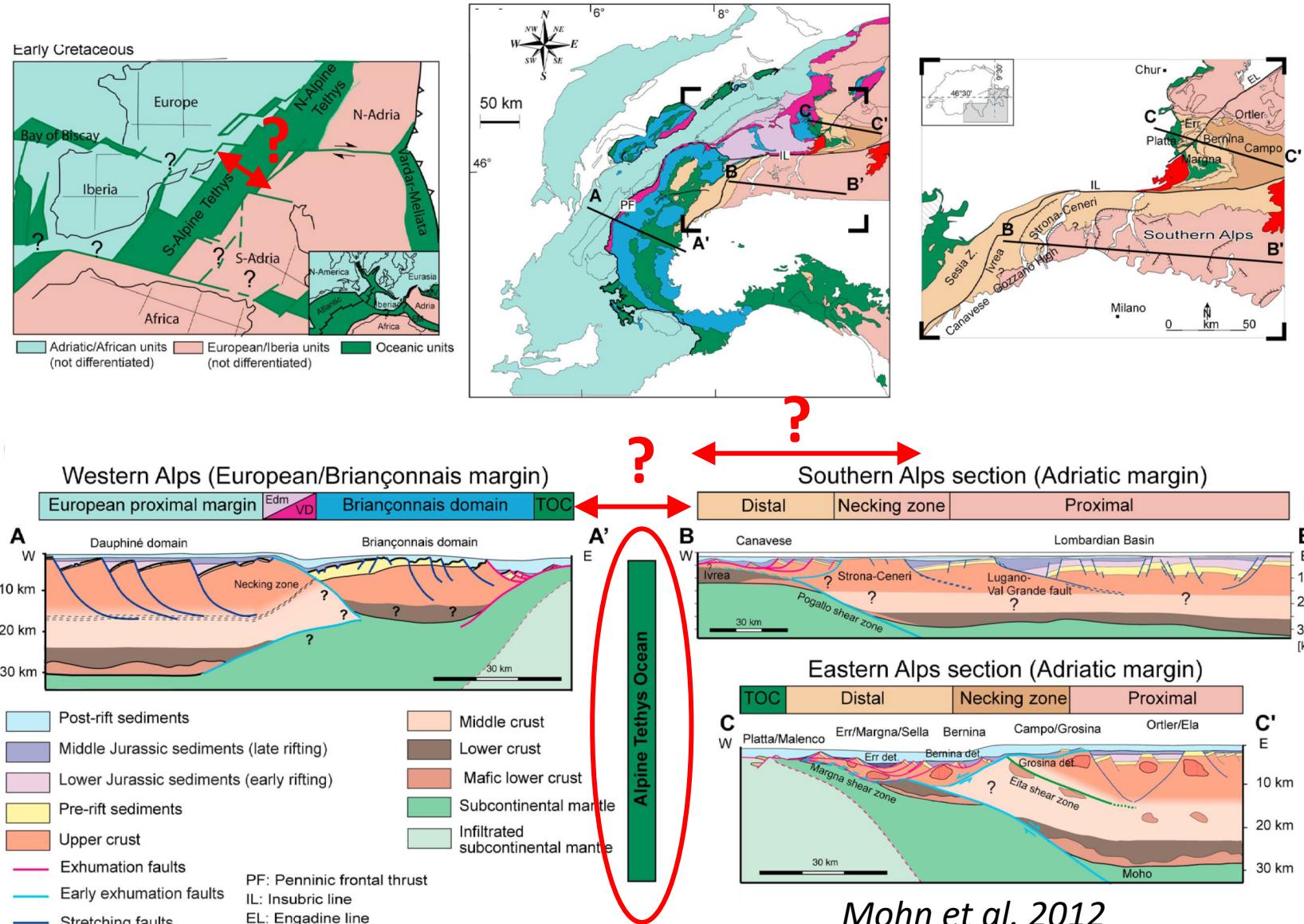
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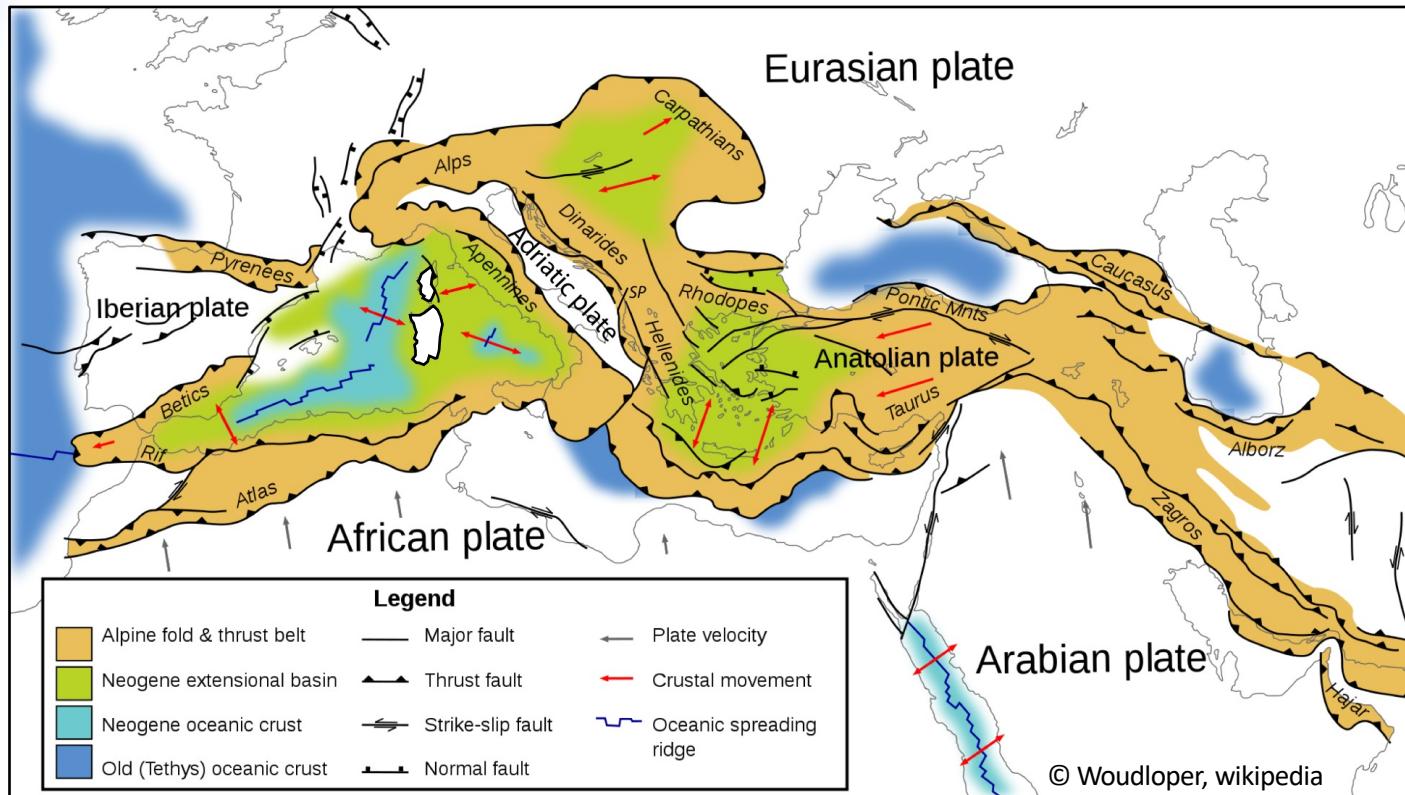


# The Liguro-Piemont Ocean and its margins



- Field evidence for a hyper-extended magma-poor type of continental margin and ultra-slow spreading
- **Aim of this work:** provide quantitative constraints on the opening and extent of the Liguro-Piemont Ocean and margins
- Crucial to understand subduction and exhumation processes during the Alpine Orogeny

# Kinematic Model



## ➤ Key players:

**Europe, Africa, Iberia:** Kneller et al. 2012, Barnett-Moore et al. 2018

**Adria:** Le Breton et al. 2017 and in prep; Schettino & Turco 2011

**Sardinia-Corsica:** Le Breton et al. 2017 and in prep, Speranza et al. 2002, Bestani et al. 2016

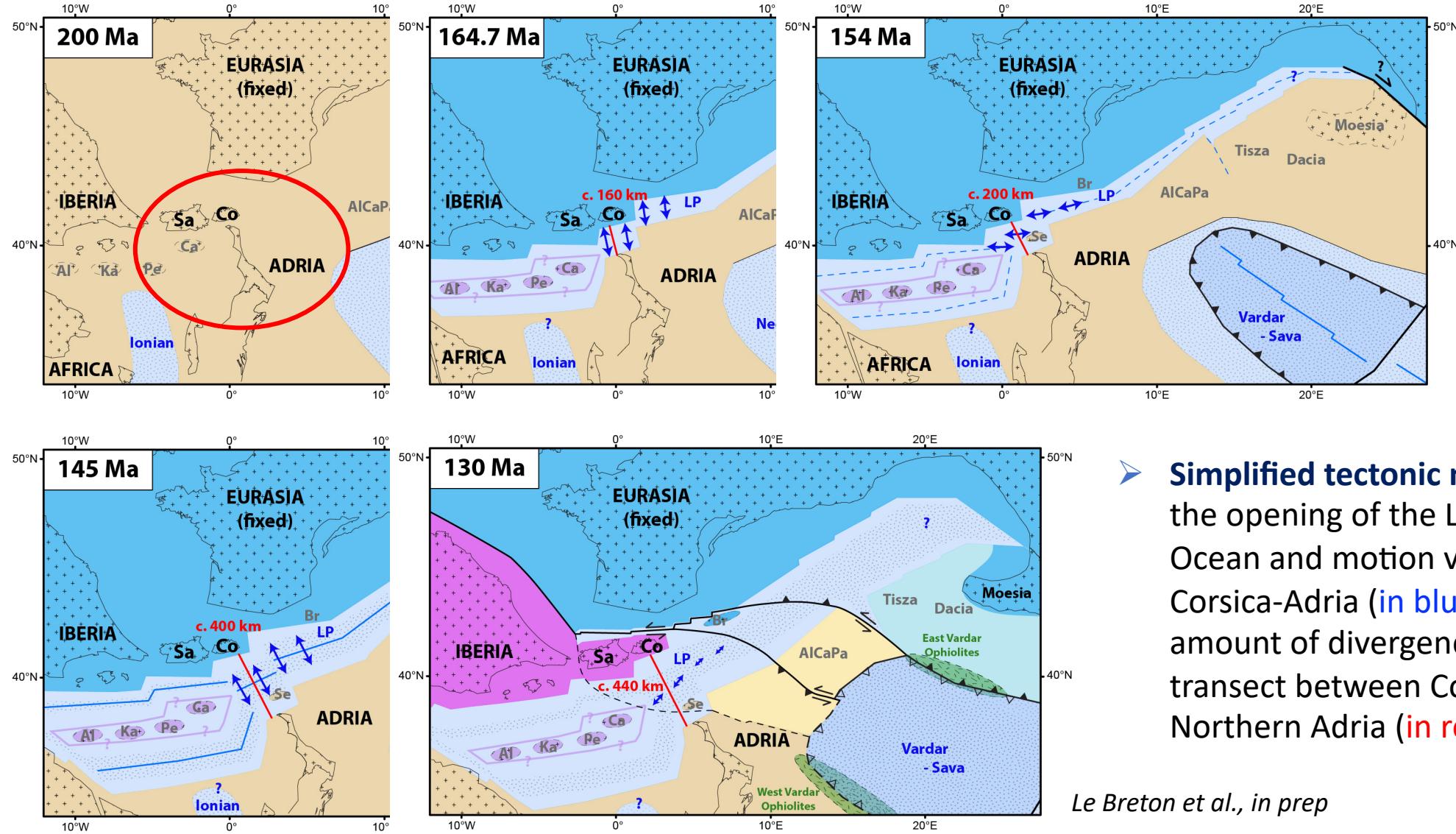
Our kinematic reconstructions of the Mediterranean has been implemented into a global plate motion model using Gplates (Müller et al. 2019), link to gplates files and animations:

[https://www.earthbyte.org/webdav/ftp/Data\\_Collections/Muller\\_etal\\_2019\\_Tectonics/](https://www.earthbyte.org/webdav/ftp/Data_Collections/Muller_etal_2019_Tectonics/)

# Opening of the Liguro-Piemont Ocean



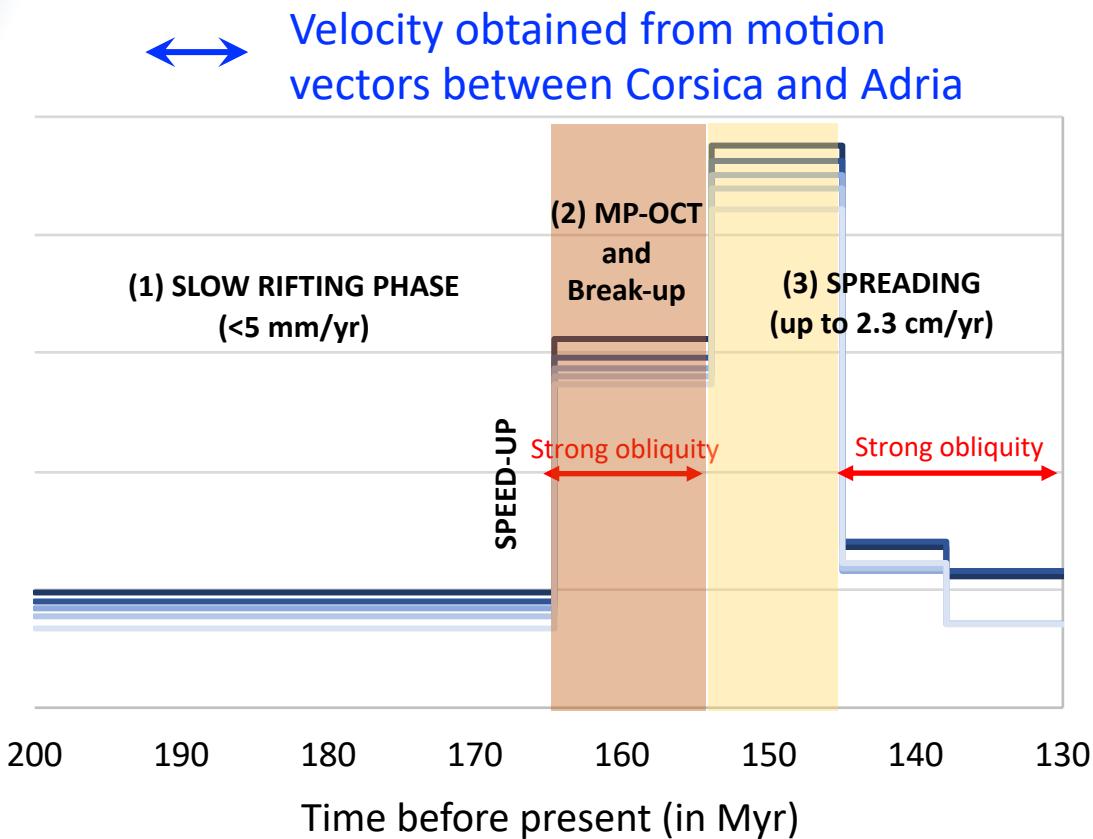
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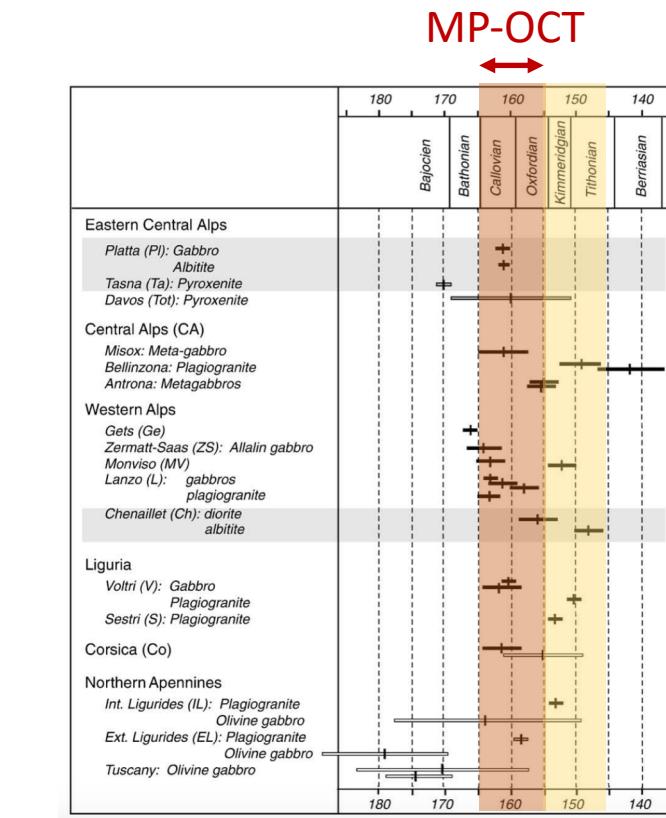
➤ Simplified tectonic maps showing the opening of the Liguro-Piemont Ocean and motion vectors of Corsica-Adria (in blue ←→) and amount of divergence along a 2D transect between Corsica and Northern Adria (in red)

Le Breton et al., in prep

# Rifting/Spreading velocity

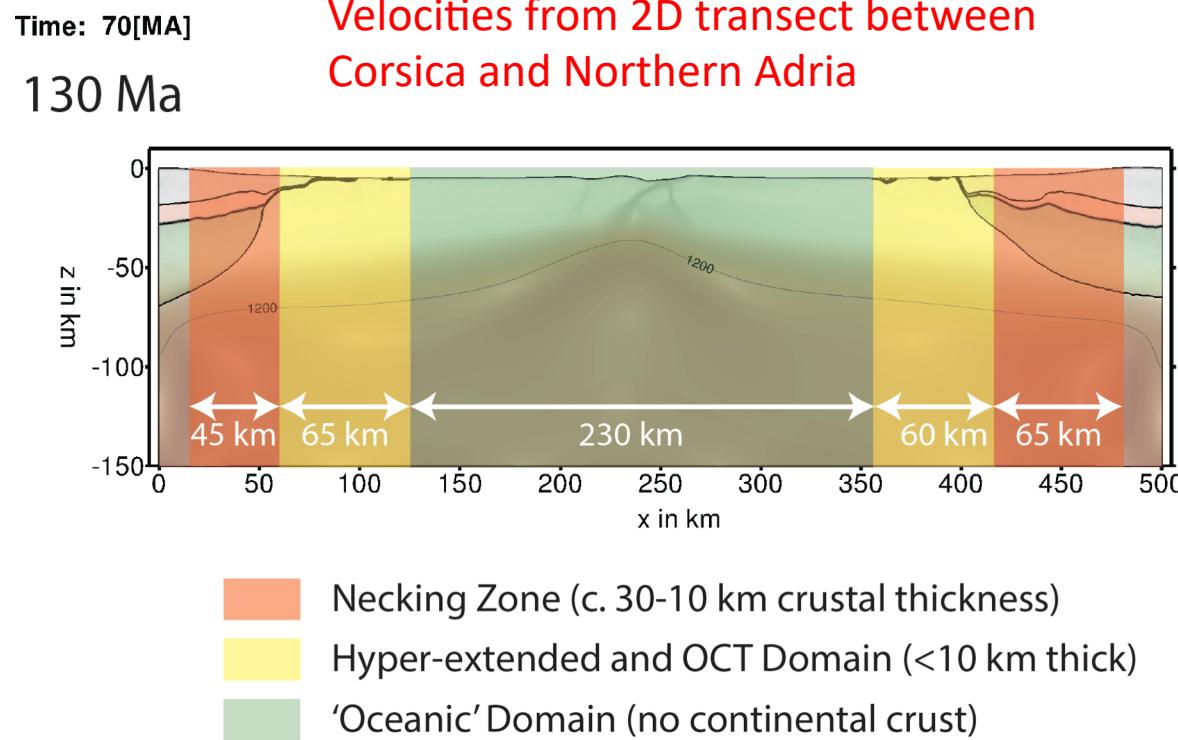


- Abrupt acceleration of plate divergence before break-up as observed along many other margins worldwide (Brune et al. 2016)



- **Three phases of opening:**
  - Slow rifting phase (c. 200-165 Ma)
  - Fast rifting phase and magmatism along OCT before breakup (c. 165-154 Ma)
  - Spreading (up to 2.3 cm/yr between c. 154-145 Ma then rapid decrease and end of spreading at c. 130 Ma)

# Extent of the Alpine Ocean and its continental margins along a transect between Corsica and Adria



Results at Time 70 Ma using velocities of 0.4 cm/yr from Time 0-46, 2.2 cm/yr from Time 47-55 and 0.3 cm/yr from Time 56-70 Ma

See Brune et al. 2014 for details on the numerical modelling approach

- High-resolution **thermo-mechanical modelling** of the rifting phase using kinematic constraints from our plate model allows us to identify more precisely the following stages:
  - (1a) Rifting and narrowing of the rift (= crustal thinning from 30 to 10 km) from 200-180 Ma
  - (1b) Necking and onset of hyper-extension (= crustal thinning below 10 km) at 180 Ma
  - (2) Onset of mantle exhumation at 165 Ma
  - (3) Break-up of continental lithosphere at 154 Ma

⇒ Our results are in very good agreement with geological reconstructions of relics of necking zone and adjacent distal margin in the Alps (Mohn et al. 2012)

- **The Alpine (Liguro-Piemont) Basin has opened in three stages:**
  - 1) Slow rifting phase (< 5 mm/yr) between 200-165 Ma (Lower-Middle Jurassic)  
⇒ Rifting of the proximal continental margin, necking and hyper-extension at 180 Ma
  - 2) Fast oblique rifting (up to ~15 mm/yr) between 165-154 Ma (Middle-Upper Jurassic)  
⇒ Mantle exhumation and OCT formation
  - 3) Break-up and short-lived ultra-slow oceanic spreading (up to ~ 23 mm/yr, full rate) between 154 and 145/130 Ma (Upper Jurassic-Lower Cretaceous)
- **Width of the ocean and margins** (along a transect between Corsica and N. Adria):
  - ~ 500 km of rifted margins (~ 380 km proximal and necking zones and ~ 120 km hyper-extended and OCT zones)
  - ~ 240 km of oceanic crust

We test other kinematic scenarios for the motion of Iberia-Sardinia-Corsica and for the opening of the Ionian Basin which would increase the obliquity of rifting and reduce even more the width of the extended domain. Therefore, our calculated extent of the LP Ocean constitutes a **maximum estimate** providing crucial constraints for geodynamic modelling and a better understanding of subduction processes during the Alpine Orogeny.

# References

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Kinematic reconstructions ( GPlates files and animations): [https://www.earthbyte.org/webdav/ftp/Data\\_Collections/Muller\\_etal\\_2019\\_Tectonics/](https://www.earthbyte.org/webdav/ftp/Data_Collections/Muller_etal_2019_Tectonics/)