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# Unraveling the timing and drivers of Adria's independent motion through kinematic and 3D thermo-mechanical modelling

Eline Le Breton<sup>\*†1</sup>, Christian Schuler<sup>2</sup>, Boris Kaus<sup>2</sup>, Nicolas Riel<sup>2</sup>, and Anton Popov<sup>2</sup>

<sup>1</sup>Univ Rennes, CNRS, Géosciences Rennes – UMR 6118, Rennes, France – France

<sup>2</sup>Institute for Geosciences, Johannes Gutenberg-Universität Mainz – Allemagne

## Résumé

The complex tectonic interactions in the Mediterranean region are driven by the convergence of the Eurasian and African plates, as well as the dynamics of several subduction zones. The Adriatic microplate (Adria), located at the heart of this geological system, plays a pivotal role. The last 35 million years have been particularly significant in this complex system, as they marked the beginning of the Alpine collision and the retreat of the Apennine-Maghrebides and Hellenic subduction zones.

Present-day geodetic measurements indicate that Adria is rotating anticlockwise with respect to Africa and Europe, suggesting it moves as an independent tectonic plate. Kinematic reconstruction incorporating estimates of post-20 Ma shortening and extension in the Apennines, Alps, Dinarides, and Sicily Channel Rift Zone also indicates that Adria rotated anticlockwise as it subducted beneath the European Plate to the west and to the east, while indenting the Alps to the north. This independent motion is thought to be strongly influenced by the dynamics of the surrounding subduction zones and the convergence between Africa and Eurasia. However, the role of mantle dynamics in the Mediterranean region and its effect on Adria's motion remains poorly understood.

To address this, we present results from hundreds of high-resolution, 3D visco-elasto-plastic thermo-mechanical models that simulate the geodynamic evolution of the Mediterranean over the past 35 million years. These simulations incorporate the convergence of the African and Arabian plate with Eurasia, and account for key subduction systems to the west (Apennines-Calabria-Maghrebides), to the east (Dinarides-Hellenides), and to the north (Alps-Carpathians) of Adria.

The models show that subduction systems generate complex asthenospheric flow patterns within the central Mediterranean, with Adria's motion being primarily influenced by: 1) the convergence of Africa with Eurasia, 2) the retreat of the Alpine subduction zone north of Adria, and 3) the distance between the retreating Calabrian and Hellenic subduction zones around Adria. It is notable that, in an actively converging system, slab pull from nearby subduction zones significantly affects Adria's anticlockwise rotation only when these zones are within a few hundred kilometers, suggesting that Adria's independent motion began only recently, within the last 5 Ma.

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\*Intervenant

†Auteur correspondant: eline.lebreton@univ-rennes.fr

**Mots-Clés:** Mediterranean, Adriatic Plate, 3D modelling, Plate Kinematics, Subduction dynamics