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New GPS constraints on Adria microplate kinematics, dynamics, and rigidity from the Istria peninsula (Slovenia and Croatia)

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Precisely quantifying the current motion of the Adria microplate, more simply termed Adria, remains one of the major challenges in Mediterranean geodynamics. Knowing how Adria moves is critical for understanding the kinematic boundary conditions that drive circum-Adria active deformation in the Apennines (Italy), the western, central, eastern, and southern Alps (France, Switzerland, Italy, Slovenia, Austria), and in the Dinaric Alps (Slovenia, Croatia, Bosnia-Herzegovina, Serbia and Montenegro, and Albania). More broadly, knowing how Adria moves should give some important basic constraints still required for developing a better understanding of the geodynamics in the complex Nubia (West Africa)-Europe collision zone.

We present results from our PIVO-2003 (PIVO=Periadriatic Istria Velocity Observations) GPS experiment. We used decade-scale episodic GPS data from 7 sites in Adria's major aseismic outcrop, the Istria peninsula of Slovenia and Croatia, together with continuous GPS data from 2 permanent GPS sites on the Po Plain. We also used data from 15 permanent GPS sites to define a stable Eurasia-ITRF-2000 reference frame. We processed all GPS data using GIPSY (release 2.5) software and precise satellite ephemeris and clock files. We formally inverted subsets of the Istria and Po Plain Eurasia-referenced GPS velocities for a series of Adria-Europe trial rotation poles; these did not vary significantly when we varied site combinations. We thus obtained a robust rotation pole ($\sim$46.7˚N, 9.7˚E, 0.4˚/m.y. ccw). Our pole locates near the pole Anderson and Jackson (1987) derived earlier by inverting a broadly distributed circum-Adria set of earthquake slip vectors. Our mean rate residuals (0.53-1.09 mm/yr) average 0.88 mm/yr, suggesting that the northern Adria microplate is rigid to $<$ 1 mm/yr. The coincidence between our Istria/Po Plain pole and Anderson and Jackson's circum-Adria pole brings into question the recent hypothesis that Adria is actively fragmenting into two major sub-blocks.

Episodic decade-scale GPS data from additional 29 sites, distributed accross Slovenia and northern Croatia, were used to assess and quantify active deformation at the NE corner of the Adria – Eurasia collision zone. We observe a significant and sharp (few mm/yr) dextral ($\pm$transpressive) gradient in GPS velocities along the Periadriatic fault system, suggesting that lateral extrusion in the Eastern Alps is still active and being driven by the ccw rotation of Adria. This motion appears to become more diffuse to the east where it is probably distributed across the Sava foldbelt.

The convergent accretionary prism tectonics recorded in the geology of the Italian Apennines contrasts with the active normal faulting observed there. Our results suggest that Apennine normal faults are probably not simply crustal faults related to upper-plate extension in the prism, but rather lithospheric-scale faults bounding the eastern edge of the Adria microplate. The contrasting Apennine geology and neotectonics can be reconciled via a sub-Apennine Adria slab break-off that occurred within the past few m.y. This, in addition to a sub-Dinaric eastward pull and a pin in north in the Po Plain, probably drive Adria's motion.