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Neogene kinematics and structural evolution of the Giudicarie Belt and eastern Southern Alpine orogenic front (Northern Italy)

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The eastern Southern Alps are part of the deformed leading edge of the Adriatic plate indenting the European plate to the north. Neogene deformation in the eastern Southern Alps is partitioned into three, kinematically linked fold-and-fault systems: (1) The Giudicarie Belt, (2) the Valsugana Thrust System and (3) the external fold-and-thrust systems of the orogenic front, including the strike-slip Schio-Vicenza Fault. We aim to constrain fault kinematics from the Southern Alpine orogenic front to the Northern Giudicarie Fault to better understand deformation of the Adriatic indenter since Miocene time.

The Giudicarie Belt is a sinistral transverse zone characterized by NNE-oriented faults. Some of these faults originated in the Mesozoic as NNE-SSW trending normal faults, which were inverted during Alpine orogeny. Most of the Mesozoic normal faults are oriented oblique to sub-parallel to the main Neogene shortening direction, which led to strain partitioning between thrust and strike-slip faults. This significant strike-slip component complicates kinematic and structural restoration of geological cross-sections in 2-D because rock units moved into and out of the section trace, distorting in-section shortening estimates.

To assess lateral variations in shortening and quantify strain partitioning along and across the strike of the Giudicarie Belt, we constructed and balanced a network of closely spaced cross-sections perpendicular to the main structural trend. Seven 2-D NNW-SSE cross-sections from the Northern Giudicarie Fault to the Southern Alpine orogenic front reveal that the amount of Neogene NNW-SSE shortening varies from 11 km in the vicinity of the Adige embayment to 27 km further NE, with most shortening (20 to 26 km) accommodated within the Valsugana and Giudicarie systems. Shortening differs on either side of the Trento-Cles, Schio-Vicenza (4 km difference) and Ballino-Garda (7 km difference) strike-slip faults. These faults are inherited Mesozoic faults that coincide with significant stratigraphic thickness variations, which we constrained along orogen-parallel cross-sections. The SW-NE variation in shortening is inferred to have been taken up by these sinistral strike-slip faults, but also including the Northern Giudicarie Fault, for which we estimate the minimum amount of slip to be 19 km.

Exposure of Pre-Permian basement in the hanging wall of thrusts indicates a thick-skinned style of

deformation. Forward modelling using the MOVE Suite Software indicates that the depth of the detachments within the Pre-Permian basement is no greater than 20 km. A recently located cluster of minor seismic events (2017-2018) within the study area is aligned between 5 and 15 km along the modelled detachments. These earthquake clusters occur within the external fold-and-thrust systems of the orogenic front, suggesting that ongoing shortening is taken up within this system and that the Valsugana and Giudicarie systems are inactive today.