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Triclinic Transpression in brittle shear zones evaluated via combined numerical and analogue modeling: the case of The Torcal de Antequera Massif, SE Spain.

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Numerical kinematic models have been widely used to understand the parameters controlling the generation and evolution of ductile transpression zones. However, these models are based on continuum mechanics and therefore, are not as useful to analyse deformation partitioning and strain within brittle-ductile transpression zones. The combination of numerical and analogue models will potentially provide an effective approach for a better understanding of these processes and, to a broader extent, of high strain zones in general. In the present work, we follow a combined numerical and analogue approach to analyse a brittle dextral transpressive shear zone. The Torcal de Antequera Massif (TAM) is part of a roughly E-W oriented shear zone at the NE end of the Western Gibraltar Arc (Betic Cordillera). This shear zone presents, according to their structural and kinematic features, two types of domains i) Domain type 1 is located at both TAM margins, and is characterized by strike-slip structures subparallel to the main TAM boundaries (E-W). ii) Domain type 2 corresponds to the TAM inner part, and it presents SE-vergent open folds and reverse shear zones, as well as normal faults accommodating fold axis parallel extension. Both domains have been studied separately applying a model of triclinic transpression with inclined extrusion. The kinematic parameters obtained in this study (φ, υ and W_k) allows us to constrain geometrical transpression parameters. As such, the angle of oblique convergence (α, the horizontal angle between the displacement vector and the strike of the shear zone) ranges between 10-17º (simple shear dominated) for domain type 1 and between 31-35º (coaxial dominated) for domain type 2.

According to the results obtained from the numerical model and in order to validate its possible utility in brittle shear zones we develop two analogue models with α values representative of both domains defined in the TAM: 15º for type 1 and 30º for type 2. In the treatment and analysis of generated structures, we applied digital particle image velocimetry method (PIV), which allows us to calculate a velocity field of incremental deformation.

Results show a sharp contrast between both experiments. For, α = 15º the main structures formed were typical of the strike-slip regime, with two dextral strike-slip master faults parallel to the backstop and Riedel and anti-Riedel minor faults. On the other hand, for α = 30º, the deformation was accommodated by a shear zone where the displacement was partitioned between strike-slip movements along boundaries-parallel faults and shortening mainly accommodated by structures formed at ca. 45º to the strike of the shear zone. These results fairly resemble some of the main structures observed in the TAM and particularly, the strain partitioning between the two main domain types, in relation to different α angles. Also, our results suggest the application of numerical modelling in transpressive zones related to upper crustal deformation provides the opportunity to constrain the geometrical parameters to reproduce the main structural and kinematic features.