Geophysical Research Abstracts
Vol. 16, EGU2014-5821, 2014
EGU General Assembly 2014

Tectonic uplift related to inclined transpression with oblique extrusion: Preliminary data from the Torcal shear zone (External Betics, southern Spain)

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Transpression results where plate convergence vectors are oblique to plate boundaries, and hence it should be considered as the general situation in both dominantly convergent and strike-slip tectonic settings. In consequence, understanding tectonic uplift produced in transpression is crucial to a better knowledge of mountain building. Tectonic uplift produced at monoclinic transpression has been modeled previously. In this contribution, the model of triclinic transpression with oblique extrusion is implemented to estimate tectonic uplift in more general transpressional settings.

Transpression is kinematically defined as the combination of simple shearing parallel to the shear zone boundary and a coaxial strain producing shortening orthogonal to the shear zone boundary and extrusion parallel to it. Monoclinic transpression occurs in vertical shear zones where simple shearing is parallel to the shear zone direction. In these cases, the simple shear component produces only lateral displacement and tectonic uplift is generated uniquely by vertical coaxial extrusion.

In contrast, triclinic transpression occurs where the simple shearing direction is oblique to the shear zone direction (a direct consequence of an inclined shear zone) and/or the extrusion produced by the coaxial component is oblique to the shear zone dip direction. Tectonic uplift produced in these situations is more complex. Oblique simple shear component produces both lateral and dip parallel displacement, the latter contributing to tectonic uplift. The tectonic uplift produced by the simple shear component $S(\upsilon)$ can be defined in terms of the total displacement produced by simple shearing $S(\gamma)$, the transpression obliquity angle ϕ and the dip of the shear zone δ:

Furthermore, the extrusion due to the coaxial component of strain is never vertical in inclined shear zones. Considering the possibility of oblique extrusion, the tectonic uplift of any rock level produced by this coaxial deformation $E(\upsilon)$is a function of the initial distance of the considered rock level to the basal decoupling level $Z(t_0)$, the coaxial strain rate

, the extrusion obliquity angle υ and time t:

The total tectonic uplift in inclined triclinic transpressional zones is the sum of $S(\upsilon)$ and $E(\upsilon)$.

This theoretical modeling is being applied to the Torcal shear zone (TSZ), a dextral triclinic transpressional shear zone at the external Betics (southern Spain) that has been active since the Miocene. According to kinematic measurements, the original distance between the topographic surface and the basal decoupling was $Z(t_0)$ = 4500-6500 m, the extrusion was nearly dip-parallel ($\upsilon = 0^o$) and

t = 0.2 – 0.27. With these data, the surface tectonic uplift due to the coaxial deformation acting at the TSZ was 1000-2000 m, which should be considered a minimum as the contribution of the simple shear deformation to the total tectonic uplift has not been considered. These results are compared with preliminary data of altitude differences of Tortonian-Messinian rock levels inside and outside the TSZ (700 m in the central part of the TSZ). Differences with respect to theoretical results could be likely related to the age of deformation and/or overestimation of input kinematic parameters.