Appendix A1.- Estimation of tectonic uplift produced in upper Miocene formations due to transpressional deformation at the TSZ, from kinematic models

Tectonic uplift can be defined as the difference in the vertical distance *z* to a reference layer produced by tectonics in a time interval $t_0 - t_1$:

$$U(dt) = z(t_1) - z(t_0) \qquad \text{(Eq. A1.1)}$$

Schulmann et al. (2003) defined $z(t_1)$ as proportional to $z(t_0)$, where both vertical distances are measured with respect to a level of no vertical displacement, whose depth is defined as the Rigid Floor Depth (*RFD*). The definition of the *RFD* in natural systems depends on their rheological conditions. As such, in lithospheric shear zones, there is no such rigid floor but rather an exhumation compensation level from which downward motion controlled by isostasy can be expected (see Schulmann et al., and references therein). However, in most crustal systems, the *RFD* would be defined by the basal detachment surface of the shear zone.

From a purely kinematic point of view, transpression in tabular-shaped shear zones is defined as the simultaneous combination of (1) a coaxial component of infinitesimal deformation producing shortening orthogonal to the shear zone boundaries and extrusion parallel to them and (2) simple shearing parallel to the shear zone boundaries (Fernández and Díaz-Azpiroz, 2009). According to this definition, uplifting due to transpression is produced inside the shear zone mainly by the extrusion due to the coaxial component and, in the uplifted block, outside the shear zone, by the up-dip component of simple shearing. In the present case-study, we focus on the first situation. The main angle in this geometric configuration is υ, the angle between the extrusion direction of the coaxial strain and the dip direction of the shear zone.

Assuming deformation is steady-state, the resulting transpression is reproduced by a 3 x 3 finite strain tensor *F*, whose specific form depends on the main geometrical parameters of the transpressional system. The main diagonal of *F* is defined by the particle motion due to coaxial deformation along the direction of the three main finite strain axes, such that F_{22} is shortening across the shear zone, F_{33} is extrusion along the shear zone that forms an angle υ with the dip direction and F_{11} is the motion parallel to the shear zone and normal to F_{33}. From this, it is obvious that the uplift due to the coaxial component of transpression is function of F_{33}. Therefore, for monoclinic transpression in vertical shear zones with pure shear as the coaxial component, defined by the *F* tensor (Schulmann et al., 2003)

$$F = \begin{pmatrix} 1 & \frac{\dot{\gamma}}{\dot{\varepsilon}}\,[1 - \exp(\dot{\varepsilon}t)] & 0 \\ 0 & \exp(-\dot{\varepsilon}t) & 0 \\ 0 & 0 & \exp(\dot{\varepsilon}t) \end{pmatrix} \qquad \text{(Eq. A1.2)}$$

the vertical distance to the *RFD* at a time t_1 is defined as:

$$z(t_1) = z(t_0)\exp(\dot{\varepsilon}t) \qquad \text{(Eq. A1.3)}$$

where $\dot{\varepsilon}$ is the strain rate of the coaxial component and t is time. Note from F that the coaxial component is pure shear (plane deformation), where shortening across the shear zone (F_{22}) is completely compensated by uplifting (F_{33}).

Analogously, for triclinic transpression in vertical shear zones with variable υ angle, defined by the F tensor (Fernández and Díaz-Azpiroz, 2009)

$$F = \begin{pmatrix} cos^2\,\upsilon + \, sin^2\,\upsilon \,\cdot\, \exp(\dot{\varepsilon}t) & F_{12} & \cos\upsilon\sin\upsilon\,[1-\exp(\dot{\varepsilon}t)] \\ 0 & \exp(-\dot{\varepsilon}t) & 0 \\ \cos\upsilon\sin\upsilon\,[1-\exp(\dot{\varepsilon}t)] & F_{32} & sin^2\,\upsilon + \, cos^2\,\upsilon \,\cdot\, \exp(\dot{\varepsilon}t) \end{pmatrix} \quad \text{(Eq. A1.4)}$$

the vertical distance to the *RFD* due to the coaxial component of transpression at a time t_1 is thus defined as:

$$z(t_1) = z(t_0)\,[sin^2\,\upsilon + \, cos^2\,\upsilon \,\cdot\, \exp(\dot{\varepsilon}t)] \quad \text{(Eq. A1.5)}$$

In the case of non-vertical shear zones, the entire system must be rigidly rotated toward the actual position of the analyzed case. Therefore, the final vertical distance to the *RFD* at a time t_1 is also function of the dip angle of the shear zone (δ):

$$z'(t_1) = \sin\delta\,\cdot z(t_0)\,[sin^2\,\upsilon + \, cos^2\,\upsilon\,\cdot \exp(\dot{\varepsilon}t)] \quad \text{(Eq. A1.6)}$$

By substituting Eq. A1.6 into Eq. A1.1, we obtain the tectonic uplift produced by coaxial deformation in an inclined triclinic transpressional zone with oblique extrusion:

$$U(dt) = z(t_0)\,\{\sin\delta\,[sin^2\,\upsilon + \, cos^2\,\upsilon \,\cdot\, \exp(\dot{\varepsilon}t)] - 1\} \quad \text{(Eq. A1.7)}$$

See Díaz-Azpiroz et al., 2014 for further information.

Díaz-Azpiroz, M., Barcos, L., Balanyá, J. C., Fernández, C., Expósito, I., & Czeck, D. M. (2014). Applying a general triclinic transpression model to highly partitioned brittle-ductile shear zones: A case study from the Torcal de Antequera massif, external Betics, southern Spain. *Journal of Structural Geology*, *68*, 316-336.