

Interactive comment on “Transverse jointing in foreland fold-and-thrust belts: a remote sensing analysis in the eastern Pyrenees” by Stefano Tavani et al.

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Comment

it [the ms.] still suffer some important points that needs to be adressed. 1) The first one is that the overall interpretation seems heavily model driven. Indeed the E-W fractures are interpreted as forebulge-parallel extension, which make sense, but the systematic attribution of the N-S fractures to accros strike extension can be argued against: - an alternate interpretation would be to consider the N-S fractures as related to LPS, postponing the E-W, forebulge related fractures, leading to similar patterns than the one described.

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Response

We thank the reviewer for this comment. We will add this text in the revised version “These could be also interpreted as layer parallel shortening (LPS)-related transverse extensional structures. However, LPS-related extensional structures include mm- to cm-long fractures filled with calcite (which is removed from pressure solution seams; Tavani et al., 2015 and references therein). The type (joints with no calcite infill) and size (tens of m-long) of transverse extensional structures described here are incompatible with layer-parallel shortening.

Comment

The occurrence of a NNESSW (what is the mean strike of it?) goes well into this alternate scenario, as the Ebro Basin underwent a regional 20° Clockwise rotation during paleogene, as reconstructed by the paleomagnetic data (Parès et al., 1988, Physics of the Earth and Planetary Interiors, Volume 52, Issue 3-4, p. 267-282). This rotation does not seem to have been considered by the authors, and I think this needs addressed.

Response

It has been recently demonstrated (after the initial papers describing paleomagnetic data in the Triassic red beds) that the Ebro basin has not experienced a general rotation during the Paleogene. Paleogene vertical-axis rotations in the Pyrenees are mainly related with displacement gradients of the thrust sheets, mostly resulting from the distribution of the Triassic salt detachment horizon (Sussman et al., 20014; Soto et al., 2006; Muñoz et al., 2013). In addition, older vertical axis rotations, can be related with the extensional and sinistral displacement of Iberia during Early Cretaceous (Dinarès-Turell and García-Senz, 2000; Gong et al., 2009). Apart from these vertical axis rotations, which are at present well documented, the Ebro basin and in detailed the eastern part of the Ebro basin where this study has been located has not experienced any vertical-axis rotation as documented by paleomagnetic studies (Burbank et al., 1992; Taberner et al., 1999).

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Burbank, D. W., Puigdefàbregas, C., Muñoz, J. A. (1992). The chronology of the Eocene tectonic and stratigraphic development of the eastern Pyrenean foreland basin, northeast Spain. *Geological Society of America Bulletin*, 104(9), 1101–1120. [http://doi.org/10.1130/0016-7606\(1992\)104<1101:TCOTET>2.3.CO;2](http://doi.org/10.1130/0016-7606(1992)104<1101:TCOTET>2.3.CO;2)

Dinarès-Turell, J., Senz, J. G. (2000). Remagnetization of Lower Cretaceous limestones from the southern Pyrenees and relation to the Iberian plate geodynamic evolution. *Journal of Geophysical Research: Solid Earth* (1978–2012), 105(B8), 19405–19418. <http://doi.org/10.1029/2000JB900136>

Gong, Z., van Hinsbergen, D. J. J., Vissers, R. L. M., Dekkers, M. J. (2009). Early Cretaceous syn-rotational extension in the Organyà basin—New constraints on the palinspastic position of Iberia during its rotation. *Tectonophysics*, 473(3-4), 312–323. <http://doi.org/10.1016/j.tecto.2009.03.003>

Soto, R., Casas-Sainz, A. M., Pueyo, E. L. (2006). Along-strike variation of orogenic wedges associated with vertical axis rotations. *Journal of Geophysical Research: Solid Earth*, 111(B10), B10402. <http://doi.org/10.1029/2005JB004201>

Sussman, A. J., Butler, R. F., Dinarès-Turell, J., Vergés, J. (2004). Vertical-axis rotation of a foreland fold and implications for orogenic curvature: an example from the Southern Pyrenees, Spain. *Earth and Planetary Science Letters*, 218(3-4), 435–449. [http://doi.org/10.1016/S0012-821X\(03\)00644-7](http://doi.org/10.1016/S0012-821X(03)00644-7)

Taberner, C., Dinarès-Turell, J., Giménez, J., Docherty, C. (1999). Basin infill architecture and evolution from magnetostratigraphic cross-basin correlations in the southeastern Pyrenean foreland basin. *Geological Society of America Bulletin*, 111(8), 1155.

Comment

Two important things are missing to back up the interpretation of the authors: relative

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chronology; and observation and report of systematic occurrence of N-S joints with E-W joints.

Response

The few E-W striking joints systematically abut on the N-S striking set, indicating that E-W striking joints are cross-joints formed perpendicular to the master (N-S) joint set. This is well shown in figures 2D and 2E (for the NNW-SSE striking set), and it will be mentioned in the revised version.

Comment

I would be interested to see reported the length of the fracture tracks for each set, I am sure it could be of interest as well to solve the problem I mentioned in my first comment.

Response

This graph will be added

There is also minor remarks:

Comment

Page 2, line 26-27: "Even in arched systems, the forebulge, the foredeep, and the belt tend to be nearly parallel to each other locally" → can you report related references?

Response

References will be added

Comment

Page 4, line 28-29: "The NE and SE portions of the study area are highly vegetated (Fig. 3d,e) and only a few joint traces have been mapped there." → how does it affect

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the statistic? Why not leaving these out?

Response

We agree. Nodes with < 20 data have not been considered in our analysis. This will be mentioned in the new version of the ms.

Comment

Page 5: Why did you choose these lengths for the triangular mesh? Do you need it to be one order of magnitude longer than the longest fractures? Can you discuss the impact?

Response

The radius of the circular moving window is set to these values for these two reasons: 1) it is two orders of magnitude longer than the average length of joints; 2) it is larger enough to ensure that at each node the data number is >20

Comment

Figure 2 C-F: The north is not really clear from this representation.

Response

we will add the north.

Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2020-70>, 2020.

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