Revision of "Reconciling post-orogenic faulting, paleostress evolution and structural inheritance in the seismogenic Northern Apennines (Italy): Insights from the Monti Martani Fault System" by Riccardo Asti and coauthors

General Comments

In this study, Asti and co-authors present a structural analysis of a fault system in central Italy. Specifically, the study focuses on the Monti Martani Fault System (MMFS), which forms the western and southern boundaries of the Monti Martani Ridge (MMR). This ridge is elongated in a North-South direction and is characterized by Mesozoic structural highs and lows that were later involved in the Apennine orogeny. The MMFS is analyzed through very precise mesoscale observations, and the collected structural data are used to reconstruct the paleo-stress field and to improve the fault system mapping.

Asti and co-authors demonstrate that the recent extensional fault system is segmented and consists of fault segments oriented NW-SE and, to a lesser extent, NE-SW. These observations contradict previous literature, which described the MMR as being bordered by a single, L-shaped fault. Asti and coauthors therefore show that the morphostructure of the MMR, elongated in a N-S direction, is not exclusively controlled by the recent extensional fault system. Instead, the elongation of the MMR more closely aligns with the orientation of the older Jurassic faults that bordered the structural highs. The authors propose that the architecture of the MMFS, particularly the distribution of its segments, is controlled by the orientation of these older Jurassic faults, even though they were not reactivated.

The inversion of kinematic data suggests three extensional regimes with different orientations of the principal minimum stress: NE-SW, NNE-SSW, and NW-SE. The first two are attributable to the recent extensional phase, while the latter is subsequent to the first two and is more difficult to interpret. In my opinion, the structures associated with a NW-SE extensional field are too localized (2 sites on a structure that extends for tens of kilometers) to be attributed to a regional stress field. These same structures could be interpreted as local complications in the stress field. Therefore, I believe this more conservative interpretation should be preferred.

Overall, I find this study highly interesting for the readers of Solid Earth as an example of the application of structural observations to better constrain the architecture of an extensional fault system. In particular, I believe it could serve as a valuable case study for a better understanding of the role of inherited structures in the development of recent extensional systems. However, before the paper can be considered for publication, I suggest that the paleogeography and, consequently, the orientation of the Jurassic extensional faults in the Monti Martani be better described, particularly concerning Figure 3. In this Figure, the Meso-Cenozoic succession is represented in a uniform color without differentiating formations and key elements, which would be necessary to allow readers to infer the existence and orientation of the Jurassic structural high(s).

Please find below some specific comments.

Best regards,
Marco Mercuri

Specific comments

Abstract. The methods section of the abstract is somewhat vague and lacks detail: please briefly specify the scale at which the observations were made, and the type of analysis conducted. The aim of the study is clearly stated and focuses on using the MMFS as a case study to understand the role of pre-orogenic inherited structures in post-orogenic tectonic evolution.

- **Line 20 and following**: The relationship between the paleostress field analysis and the morphological control of the N-S and E-W pre-orogenic faults is not immediately clear.

Introduction. The relevance (Lines 30-34) and the aim (Lines 53-57) are clearly stated. Please consider the following suggestions:

- **Line 30:** In complex fault systems, the orientation and spatial distribution of the individual fault segments
- **Lines 30 - 34:** The conceptual link between these two sentences is unclear. I suggest stating that structural inheritance influences the architecture of the fault system (i.e., the spatial distribution, orientation and linkage between different slip surfaces at a 100m-1km scale). Consequently, structural inheritance also plays a role in the seismological behavior of the fault system.
- **Lines 43-45:** For better clarity, I suggest explicitly stating that the ~N-S structural features separate different paleogeographic domains before the orogeny.

Geological setting. The presence of a structural high during the Mesozoic is very important for the aims of this work. This is well described in the Geological Setting (Lines 9-123) but it is not adequately reflected in the figures. The main issue is that the Meso-Cenozoic succession is not differentiated in Figures 3 and 4. In my opinion, a more detailed mapping would improve the manuscript. A good compromise would be to differente the pre-rift (i.e., Calcare Massiccio), the condensed pelagic succession, the complete pelagic succession, and the Maiolica-Schlier interval.

- **Line 78**: I suggest using the term "intrabasinal structural highs" because the Apenninic platform is also a structural high and does not have a condensed sequence on its top.
- **Line 80 and following:** The strike of the Jurassic faults appears to be quite important in your study, but it is not mentioned here. I suggest adding a sentence about it.
- **Line 108:** From the earlier description, it seems that the MMFS separates the Medio Tiberino and Terni basins (Line 49). I suggest adding these names in Figure 1b for better clarity.
- **Figure 3:** Please consider indicating the difference between active and inactive alluvial fans.

Methods: I believe the methods are adequate for characterizing the architecture of the fault system and for the analysis of the paleostress. However, I am not sure if the applied methods are sufficient to investigate the structural inheritance of the pre-orogenic structures on the post-orogenic extensional fault system (see also previous point). Please consider also the following suggestions:

- **Figure 5:** The text within this figure is difficult to read (one has to zoom in at 200% to read it). Please consider increasing the font size slightly. I also suggest explaining the "gaussian parameters" in the caption and adding bedding information to each stereoplot, if possible.
- **Figure 6:** To improve readability, I suggest adding a miniature of Figure 3 somewhere in the figure, showing the location of the structural stations along the MMFS.

Results: In many figures showing field observations (e.g., Figs. 8-15), it is difficult to see the structures described in the text (e.g., the NE-SW striking veins in Figure 8) because they are obscured by the line drawings. I suggest finding a way to make these structures more visible in the figures. Additionally, the need to constantly switch between the field observation figures (8-15), the figure showing the location of the structural station (3), the stereoplots (6), and the kinematic inversion (7) makes the text somewhat difficult to follow. I suggest reorganizing the figures to make the text easier to follow.

- **Figure 5c:** To better visualize the three main azimuths of the slickenlines, I suggest, if possible, showing them in a rosediagram (similar to Figure 5a).
- Regarding the NE-SW oriented veins described in the Viepri site, which cut the cataclasite and the hanging wall of the fault: are they also present in the footwall? I agree that they

may form in a stress field with NW-SE minimum principal stress, but at the same time, I think this could be a local complication of the stress field. For example, a variation in throw along the strike of the main fault could be accommodated by extensional structures perpendicular to it (e.g., release faults; Destro, 1995).

- **Line 321**: I am not sure it can be called a "neptunian dyke" if the sedimentary infill occurs outside the submarine environment. I suggest double-checking the use of this term.
- **Figure 14:** Dip-slip slickenlines are visible, while oblique-slip and strike-slip slickenlines are very difficult to discern. Perhaps better image quality could help.
- There are a lot of figures. Consider moving some to supplementary material, if possible.
- In many figures showing field observations, the line drawings obscure the visibility of the structures themselves.

Discussion. In my opinion, the section on the structural inheritance of Jurassic faults in the morphostructure of the MMR (section 5.2) is very interesting. However, I believe it needs more "visual" support regarding the paleomorphology of the Jurassic structural high. Specifically, I think it is necessary to at least hypothesize the location and the orientation of the paleoescarpments. One idea could be to provide more detail in the map in Figure 3 by differentiating the Meso-Cenozoic succession into Calcare Massiccio condensed succession, complete succession, and post-paleotopography succession (i.e., from Maiolica) (see also the comment in the Geological Setting). The visualization of a transition from a structural high to a structural low proceeding in the footwall towards the MMFS could be helpful. The section concerning the existence of a NW-SE extensional stress field (section 5.3) is supported by limited data: the subhorizontal slickenlines younger than dip-slip ones on NW-SE oriented fault planes are convincing, but besides being well documented only in the Cesi quarry, they could also be attributed to local complications of the stress field. Local complications of the stress field might occur, for example, due to interaction between the main fault segments. The veins that cut the cataclasite and the hanging wall of the fault near the Viepri site could also be interpreted as a very local complication of the stress field (see comments in the Result section). I believe the interpretation of the structural data should also consider the possibility that a regional NW-SE extensional stress did not exist.

- **Lines 410-413**: I find the alignment of the epicenters in the NW-SE or WNW-ESE direction difficult to identify. My suggestion is to make this more visible in some way in Figure 3, or consider removing the sentence.
- **Lines 485-490 & 498-528**: I believe that the NW-SE extensional stress field, being "documented" in only two locations along a structure that extends for tens of kilometers (as shown in Figure 17), cannot be attributed to tectonics on the scale of the structure

itself or larger. I think the more conservative explanation is the existence of a local NW-SE extension direction in areas with local structural complications (e.g., relay zones?).

Conclusions

- **L 574-576**: What do you mean by "kilometer-long"? Did you perhaps mean "tens of kilometers"?

Technical corrections

- L. 38: s~~i~~yn-orogenic
- L. 49 forming a ~N-S structural ridge
- L. 49: I suggest highlighting the Medio Tiberino and Terni basins in Figure 1b.
- L. 51: ~~form~~ from
- L. 150 ~~ang~~ and
- Line 189. The web address provided does not work. Please update the link to the correct website.
- Figure 7. What do the different colors of the arrows represent? For example, what is the significance of the purple versus black arrows in panel c? Please explain the symbols in the caption.
- Figure 8. Please, find a way to make the veins visible also without the line-drawing obscuring them.
- Figure 9. I assume S0 represents bedding, but it is not mentioned in the caption
- L.278. Stereonet n. 8 in Fig. **6**
- L.290. Did you mean "fault core"? In my opinion cataclasite implies rotation and disaggragation of grains which makes it impossible to see the primary features (whose recognition allows to identify a damage zone).