Response to comments from Reviewer #2,

I thank the authors for considering my comments and implementing them in the second version of the manuscript. Compared to the previous version, the current manuscript is much clearer. Also the GIFs really help interpreting the evolution of the models. Except for some minor aspects, I have no further suggestions.

We would like to thank Reviewer #2 (Lorenzo Giuseppe Candioti) for careful reading and a constructive review of the manuscript.

General comments

The newly added paragraphs seem to be stitched into the manuscript and sometimes interrupt the reading flow. I think it would be worth refining the transitions and maybe reordering the paragraphs for a more seamless integration into the manuscript. An example is given in my specific comments below.

Thanks, we tried to rewrite and move the mentioned paragraph connections and flow accordingly.

"In the Fars Arc, the activity of inherited faults has influenced the progression of deformation towards the foreland, with the Mountain Front Fault being associated with basement thrusting (Bahroudi and Koyi, 2003; Mouthereau et al., 2006, 2007a; Yamato et al., 2011; Ruh et al., 2014; Najafi et al., 2021). According to Mouthereau et al. (2006), basement deformation and thickening play a critical role in the Zagros Folded Belt, helping to explain the observed topographic growth. They also emphasize that the reactivation of pre-existing faults during the early stages of compression in the Zagros foredeep suggests a significant influence of inherited structural features on present-day deformation. Balanced cross-sections support this by demonstrating that basement involvement is necessary to account for varying base topographic elevations in Paleozoic and Mesozoic formations (Blanc et al., 2003; Molinaro et al., 2005; Mouthereau et al., 2007a). However, other studies propose that the most substantial impact of basement deformation on surface structures occurred later in the region's tectonic history, particularly during the Pliocene and Pleistocene (Molinaro et al., 2005; Sherkati et al., 2005; Tavani et al., 2018; Vergés et al., 2011; Najafi et al., 2018; Etemed-Saeed et al., 2020). It is widely accepted that the high-angle reverse faults initially formed as normal faults in the Arabian basement during the Permian–Triassic rifting of the Neo-Tethys Ocean (Navabpour et al., 2010), remaining inactive through the Jurassic to Late Cretaceous passive margin phase, before being reactivated during the Cenozoic collision between the Arabian and Eurasian plates."

"Seismic activity at mid-crustal depths provides key evidence for basement involvement in the Zagros. Most earthquake centroid depths range from 4 to 25 km, affecting both the basement and cover, with many exhibiting reverse focal mechanisms (Jackson and Fitch, 1981; Berberian, 1995; Talebian and Jackson, 2004; Karasözen et al., 2019). In the Fars Arc, the major inherited basement reverse faults, from SW to NE, include the Mountain Front Fault, the Surmeh Fault, the High Zagros Fault, and the Main Zagros Thrust (Fig. 1). A geological cross-section of the Fars Arc reveals evidence of both thin-skinned and thick-skinned tectonic deformation occurring simultaneously (Mouthereau et al., 2007b;

Najafi et al., 2021; Fig. 1c). This deformation is expressed through large-scale detachment folds and forced folds (Jackson, 1980; Lacombe et al., 2011; Mouthereau et al., 2012).

While numerous studies have focused on the Zagros fold-thrust belt and the Fars Arc, several crucial aspects of the Fars Arc's geological evolution remain poorly understood. Specifically, the exact mechanisms and timing of basement involvement, the interaction between basement faults and salt décollements during tectonic inversion, and the relative influence of thin-skinned versus thick-skinned tectonics on the overall structural evolution are still unresolved (Mouthereau et al., 2006; 2012). To address these uncertainties, we employ a numerical model that simulates the full tectonic history of the Fars Arc, including both an initial extensional phase and a subsequent compressional phase."

"Weak zones within the deformed rock layers play a crucial role in shaping the structural evolution of fold-and-thrust belts. In the case of the Zagros, numerical experiments demonstrate that both the sub-horizontal salt horizon and inherited weak basement faults significantly influence the partitioning of strain. Regardless of whether the viscous décollement can fully decouple the upper and lower crust mechanically, the basement exerts a strong influence on the overall structural evolution of the Zagros fold-and-thrust belt. This must be considered when constructing structural cross sections."

"Previous numerical models of fold-and-thrust belts have typically focused on thin-skinned tectonic systems, investigating parameters such as wedge and décollement strength, rheology, surface processes, and mechanical stratigraphy (e.g., Stockmal et al., 2007; Buiter et al., 2016; Simpson, 2011; Burbidge and Braun, 2002; Ruh et al., 2012). However, the inclusion of rifting prior to collision adds a new dimension that has often been overlooked in these studies. This approach allows for a more comprehensive understanding of tectonic evolution by examining how pre-collisional structural configurations influence later deformation patterns."

"Fernandez and Kaus (2014) showed with numerical modeling that pre-existing salt diapirs can significantly influence the pattern and growth of three-dimensional folds and fold patterns, accelerating fold formation and localizing deformation, highlighting the important role of diapirism in structural evolution during tectonic processes."

The difference between models that do not include a rifting phase and those presented here could still be discussed in more detail. If modeling the rifting phase is important for the convergence model, what do the presented models predict that pure convergence models with prescribed weak zones fail to predict?

During tectonic inversion, faults invert from a normal to a reverse mechanism. In the model, when the extension phase is considered, the faults that were affected by extension are reactivated in reverse. This highlights the significant influence of the earlier extension phase on the structures and localization of strain.

in the manuscript, we have already mentioned to this important. (for example, in the Comparison with numerical modelling studies section).

A brief description of what happens in each GIF in the supplement would help the reader to interpret the evolution of the models.

Thanks, for suggestion. We extended the supplementary word file with explanations related to each of the presented GIF.

Specific comments

line 14: fold-thrust belt (remove the whitespace)

Thanks, we have changed all to "fold-and-thrust belt".

line 15: fold-and-thrust belts or fold-thrust belts (as in line 10)? Please, keep consistent nomenclature for clarity.

Thanks, we have changed all to "fold-and-thrust belt".

line 17: fold-and-thrust systems maybe?

Thanks, corrected.

line 101: I would remove „On the other hand" and combine this paragraph with the previous.

Thanks, has been removed.

line 105: It would be interesting to read more about the potential of hydrocarbon exploration in the Zagros (also mentioned in the abstract, but I didn't read much about it in the manuscript) here and read a discussion on your findings in that context later in the manuscript.

Thank you for your comment. However, the aim of our study is not to discover areas with hydrocarbon potential. Our reference to it was just to point out one aspect of our study, which is that by examining structural evolution, it is possible to assist in identifying hydrocarbon potential. We prefer not to add another paragraph.

line 125: After introducing the abbreviation, use ZFTB throughout the rest of the manuscript.

Thanks, we have changed all to "ZFTB".

line 268: As far as I understand, the basement faults formed during the Permian-Triassic rifting phase, i.e. they should result from the rifting model and serve as initial condition for the convergence model. Why are they already present in the initial configuration of the rifting model?

Yes, that is correct. We want to model the rifting phase where inherited faults have a certain the position in the model as an initial condition. Furthermore, no inherited faults lead otherwise to no localized normal faults in the model during the rifting phase (see the Model 7 in our tests).

lines 281-282: It should at least be acknowledged that the quiescence period has an impact on the thermal field (as mentioned in my comments), because the temperature influences the rheology which is an important aspect of this study. Why is it justified to make this simplification?

We simplified the model by assuming that the temperature field reaches a steady state by the beginning of the collision phase. This approach takes the essential thermal conditions resulting from the quiescence period without significantly complicating the model.

"Tectonic quiescence affects the thermal state and, consequently, the rheological behaviour of the rocks. However, we assume that the temperature field reached a steady state by the onset of the collision phase to simplify the model setup. This implementation allows us to effectively capture the relevant thermal conditions while maintaining focus on the critical dynamics of the extension and collision phases."

line 310: Kappa has been used in the temperature equation. For clarity, it would be better to either use different symbols or subscripts for Kappa in these two equations.

Thanks, it has been corrected, we use K now.

lines 454-456: An indication of coordinate would help to identify the pop-up structure.

Thanks for suggestion, we added the x coordinate:

"A large pop-up structure (x ≈ 230 km) without mechanical decoupling between the basement and the sedimentary cover develops in front of the salt pinch-out"

line 477: This is confusing: is it 25% or 75% of vx?

The sentence has been changed. "With a basement involvement of 25% ($v_{x\_b} = 0.75 \cdot v_x$), the fault on the right side almost entirely left the model domain, and the other two faults experience lesser degrees of involvement, roughly displaying 100% of tectonic inversion (Model 10; Fig. 10c)."

Figure 11: I guess the y-axis in panel e should have labels of 0, 5, 10, and 15 TN/m instead of 0, 5, 1, 15 TN/m.

Thanks, it has been corrected.

line 525: Use either illustrates or shows.

Thanks, it has been corrected.

line 594: How much larger is „slightly larger"?

We changed it to "larger".

line 616: Exhibited or demonstrated?

Thanks, it has been corrected.

lines 674-677: This paragraph disrupts the reading flow. I would move it to the end of this section.

Thanks for the suggestion, we moved the paragraph.

Table 1: In the column header of thermal conductivity, the unit of power should be a capital letter. I guess the unit of cohesion (C) should be MPa instead of MPs.

Thanks, we corrected the mentioned errors.

GIFs: I could not find references to the GIFs in the manuscript. They should be referenced in the text, otherwise the reader has no context when watching them.

> *Thanks for the comment. We now mention all GIF's presented in the Supplementary Material in the main text when applicable as Fig. S1-11.*