Dear Hamed,

Thank you very much for your thorough review which helped improve this manuscript. We addressed all of your comments and amended our manuscript where possible. Please see our answers below.
Please do not hesitate to contact us for further clarification of any of our responses.

Kind regards,
Dan Tamas on behalf of all authors

General Comments:

My main comment is regarding the main controlling factor in the vertical propagation of the inverted fault observed in the experiments versus presented natural cases. Authors conclude (line 384-397) that in the experiments the amount of shortening/compression controls the upward propagation of the inverted fault, while in the presented natural cases a higher syn vs. postrift ratio "tend to inhibit the propagation of thrust fault up-section".

As I understand, authors aim to present natural cases for comparison with observations from the experiments. However, in the conclusions (line 384-397) authors state that further experiments (with larger syn to postrift ratio) are needed to fully reproduce geometries observed in presented natural cases. In my opinion if the authors give some information/estimation about the amount of shortening/compression in the presented natural cases, comparison between the experiment and the natural cases will be easier.

Natural case studies: The results of the presented experiments suggest that the main parameter controlling the inversion structures and fault propagation is the amount of shortening/compression during tectonic inversion and the syn vs. postrift ration has a minor influence. However, the natural cases presented are discussed only in terms of their syn versus postrift thickness ratio. I would suggest that the authors consider adding some sentences on the amount of shortening/compression for each natural cases presented (also mentioned above).

Answer: Sorry this part was not very clear, I think we generally focused a bit too much on the differences rather than the similarities. We adjusted this aspect throughout the paper and compared the finding with the natural examples presented.

Please also consider shortening the geological history of the presented cases.

A: We also shortened the geological history of the case studies.

Post-rift versus post-inversion: I am not entirely sure, but post-inversion is also part of the post-rift, right? Basically, all units deposited after the cessation of rifting are post-rift including syn and post inversion. I understand that when authors compare the thickness of units in Mode I and II, they are referring to the syn-inversion sequence of the post-rift. However, to avoid confusion, please consider clarifying this early on in the text.

A: we clarified this in the introduction.

Fault geometry effect: listric fault (sub-horizontal fault geometry at depth) vs. more planar fault. In the experiments, as nicely shown, main bounding fault is a listric master fault which dips to sub-horizontal at depth. It is very interesting to see what the inversion structure would look like if the main fault was not listric (sub-horizontal at depth) and rather had more planar geometry at depth developing graben and half graben structures as it is shown in all presented natural cases. Perhaps the fault geometry has not a major influence on the inversion structure, but I think it is worth mentioning.
A: Yes, indeed that would be a nice thing to try, however, we believe the fault propagating into the post-rift cover should not differ much if at all. We commented a bit on this in the text.

In my opinion, adding information about the amount of shortening/compression for each natural case (as much as possible/available) will establish a stronger link between the experiments and the natural cases. Please note that I am only commenting on the points where I think it could be improved, of course there are many interesting results and nice figures presented in this nice work. Please let me know if are there any questions or concerns regarding my comments, I am happy to discuss further.
A: We adjusted this aspect throughout the paper and compared the finding with the natural examples presented.

Abstract:
Please consider stating the influence of the postrift vs. synrift thickness clearly, as this appears to be the main parameter to be tested in this study and is the question asked in the title.
A: we adjusted our abstract to clarify our main findings.

Please consider first defining the Mode I and II
A: defined now in the abstract.

Amount of positive inversion?
A: Thanks for the suggestion, we changed that throughout the paper.

Please consider moving to the later parts of the abstract. Also mention Romania case study too.
A: moved, and we mentioned now the Romania case study.

I have difficulties understanding this sentence. This might only be my confusion but "mild-to moderate inversion structure" and the "style of deformation within the post-rift" are synonyms and both pointing out the inversion related structures, right?
A: rephrased that, we were referring to open/gentle forced folds, we clarified in the abstract.

I am confused here, mild and moderate inversion are different degrees of an inversion, how they can be controlled by the "degree of inversion"? Perhaps the "amount of shortening" or the "amount of fault positive inversion" is better wording. Please consider rephrasing.
A: rephrased and replaced with the amount of compressional displacement accommodated by the inherited listric fault.

Please clarify, different in comparison to what?
A: rephrased.

Amount of displacement during the inversion, or during the extension and the inversion? please clarify.
A: rephrased.

Please consider mentioning the influence of the postrift vs. synrift thickness clearly, as this appears to be the main parameter to be tested in this study and is the question asked in the title.
A: mentioned clearly now.

Introduction
"fault geometry" also includes "Strike and dip" of a fault, right? Please consider rephrasing.
A: rephrased.

Please consider adding references.
A: reference added.

I am wondering how we can define the "degree of inversion"? Is the degree of inversion a product of the amount of positive inversion along the preexisting fault? that can be measured by measuring the inverted fault displacement. The latter, in turn is related to the amount of shortening.
A: Thanks for helping us clarify this, we adjusted here and elsewhere in the paper.

2 Methodology
seismic reflection
A: corrected

This reads repetitive, consider deleting.
A: corrected

We only have one listric fault, right?
A: Yes, corrected.

3 Analogue modelling results
Please consider moving references to the end of the sentence as much as possible.
A: thanks for the suggestion, in this particular case we wanted to introduce the figure which is relevant for the experiment.

This sentence fits better to the methods, e.g. line 93-94.
A: True, we removed this part.

As mentioned in line 113-144 that the extension phase is not the the main focus of this study, please consider shortening this section.
A: Although the extension phase is not the main focus of this study we think it is still important to describe briefly the extension-related structures.

Please try to be consistent throughout the text and figures, in the figures is post-kinematic. It is a bit confusing with post-tectonic, post-kinematic and post-rift.
A: thanks for the suggestion we adjusted throughout the paper.

Strain
A: added

Develop
A: corrected

Please consider rephrasing
A: rephased

We only have one listric fault, right?
A: yes, rephrased.

Or" Deformation localizes"...
A: rephrased.

Please be more specific, significant in number of faults? or fault displacement? or both?
A: rephrased.

Applied
A: corrected

4 Summary, discussions and examples from nature
4.1 Summary of model results
Lines 219-230 does not fit into the discussion chapter, please consider adding to the previous chapter, for example.
A: We renamed this Chapter as 4 Summary, discussions and examples from nature, and reorganize this into 3 sub-chapters.

Please read my comment in Line 48. Here the "amount of shortening" or the "amount of compression" would fit better.
A: corrected

Post-rift? please see my comment in Line 136.
A: corrected

This is confusing, shouldn't be 2-4? or 2 and 3? Please modify.
A: corrected

or compression? Please clarify how horizontal compaction leads to the uplift.
A: we refer to compaction and related thickening of the sand package during compression. This is common in analogue modelling experiments.

Hangingwall
A: added

Does the sand layers get thicker during the inversion? Please explain how and what are mechanism for the thickening.
A: we refer to compaction and related thickening of the sand package during compression. This layer parallel shortening and thickening during compression is common in analogue modelling experiments.

In general, we add all postrift layers first and then invert the model, or the inversion happens syn-sedimentary?
A: all of the post-rift layes are added before inverting the models. No syn-inversion layers have been added to these experiments.

4.2 Discussions
I think this is where the discussion chapter can start.
A: yes, that is a very good suggestion, we reorganized that part.

This is confusing, do you mean "same syn-rift vs. postrift ratio"?
A: corrected

This is the major finding of this study, and it should be mentioned also in the abstract
A: mentioned in the abstract.

same as before, perhaps better to say "the amount of shortening"?
A: corrected

Please clarify, extensional or compressional displacement? or the total amount of displacement that occurred during the extension and the compression?
A: corrected

4.3 Examples from nature

Please briefly mention why authors decided to only give Mode II examples.

A: There is also Mode II, we clarified this part.

Please show the "wedge-shaped" units in the Fig. 9

A: we think that adding that will crowd the image which is already busy, but we clearly indicated the syn-rift strata now.

Please mention which formations are Upper Cretaceous and which ones are Paleogene.

A: Added

Which fault is Manaia fault?

A: Indicated

Please label faults and structures in Fig. 9

A: Added

Please clearly show the syn and postrift units in Fig. 9

A: added

Which structures? please be more specific.

A: we restructured that part.

Please consider showing evidences on a figure or add references.

A: Added

Please explain why these natural cases are chosen when experimental results does not show similar geometries? Thanks

A: They do show similar geometries, we clarified this in the manuscript.

Please show syn and postrift units in Fig. 10

A: Added

If possible, please show the seismic reflection data used to produce the cross section shown in Fig. 10.

A: Unfortunately, we were not able to obtain the necessary approvals in time.

Please introduce and show "Syrian Arc" on a figure.

A: we removed this part while simplifying the geological background.

Assuming that rifting occurred during the Permian, then all above units to the Sea bed are postrift, right? Please clarify this.

A: Syn-rift units are Permo-Triassic; we clarified this in the text.

Please show this in Fig. 11
It is a bit hard to follow Line 319-329, as a non familiar reader to the local geology of the Black Sea region. There are many locations and names that need to be introduced and shown on a figure first, or if the local structures are not critical in understanding and following the text, please consider shortening these parts, in all presented natural cases.
A: As per your suggestion elsewhere in this section, we removed some very specific details and shortened the sections.

This should be 11a, right?
A: yes, modified.

Postrift
A: modified.

syn-rift
A: added.

Please add references.
A: indicated in the figure.

Please mention what exactly is added.
A: added

Direction
A: added

It would be beneficial to show the seismic section here too.
A: Unfortunately, we were not able to obtain the necessary approvals in time.

5 Conclusions and outlook
(see the answer for all the below comments at the end)
Line 356-375 describes the geological background, please consider shortening this and focus more on the similarities and differences between experiments and this case study. I think this comment can also be applied to other presented case studies. In my opinion, it would be interesting to read (as a reader) about natural cases that are similar to the each experiment, if possible.
Most of the discussion is around the petroleum systems developed in Mode II of inversion structures which is very interesting. However, I think more detail discussion on the controlling parameters and their relative importance would greatly add to this nice work.
Sorry, I am confused here, is this sentence tends to mention that results of experiments is not supported by the presented natural cases? If yes, then why these natural examples are chosen?
Please consider rephrasing.

I might have missed something here, but this reads contradictory to the statement in line 385-386.??
Looking at experiments 3 and 5 where the initial set up and the syn vs. postrift ratio is similar, with larger shortening/compression, inverted listric fault propagates all the way to the free surface. In my opinion, this shows that the amount of shortening/compression controls the fault vertical propagation and not the syn vs. postrift ratio.
As I mentioned, I might have missed something, but please clarify, thanks.
I am wondering why authors do not present natural cases that fit better to the experiments, is there any limitations here?
A: Sorry this part was confusing, I think we generally focused a bit too much on the differences rather than the similarities. We adjusted this aspect throughout the paper and compared the finding with the natural examples presented. We are indeed a bit limited by the (uninterpreted) data availability and we rely a lot on models. We hope that in the future we will be able to shed more light into faulting to folding transition as a function of post-rift thickness and (reactivated) fault displacement, validate it against clear subsurface seismic profile and create an interpretation template in regions where this transition in not clear on seismic data.

Fig. 1
Post-inversion is also part of the post-rift sequence, right? Please consider clarifying this avoiding confusion.
A: That is correct, however including the post-inversion strata to the post-rift cover does not help to tell the story in this case. We clarified this in the text.

Fig. 2
Shouldn't this be "total shortening/compression"? Or please explain how do we measure the amount of inversion.
A: corrected.

Fig. 3 to 7
Perhaps mentioning syn vs. postrift ration and the amount of inversion for each experiment here would help readers to remember the specification of the model setup without going back to the fig. 2 each time.
A: added

Please explain what this red layer represents and why it is absent in the interpreted cross section in 3g.
A: this layer is added just to level up the experiment so it can be wetted end cut.

Please show the crestal collapse block on the figures, or instead say in the hangingwall block
A: changed.

Is this experiment 02 (mentioned on top) or 03?/ experiment 04 or 03?
A: Corrected this in the figure, the one at the top was the right number.

Fig. 5

Interpreted section in 5e shows five post-kinematic black (drak grey) layers, while the uninterpreted one has seven layers, is there any reason on not showing upper two layers?

A: The interpreted section and the experiment has the same post-rift thickness. In this experiment (compared to the other experiments) the black layers are thinner because we tried to see if some small displacements can be better interpreted if the layers are thinner. As there was no difference we continued with the normal layering, however to look consistent, in the interpreted section we adjusted the thickness so they will be similar to the other experiments.

Fig. 8

I think it would be very beneficial to show the main specification of each model here. We have enough space here to avoid going back and forth to the figure 2.

A: added

Fig. 9

Please show these unit markers larger.

A: added just for the key units as the image is becoming very busy.

Please show the location of the 9a, and the New Zealand in an inset map.

A: Although we understand why adding an inset map can help, this figure is already very busy and is not particularly relevant in this case.

Please show formation top markers in 9b and 9c larger.

A: added just for the key units as the image is becoming very busy.

Please label major fault and structures.

A: labeled

Please mention the vertical exaggeration.

A: there is no vertical exaggeration in the section.

As the interpretation shows, fault tips out somewhere below T66 in the depth domain while in the time domain in 9b, propagated to the shallower intervals, please modify.

A: we have inherited the interpretation from Wunderlich et al 2019, and on Fig. 9c we show our alternative. We clarified this in the caption.

Fig. 10

Please show the location of the section in an inset map.

A: Although we understand why adding an inset map can help, a map is not particularly relevant in this case.

Looking at this section, I can see that Permian sequence is most likely the synrift, but please label the syn and post-rift sequence.

A: we labeled the syn-rift

Fig. 11

Please show the synrift and the boundary to the postrift

A: all the stratigraphy is post-rift in the well (we labeled it).

Fig. 12

Please add the vertical and horizontal scale

A: This is a play conceptual cartoon, not to scale (we clarified this)