Dear authors,

Thank you for submitting "Analogue modelling of basin inversion: the role of oblique kinematics and implications for the Araripe Basin (Brazil) to Solid Earth. I received a detailed evaluation of the revised version of your manuscript. As you see R1 still raises substantial concerns related to the novelty of the paper, quantitative aspects of your study, consistency between text and features shown in the figures and the interpretation of the results in context of explaining the Araripe Basin inversion.

- **Answer:**
    - We thank you and reviewer 1 for considering our manuscript. Please find detailed replies below

Though R2 exposes some weaknesses, which need to be addressed to make the manuscript suitable for publication in Solid Earth, the review also provides clear guidance on the critical issues to focus on and hence provides the pathway to improvement.

- **Answer:**
    - We did not receive any files from a second reviewer. We contacted Solid Earth, but they informed us no second review was received. As such, we focus on the comments from reviewer 1.

It would probably be most efficient to start with comments 3 & 4 under "Main comments" as these form the foundation for the other comments. Consistency between modelling results described in the text and the structural and topographic elements in the figures needs to be warranted.

- **Answer:**
    - We believe that various of the issues raised by the reviewer seem to stem from a misunderstanding of the text and our model series. We have provided detailed answers as to why we believe that our manuscript needs only limited modification.

Based on the above, I am returning the manuscript so that you can make the necessary changes.

Looking forward to receiving the modified version of your manuscript.

Ernst Willingshofer

**Referee 1 -** Fernando Ornelas Marques

***Assessment**: the topic of the ms. is relevant for geosciences, and therefore suitable for EGUsphere, but not in its present form. The main problems to be addressed are: (1) lack of quantification of length (so far only qualitative); (2) novelty (what is actually new? Think very carefully); (3) misleading use of the experimental results (do not say that there are no signs of inversion, as in the Abstract, when we can see them clearly in the submitted figures); (4) comparison between experiments and nature (find a length ratio); (5) comparison with previous work (you cannot compare onions with potatoes, and you should read previous literature more carefully, e.g. Marques et al., 2014, and Rosa et al., 2023). If these problems are not properly solved, I do no think this ms. should be accepted for publication because it comprises fatal flaws.*

**Main comments**

1. The title of the ms. is misleading in two ways: (1) the first part of the title "Analogue modelling of basin inversion: the role of oblique kinematics", because obliquity was not fully tested, i.e. from 0 to 90º, only the 90 and 45º that have long been shown unfavourable to invert high-angle, high-friction precursory normal faults; and (2) the second part "implications for the Araripe Basin (Brazil)" because the authors did not test the relevant variables and parameters, and, therefore, cannot directly compare the experiments with the AB.

- **Answer:**
  - **Point 1:** we disagree as we do most certainly test oblique extension, vs. orthogonal extension, and the modelling approach is reasonable as explained in our answer to point 2

- **Point 2:** we must point out that all (analogue) models are simplifications of natural systems, used to test specific parameters. In our models we run 45˚ oblique rifting models vs. orthogonal extension models, which is inspired by hypotheses regarding plate motion direction during Araripe Basin formation and later basin inversion. As we explain in the manuscript, the general insights derived from our models fit quite well with observations from nature, so we believe that this objection by the reviewer does not hold.

2. To explore how tectonic basin inversion in the AB could have taken place, you would need to: (1) reproduce the natural example in the rift phase, which you did not accomplish entirely, because you only produced one set of parallel faults, and the AB has at least three main sets (E-W, NE-SW, and NW-SE (e.g. Rosa et al., 2023). (2) Use the full range of shortening directions, because it is long known that high-angle convergence (> 45º) does not produce inversion in high-angle precursory normal faults. (3) Test fault rock rheological properties, e.g. viscous behaviour materials as observed in the AB (clays and evaporites). Unfortunately, you did not test any of these variables and parameters. What you tested (shortening angle) has been tested and theoretically explained long ago. Not having tested the most relevant variables and parameters that can be responsible for the inversion of high-angle precursory normal faults, you have no argument to claim that Marques et al.'s hypothesis is wrong.

- **Answer:**
  - **Point 1:** again, models are a simplification of reality. Trying to simply reproduce all aspects of the natural example may look nice, but hampers a proper understanding of the actual processes since it will become near impossible to understand the impact of a given parameter. As such, it is much better to design simpler models. The models we completed show first-order insights that we can apply to better understand the general inversion history of the Araripe Basin.
  - **Point 2:** We did test a number of parameters and believe that our model results are sufficiently robust to support our interpretation of the Araripe Basin. Running additional models is therefore beyond the scope of our study. It is in fact reassuring that our results, obtained with a new set-up, fit with previous modelling results that involved other set-ups, we do not

see how this can be a weakness here (we see it as a confirmation that our results are valid).

- **Point 3:** Again, we test large-scale processes. It is true that similar insights have been provided by previous modellers, but we apply a different model set-up than was previously used. Furthermore, the fact that our model results fit well with previous model results supports their robustness, rather than proving its weakness.
  - Regarding the inversion of high-angle faults: as we point out in our manuscript, there is precious little evidence for large-scale inversion of high-angle faults in the Araripe Basin. As such, the whole discussion regarding inversion of rift-related normal faults is rather irrelevant. Our models show that instead of inverting the original rift faults, both orthogonal and oblique inversion should result in the development of new reverse faults instead. As we point out in our manuscript, there is good evidence in the region to support this new interpretation, over the previous Marques et al. 2014 interpretation that invokes large-scale inversion of initial high-angle normal faults.
    - NB: Marques et al. (2014) do mention the observation of some reverse faults outside the Araripe Basin, but in their discussion they clearly promote the concept of large-scale inversion of normal faults. We have added this to the discussion.

3. Inversion of graben faults must be quantified in mm, and faults location must be shown on the topography graphs. Figure captions must include the amount of vertical exaggeration. How do you explain inversion with shortening at 90º that we can see in all topography graphs and model sections (Fig. 7)? This is critical to your work.

- **Answer:**
  - We are sorry to answer a bit harshly here, but we believe that the reviewer is nitpicking here, the structures are perfectly well visible in the images we prepared. Also, a vertical scale is already provided in the figures, next to the horizontal scale, but we have added a mention of the vertical exaggeration to the captions. It is not clear what the reviewer means with

the last part of the comment. Inversion in all models leads to the development of reverse faults and uplift of the original rift basin + surrounding material along these reverse faults.

- NB: there seems to be some topography along the axis of the model in the models involving orthogonal inversion, which seems to suggest minor inversion of previous rift normal faults. This is an artifact of manually filling in the basin during rifting, leaving a higher topography due to minor filling errors (the model was not scraped flat after each sedimentation interval). DIC results show no indication of reactivation of these faults, and even if there would indeed be some inversion of normal faults, it is really not much compared to the overall displacement in the system and thus not significant (a boundary effect).

4. How can you compare amounts of inversion in model and nature if you do not define the length ratio? How many meters in nature for each millimetre in the model? If we take the value of 1,600 m for the depth of the AB (de Castro and Branco, 1999) and the ca. 20 mm depth in the models, then we have a length ratio of 1.25E-5. This means that 1 mm in the model corresponds to 80 m in nature (scale = 1/80,000). If we use this ratio in Fig. 6h, for example, we can see that the model topography is greatly exaggerated compared to nature, because it is more than 3 times (ca. 1730 m) the 500 m in the AB. For the graben to vanish between the rift and inversion stages, and stand out of the topography at the end stage, the graben must be uplifted by ca. 6.8 mm, i.e. ca. 550 m in nature, which corresponds to the actual altitude of the AB relative to the host basement altitude (ca. 500 m). This is the opposite of your conclusion that tectonic inversion cannot explain the AB. Now the problem is to explain inversion with high angle shortening (including 90º), which could comprise the novelty of your work. The authors should also say that the inversion structures found by Marques et al. (2014) in the host basement outside the basin were also found in the experiments, but disproportionate in height to what we observe in nature. If you read Marques et al. (2014) carefully, you will see that they propose reverse faulting outside the current Araripe Basin. You can confirm that in section 3.3.2.3 and Figs. 15 and S1. However, you never mention this in your text, especially when discussing the experimental reverse faulting outside the basin and relation to what is known in the AB.

- **Answer:**
    - The reviewer seems to demand and exact reproduction of the Araripe Basin in the sandbox, which he, as an experienced analogue modeler, must know is impossible. As explained before, we present simple models to try and understand the impact of oblique kinematics on the evolution (and inversion) of the Araripe Basin. We provide a first-order interpretation that fits well with observations from the area, which we believe should be quite clear from our manuscript.
    - Scaling is clearly provided in the text (3 cm = 10 km).
    - Regarding the 6.8 mm inversion the reviewer seems to identify in our models: the reviewer seems to have misunderstood the models. After rifting, the basin is filled so that the model topography is (more or less) flat again. During inversion, the basins are inverted by the development of new reverse faults, which cause the uplift of the basin and its surrounding "basement". In no case do we see the 6.8 mm inversion accommodated by normal fault reactivation the reviewer argues for.
    - We have re-read the Marques et al. 2014 paper in detail. In their results section, the authors indeed mention some faults in the basement. We added a reference to these faults in our discussion, which does nicely support our interpretation of how inversion in the Araripe Basin could have been achieved by the development of new large-scale and low-angle reverse faults.
        - However, we must point out that in their discussion, Marques et al. (2014) explicitly champions the (dominant) role of the inversion of normal faults (while ignoring the potential [dominant] contribution of the new reverse faults the did observe in the field). The large-scale inversion of rift faults as proposed by Marques et al. (2014) is simply not visible on seismic data, as discuss in our manuscript.

5. What are the effects of deformation of the foam/plexiglass base on the observed strain in sand? This seems to me critical to the partial understanding of the experimental results.

- **Answer:**

    - The foam/plexiglass base creates a distributed stretching boundary condition at the base of the model, which can be oriented either in an orthogonal or an oblique direction to induce either orthogonal or oblique rifting, respectively. Vice versa, orthogonal and oblique inversion can be induced. This deformation is transmitted through the viscous layer into the overlying sand layer. In this sand layer, we apply a weakness (a seed) to localize a rift basin along the central axis of the model. This set-up is very different from set-ups using base plates or moving basement blocks, as it allows the system more freedom to develop. Also, the viscous layer acts as a buffer layer that evenly distributes the velocity field and dampens potential displacement/strain heterogeneities from the basal setup. We tested this setup using DIC once, and it clearly showed that (for those velocities we are using) the surface of the viscous layer deforms homogeneously. Even so, we get similar results to previous modelling studies, which indicates the validity of our approach.
        - For more details on the various set-ups used for analogue modelling, and the uniqueness of our model set-up, see the review paper by Zwaan et al. 2022 in Solid Earth
            - Link: https://doi.org/10.5194/se-13-1859-2022

Lines 47-48 – “The rift structures of the Araripe Basin mainly strike NE-SW”: This is not true, because the main boundary fault is E-W, by brittle reactivation of the Precambrian Patos Shear Zone. In your experiments, the NE-SW structures are not even faults, they are "strain bands" as you call them (e.g. Fig. 5).

- **Answer:** Araripe Basin is a system of half-grabens mainly controlled by normal faults striking NE-SW. The Patos Shear Zone is the main E-W shear zone limiting (more or less) the present-day north limit of the basin; however, the grabens within the Araripe Basin are mainly controlled by the other NE-SW Precambrian shear zones connecting the E-W Pernambuco in the south and Patos shear zones in the north. We have modified the sentence to avoid any further confusion.
    - As we clearly write in the manuscript, the models develop in series of en echelon faults that represent the basin orientation within the Araripe Basin structure. The “strain bands” are later structures within the basin, that also

follow the general orientation of intra-basin structure. We do not really follow how that is an issue. As said before, we are interested in the large-scale development of inversion in the Araripe Basin, and these model features are quite compatible with both oblique rift kinematics as with the structural orientations in the Araripe Basin.

Lines 66-67 – "The Peulvast and Bétard (2015) scenario fits with the general absence of large-scale inversion of normal faults as seen on seismic sections from the Araripe Basin (Ponte and Ponte-filho, 1996, Rosa et al., 2023": The 1996 reference is missing in the references list, and I could not even have access to it through my Brazilian colleagues. If the reader cannot have access to these seismic data, you cannot use them as argument. Regarding Rosa et al. (2023), they only show two and very short seismic lines. Interestingly, you can see good signs of inversion in one of the lines. In fact, Rosa et al. (2023) report important signs of tectonic inversion in the Araripe Basin. They simply interpret them differently from Marques et al. (2014).

- **Answer:**
  - We have now added the Ponte and Ponte-filho (1996) reference, which is a regularly cited work in the context of the Araripe Basin (it is for instance also cited in Marques et al. 2014). As such, we do not see why we cannot refer to this publication in our manuscript. Link: https://www.researchgate.net/publication/355575301_Estrutura_Geologica_e_Evolucao_Tectonica_da_Bacia_do_Araripe
  - The inversion of initial rift faults reported by Rosa et al. (2023) is not "simply" a different interpretation; as we discuss in the manuscript, they present a fundamentally different interpretation: that these inverted normal faults are related to a shift in kinematics during the rifting phase, and not to later inversion. As showed by the very representative seismic lines of the Araripe basin, this inversion of rift faults is only present in the rift formations and does not affect the post-rift formations. If there was a high degree of normal fault inversion of Araripe Basin as proposed by Marques et al (2014), it should be very clearly seeing in any of the seismic lines, which it is not.

- Instead, we present a different interpretation of inversion in the Araripe Basin involving the formation of new reverse faults to explain the present-day situation. We believe that our interpretation does fit the observations obtained from both our model and nature.

Line 77 – "… novel set-up": Where is the novelty?

- **Answer:**
  - The novelty is that the set-up is the use of a foam and Plexiglass base, which was until now only used for (oblique) rifting experiments, and now for the first time for inversion experiments (see also the Zwaan et al. 2022 review paper). In contrast to previous inversion modelling works, we use a foam-plexiglass base that induces distributed deformation at the base of the model. As such, deformation the model is less directly constrained than in more traditional base plate model (see also previous reply).
    - Note that the details of the set-up are addressed later in the methods, and the reader should not expect to find all details here in these lines in the introduction.

Line 79 - I do not understand this rationale, because these angles are long known to work against tectonic inversion in high-angle normal faults

- **Answer:**
  - We apply a new set-up for basin inversion modelling that also show that orthogonal inversion counteracts normal fault reactivation. This is a good result we thing (see also previous replies).
  - The kinematics applied in our modelling study were inspired by the kinematics proposed for the Araripe Basin by various authors, as is detailed in the methods section.

Line 119 – "model set-up … fundamentally different": Why is that so? What changes? What are the effects on final results?

- **Answer:**
  - Please see previous replies on this topic

Lines 141-142 – "… 6 cm thick layer of fine quartz sand … representing a 20 km brittle upper crust": If 60 mm in the model correspond to 20E6 mm in nature, then L* = 3E-6. This means that 1 mm in the model equals 333 m in nature. Given that the average graben in your experiments is ca. 20 mm deep, this scales up to nature to 20x333 = 6660 m, which is more than 4 times the 1600 m proposed by de Castro and Branco (1999)

- **Answer:**
  - The models cannot (and are not expected to) perfectly reproduce every single detail of the natural example. See previous replies regarding our general modelling approach.

Lines 307-308 – "… localized strain both along the intra-graben faults …": How do you explain intra-graben inversion by orthogonal shortening? This is critical to your work.

- **Answer:** All grabens without sedimentation had intra graben reactivation during inversion due to the lack of stability that sedimentation would provide like it did in the syn-rift sedimentation experiments. This is therefore not an issue (similar observations are known from other modelling works → see the Zwaan et al. 2022 review paper for more details).

Figs. 4 and 5 – several features can be measured on the topography graphs, which deserve explanation.

- **Answer:**
  - This is not the scope of our study, we are interested in the large-scale model structures, which show that inversion of initial rift faults does not really happen. Instead, reverse faulting outside of the basin are more likely to have caused uplift, an interpretation supported by field data.

Fig. 6 – panels g and h show that the graben has vanished from the rift to the inversion phases; how do you explain this? Besides, there is good evidence in panel f for inversion of the N master rift fault (sharp step in blue shades).

- **Answer:**

- The grabens did not vanish; they were filled with sedimentation.
- In the DEM, what might look like graben inversion, is an artefact of graben sedimentation. When inspecting the DIC data, it is clear there is no tracible fault reactivation.

Fig. 7 – in panels a and b you must give the references of the syn-rift layers on both sides of the faults so that we can evaluate the amount of inversion.

- **Answer:** This is not possible because there is no normal fault inversion in these models. When inspecting figures 6d,e and 8d,e, the DIC analyses only shows strain localization along the new reverse faults. Therefore, there is no inversion in the rift faults to be measured. That is sufficient observation to support our interpretation of basin inversion along newly formed reverse faults in the Araripe Basin.

Lines 377-378 – "… while no reactivation is visible in the inherited rift structures": Then how do you explain that the initial graben (panel g) has vanished (panel h) in Fig. 6? The same applies to Fig. 8.

- **Answer:** Again, the graben was filled with syn-rift sedimentation. Thus, no graben structures can be seeing in top view images during inversion.

## Abstract

- **Author comment:** Thanks for the detailed comments on the abstract. However, we must point out that we cannot add all the details the reviewer requests in the abstract, that is what the main text is for.

**Line 15**

- **Comment:** Given like this, this 1000 m altitude means very little, because the basement could also be at 10000 m. The rpoblem is that the AB peaks at 500 m altitude above the host basement
- **Answer:** Thanks for the suggestion, it is modified.

**Line 16**

- **Comment:** 1000 m is not a topographic high if everything around is also at 1000 m
- **Answer:** We understand that, however, in this case, we say this because it is a topographic high.

**Line 18**

- **Comment:** and differential erosion
- **Answer:** Than you for the suggestion, it is modified.

**Line 18**

- **Comment:** Where are the seismic data?
- **Answer:** The seismic data observations are from works referenced in the main text (citations are not appropriate to have in the abstract)

**Line 18**

- **Comment:** Newly formed reverse faults and reactivation of precursory normal faults fully explain the field data collected by Marques et al. (2014)
- **Answer:**
    - There is very little reactivation, if at all, of precursory normal faults, as shown by seismic lines.

**Line 19**

- **Comment:** To do this, you need to: (1) reproduce the natural example in the rift phase, which you did not accomplish entirely, (2) use the full range of shortening directions relative to main boundary fault, and (3) test fault rock rheological properties
- **Answer:**

    - See general reply on earlier comments on our modelling approach. We are interested in the large-scale structures, and our results fit well with field observations and seismic data.

**Line 21**

- **Comment:** Has this been observed in nature? What is the relevance of this model?
- **Answer:**
    - When running analogue models, it is important to systematically explore the parameter space so that we may understand the impact of specific parameters. As such, we added these models. (See also previous replies)

**Line 22**

- **Comment:** Should be placed between "extension" and "followed"
- **Answer:** Thanks for the suggestion, it is modified.

**Line 23**

- **Comment:** Irrelevant for an Abstract
- **Answer:** Thanks for the suggestion, we agree that this detail is not key to the abstract and can be remove. It is modified.

**Line 28**

- **Comment:** This has long been shown by previous work. "is" should be changed to "was" for verb tense consistency
- **Answer:** Thanks for the suggestion, we modified it
    - The fact that previous modelling results are reproduced with our new set-up shows the robustness of our modelling results.
    - It is not a bad thing to rerun previous models, especially since we apply new techniques (topography analysis + DIC).
    - See also previous replies

**Line 29**

- **Comment:** Normal or reverse?
- **Answer:** Reverse

**Line 29**

- **Comment:** Has this been observed in nature? What is the relevance of this model? **Answer:** Parameter space exploration (See previous comment). We need to understand what our models are doing, otherwise we cannot properly apply their results.

**Line 30**

- **Comment:** Images of experiments show otherwise
- **Answer:** No, they don't. Figures 6 (d,e) and 8 (d,e) do not show any rift related fault reactivation, strain is concentrated in the new reverse faults only.

**Line 32**

- **Comment:** Do you have an explanation for this behaviour?
- **Answer:** It is a mass of sand filling in the graben, buffering it from reactivation as it removed the weakness. We have add a couple of words to clarify this here.

**Line 33**

- **Comment:** This comparison with nature is misleading
- **Answer:** We do not really follow this comment. What is states in this sentence is that we propose an alternative scenario for the evolution of the Araripe Basin.

**Line 34**

- **Comment:** Where are they?
    - This refers to evidence of low-angle reverse faults outside of the basin. The evidence for this is detailed in the main text.

**Line 48**

- **Comment:** This is not true, because the main boundary fault is E-W, by reactivation of the Precambrian Patos Shear Zone. In your experiments, these are not even faults, they are "strain bands" as you call them
- **Answer:** Yes, the Patos shear zone is reactivated, however rift structures are in the Araripe Basin are mainly NE-SW. One does not invalidate the other.

**Line 49**

- **Comment:** formation?
- **Answer:** Thanks for the suggestion, it is modified.

**Line 50**

- **Comment:** remains
- **Answer:** Thanks for the suggestion, it is modified.

**Line 61**

- **Comment:** Coblentz and Richardson (1996) should also be cited here
- **Answer:** Thanks for the suggestion, it is added.

**Line 67**

- **Comment:** Only two and very short seismic lines
- **Answer:** The seismic lines showed in Rosa et al (2023) are good enough to show at least 6 rift related faults and some flower structures. The positive flower structures are interpreted as rift inversion since they do not propagate to younger

units. These seismic lines should reveal rift faults inversion affecting younger units of the Araripe basin if it had undergone major basin inversion.

**Line 67**

- **Comment:** This reference is missing in the references list, and I could not even have access to it through my Brazilian colleagues. If we cannot have access the these seismic data, you cannot use them as argument
- **Answer:** Thank you for pointing the reference is not on the list, we fixed that. Ponte & Ponte-Filho (1996) can be found online, and it is a well-known and often-cited Araripe Basin work (for instance, Marques et al (2014) cited this work as well), so we do not follow why we should not be allowed to cite it too. The fact that the data are perhaps not that easily accessible does not make them untrue after all.

**Line 77**

- **Comment:** Where is the novelty?
- **Answer:** The novelty is that we use a set-up that has previously been used for (oblique) rifting modelling for basin inversion modelling. Except for the recent efforts by Guillaume et al. (2022), this kind of set-up has never been used for basin inversion modelling (see also the Zwaan et al. 2022 review on analogue modelling of basin inversion, published in Solid Earth).
- See also previous replies.

**Line 79**

- **Comment:** I do not understand this rationale, because these angles are long known to work against tectonic inversion in high-angle normal faults
- **Answer:** We use a new set-up here, and we need to explore the parameter space. As such, we need to include orthogonal kinematics if we want to properly understand oblique kinematics in these models.

**Line 85**

- **Comment:** This is not consistent with Marques et al. (2014)
- **Answer:** We are representing the same normal faults and stratigraphic inversion sketched by Marques et al (2014) in their figure 18D.

**Line 119**

- **Comment:** Why is that so?
- **Answer:** See previous reply on the set-up

**Line 142**

- **Comment:** If 60 mm in the model correspond to 20E6 mm in nature, then L* = 3E-6. This means that 1 mm in the model equals 333 m in nature.
- **Answer:** That is correct

**Line 183**

- **Comment:** In all topography graphs you must say how much you have exaggerated the vertical scale relative to the horizontal
- **Answer:** Thank you for the suggestion, we added the information to the caption.

**Line 183**

- **Comment:** Add (no sedimentation)
- **Answer:** Thank you for the suggestion, we added the information.

**Line 183**

- **Comment:** Add (with sedimentation)
- **Answer:** Thank you for the suggestion, we added the information.

**Line 307**

- **Comment:** How do you explain this inversion?
- **Answer:** Because there was no sedimentation the rift faults were not stabilized by sedimentary infill, so that the basin represented a weakness that was reactivated during compression of the model.

**Line 317**

- **Comment:** How do you expalin this?
- **Answer:** Orthogonal inversion adds more compression to the model than oblique inversion, and this translates in higher elevation for the orthogonal inversion models.

**Line 321**

- **Comment:** Add (no syn-rift sedimentation)
- **Answer:** Thank you for the suggestion, we have added it here, and also to the title of header 3.2.

**Line 360**

- **Comment:** syn-rift sedimentation
- **Answer:** Thank you for the suggestion, we made the modification.

**Line 368**

- **Comment:** at
- **Answer:** Thank you for the suggestion, we corrected that

**Line 377**

- **Comment:** Then how do you explain that the initial graben (panel g) has vanished (panel h)?
- **Answer:** The graben was filled with sediments, covering the graben structures (see previous replies on this topic).

**Line 392**

- **Comment:** This inverted fault should be drawn on the topo profile in panel h.
- **Answer:** The inverted faults are pointed to in the DIC result map view images, in the profiles and in the cross-sections shown in Figure 7.

**Line 401**

- **Comment:** What are the equivalent layers on this block? Without the references on both sides of the faults, we cannot evaluate displacements
- **Answer:** There are no equivalent layers outside basin since we only applied sediments within the basin itself. However, the thickness of each sediment layer does show the subsidence of the basin.

**Line 423**

- **Comment:** How do you explain graben vanishing?
- **Answer:** The grabens do not "vanish", they are simply being filled with syn-rift sedimentation.

**Line 457**

- **Comment:** Why do you discuss this?
- **Answer:** I discuss this because it is part of my results and an important part of my models. Leaving out a discussion of the rifting phase in the models would simply not do.

**Line 476**

- **Comment:** Where are they?

- **Answer:** The evidence is discussed in the preceding sentences. To avoid confusion, we added the references used in the discussion here as well, and slightly modified the wording.

**Line 582**

- **Comment:** Who saw these faults in the field?
- **Answer:** These are the proposed faults according to the models. We added minor normal fault inversion and concentrated deformation along new reverse faults. As we point out in the discussion, there are good grounds to predict such faults, based on field data and our model results. We now added that also Marques et al. (2014) observed some reverse faulting in the area that was not related to normal faults, which supports our interpretation of Araripe Basin inversion, even though these authors clearly champion an interpretation that is dominated by normal fault reactivation.

**Line 585**

- **Comment:** This is not consistent with data from the literature (cf. Marques et al., 2014)
- **Answer:** See previous answer, we propose a new scenario for inversion in the Araripe Basin, based on both our model results and field evidence cited in the discussion. It should not come as a surprise that our new scenario, which involves limited rift fault inversion and the establishment of new reverse faults, contradicts the scenario championed by Marques et al. (2014), which proposed major rift fault inversion as the main inversion mechanism.

**Line 485**

- **Comment:** Where did the authors get this orientation? E-W is highly oblique to the main boundary fault, the Patos shear zone, which is very different from the angles used in the experiments
- **Answer:** We here adopt the exact same orientation as Fig. 18 in Marques et al. (2014), to better illustrate the differences between both the Marques et al. 2014

and our scenario. As specified before, the Patos shear zone may delineate the northern extent of the present-day Araripe Basin domain, but the general rift basins within the Araripe Basin are oriented NE-SW, so the orientation of our schematic sections are oriented perpendicular to these NE-SW structures.

- The shortening follows from the interaction between the Andes in the west, and the Mid-Atlantic Ridge in the east, as is specified in the intro, and the orientation should indeed be ENE-WSW instead of E-W. Thanks for noticing, we have modified it in the figure and caption, as well as in the discussion.