Reviewer 2 – Georgios-Pavlos Farangitakis

Overall assessment:

The authors present a novel analogue modelling approach through a rotating apparatus to delineate the evolution in response to rotational motions of rifts and use the East African Rift System as a natural example. They explore different rift-seed configurations and how these reflect on various features of the East African Rift System, making observations in the process about rotational stresses, microplate formation and preferential rift (re)activation.

A particularly novel part of this work is that the authors do a direct comparison on the initiation of a rift based on top-view photos, digital topography and particle tracing techniques and discover that rifts cluster far earlier than is generally observed with traditional means of capturing observations.

The only content related comment on this work is that the manuscript is missing a discussion on the potential discrepancies that arise due to a) the non-differentiation of crustal nature within the Somali plate (author models use a uniform continental plate rheology) and b) the absence of a key inheritance feature trending parallel to the extension direction, the Davie Fracture Zone.

The manuscript is well written and concise, and most other comments on this work are formative (consisting of missing scale bars in figures, acronyms, shortening sentences and possibly rephrasing some expressions).

Therefore, I recommend this work to be accepted for publication after these revisions are addressed.

For specific comments see below:

Dr Pavlos Farangitakis, Shell Global Solutions International

- **Reply:** We kindly thank the reviewer for the positive assessment of our manuscript, and have addressed the comments in the text below.

General comments:

- I believe the manuscript would benefit from a discussion on how the difference in the nature of the crust (continental vs oceanic), would affect the evolution of the region. Between Madagascar and Mozambique, there is a stretch of a few 100s of kms of oceanic crust. I understand the limitations of analogue modelling and not being able to place different crustal compositions side by side in such an experiment, however it does merit a discussion point. I have added specific comments on where parts of this could fit through the manuscript

- **Reply:** The reviewer is right to point out the difference between oceanic and continental lithosphere, and the potential impact of the Davie Fracture Zone. Indeed, the NE margin of the Rovuma plate seems to follow this fracture zone, which we now mention in the text.
- However, for the model set-up we consider the whole Somalian plate as a rigid plate. We believe this is permissible since:
  - The configuration of plates southward of the continental East African Rift System remains debated
  - The plate motion velocities south(east) of the (continental) East African Rift System are very minor in comparison to plate motion velocities in the continental East African Rift System
  - These areas are found in close proximity to the Nubia-Somalia rotation pole, which makes their (limited) motion rather complex. Hence we focus our modelling study on the system north of this rotation pole.
  - The Mesozoic rifting that caused the separation of Madagascar from the African continent and the development of the Davie Fracture Zone was not active during the Cenozoic development of the East African Rift System (Phethean et al. 2016).
- This is now also addressed in the text.

- Further to the previous comment, part of the key pre-existing structural fabric is missing (such as the Davie Fracture Zone – see Phethean et al. 2016 or Reeves et al. 2016). Why do you consider this to not play a part on the EARS and do not include it in your set-up? It would be useful to see a discussion on what the omission of these two features (oceanic crust and Davie Fracture Zone) entails for your experiments (I suspect not much given that first order similarity is always the key outcome, however, will supplement the manuscript's quality having captured the entirety of the key lithospheric features).

  - **Reply:** In our models we implemented the main **active** EARS plate boundaries as proposed by e.g. Saria et al. (2014) and Stamps et al. (2021). As such, the Davie Fracture Zone is not completely included (apart from the NE boundary of the Rovuma plate. We have now expanded the discussion of weaknesses in East Africa.

Specific comments:

- (L10-15) Short summary: I am not sure whether this is also doubling as a plain language summary or not, if it is the case, consider adding in brackets in the first sentence that the "features splitting continents apart" are called rifts. If not, ignore this comment.

  - **Reply:** We believe the current text is sufficiently clear (including the use of "Rift" in the name of the East African Rift") and prefer to keep things as they are.

- (L43-56) Introduction: What is missing from this section is a discussion/reference on the relative timing of each of the features on the EARS, particularly if references to inherited structures are made (such as the ones Glerum et al. 2020 refer to). Might be worth adding also some info on the map the further northward extension of the the Davie Fracture Zone, as you'd expect them to play a part in the plate configuration (See Phethean et al. 2016 this also refers to Fig 1 and later to the set-up).

  - **Reply:** We agree that details on timing is missing here, and have added these in the new text. Timing of East African rift development is now also discussed in more detail in the discussion section.
  - See previous replies regarding the Davie Fracture Zone.

- Figure 1: Can you add the respective scale to each of the sub-panels?

  - **Reply:** We have added scales to panels (a) and (c)

- (L84-93) Methods: I believe this section would benefit from a small 2-3 sentence section on highlighting the specific novelty of rotational analogue models in general (i.e. the works of Souriot and Brun 1992, Molnar et al. 2017, Farangitakis et al. 2019, 2021)

  - **Reply:** We understand what the reviewer means, but don't feel that the methods are the right place to do so (we feel it would mostly provide a distraction from our modelling set-up details). But note that we already cited some of these modelling studies in the introduction, which was also rewritten to accommodate suggestions made by reviewer 1 as well.

- (L90-92) Methods: This sentence reads slightly odd. Consider breaking in two or putting the "at a rate of 4mm/h at the farthest point from the rotation axis" in a bracket.

  - **Reply:** We agree and have made this part of the sentence into a separate sentence following the original sentence.

- (L95-101) Methods: Again, the DFZ is missing from the story here and the oceanic crust as well.

  - **Reply:** See previous replies to comments on the DFZ and oceanic crust

- (L97-98) Methods: Consider also explaining how these seeds have also been used to simulate inheritance in rifted basins (such as the Gulf of Aden models in Autin et al. 2013).

  - **Reply:** We added some details on how seeds have been used in previous models. The use of seeds here is somewhat different than in Autin et al. 2013 though (we use linear seeds, where Autin et al. 2013 use broader "patches" of weak materials that cause deformation over a wider area).

- (L143) Methods: I would like to see a bit more discussed on the 4 mm/h velocity since we are in a rotational environment and thus any velocity displays an “angular velocity” character. In line 90 it is mentioned this 4mm/h is the max velocity, so it is worth mentioning that going “south” in the rifted profile means velocities are less.

    - **Reply:** We have added some more context to the text, but we made the choice to define model velocities in mm/h, since these can be directly upscaled and compared to the mm/yr as found in GPS-based studies of plate motions in East Africa (e.g. Saria et al. 2014. Stamps et al. 2021).

- (L143) Methods: Why do you not consider this to be a major issue (answer might be my above comment)?

    - **Reply:** It is not a major issue as long as we do not get wide rifting (distributed deformation due to strong coupling between the foam base and sand layer as a result of too fast movement): the seeds still localize deformation as they are intended to, and the behavior of the model is therefore valid (narrow rifting style).
        - This was already in the following sentences, but recognize that the original manuscript is a bit unclear here, and have rephrased the text to avoid confusion.

- (L172) Methods: agisoft website needs its bracket to close

    - **Reply:** thanks for noticing, it is modified

- (L181-306) Results: There are references to Figures 3-7, such as to the “Malawi Rift”, that require the reader to revert back to Figures 1 and 2 to see where that is. Might be worth adding the names of the key features in panel (a) of each of the Figures 3-7.

    - **Reply:** We think this is a good idea and have added the suggested labeling to the figures

- (L331-372 or 415-475) Discussion: See “General comments 1 & 2”

    - **Reply:** We agree and have added details to the introduction and discussion (see reply to previous comments)

- (L423) Discussion: This is the first time that any feature’s relative timing is mentioned in the manuscript (see my earlier comment in the Introduction).

    - **Reply:** We agree and have added details to the introduction and discussion (see reply to previous comments)

- Figure 9: Please add scales to the image.

    - **Reply:** We have now added the necessary scales to the figures.

- (L440) Discussion: I would refrain from using the phrase “all things considered” as it is quite informal.

    - **Reply:** We agree and now use “overall” instead.

- (L449-465) Discussion: I recommend using one of the terms “microplate”, “micro plate” or “micro-plate” for consistency.

    - **Reply:** Thanks for noticing that the terminology was not consistent, we have opted for using “microplate” throughout the text

References:

- Autin, J., Bellahsen, N., Leroy, S., Husson, L., Beslier, M. O., & d'Acremont, E. (2013). The role of structural inheritance in oblique rifting: Insights from analogue models and application to the Gulf of Aden. Tectonophysics, 607, 51-64.

- Farangitakis, G. P., Sokoutis, D., McCaffrey, K. J., Willingshofer, E., Kalnins, L. M., Phethean, J. J., ... & van Steen, V. (2019). Analogue modeling of plate rotation effects in transform margins and rift-transform intersections. Tectonics, 38(3), 823-841.

- Farangitakis, G. P., McCaffrey, K. J., Willingshofer, E., Allen, M. B., Kalnins, L. M., van Hunen, J., ... & Sokoutis, D. (2021). The structural evolution of pull-apart basins in response to changes in plate motion. Basin Research, 33(2), 1603-1625.

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- Molnar, N. E., Cruden, A. R., & Betts, P. G. (2017). Interactions between propagating rotational rifts and linear rheological heterogeneities: Insights from three-dimensional laboratory experiments. Tectonics, 36(3), 420-443.

- Phethean, J. J., Kalnins, L. M., van Hunen, J., Biffi, P. G., Davies, R. J., & McCaffrey, K. J. (2016). Madagascar's escape from A frica: A high-resolution plate reconstruction for the W estern S omali B asin and implications for supercontinent dispersal. Geochemistry, Geophysics, Geosystems, 17(12), 5036-5055.

- Reeves, C. V., Teasdale, J. P., & Mahanjane, E. S. (2016). Insight into the Eastern Margin of Africa from a new tectonic model of the Indian Ocean. Geological Society, London, Special Publications, 431(1), 299-322.

- Souriot, T., & Brun, J. P. (1992). Faulting and block rotation in the Afar triangle, East Africa: The Danakil" crank-arm" model. Geology, 20(10), 911-914.