Dear Editors, dear Referees,

We are grateful for the careful reading of our manuscript by both referees. We appreciate their insightful and constructive comments which highlighted some of the manuscripts weaknesses and allowed us to address them.

Below, we reply to individual points raised in the referee reports. In our responses, we outline what changes were made to the manuscript and provide clarifications on the questions and concerns raised. The original text of the report is in black, our response in green

On behalf of the authors

Filip Havlíček

Referee report 1 (Danielle Maestrelli)

Dear Editor, dear Authors,

I am here submitting my review comments for the manuscript entitled “Modelling the interactions of discrete inherited structures, pervasive fabrics and extension direction during rifting: application to the Cenozoic Eger Graben” by Filip Havlícek and co-authors.

This interesting manuscript deals with analogue modelling of rift settings and the interaction with inherited fabrics. The main aim of the models is to explain the present-day structural architecture (and the relationships with inherited fabrics) of the Eger Graben. The Authors produced 3 experimental series using 2 different setups, a first one using the classical VD approach to induce rifting under single- and multi-phase (oblique) extension, and a second one (using an expanding foam at the base) to test the effect of variously shaped fabrics in the crust, simulated via a preformed PDMS layer.

Overall, the manuscript is very well written and very well illustrated, even if the structure of the manuscript is sometimes redundant (e.g., Chapter 2 is long and very detailed, sometimes resembling more a thesis chapter, and could be shortened a bit; there are two limitations sections, one of which—5.3—could be easily incorporated into Section 5.2). Besides, the experimental series are well designed and monitored through the use of up-to-date PIV analysis and more classical line-drawing interpretation. Modelling results are very nice and nicely described.

Response:

We appreciate the very positive evaluation and a multitude of constructive comments and suggestions dispersed throughout the annotated manuscript PDF. On specific issues regarding the perceived redundancy of certain aspects of the manuscript structure:

- We have shortened and simplified Chapter 2, specifically section 2.1 dealing with the pre-rift geodynamic history of the study area. Now it should discuss exclusively those aspects of basement history which are pertinent to the analogue modelling without potentially unnecessary details. Figures 1, 2, 3 and 5 were modified and streamlined per the referees comments. On closer inspection, Figure 4 was deemed unnecessary and was removed entirely.
- We have unified both the "limitations" sections (5.3 and 5.5) of the discussion into one which addresses the technical limitations of both model setups together. Additionally, section 5.3 was shortened and merged with 5.2, since it discusses the limitations of the applicability of our models to the Eger Graben rather than technical aspects of the modelling approach.

I do have several comments (see below and the annotated version of the manuscript), but I think the manuscript deserves publication after minor/moderate revisions are accomplished. It presents interesting results and insights about fault reactivation, inheritance and, more specifically, about the structural setting and evolution of the Eger Graben. This will attract the interest of both the structural geology and analogue modelling communities, as well as researchers interested in studying the specific study area.

My main concerns are summarised as follows, but they are better detailed in the annotated PDF:

- The focus of the manuscript is on inheritance, and specifically on pervasive and discrete fabrics. Nonetheless, a precise definition of these two features is missing. This is not trivial, as pervasive and discrete are relative concepts, especially in analogue modelling, where scaling effects can change their meaning. I invite the Authors to clearly define what they mean by discrete and pervasive inherited fabrics in the introduction and to consider this when discussing limitations to modelling in paragraph 5.5.

  Response:

  We agree that precise definitions of the concepts of "discrete" and "pervasive" inherited fabrics were indeed missing in the initial manuscripts version. To address that, we have rewritten and expanded the introduction to include paragraphs defining those concepts, both in nature and how they are typically implemented in analogue models.

  From that point on, we adopt the term "distributed fabric" rather than "pervasive" fabric to describe our models of series T and A (which include these fabrics). We believe it better represents our modelling approach which only approximates the role of a pervasive anisotropy rather than recreating it in the analogue materials themselves.

- The Authors should improve the comparison with previous works: particularly, some Authors (see, e.g., the many works by Zwaan et al.) have already used a

similar setup to study the interaction between rifting and inherited structures, using, e.g., a viscous PDMS seed. Chapter 5 cites some of these works, but a more detailed discussion, better stating the similarities and differences, is indeed necessary.

Response:

We acknowledge the issue and have made improvements in the corresponding sections of the manuscript. First, the introduction was reworked to include definitions of discrete and pervasive inherited fabrics (see response above) and, more crucially to this point, a review of different methods of implementing these features in analogue modelling studies. In Chapter 5, these diverse approaches are compared to our experimental results (especially model series T and A which incorporate multiple types of predisposed weaknesses), which was lacking in the initial manuscript version.

- There is a bit of confusion in the setup description. Specifically, I have some concerns about the thickness of the PDMS layer and the thickness of the viscous seed. As it is written now, it is not clear how thick the seeds really are in comparison with the upper brittle crust. This is important to assess crustal strength reduction, as properly highlighted by the Authors.

Response:

Regarding the seeds and the thickened silicone slab, we are of the opinion that their size and shape is clearly stated in the methods section. Seeds are implemented as cylindrical silicone rods 0,8 cm in diameter while the “thickened slab” represents an additional 0,5 cm silicone layer on top of the basal silicone layer giving a total of 1 cm.

We acknowledge that the description of the distributed fabric of regular grooves may be confusing. To clarify: During the surface preparation using the textured rolling pin, part of the silicone was pressed from within the grooves and displaced towards the adjacent ridges. Inside the grooves the silicone layer thickness was thus slightly reduced whereas in the ridges it was slightly increased compared to the initial thickness of 0.5 cm. Therefore, the brittle layer thickness varied between roughly 2.75 cm (above the deepest portion of the groove) and 2.25 cm (above crest of the adjacent ridge) as stated at line 257.

To avoid confusion on this issue, we have modified parts of section 3.3 to more clearly describe the process of silicone surface preparation. Furthermore, we have included an additional diagram in Fig. 6 (now fig. 5) which illustrates a cross-section through the model crust above the distributed fabric.

- In the Methods section, the distinction between the two different setups is not very clear (it becomes clear only later, when reading the following sections). This

is reflected in Fig. 6, which mixes the two of them but lacks a bit of clarity. I think this can be easily improved by clearly stating the differences between them and referring to a revised version of Fig. 6, separating and clearly indicating the two setups.

Response:

We appreciate this point and agree that the distinction between the two setups should be made clearer. Model series names were added to section titles (Sections 3.2 and 3.3) describing the two setups and we attempted to make the distinction between the two setups sharper in the opening paragraph of Chapter 3.

Figure 6 (now Figure 5) was modified per the referee's comments so that the two setups are clearly distinguished and so that the diagrams accurately illustrate the respective model setups. Further information was added in Fig. 6 to clarify the relationship between silicone layer and brittle layer thickness above the distributed fabric in setup 2 (see reply above)

- Admittedly, the PDMS layer used to simulate the lower crust (or part of it) poses some problems. Density is not scaled (some amount of corundum could have been mixed in to reach the proper scaling, paying attention not to change the rheology of the silicone), but the Authors clearly and fairly state (lines 325–331) that the use of this layer bears limitations. Nonetheless, a justification for its use is missing (I suggest adding that it is used as a technical expedient to distribute deformation, despite the above-mentioned limitations).

Response:

We respectfully disagree with the first comment about improper density scaling. Although we did not mix corundum nor any other density increasing additives into the silicone, we did use a low density homogeneous granular mixture of sand and fillite (rho = 915 $kg*m^{-3}$) to avoid an inverted density profile, as already stated in the manuscript on lines 183-184. For model series T and A, this gives a model UC/LC density ratio of around 0.94, comparable to 0.93 in nature, assuming natural densities of 2700 $kg*m^{-3}$ and 2900 $kg*m^{-3}$ for upper and lower crust, respectively. We have added a few sentences to the “Materials” section (3.1) to state this point more directly.

Regarding the PDMS layer in setup 1 (E-series), we very much agree with the referees comments and consider their suggestions very helpful. We have rephrased the text around lines 321-331 to clearly state that the PDMS layer serves primarily as a technical expedient to distribute strain due to the use of a VD setup, which itself should be considered a limitation. In the natural prototype, the PDMS layer thus approximates a “general”, largely hypothetical, weak layer within the rheological profile rather than a defined rock layer. We keep the scaling of this layer to salt,

since it would represent the most realistic natural analogue, while explicitly acknowledging its absence in the Eger Graben.

- Similarly, the foam is presented as an analogue for the lower crust (lines 335–336). If presented in this way, it should properly scale to lower crust properties. I would therefore clearly state that, like PDMS, it is used to distribute deformation and therefore represents a technical expedient.

Response:

We are very much in agreement with the referee and appreciate the suggestion. We will clearly state, mainly in the scaling section but also in other parts which discuss this, that the foam block is a technical tool to drive extension in the overlying material, NOT a scaled geological layer - similar to other studies which use this setup (e.g. Osagiede et al., 2021; Zwaan and Schreurs., 2020 and others)

- Figure labels are sometimes very small or have colours that are difficult to distinguish against the background. This can be easily improved (see specific comments in the PDF).

Response:

Thank you for pointing the issue out and for detailed comments in the annotated PDF. We have modified the specific figures to ensure better readability.

- The relationships between Figs. 2–3–4 are not extremely clear, and so it is not clear which is the target study.

Response:

Figure 4 was removed entirely since, with further consideration, it represented unnecessary complexity. Figures 2 and 3 were modified and streamlined per referee comments while references to figures throughout the text were improved.

It has been a pleasure to review this interesting manuscript, and I look forward to seeing it published. Should the Authors need clarification about my comments, I am fully available to them.

Daniele Maestrelli