Naples, Italy. January 23rd, 2025

***Subject*: Responses to the Referee Comments on 'Strike-slip kinematics from crustal to outcrop-scale: the impact of the material properties on the analogue modelling'**

***To*: Solid Earth Referee**

Dear Referee,

First of all, my co-authors and I would like to sincerely thank you for the extremely useful comments and suggestions that helped us to significantly improve the paper.
All the critical comments have been addressed in the revised version of the manuscript, and the suggestions were fully taken into account, as explained in the following point-by-point reply.

We are confident that this revised version of the paper has significantly improved in line with the Reviewers' comments, and we sincerely hope it will fully satisfy the high standards required for publication in Solid Earth.

Sincerely,

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Reviewer #1

I enjoyed reading and reviewing this paper. The experiments are neat and well-presented. I believe that after some revision this will become a paper that is relevant to the analog modeling community as well as folks interested in shear localization. My comments focus mainly on some structural issues with the text where a rearranging of some sections would make the manuscript flow better. I also have some suggestions for the figures to make them easier to compare. In addition, I made some stylistic and language suggestions. Detailed comments can be found in the attached pdf.

It was exciting to see a paper with experiments using GRAM. Thanks! Jacqueline Reber

R: thank you very much for your words and for the constructive comments and suggestions. We appreciated and agreed most of the in-text suggestions, as you will see in the revised manuscript.
Below, we collected and replied to the main points mentioned throughout the text.

I would suggest to change the wording to: Analog modelling techniques are a powerful tool to investigate such complex structural, kinematic, and mechanical deformation processes at various scales.

R: in the revised text, the sentence was modified as suggested.

The abstract could use some more detail on what the outcome of the study is. How did the different model materials impact the deformation pattern? How exactly is the multi-scale approach beneficial?

R: in the revised text, we reworked the abstract as suggested.

Currently the introduction is missing a clear motivation. Why are you conducting this study? Why is it relevant? You already mention the application now it just needs a couple more sentences that explain how what you do here is informing these areas.

R: as suggested, we added a few sentences in the introduction chapter to better explain the motivation of the paper:
'In this study, we present results from strike-slip experiments using four analogue materials that enabled different levels of dynamic scaling. With such comparison between models, we aim at highlighting the impact of the material properties on the analogue modelling results. The selection of the model material must be in line with the processes aimed to simulate and to the scale of resolution intended to achieve.'

So basically the model material is sand with various (or none) binding materials.

R: Yes, sand shows mechanical properties ideal for simulating natural rocks nonlinear elastic-plastic frictional behaviour, with strain hardening and strain softening, dilatancy and shear strength. Therefore, we wanted to use model materials mainly composed of quartz sand but with different dynamic scaling.

This paragraph feels out of place. It probably would fit better in the model material section?

R: this paragraph was intended to connect the previous one (explaining what materials have been used) with the following one (regarding the experiments). The missing step is about the mechanical properties and the scaling definition. However, in the revised text we reworked this part, giving less information in this stage since they would be repeated in the paragraph 4.3.

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Not sure this works as a title for the following three sections. It seems to me that the strike-slip fault system should be its own section with a pert on the observations on nature and a part with the models.
The scaling section could be combined with the method section.

R: in the revised text, we modified these headers as suggested, moving the analogue modelling scaling paragraph at the beginning of the methods chapter, as 3.1.

This is a nice summary of how to apply scaling. What is currently missing is a table where you list the scaling parameters fro all the materials used in this study. You could even consider incorporating one of your materials into the general explanation. Basically explaining the concept with your materials and experiments conditions.

I see that the table with all the numbers comes later. But my point stand, consider putting all the scaling stuff together.

R: thank you for your suggestion, however we believe that the table with the scaling parameters of the materials used in this study should be presented in the following chapters (Table 5 at the beginning of the results chapter) since at this point, we haven't introduced yet the four materials.

This is another example where I feel that putting it together with the actual results from your test would make the manuscript flow better.

R: We included this information in this methods paragraph because they are not results directly obtained in this study but derived from previous ones.

This is not quite clear. Don't all cameras acquire images? What is the purpose of this third camera?

R: This third camera is for photo acquisition independent from the DIC analysis. We clarified it in the revised text.

Please provide the values so that the reader does not have to go to the original sources if they want to follow your math.

R: They are in Table 5, which is just in the successive paragraph. However, in the revised text we recall the table also in this sentence in the revised text.

How many experiments did you do per model material?

R: It varied for type of material, with GRAM we run 15 experiments, 3 with dry sand, 3 with wet sand, and 6 with sand-clay.

I'm not sure stages is the right word. I would stick with displacement.

I would suggest to just use displacement to describe how advanced the models are. Stage and step do not make terribly much sense as we are looking at continuous deformation.

R: We realised that the words "stage" and "step" were not ideal as they can confuse since we are imposing continuous deformation. Therefore, we corrected them throughout the chapters making it clearer in the revised manuscript.

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? uplift?

R: The z-displacement is one of the DIC outputs, and can indicate uplift or subsidence, as we clarify in the paragraph 5.2.

The term structures is confusing.

R: We agree and replaced the term “structures” with “discontinuities” in the revised text in most cases.

Figure 2: I understand that the shear strain is the same between the shear stress and dH plots. It is however, a bit strange to have it only labeled on one of them (especially as it is the top one). I would suggest to add the x axis labels to all the plots.

R: Modified as suggested.

Figure 5: It's not clear to me why this figure requires the box. Do I not get it's full purpose?

R: It is not for a particular reason, it just looks better.

Figure 7: Keep the color bars (max and min values) constant between different strains in the same experiment.
Figure 8: The color bar changes between individual time steps in the same experiment. This makes it very difficult to see the actual evolution of the structures. Also consider not using a 'rainbow'-type of color scheme as they are hard to read and often not properly scaled. See Crameri et al. 2020 for more detail preferred color schemes.
Figure 10: This figure would be even better if the color bar would not change between the different model materials. I understand that this is not necessarily easy to do as some of the details are less obvious but I think it would help with making the comparison between individual materials.

R: thank you for your suggestion, we tried in the first place to compose the panels of figures 7, 8, and 9 with constant colour bars but since the displacement, shear strain, and vertical displacement reached very different values between the models it would make most of the discontinuities not visible in some models. Therefore, we decided to prioritise the visualisation of the shear zone and the different faults developing in each phase. Also, in this way the maximum value of the colour bar gives a quick information on the evolution of that parameter during the experiment for each material.
However, in the revised text we reworked these three key figures recalculating the DIC properties with a common incremental step size to enhance the comparison. Also, we used a colour scheme as suggested by Crameri et al., 2020.

Figure 9: This is still confusing to me. Is this uplift?
The same applies to this figure concerning the color bar and colormap choices.

R: The z-displacement describes uplift with the positive values (warm colours) and subsidence with negative values (cold colours), as we clarified in the paragraph 5.2.
Regarding the colour scheme, we changed it as explained in the point above.

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