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Discussions
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Interactive comment on "Influence of inherited structural domains and their particular strain distributions on the Roer Valley Graben evolution from inversion to extension" *by* Jef Deckers et al.

Alexander Malz (Referee)

malz@lagb.mw.sachsen-anhalt.de

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Dear authors and editors,

first of all, I would like to thank you for the interesting manuscript (se-2020-23), which handels with the influence of inherited structures to the reactivation potential of the Roer Valley Graben. The focus of the manuscript is of great interest to the readership of Solid Earth, particularly for that special issue on inversion tectonics. It is in general well-written and easy to read. The authors provide several illustrations that help the reader to understand the descriptions. Nevertheless, there are several issues to improve and probably make the manuscript more interesting for a broader audience. 1.

As it stands now the manuscript is more or less a local study of the RVG, which is interesting and important as well. Clarifying what we can learn from your study applicable to similar tectonic settings would highly enhance the importance of your manuscript. In the introduction you should give a short (one or two sentences) overview of the 'state of the art' in our understanding of inversion tectonics. What are the main controlling factors (mechanical weakening, fault orientation, strain distribution, thermal heating, etc.) for or typical structural features associated with inverted systems. You can then pick up these e.g. factors in your conclusions, which will provide a nice 'frame' for your observation/study. 2. A more or less general or regional overview is missing. Adding an overview map with the location of your study area would be nice. Furthermore, I was wondering about a missing illustration of e.g. a subcrop map of the base Cenozoic and a cross-section including pre-Chalk Group strata, which would help to better understand the situation. 3. As a general comment: All regional and local names used in the text should be shown in at least one figure. Keep in mind that your audience is not familar with local geographical and geological names. 4. Even if the authors concentrate on the extensional reactivation of the RVG, the RVG initially formed as a graben during Jurassic times and became contractionally overprinted during the Cretaceous. During the Cenozoic the RVG became reactivated again under extension. How are the relations - and thus the reactivation potential - between Jurassic, in parts reactivated normal faults and Cretaceous reverse faults (and footwall shortcuts)? Which faults became extensionally reactivated? Is there any relationship between mechanical weakening due to repeated fault activity or between the geometry and kinematics (fault dip or initial sense of slip) and their reactivation potential during extension? 5. The "Dataset und methodology" chapter needs some improvements. As it stands know, it is still unclear for me whether the authors made (1) a new model presented in that study, (2) made the G3Dv3-model for that study or (3) extracted parts or maps and cross-sections from the G3Dv3-model. Either in the abstract "In Flanders, a new geological model was created..." or in chapter 3.3 "...we constructed a map view..." some misleading information is provided. Therefore I strongly suggest reworking the methods

chapter to clarify what was done for exactly that study. Which software was used? Did you generate a 3D-model or a "map-based" GIS-model, etc.? 6. In chapter 4 (results) the authors should think about chapter captions and the associated text. In general, the text gives a very extensive description of individual structural features. In contrast, captions suggest that processes leading to these structures are described. Probably restructuring this chapter a little bit, would improve the manuscript. Therefor, I suggest to separate the 'results' chapter into 'description of model results' (very concise) and 'interpretation and indications for fault kinematics'. 7. Separate the chapter 5. Discuss your interpretation and afterwards precisely write your conclusion. Do not mix! 8. The polyphase evolution of the RVG make some descriptions difficult to follow. Especially in chapter 4 there are plenty descriptions of fault throws and the authors should carefully check their description. E.g. (L359-360) "Due to Cenozoic normal reactivation, only few faults in the study area have net reverse throws as the result of Late Cretaceous compression." If that is the case, how can we ensure that these faults were reactivated? Is there any indication for past fault throws on single faults? How is throw distributed on single faults (e.g. for the pre-Chalk Group strata, syn-inversion strata and rift-strata)? Do the model have the potential to show throw distribution on single faults and for single horizons (e.g. by use of Allan Maps, etc.)? If yes, that would significantly help to illustrate and understand strain distribution across the RVG. 9. Furthermore, there are some detailed comments to the text: a. L41: What means "both" here? You mention at least three stratigraphic units. b. L56: Please specify the used data. Is it reflection or refraction seismics? What kind of borehole data was used? c. L58: What means "basement" in that context? Crystalline or sedimentary "sub-décollement" strata? I suggest to clarify/define that. d. L70: Here, you mention "Chalk Group". I highly suggest to provide ages and chronostratigrapic names. Please keep in mind that most of your readers are not familar with the local stratigraphic names of the RVG region. e. L77-78: Although I understand the intension of this from the modeller's point of view. Nevertheless, it seems a little bit confusing that Mesozoic strata is named 'Cenozoic'. Probably, it would be helpful to modify/enhance the stratigraphic overview figure (Fig.

2) and include some 'real' stratigraphic horizons in relation to your 'model stratigraphy'. f. L87: Please use (or define) the names of structures. What is the Roer Valley Rift System? The Roer Valley Graben? Or is the graben a part of that system? You should check the entire manuscript and use unique names. g. L91: "main faults or those with the largest displacement" - Especially in inverted systems with a high potential to fault reactivation this definition is problematic. Delete that part or provide a definition for 'main faults'. h. L92: Please check the consistent use of abbreviations. The use of 'CB vs. Peel Block vs. RVG' in one sentence isn't good style. i. L94: What is the âĂŽOligocene Voort Formation'? That should be shown in your stratigraphic chart. j. L329-330: Contradictory numbers (150m vs. 100m)?

As said above, I strongly suggest the publication of this work. Even if this is still one local piece, such case studies will significantly improve our understanding of inversion tectonics. Furthermore, the study shows how geological modelling can help to understand even complex structures like the RVG and their kinematics. If systematically interpreted and evaluated this third - or, if analysed for various chronostratigraphical horizons as done in that study, fourth - dimension enable various new insights into 'inversion tectonics'. Some modifications and additional work will significantly improve the manuscript.

Congratulations for that very interesting contribution. Kind regards, A. Malz

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