Solid Earth Discussions

Solid Earth Discuss., author comment AC1
https://doi.org/10.5194/se-2021-17-AC1, 2021

Reply on RC1

Michael Warsitzka et al.

Author comment on "Contribution of gravity gliding in salt-bearing rift basins – a new experimental setup for simulating salt tectonics under the influence of sub-salt extension and tilting" by Michael Warsitzka et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-17-AC1, 2021

Reply to review 1 by Gaël Lymer (https://doi.org/10.5194/se-2021-17-RC1)

We thank the reviewer Gaël Lymer for the positive evaluation of our manuscript and his helpful comments. Our responses to each comment is given below. We basically agree with all of his suggestions and changed the manuscript accordingly.

Kind regards,

Michael Warsitzka on behalf of all co-authors

Comments by reviewer 1 Gaël Lymer (italic) and replies by the authors (>>):

- Line 17: Jackson and Hudec, 2017; You could also refer to Vendeville B.C. and Jackson M.P.A., 1992. The rise of diapirs during thin-skinned extension. Marine and Petroleum Geology, 9: 331–354 ; 25 yrs before Jackson and Hudec, 2017.

>> Reference was added.

- Line 49: "The oppositely acting processes of gravity spreading and gliding in SBRB provoke the question" > Arise? Raise? Ask?

>> Sentence was rephrased

The question as it is in the text feels to me that it has been answered in works by Vendeville, 1987; Vendeville and Cobbold, 1987; Cobbold et al., 1989, 1995; Brun and Fort, 2004: Gravity gliding process can occur when the base of a mobile salt layer is tilted by an angle as low as 1°. Maybe rephrase or specify "for such a case"?

>> The references listed above focus on passive margin salt tectonics, where relatively thin overburden sediments occur in downslope regions. In contrast, we focus on rift basins in which thickest sediments occur in the basin centre. Thus, results of these previous

works cannot be fully translated to the case presented in our study. We rephrased the question:

"The oppositely acting processes of gravity spreading and gliding in SBRB prompt the question of which geological configurations have to be fulfilled to initiate gravity gliding in the case of SBRB, i.e. which minimum topographic gradient and basin slope is required?"

- Line 62: "However, the influence of basin-wide tilting of the subsalt basement and, hence, effects of gravity gliding, on the evolution of supra-salt sedimentary structures and salt flow pattern have not been investigated yet."

You cite my work line 58 (Lymer et al., 2018) and I thank you for your interest in my research. This article investigated the effect of gravity gliding triggered by tilting of sub-salt basement on the evolution of geometry and structures of the supra-salt layers, thus dealing with the "effects of gravity gliding on the evolution of supra-salt sedimentary structures", although not as thoroughly as your study, hence maybe you could nuance the sentence above (L62)? :)

>> We are aware that tilting of a graben structure was modelled in Lymer et al., 2018. We rephrased to sentence slightly to emphasize that we address basin-wide tilting.

- Table 1: Your average values in Table 1 are systematically different than those I obtain, for example for max offset of sub-salt faults I obtain 2400 vs 2200 for you, which is still ok, I assumed you rounded the result? But I do not get how you obtained 60000 km for the average of the width of the flanks (I obtain 1328 from your data)? There are also inconsistencies between table 1 and the text lines 74-87 that describe the table. For example, average salt layer is 1500 m in table, stated 1800 m in text, whereas I obtain 1637 m. Please check consistency between table and text and clarify these values.

A question arising from this: For the width of the flanks, did you use 0.6 in your model (for 60000 in nature) and if so why?

>> The reviewer is correct. Some mistakes happened when inserting the values into the Latex table. We checked the values for each basin again and corrected the, if necessary (see red values in the marked version of the manuscript). Furthermore, we changed the parameter "Width of the flanks" to "Width of the basin". The graben flanks cannot be clearly distinguished from the central graben structure in some basin. Thus, the width of the entire salt basin is more meaningful.

Furthermore, we corrected the related values in the text to be consistent with the Table. The table was moved to the appendix (Appendix A in the revised version of the manuscript) to save some space in the main text.

- 3 Method - The apparatus and scaling of the models are well presented, the relationship between model and natural scales are well defined for a large range of parameters; they are in agreement with typical other studies and seem to fall within natural ranges of parameters rates. However, I think it would be good to clarify how you designed the dimensions to the model in link with your table 1 (see question above).

>> We agree and added a sentence in the first paragraph of section 3.1.

- Line 208: "We choose intermediate rates 1mmh−1 for practical reasons so that a simulation duration of several hours to a few days is achieved." I was about to ask for further discussion on effect of rate of extension but lines 366 & 437 suggest that it is in your plans; I am looking forward to it :)

>> Yes, we are working on that topic and plan to perform a parameter study in future.

- 4 Results - If there is a room in the figures presenting the different experiments (§, 7, 8, 9, 10, 12), I think it would help the reader to show a schematic cross section of the model geometry, maybe at the beginning and the end of experiment?

>> We agree and added a cross section view of each experiment, which illustrate the final deformation structures and the topography. This cross section will help the reader to better understand and interpret the top view displacement and strain patterns.

-Line 356: "the the graben centre." delete "the"

>> Word was deleted

- Line 356: "We suggest that basin-margin fault zones and shortened graben fault zones, in particular if they are active subsequent to the rifting, are diagnostic indicators for the influence of gravity gliding on the structural dynamics in natural rift basins."

This phrase has been a little confusing to me (e.g.; "shortened graben fault zones" could refer to fault inversion for some people), maybe reword? Also, I wonder how an observer could identify a fault zone that has been shortened and thus use this as a diagnostic indicator for the influence of gravity gliding. Can you provide clues?

>> "shortened graben fault zones" might be indeed laterally compressed extensional faults zones. At the beginning of the model evolution, the cover next to the graben is extended. Later, during increased flank tilting, these extended zone is shortened due to gravity gliding. Thus, clues for gravity gliding could be thin-skinned inverted normal faults in downslope regions of the rift basins. Nevertheless, we rephrased the sentences to emphasize that we mean thin-skinned shortening in the supra-salt overburden.

- Line 359: "The experiment with syn-kinematic sedimentation (ETS1) demonstrates that the ability of downward gliding is reduced by sediment accumulation in the basin centre. In particular during the post-extensional phase, gravity driven deformation decreased rapidly after the first post-extensional step of sand accumulation."

This is similar observation than for gravity spreading (Rowan, M. G., F. J. Peel, and B. C. Vendeville, 2004, Gravity-driven fold belts on passive margins, in K. R. McClay, ed., Thrust tectonics and hydrocarbon systems: AAPG Memoir 82, p. 157–182) and could be worth mentioning as these gravity-driven mechanisms are essentially similar.

>> We agree and added a sentence citing this reference.

- Please move figure 14 to main text (currently after the references).

>> Latex does this automatically. This will be fixed during final editing of the manuscript