Solid Earth Discussions

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# Comment on se-2021-17

Gaël Lymer (Referee)

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Referee 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-RC1, 2021

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The preprint entitled "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 Warsitzka et al. investigates salt flow and evolution of the structures generated by associated gliding of the supra-salt layers at salt bearing rifted basins.

The authors have designed a new analogue apparatus permitting to separately test a range of parameters (pure extension without tilting, pure uplift of the flanks without extension and combined motion of graben and flanks) influencing supra-salt structures during basin evolution.

The goal of the paper is to demonstrate the main functionality of the experimental procedure and setup of the apparatus, which is successfully done in my opinion.

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 at my knowledge fall within natural ranges of parameters rates. The approach permitting to separately test different modes of basin evolution is very interesting and the results are clearly showing the effects of different parameters. The observation that salt flow continues toward the graben even after extension has stopped, or that syn-kinematic sedimentation in the graben reduces downslope gliding, are well demonstrated. The limitation of the procedure and the required simplification of the system are well described and discussed, and the results obtained are also convincingly compared with a range of natural salt basins observed from seismic data.

I have only a few questions and suggestions listed below, with my main concern being inconsistencies in the data presented in table 1 (see specific point below).

Other than that. the article is well illustrated and well written (I found one typo, line 356), and the presented research fully fits with the scope of Solid Earth journal, thus I recommend to publish the preprint after solving the minor points below.

Best regards,

Gaël Lymer

- 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.

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

- Line 49: "The oppositely acting processes of gravity spreading and gliding in SBRB provoke the question, which geological configurations have to be fulfilled to initiate gravity gliding in SBRB, i.e. which minimum topographic gradient and basin slope is required?"

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"?

- 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)? :)

- 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?

- 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).

- 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 :)

- 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?

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

- 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?

- 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.

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