

Interactive comment on “Thick- and thin-skinned basin inversion in the Danish Central Graben, North Sea – the role of deep evaporites and basement kinematics” by Torsten Hundebøl Hansen et al.

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Dear editors and authors,

The authors present detailed seismic mapping and careful observations to examine the role of the Zechstein detachment in decoupling thin- and thick-skinned structures during inversion tectonics in the Danish Central Graben. This work provides another case study that reinforces the important role that mobile salt detachments can play in controlling the structural evolution of extensional and inverted basins. Overall this paper

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provides a very interesting contribution to salt-influenced inversion tectonics and will surely be of interest to the structural geology community and Solid Earth readership. The paper is well-structured with observations and interpretations clearly separated for the most part. With some improvements, as detailed below, I would recommend this paper for publication in Solid Earth.

General comments

A key issue with the paper as it stands concerns the use of given names for many of the structures, sub-basins and other local features in the area (e.g. Bo-Jens Ridge, Arne Ridge, Arne-Elin Graben, Tail-End Graben, Poul Plateau, Mads High, Roar Basin, etc.). These names are frequently referred to in the text without a figure call-out showing their location. At times this makes it very difficult for someone unfamiliar with the area to remain spatially oriented. Whilst it may not be possible to put the location of all features on a composite map due to the different structural levels, the authors need to carefully ensure that every time a given name is referred to in the text, a corresponding figure citation shows its location. I have highlighted some examples in the attached pdf.

As well as keeping the reader spatially oriented, more figure call-outs are needed generally to support observations described in the text. Any sentence that describes a structure observed in the data needs an appropriate figure call-out at the end - preferably both a cross section and map view, not just one or the other - for the reader to visualise the structure in 3D. The figures presented in this paper are well-illustrated and very informative and more use of these figures should be made in the text. Do not assume that the reader will take your word for it or will remember from a previous section which figure that structure is shown in. I would also recommend that to avoid confusion the figure numbers correspond to the order in which they are called out in the text.

Specific comments

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The key mechanism proposed to explain the decoupling between slip on thick-skinned basement faults and the thin skinned salt-detached faults involves the 'triangle zone' theory (L461 – L474). This conceptual model succeeds in explaining the formation of thin-skinned backthrusts with relatively little evidence of inversion on the basement faults. However, it is difficult to understand the mechanism proposed in this paper without the reader already having an intimate knowledge of the work of Stewart (2014). I would recommend that either the schematic presented in Figure 13 be modified to include additional steps which explain the triangle zone theory as applied in this context, or that a simplified schematic such one taken from Stewart (2014) be added. In that case the reader is not required to revise the work of Stewart (2014) in order to understand the present paper.

I would also urge the authors to consider whether the triangle zone theory is the only way of explaining the observed relationship between hangingwall synclines and salt detached faults. The possibility of local thin-skinned gravity gliding on a dipping detachment is lightly touched upon in the paper, but it is not clear to me why the authors ultimately favour the triangle zone model over a local gravity-driven gliding model. And if the triangle zone model best fits the observations, what role did gravity driven deformation play, if any?

Finally, some additional clarification would be beneficial to explain why the salt detachment does not appear to decouple thin- and thick-skinned structures in the same way along segment 3 of the Coffee Soil Fault (L483-L490). This is an interesting assertion that may have wide applicability to other salt basins. The authors propose that this region may not be at a 'favourable angle' but this idea requires unpacking. Is there a mechanical explanation for the favourable orientations? Could there be other factors at play?

Small technical corrections such as typos and other comments are highlighted in the attached pdf. I hope that my comments help the authors improve the quality of the manuscript and I congratulate them on an interesting and thorough piece of work.

C3

Please also note the supplement to this comment:

<https://se.copernicus.org/preprints/se-2020-127/se-2020-127-SC1-supplement.pdf>

Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2020-127>, 2020.