

## ***Interactive comment on “Pre-inversion normal fault geometry controls inversion style and magnitude, Farsund Basin, offshore southern Norway” by Thomas Brian Phillips et al.***

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In this publication the authors deal with faults and inverted graben structures along the western part of the Sorgenfrei Tornquist Zone (STZ). A prominent basin in this region is the Lower Cretaceous Farsund Basin. Within the manuscript the authors interpret on the base of a comprehensive seismic mapping study and additional well analysis the structural history of this structure and especially focus in detail on the uplift and exhumation history. The differences of two in structural style different inversion/uplift events were described in detail - the Late Cretaceous and a Neogene event. The estimates of uplift and erosion of this region provide important information for assessing

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the importance of the STZ during the Late Cretaceous and Neogene in the context of the Central European Basin System. Furthermore, the authors show that the structures in their study area are segmented and that the structural inversion had different effects on individual sections of the Farsund basin. Possible causes for that are discussed in detail in the manuscript. The subject matter is well presented in the manuscript. Most illustrations contribute to understanding of the manuscript in their current form. The manuscript provides important new insights into the structural development along the STZ. For this reason I recommend publishing the manuscript after moderate revisions have been made.

Detailed comments can be found in the annotated PDF in the supplement. The main points of the review are briefly summarised below:

- 1.) The authors should explain more clearly their definition of "inversion" and "reactivation". Are all the interpreted parts of the structure which show uplift/erosion are inverted? Or is inversion one structural style of shortening along the whole structure? Is inversion the effect of shortening or as well of other processes? Is the term "inversion" used as umbrella for structural inversion as well for basin inversion? Compressional/transpressional reactivation/shortening is perhaps the better umbrella term. Unfortunately not so handy in the description. Inversion as reverse reactivation of faults, and uplift of grabens & basins is not the only effect of Upper Cretaceous shortening. In some areas only basement flexures and steep reverse-faults can be detected.
- 2.) Can the uplift, especially the Neogene, be explained by other processes as shortening (e.g. dynamic topography)? And can the Neogene Uplift which is not clearly related to structures or basins really be called inversion?
- 3.) Not the Alpine-Carpathian orogeny is the reason for Late Cretaceous shortening of structures in the CEBS, but it's the result from Africa-Iberia-Europe convergence. Greater parts of the alps show an extensional setting during the Cretaceous. But the Pyrenees were active during this time.

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REF: -Kley, J. & Voigt, T. (2008): Late Cretaceous intraplate thrusting in central Europe: Effect of Africa-Iberia-Europe convergence, not Alpine collision. *Geology*, 36, 11: pp. 839-842. DOI:10.1130/g24930a.1

4.) Please avoid "unclear relations", generalisations like: - Late Cretaceous inversion (Late Cretaceous shortening has not only produced inversion structures.) - Neogene shortening (the mechanism behind Neogene uplift is still under discussion) - Alpine compressional stresses - Alpine inversion - Late Cretaceous-Neogene inversion (The link with hyphen is misleading, since there were long pauses between events.)

5.) What is with in literature described indications of Paleogene uplift of this region?

REF e.g.: -Clausen, O.R., Nielsen, O.B., Huuse, M. & Michelsen, O. (2000): Geological indications for Palaeogene uplift in the eastern North Sea Basin. *Global and Planetary Change*, 24: pp. 175-187.

-Japsen, P., Green, P.F., Nielsen, L.H., Rasmussen, E.S., Bidstrup, T., 2007a. Mesozoic–Cenozoic exhumation events in the eastern North Sea Basin: a multi-disciplinary study based on palaeothermal, palaeoburial, stratigraphic and seismic data. *Basin Res* 19, 451-490.

Please discuss more the definition and proof of the uplift events presented here. Are others to be excluded or just not to be recognized or verified by the applied analytics?

6.) a map of data coverage in relation to the interpreted structures would be useful

7.) some questions of understanding to the data & methods chapter (see comments in the annotated PDF in the supplement). If possible, please make additional insertions in the text for better understanding.

8.) To "6.3 Localisation of inversion along pre-existing structures" line 448: Huyghe & Mugnier (1994, 1995) point to the relationship between rifting, the time elapsed thereafter and the potential for reactivation/inversion of the structure. So maybe the fault-reactivation and structural inversion with anticlinal folding is a consequence that

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compression in a properly aligned vector meets with the Farsund Basin a young "fresh" graben.

REF: -Huyghe, P. & Mugnier, J.L. (1995): A comparison of inverted basins of the Southern North Sea and inverted structures of the external Alps. (In: Buchanan, J.G. & Buchanan, P.G. (Eds.): *Basin Inversion*). Vol. 88: pp. 339-353; London (Geological Society Special Publication).

-Huyghe, P. & Mugnier, J.L. (1994): Intra-plate stresses and basin inversion: A case from the Southern North Sea. (In: Roure, F. (Ed.): *Peri-Tethyan platforms*). pp. 211-226; - (Éditions Technip).

-Huyghe, P. & Mugnier, J.L. (1992): Short-cut geometry during structural inversions; competition between faulting and reactivation. *Bulletin de la Société Géologique de France*, 163, 6: pp. 691-700.

8.) "488-490: We suggest that the likelihood of a structure to be reactivated and undergo inversion is not solely related to the size and 'weakness' of the structure; the relative complexity of the structure also plays an important role."

Your presented seismic profiles show only the top 6 sec. twt of the strat. column. What information do the authors have about the geometry and complexity of the fault with the depth. A complex fault pattern in the most upper strat. column does not have to mean that the fault in the deeper section must have a complex geometry.

9.) Can statements about the amount of shortening during the Late Cretaceous and during "the Neogene" (if this event is related to shortening) be made?

10.) Various comments on illustrations (Please see the annotated PDF in the supplement). - Figure 3 and 11 in particular should be adapted.

Please also note the supplement to this comment:

<https://www.solid-earth-discuss.net/se-2020-27/se-2020-27-RC2-supplement.pdf>

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