



EGUsphere, referee comment RC1  
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## **Comment on egusphere-2022-26**

David Ferrill (Referee)

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Referee comment on "The analysis of slip tendency of major tectonic faults in Germany" by Luisa Röckel et al., EGU Sphere, <https://doi.org/10.5194/egusphere-2022-26-RC1>, 2022

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Review of "**The analysis of slip tendency of major tectonic faults in Germany**" by Luisa Röckel, Steffen Ahlers, Birgit Müller, Karsten Reiter, Oliver Heidbach, Andreas Henk, Tobias Hergert, Frank Schilling.

Review by David A. Ferrill

### **GENERAL**

The manuscript provides new slip tendency analyses to constrain the potential for fault activity in Germany, which is important for assessing seismic hazard as well as other fault related processes such as energy extraction and subsurface disposal or storage activities. This is a very interesting manuscript – the material should be of interest to a broad readership, and make a very nice contribution to Solid Earth.

My greatest concern with the article is that, for the article to stand alone and be easily understood, it needs to illustrate the regional stress field and provide representative slip tendency plots. Lacking this information, the slip tendency fault maps are difficult to understand and the related description is rather abstract.

A second concern is related to the justification for the assumption of a vertical fault set. This vertical-fault assumption needs to be (i) justified by providing the geological basis for assuming the faults are vertical, or (ii) explained with appropriate caveats provided regarding impacts of an incorrect assumption on slip tendency results for the stress fields of Germany.

Below are several specific comments and suggestions that could help improve the manuscript. Additional editorial comments are marked in an annotated pdf that will also be provided with this review.

## **SPECIFIC COMMENTS**

### **Description and illustration of stress states and slip tendency plots for study area (Section 2.1, 3D Stress State):**

What are the stress regimes in Germany? This section should summarize the stress state of the study area in terms of stress regimes (e.g., normal faulting, strike-slip faulting, thrust faulting), maximum horizontal stress directions, and variation as a function of depth. In present form, the paper relies on Ahlers et al. (2021), and discusses the stress analysis methodology of Ahlers et al. (2021) but not the result of that analysis which is a primary input for the slip tendency analysis in this paper.

The manuscript would be greatly improved by illustrating the stress states by providing a map with representative slip tendency plots for subregions. Specifically, I recommend a map similar to figure 7 in Morris et al. (2021). Such a map would convey not only stress orientations, but also stress regime (cf. figure 1 in Morris and Ferrill, 2009, The importance of the intermediate principal effective stress ( $\sigma'_2$ ) to fault slip patterns. *Journal of Structural Geology* 31, 950-959). Because of the variation in regime as a function of depth indicated by figure 11 of Ahlers et al. (2021, *Solid Earth*), it may be necessary to provide maps with representative slip tendency plots at two depths.

### **Assumption of "Vertical fault set" (Section 2.2):**

Is there a technical basis for the "vertical" assumption, or is this just a matter of convenience? This assumption has major impact on slip tendency, and results are highly sensitive to stress regime. Please provide (i) a geological basis for assuming the faults are vertical rather than some other dip angle, and/or (ii) a rationale for making the assumption, with acknowledgement that -- if wrong -- this assumption can introduce large error in slip tendency calculation. Vertical faults may be ideally oriented for slip in a strike-slip stress regime, whereas vertical faults are never ideally oriented for slip in normal faulting or thrust (reverse) faulting Andersonian stress regimes. Therefore, the vertical-fault assumption will tend to skew slip tendencies lower values for stress regimes other than strike-slip regime.

### **Results Section 3.1 – Vertical fault set:**

Manuscript states that “Results near surface are visualized” (Line 115): What depth, and why near surface? Earthquakes tend to nucleate at significant depth rather than near the surface.

As noted earlier, if not correct, the vertical fault assumption is problematic and may artificially skew slip tendencies lower for stress regimes other than strike-slip regime where vertical faults are ideally oriented for slip. It would be good to acknowledge this in this results section

### **Subscripting for slip tendency symbols:**

In all figures and throughout article, need to be consistent with subscripting of  $T_s$ ,  $T_{s\text{norm}}$ ,  $T_{s\text{eff}}$ , and  $T_{s\text{normeff}}$  for consistency with text.

### **Referencing:**

Although cited in the text, Morris et al. (1996) is missing from the reference list:

- Morris, A.P., Ferrill, D.A., Henderson, D.B., 1996. Slip tendency analysis and fault reactivation. *Geology* 24, 275–278.

Recommend citing the following paper in the Introduction (Line 41) as a very careful example of regional slip tendency analysis of 3D faults:

- Morris A.P., Hennings, P.H., Horne E.A., Smye, K.M., 2021. Stability of basement-rooted faults in the Delaware Basin of Texas and New Mexico, USA. *Journal of Structural Geology* 149, 104360.

Please also note the supplement to this comment:

<https://egusphere.copernicus.org/preprints/2022/egusphere-2022-26/egusphere-2022-26-RC1-supplement.pdf>