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Reply to the comment by Joschka Röth

Michal Kruszewski et al.

Author comment on "In situ stress database of the greater Ruhr region (Germany) derived from hydrofracturing tests and borehole logs" by Michal Kruszewski et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2022-196-AC4, 2022

Dear Joschka,

Thank you very much for your comments. They really helped us to improve the quality of our manuscript and posed some new and interesting questions regarding the importance of the regional tectonics. What we would like to, however, emphasize, that the main scope of our study is to provide a high-quality in situ stress magnitude and orientation dataset (and its detailed description) and to present ways of how this dataset can be used for future studies. We encourage, however, to use our dataset to motivate future studies related to topics of e.g., regional geology or tectonics. Please see below our answers to your comments in detail.

With Best Wishes,

Authors

Comment: “In this context, what are 1900 m of depth below surface (your studied formation) compared to dozens of km horizontal movements that occured at the nearby Osning Fault?”

Author reply: We are not perfectly sure what the question is. Did you mean, how the Osning fault, being the limit of the Variscan Deformation Front, influenced our hydrofracturing test results? Such speculations would go far beyond what our data is able to provide. We encourage, however, future studies to use our dataset in combinations with modelling techniques to investigate such influence. However, from other studies, that we are about to publish, we conclude that at a distance of 500 – 1000 m from an active fault the impact of the stress magnitudes is rather small compared to the uncertainties of the stress magnitude data.

Locally the stress orientation can be, however, influenced by fault zones. In more homogenous sections, were no faults crosscut the rock mass, the stress orientations measured during hydrofracturing tests will reflect the actual far field stress. This could be seen e.g., in the “Heldburger Gangschar”, which shows numerous dikes from Tertiary (Miocene) which crosscut all older structures and faults without any visible stress rotations.

Comment: "What does it mean when your data agrees with the regional stress regime (Shmax = +/-160 degrees)? What is the cause for this orientation? Did this stress orientation change over time? What are the major tectonic features in the surrounding?"

Authors reply: The mean orientation of S_{Hmax}, based on our and previous studies from the region, amounts to a value of 161 +/- 43°. This means that there is a high variability of the S_{Hmax} orientation in the region. The data that was used to compute this value is based on the present-day stress indicators (i.e., hydrofracturing tests and borehole breakouts) and, therefore, it represents the orientation of the currently acting SHmax. The main cause of the present-day stress orientation of the greater Ruhr region can be perhaps the best explained as a combination of the ridge push from the central and northern segments of the Mid-Atlantic ridge and the northwards directed push of Africa with respect to Europe. The (paleo)stress state has change over time (and in different geological periods) where the area, except of the Variscan orogeny and its deformation front, was affected by the tectonic movements of the Late Triassic, Late Cretaceous transpression, and the Tertiary extensional movements (Drozdzewski, 1993). For more detailed information on the regional tectonics please see Drozdzewski (1993) and Drozdzewski et al. (2009); we add both of these references to our manuscript. We also add the main tectonic features to the chapter "Geological Setting" in our manuscript.

Comments: What I am missing in your analysis / discussion is the regional tectonic context.

Authors reply: We accept this comment and additional information and references to the "Geological Setting" chapter as well as briefly discuss the regional tectonic context of our data in the "Discussion" chapter.

Comment: Last but not least, the Alpine Orogeny definitely contributes to the present-day stress field in your study area, however the Alps and their far-field tectonic effects (i.e., basin inversion in Northern Germany and platform tilting in the south) are not mentioned in the text.

Authors reply: We agree with the comment and include the Alpine Orogeny to the text of the manuscript.

We would like to also thank for the extensive list of additional literature. We decided, however, not to include these, as we believe that they are not directly relevant to the focus of our paper.

References:

- Drozdzewski, G. (1993). The Ruhr coal basin (Germany): structural evolution of an autochthonous foreland basin. International Journal of Coal Geology, 23(1-4), 231-250.
- Drozdzewski, G. H., Hoth, P., Juch, D., Littke, R., Vieth, A., & Wrede, V. (2009). The pre-Permian of NW-Germany structure and coalification map. Zeitschrift der deutschen Gesellschaft für Geowissenschaften, 159-172.