Dear Daniel,

thank you for your questions. We are coming back with answers.

In the end, the present-day in situ stress state of the greater Ruhr region is far from simple. Due to more than 700 years of coal mining activities across the region (i.e., rock withdrawal and pore pressure reduction due to pumping out of the water from the mines, as well as recent mine flooding operations), it is expected that the in situ stress state "situation" has changed significantly. The hydrofracturing tests we have analysed, although being located around 40 meters away from the mine infrastructure, can be still considered to be located within the mine's local sphere of influence. Thus, we expect that the derived stress magnitude values besides general measurement errors have also systematic errors (assuming that the undisturbed stress components are being measured). These uncertainties as well as the ones resulting from fault geometry assumptions and pore pressure values (see below) need a sound assessment to derive uncertainties and mean values of the slip tendency. The value that we present is only from a single set of parameters and should be interpreted with caution and we will make this clearer in the paper to avoid conclusions by the reader that are not robust.

Regarding the pore pressure the hydrofracturing tests recorded very low or zero values. These negligible pore pressures could be explained by i) impermeable rock mass (mentioned in the manuscript and exemplified with low permeability values registered during in situ testing) and ii) long-term mine water drainage (ongoing until this day) which led to significantly low pore pressure values within the mine and in its close vicinity. Additionally, fluid withdrawal in the Ruhr region could lead to a significant poro-elastic stress changes induced by the reservoir compaction (Segall & Fitzgerald, 1998; https://doi.org/10.1016/S0040-1951(97)00311-9). It has been also observed in the Ruhr region that the mine flooding operations produce a significant amount of microseismicity, potentially proving the criticality of the geological structures in the area and a significant amount of stress changes created by the mining activities (see: https://doi.org/10.23689/fidgeo-4002 and https://doi.org/10.23689/fidgeo-5401). We have, anyway, used the stress measurements from mines to construct total stress gradients of the area. Figure 6 presents a normalized stress polygon based on the assumption of no pore pressure with values of stress registered in coal mines and coal bed methane wells.
For the computation of the slip and dilation tendencies, we assumed that the pore pressure is present in the area at 1.2 km depth. This is due to the fact the pore pressure reduction by dewatering activities is a local phenomenon and areas located away from coal mines (or dewatering stations) are expected to remain unaffected. In the end, the pore pressure field of the greater Ruhr region remains relatively unknown. From the recent mine flooding operations in the area, it is known that in some coal mines the water level is located at depths between 0.6 to 1.2 km (see Fig. 1). Such water table reduction would mean a decrease in pore pressure values between approx. 6 and 12 MPa and showcase that local pore pressure differences will be significant in the region. Such pore pressure changes will drastically change (i.e., decrease) the slip tendencies of major faults in the region. We could agree that the assumption of the abnormally high pore pressure, we did in the manuscript, could be seen as a bit of an exaggeration. The abnormally high pore pressure values were assumed from the recent study by Kruszewski et al., 2021 (https://doi.org/10.1007/s00603-021-02636-3), where they established that elevated pore pressure gradients could be observed in the Ruhr region (based on a high density of water samples in the coal mines and recorded drilling fluid densities from the exploration drilling campaigns in the region). For simplicity, we agree on amending the pore pressure values in the computation of slip and dilation tendencies to a hydrostatic pressure of cold water starting from the surface (i.e., with a pore fluid density of 1000 kg/m3 the pore pressure at 1.2 km depth will amount to approx. 11.8 MPa). In this way, as you pointed out, the slip tendencies will stay below 0.75 (please see Fig. 2 for a new map of slip tendency).

The main scope of our study was, however, to present in situ stress magnitude and orientation data compilation. The slip and dilation tendencies presented in the manuscript were just one of the possible applications of this data set. The effects of pore pressure influence should be, however, investigated in follow-up studies using our database as a reference. Additionally, we would recommend performing in situ measurements in areas not affected by the coal mines (e.g., south of the Ruhr region) to compare with the ones performed in coal mines. I hope that cleared out your doubts and please do not hesitate to reply to this reply.

Please see figures to this reply in the .zip file in the attachment.

Best Wishes,

Authors

Please also note the supplement to this comment: https://essd.copernicus.org/preprints/essd-2022-196/essd-2022-196-AC1-supplement.zip