In the following, I will comment and reply to the review of Referee #1 from April the 22th, 2021.

To be able to distinguish well, I use the following colour code:
Reviewer comments in italic and dark green (Ref#1)
My comments in black and normal letters (KR)
Changes are indicated in dark blue

KR: First of all, I have to thank Referee #1 to read and review the manuscript again carefully and in detail. All proposed changes are well thought out. Therefore, the most suggestions have been adopted. However, two out of them cannot be implemented suitable. I will explain that in detail below.

Ref#1: The author modifications improved the overall quality of the manuscript, the writing, and the structure. The author provided detailed replies to my previous comments. Furthermore, the modifications in Figure 11 and the new Figures (Table 1 and Figure 13) are valuable assets to this publication. However, in places, I found that incorporating further some of the contents of the author's replies within the manuscript could be valuable for the readers (see main comments below). Besides, although the text has been improved from the first version, I found that there are still some unclear sentences (see some potential suggestions in technical comments). For this reason, I suggest the publication of this manuscript after a Moderate revision.

Main comments
Ref#1: Table 1 is a summary of previous works from the literature. I think this table is a great asset in the publication. However, most of the data in this table show maximum values of rotations of 90, which is somehow not very informative. Maybe providing other values, like an average rotation or a rotation at a distance from the perturbation sources could be more informative. Besides, a value of 90 could also correspond to a stress permutation between Sh and SH, which can be related to changes in the magnitudes of the stress rather than the rotation of the stress. This may be somehow worth discussing to avoid confusion.

KR: I understand quite well the intention of the referee. The most of the entries in the list uses numerical models, which are based on a certain mesh. The problem is, that the mesh resolution is poor, especially for the older publications. Next to other aspects, potential stress rotation depends on the amount of elements between a transition and the observation point. Therefore, providing a distance would be rather a measure for the mesh resolution than for the distance. The same applies to an average value or observed range or rotation. There is already an indication, whether the rotation is within or larger than 10 km away from the specific transition. Therefore, I propose to leave it as it is.
I agree, a stress rotation of 90° at a certain location is most probably the result of a magnitude change. But the spatial distributed gradual rotation of SH (e.g. Lund Snee&Zoback, 2016, 2020, Heidbach, 2018) could not be explained with that argument.

Ref#1: The author clarifies the initial stress conditions by adding Section 4.4. The author also clarifies the boundary conditions in his reply and Section 6.2 of the manuscript. Even if this is now clearly stated in Section 6.2, I will suggest adding a few general sentences in section 4.5 for the readers. For example: "The boundary conditions are defined by displacement. They are calibrated on the reference model. The same boundary conditions are applied to all the different models."

KR: The proposed change is now used.: '… which are technical applied by a defined lateral displacement. … a good fit of the reference model…. The determined boundary conditions are used for all models.

Ref#1: The author answered the comments concerning the dip of the contacts between the units in his reply. Here again, maybe adding some of the information from the reply in Section 4.1 will be valuable for the readers. For example: "More complex geometries and variable dip angle may result in different stress patterns as the ones obtained for vertical discontinuities, however, studying such variability is beyond the scope of this paper."

KR: The proposed change is now used.: "More complex geometries and variable dip angle may result in different stress patterns as the ones obtained for vertical discontinuities. However, studying such variability is beyond the scope of this study."

The choice of the material properties is now more clearly discussed in Section 6.2 and the potential effect of failure are also discussed in Section 6.7.
I found the discussion interesting and detailed. But it is a bit difficult to follow, partly due to the numerous sections, which are sometimes very small. For simplification, maybe the author could group Sections 6.1 and 6.2. Similarly, maybe Section 6.4 could be incorporated in Section 6.5.

KR: The proposed grouping of sections is now used.

Technical comments
Ref#1: L.12: 'the horizontal stress orientation' maybe remove 'orientation'.

KR: The proposed change is now used.

Ref#1: L.13: 'in the order of up to 78' remove 'in the order of'.

KR: The proposed change is now used.

Ref#1: L.14: 'not only regions near the material transition (<10 km) are affected by this stress rotation' this is unclear.

KR: "…even beyond the vicinity of the material transition (>10km)."

Ref#1: L.232: See also Roche and Van der Baan 2015 and 2017 for references. (Roche, V., & Van der Baan, M. (2015). The role of lithological layering and pore pressure on fluid-induced microseismicity. Journal of Geophysical Research: Solid Earth, 120(2), 923-943.).

KR: Both papers provide interesting work. However, to use the reference at that point would be incorrect. In the case, I understood correctly, Roche and van der Baan uses uniaxial and/or lithostatic stress conditions as initial stress state. The Poisson's ratio is varied vertically, depending on the lithology. The here used method varies the Poisson's ratio stepwise within the whole model.

Ref#1: L.240: 'imagined' maybe 'virtual' is a better term.

KR: The proposed change is now used.

Ref#1: L.268: 'Mechanical' replace by 'Mechanically'.

KR: The proposed change is now used.

Ref#1: L.270: 'Therefore, the unit stiffness are from the deformable to the rigid ones: RHZ _ NPZ < STZ < MGCH _ MZ' This is not very clear. Also, replace 'stiffness by stiffnesses'.

KR: This sentence has been re-written: 'Therefore, the unit stiffnesses are different: they are from slightly deformable to rigid in the following order RHZ ≈ NPZ < STZ < MGCH ≈ MZ.'

Ref#1: L.278: 'no rotation is to observe' replace by 'no rotation is observed'.

KR: The proposed change is now used.

Ref#1: L.279: 'turns more counter-clockwise' remove 'more'.

KR: The proposed change is now used.

Ref#1: L.286: 'in the large density units' remove 'the'.

KR: The proposed change is now used.

Ref#1: L.300: 'Within the models having three' replace by 'For the models with three'.

KR: The proposed change is now used.

Ref#1: L.317: 'of a significant Young's modulus contrast with a cohesionless contact' replace by 'between a significant Young's modulus contrast and a cohesionless contact'.

KR: The proposed change is now used.

Ref#1: L. 321: 'point out significant larger rotation than for the stiff units' replace by 'shows larger rotations than the model with stiffer units'.

KR: The proposed change is now used.

Ref#1: L.324: 'In the models with the alternating stiffness with the low friction discontinuities (|E|e|E| and |e|E|e|) generate' replace by ' The models with alternating stiffnesses and low friction discontinuities (|E|e|E| and |e|E|e|) generate'.

KR: The proposed change is now used.

Ref#1: L.334: 'The same can be observed less pronounced in the observed SHmax orientation' replace by 'In Figure 11c, these areas show similar, but less pronounced, rotation of Shmax'.

KR: The proposed change is now used.

Ref#1: L.343: 'It is really unlikely that … as a result'. This is not clear, replace by 'Chosen properties are constant over a depth of 30 km, which is unlikely. Even for a given lithology, the properties can change with depth, as a result of'.

KR: The proposed change is now used.

Ref#1: L.394: 'only 31 rotation' 'only a 31 rotation'.

KR: The proposed change is now used.

Ref#1: L.404: remove capital at 'model'.

KR: The proposed change is now used.

Ref#1: Figure 3: 'Poissons ratio' replace by Poisson's ratio

KR: The proposed change is now used.

Ref#1: Figure 12: 'counterbalances' replace by 'counterbalance'

KR: The proposed change is now used.

Ref#1: Figure 13: replace max. rotation [°].

KR: The proposed change is now used.