Solid Earth Discuss.,
https://doi.org/10.5194/se-2020-17-AC2, 2020
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Solid Earth Discussions

Interactive comment on "Resolved stress analysis, failure mode, and fault-controlled fluid conduits in low-permeability strata" *by* David A. Ferrill et al.

David A. Ferrill et al.

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Received and published: 2 April 2020

Comment – The paper "Resolved stress analysis, failure mode, and fault-controlled fluid conduits in low-permeability strata" by Ferrill et al., is well organized and deals with the very interesting topic of mechanical models (generally speaking) where the authors are very expert. I really enjoyed reading it.

Author's Response – Accept – Thank you for the positive feedback!

Author's Change in Manuscript – No change needed to address this comment.

Comment – The paper follows some previous works extending theoretical models to

real faults deeply studied previously by the same authors. In light of this, the boundary conditions of the applied mechanical model should be very well explained and constrained, in my opinion, in order to give to the reader all the instruments to completely understand the meaning of the results. This is the part of the paper that I think should be improved.

Author's Response – Accept.

Author's Change in Manuscript – Additional detail to address stress and geomechanical assumptions and interpretations will be included in the revised manuscript.

Comment – In particular it is not clear to me for example what are the constraints for the hypothesized pore pressure, being this quite high (lambda over 0.7). The same for the mechanical properties of the involved lithologies proposed in Figure 6. No indication is reported along the paper about the source for the adopted mechanical data such as for example cohesion and coefficient of friction.

Author's Response – Accept.

Author's Change in Manuscript – Additional explanation of pore pressure, stress, and geomechanical assumptions and interpretations will be included in the revised manuscript.

Comment – Keeping the focus on Fig. 6 the proposed model is not clear to me. Since no build-up processes for fluid pressure are invoked along the text, if I well understand, rocks will fail in the initial stage, for a decrease of the sigma 3 being the system in an extensional regime. This bring mudrock to break first as showed in the model. Thus, at this time, a decrease in pore pressure is expected since, generally speaking, a rupture is related to an increase in permeability/porosity that lead to a decrease in pore pressure. However, following the model, a continuous process of build up for fluid pressure should be present in the system in order to overcome the sigma 3 and bring to hydraulic fractures on chalk. So I am wondering how can we reach the condition for

high overpressure on chalk if a rupture already occurred on mudrock. That said, should we assume different boundary conditions for mudrock and chalks and reconsider figure 3?

Author's Response – Because of different mechanical properties of mudrock and chalk, response to loading conditions produces significantly different pre-failure responses in mudrock versus chalk, and therefore different effective stress conditions from one mechanical layer to the next through the section. We are not specifically interpreting whether mudrock or chalk failed first. However, the repeated occurrence of refracted fault propagation through the section, contrasting mechanical properties of chalk and mudrock, and absence of widespread hybrid failure in chalk beds or shear failure in mudrock that is unassociated with larger multi-bed faults, suggests distinctly different effective stress conditions in mudrock and chalk shown in Fig. 6b likely coexisted in adjacent beds during fault propagation.

Author's Change in Manuscript – Text will be modified in the manuscript revision to further clarify this point.

Comment – In conclusion I think that this very interesting paper deserves some more rigorous constraints for the applied mechanical model. Moreover, a more comprehensive discussion on the model implication and on its evolution over time and space will strongly improve the paper together with a comparison with results from other authors (see line to line comments).

Author's Response – Accept.

Author's Change in Manuscript – Thank you for the positive feedback. Additional discussion and references will be included in the revised manuscript, as suggested by reviewer.

Comment – Some line to line notes are on the pdf attached file. Hope this helps, Fabio Trippetta Please also note the supplement to this comment: https://www.solid-earth-

discuss.net/se-2020-17/se-2020-17-RC2-supplement.pdf

Author's Response – Accept – thank you.

Author's Change in Manuscript – The marked-up manuscript supplement is being consulted in revising the manuscript.

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2020-17, 2020.