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Solid Earth
Discussions

Interactive comment on "Fault slip envelope: A new parametric investigation tool for fault slip based on geomechanics and 3D fault geometry" *by* Roger Soliva et al.

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First the authors would like to thank the anonymous reviewer 1 for his constructive comments, which help to improve the quality of the manuscript.

1) We made significant changes in the figures and the text of explanations of these figures (see the specific reply below). However, we do not understand why the paper appears "circular", and recalling the figures several times along the text is very conventional and necessary in many articles and reports to allow discussion of the results or the method presented before.

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2) In the new version, we provide more explanation in the text about Figure 5 in lines 271-277. We mention that although the range of friction, cohesion and angle of ïĄş1 with respect to the main fault trend (around 30°) is possible, the parametric conditions must be considered as non-realistic since the stress loading is purely uniaxial. We also explain that these conditions imply very little stress perturbation in orientation since this depends mainly on the Lode angle and fluid pressure (Kattenhorn et al., 2000 and Maerten et al, 2018). These two new references have been added to the reference list in lines 472-473 and 494-495. This parametric modelling made with uniaxial loading actually allows better understanding and validating the dependence of fault slip to the stress angle. Deterministic analysis with realistic stress conditions is presented in Figure 6 and 7. These two last points are mentioned in the new text of the method section in lines 108-110 for better understanding of the method used and figures presented.

3) Colours in (a, b and c) correspond to different fault surfaces and allow an individual fault to be identified. This is now explained in the caption text of the figure in line 593. Note that the colour in Figure 3b has been revised since a same colour was used for all the faults in the previous figure. We forgot to refer to Figure 6b in the method section 2.2 about the Olkiluoto study. This is now corrected in line 156. The colour bar scales for displacement in Figure 7 and also Figure 4 have been modified. In both cases, the variation of displacement is very large from one model to the other (e.g. Dmax varying over 3 orders of magnitude in Figure 7). We therefore gave a scale bar specific to each model result for simplicity. We understand that it would be easier for a reader to have a same scale for all model results to allow an easy comparison. We therefore modify both figures by adding a single colour bar varying along a logarithmic scale. We believe worth to mention that the bar scale is logarithmic, both in the main text and the figure caption for the two figures (see lines 263, 294, 600 and 615).

4) As explained above, Figures have been simplified and more explanation is given, especially for figure 4, 5 and 7 (lines 258-270, 271-277 and 293-297). For example,

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we better describe and define the source of fault displacement asymmetry observed in Figure 4. For this purpose, a new reference has also been added in lines 266-267 and lines 549-551.

5) We have revised the manuscript following all the comments annotated in the pdf: - Addition of the reference suggested in lines 66-67 and 443-444,

- Addition of information for how in-situ stress measurement were acquired (lines 175-176),

- Significant modifications of Figure 1 to get it easier to read, especially for fault dip.

- Origin of the real fault systems in Figure 3: the paper and data source of the 3 real fault system geometries were previously mentioned in the method section (previous lines 131-134), and this is now recalled and improved in the new version in lines 134-139 in the result section where the comment has been made in the pdf,

- Addition of explanations for Figure 5 (see the reply above),

- Addition of explanations for the choice of the model results shown in Figure 7 (lines 296-297),

- The best conditions for fault slip derived from the models seem to be the present day stress state, which does not mean that the fault must move in the present day. So we don't clearly see disagreement in the previous text in lines 293-300. To clarify this point we modified the first sentence of the paragraph in line 329. The following text in this paragraph explains why, even in this thrust fault Andersonian context, the faults are not prone to slip.

- A new sentence has been added in the discussion to clarify that the ranges of mechanical properties might evolve through time and space (lines 345-347).

- Additional text and precision have been added to better explain Figure 1 (lines 221-224),

- The colour bar has been normalized and the position of the stars has been explained (see reply above).

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Figure 3

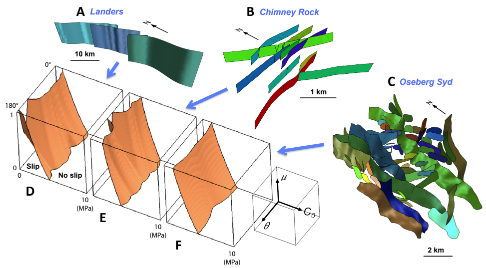

Figure 3 (2 column fitting image). Examples of 3D fault system geometry, from a simple to a very complex case, and related fault slip envelopes. (a) The Landers strike-slip fault segments. (b) The Chimney rock conjugate strike-slip fault system. (c) The Oseberg Syd normal fault system. (d), (e) and (f) are fault slip envelopes for each fault system, defining fault system stability for variable uniaxial stress orientation (θ), static friction (μ) and cohesion (C0) on fault surfaces. Colours in (a, b and c) correspond to different fault surfaces and allow an individual fault to be identified.

Fig. 1. Figure 3

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Figure 4

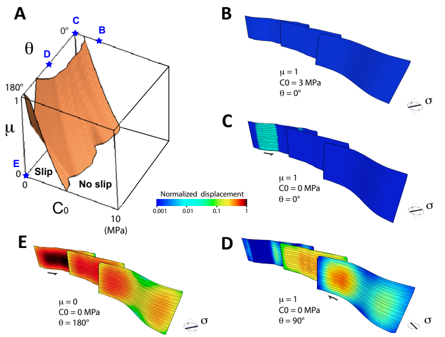

Figure 4 (2 column fitting image). Examples of 3D quasi-static fault displacement distribution on the Landers model for different mechanical conditions and uniaxial stress orientation. (a) Fault slip envelope shown in Figure 3d with reported specific model conditions used for figure parts b, c, d and e (bleu stars). (b) Displacement distribution for $\mu = 1$, $C0 = 0$ MPa and $\theta = 0°$. (c) Displacement distribution for $\mu = 1$, $C0 = 3$ MPa and $\theta = 0°$. (d) Displacement distribution for $\mu = 1$, $C0 = 0$ MPa and $\theta = 90°$. (e) Displacement distribution for $\mu = 0$, $C0 = 0$ MPa and $\theta = 180°$. The colour bar scale for displacement is logarithmic.

Fig. 2. Figure 4

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Figure 7

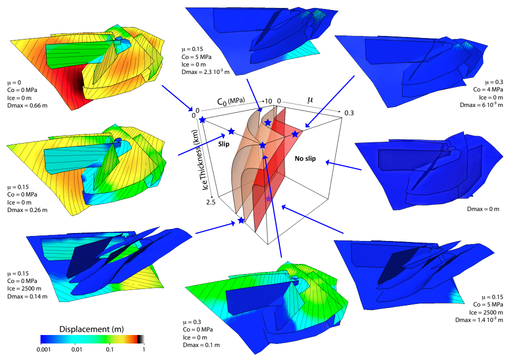

Figure 7 (2 column fitting image). Examples of 3D quasi-static fault displacement distribution on the Olkiluoto model for different loading and fault properties conditions indicated on the fault slip diagram by blue stars. Stream lines on fault surfaces are slickenlines. The colour bar scale for displacement is logarithmic.

Fig. 3. Figure 7

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