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Solid Earth
Discussions

Interactive comment on "Abutting faults: a case study of the evolution of strain at Courthouse branch point, Moab Fault, Utah" *by* Heijn van Gent and Janos L. Urai

Anonymous Referee #1

Received and published: 18 October 2019

The present study provides new insights into the understanding of local, outcrop-scale stress perturbations within rock volumes encompassing interacting faults. This is a very intriguing research topic, addresses by scientists since the 80s with the germinal work of Angelier and co-authors, which has been recently tackled again by geologists dealing with normal fault linkage and 3D relay ramp geometry. Along this line, the authors submit a research article aimed at assessing the paleo-strain and paleo-stress conditions at the abutting zone of two large faults crosscutting porous sandstones. By combining detailed structural survey of the outcropping fault zones with Numeric Dynamic Analysis (NDA) of the slip vectors and fault planes, the authors calculate the extension directions for not-parallel faults zones exposed at the Courthouse branch

point, Moab Fault, SE Utah (USA). In light of published results on the relative age of the studies structural elements, the results of NDA are discussed in terms of time-evolution of the extension direction during the processes of abutting and linkage of the two normal fault zones. In particular, the authors assess the switch of the main extensional direction from kinematic to geometric linkages (sensu Peacock et al., 2017) of the two fault zones.

The manuscript is well written (although very minor modifications can be made throughout the text, see the Specific Comments below), the aim of the work is clear, the methods robust, and both interpretation and discussion of the original data quite convincing. Overall, it nicely reports the result of a case study that corroborates the current effort on conducting detailed analyses of dimensional and kinematic attributes of interacting fault zones. On this regard, the paper cites the most significant recent articles dealing with this topic. However, a slight improvement of the manuscript can be made by considering the following four points: 1. Authors claim to deal with "thin deformation bands" (cataclastic shear bands), and then interpret their conjugate geometries according to the Navier-Coulomb-Mohr failure criterion. In order to support their interpretation, robust microstructural evidences should be provided. 2. I do not understand the reasons behind the choice of grouping together Sets 5, 6 and 7 made by the authors. According to stereoplots shown in figure 6, the aforementioned failure criterion does not justify this choice. Please explain in the revised text. 3. Since the authors report that crosscutting relationships among Sets 1&2 and Sets 3&4 were not documented in the field, their relative timing of formation should be better justified. 4. Finally, I recommend to improve the quality of the field structural maps shown in Figure 3 by adding details on attitude and abutting/crosscutting relationships among the various structural elements.

In conclusion, the work done by the authors is fascinating. The topic of the manuscript is interesting, the methods applied are robust and appropriated, and the interpretation quite convincing. However, a minor work on the outcrop and microstructural setting of the investigated DB's, and a better justification to is required before publication. For

this reason, based upon the aforementioned comments, and taking into account the overall quality of the paper, I recommend to accept with minor revisions the submitted manuscript. Specific Comments are reported below.

Specific Comments Abstract: please check for wrong punctuation marks. 1. Introduction: please re-write the first paragraph (too much information, and too many references), and check for wrong punctuation marks. 2. Regional Geology: please re-write lines 56-60 (not clear). 2.1 Outcrop Description: please change the number of this section into 2.1; insert the word “against” after “abuts” (line 67); separate sentences in lines 73 and 74; change the number of this section into 2.2; check for typos and misspells in the second and third paragraphs; delete the words “but these formed in opening Mode I (and are not sheared) in lines 97-98. 3.1 Paleostress and Paleostrain: please check for wrong punctuation marks, and misspells. 3.2 Field Observation: please clarify the meaning of the word “late” (line 163); explain how you know that fractures “results from unloading or weathering close to the surface” (line 163, as well); explain the significance of the word “similar” in lines 167; move the sentence “In agreement with. . ..” (lines 175-177) to the Results section. 4.1 Separating the data: please explain the meaning of the word “consecutive” (line 185). 4.2 Paleostrain results: please explain from what the R value is different (line 196); check for wrong punctuation. 4.3 Results in the rest of the study area: please modify the title of this section; add the word “relative” to the age relationships mentioned in line 200; re-write the second paragraph (lines 206-208); move the last sentence (lines 213-214) to the Discussion section. 5. Interpretation and Discussion: please re-write the first sentence (lines 2016-217). 5.1 Deformation during the transition: please explain the reasons behind your interpretation of Segment A being older than Segment B (line 241); please explain why you assessed the formation of Sets 1&2 ahead of the of the fault tip of Segment B; as stated above in the General comments, the whole paragraph reported in lines 251-254 is not clear to me; move the sentences reported in lines 257-259 to the Introduction section.

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