

Interactive comment on “Microstructures and deformation mechanisms in Opalinus Clay: insights from scaly clay from the Main Fault in the Mont Terri Rock Laboratory (CH)” by Ben Laurich et al.

Anonymous Referee #1

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This manuscript describes a microstructural study of scaly clay from the Opalinus Clay formation. The imaging and description is very detailed and of good quality. The authors present their detailed observations and present a model for the development of the scaly clay, which includes continuous macroscopic deformation but with localized features that migrate depending on local geometry and/or ambient fault conditions.

General Comments: In general, I have no issue with the methods or the microstructural descriptions. I do however struggle a bit to find something that is truly “new” here. The observations and following interpretations (e.g. the kinematic model, and fluid

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pressure cycling) that are presented here are very similar to those presented by other researchers (correctly cited here), for example Vannucchi et al. 2003, Labaume et al. 1997, Kirkpatrick et al., 2015, etc. It is possible that there is something groundbreaking here which I have missed, in which case (whatever it is) will have to be more clearly highlighted. A couple of minor suggestions might be to expand on things, such as the fact that the fault zone studied here has only 10 m offset, small compared to subduction megathrusts or other large-scale faults and thus may add a new perspective. Or the power-law exponents, which were presented but their significance was not explained, and not compared to other data (for example, observations by Sammis). Another aspect to include might be the relevance of the fault zone itself. Has it had earthquakes? No earthquakes? What role does the scaly clay play as a hydraulic seal? Finally, I suggest some better organization with the figure referencing – they are not referenced in order and there is quite a bit of jumping between figures throughout the text.

Minor Comments: Page 1, Lines 18-19: What is the definition of “asperity” in this sense? Page 3, Line 14: So, this is a “weight % finer than” measurement, right? Page 4, Line 19: The last paragraph talked about the influence of the sieving procedure, so what was the procedure used to obtain these data here? Page 5, Line 20: At these shallow depths (from Figure 1, less than 500 m) is pressure solution expected to be effective here? Or could there be some exhumation? Page 6, Line 11: This is a bit confusing because internal deformation was described in the previous section. It would maybe be helpful if the was emphasized earlier that the internal deformation is minor and/or uncommon. Page 7, Lines 20-21: What is the basis for this hypothesis? Page 8, Line 6: The term “strong softening” is a bit strange, suggest rewording somehow. Page 9, Lines 27-28: Actually there is quite a bit of information on low-permeability shear zones, from both experimental and modeling studies. Figure 1a: Make it clear somehow that this is a plan view. Figure 3: I’m not sure this figure is necessary. Figure 4: This is a methods figure. 1. Does the paper address relevant scientific questions within the scope of SE? yes 2. Does the paper present novel concepts, ideas, tools, or data? New data yes, but maybe not so novel 3. Are substantial conclusions reached?

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somewhat 4. Are the scientific methods and assumptions valid and clearly outlined? yes 5. Are the results sufficient to support the interpretations and conclusions? yes 6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? yes 7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? yes 8. Does the title clearly reflect the contents of the paper? yes 9. Does the abstract provide a concise and complete summary? yes 10. Is the overall presentation well structured and clear? yes, other than the figure referencing 11. Is the language fluent and precise? yes 12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? yes 13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? n/a 14. Are the number and quality of references appropriate? yes 15. Is the amount and quality of supplementary material appropriate? n/a

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