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Interactive comment on "Geologic characterization of nonconformities using outcrop and whole-rock core analogues: hydrologic implications for injection-induced seismicity" *by* Elizabeth S. Petrie et al.

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1. Illustrations of the fractures. The figures largely focus on the petrographic features and I found that the fracturing mentioned in several places is not fully illustrated. This includes, for example, (1) the near-vertical to bedding-parallel bleached fractures (l.100), (2) basement-hosted slip surfaces (l.101), cm- to m's - displacement faults (l.115), slip surfaces with oblique to dip-slip slickenlines mm's to cm's thick (l.189). . ... I think the manuscript will be improved by illustrating these features. –

We have added labels on images where possible and have provided references to work done in MS theses.

2. Lateral variability. Nonconformity zones likely have properties that are spatially heterogeneous. This is indicated l.49-52: "Due to weathering, deformation, diagenesis and fluid-rock interactions, the nonconformity zone may be hydraulically heterogeneous at the mm to 10's m scales". The paper addresses the vertical variability, but it does not fully address the lateral variability, which is critical for fluid flow and can give insights into how core data can be extrapolated to large-scale application. The studied outcrops allow analysing this lateral variability. For example, rocks studied in section 2.2.2 are observed along a 4-km long section in Gallinas Canyon. I will recommend the authors to further this point. -change made - added detail

3. Geological settings. The description of the geological setting is very sparse. I recommend the authors to provide more information for each studied area. For example, the types and ages of the fractures and some general descriptions on the tectonic setting. Maybe providing the locations of the studied areas on geological maps could be useful.

We. have added a section on geologic setting with locations on maps.

4. Analogues. Two outcrops are examined: (1) a nonconformity between late Proterozoic Jacobsville Sandstone and early Proterozoic altered peridotite outcropping in Michigan and (2) the contact between Devonian to Mississippian carbonate and clastic rocks of the Espiritu Santo Formation deposited on the Proterozoic quartzofeldspathic and amphibolitic gneiss. Also, three cores are examined: (1) a core recovered from the Cambrian Lamotte Formation sandstone and sheared Proterozoic granitoids in south-central Nebraska, (2) from the Cambrian Mt. Simon Sandstone and Precambrian altered granitoid gneiss of the Grenville Front Tectonic Zone and (3) from a section of rocks of lower Cambrian Mt Simon Sandstone overlying a Precambrian layered intrusive complex. I think it is interesting to analyse these very different areas because it

provides an idea about the diversity of the nonconformity. However, the negative point is that it is not clear whether the studied areas are analogues to fluid injection sites or not. For example, in the introduction, the authors mentioned the mid-continent United States and the works by Murray (2015). This work concerns Oklahoma's underground injections, where target rocks are mostly carbonates from the Arbuckle sedimentary strata above a crystalline basement. My knowledge of the regional geology of the studied areas is limited, but I think it will be worthy to justify the choice of the studied areas and how these areas are relevant for fluid injection operations. I think the last conclusion point: "the contact . . .. should instead be evaluated on a site by site basis prior to injection of large fluid volumes" is critical in this regard.

We have added a statement regarding the choice of localities, and how they serve as analogues, the use of Oklahoma as one example of deep injection and associated earthquakes is meant to provide the reader with the research driver that deep injection into reservoirs above the nonconformity has led to earthquakes in crystalline basement –

5. Quantitative insights. The authors briefly describe permeability values measured for one core in section 2.2.4. This is important data and the results could be described further. Besides, I think it could be interesting to provide similar information from the other studied areas. Also, there is a mention of fractures with density decreasing with depth (l.189). I think this could be described quantitatively as well. For example, by providing a fracture density log. More generally I think providing further quantitative analysis will be welcome and will make this work more valuable.

We have added fracture data where possible and have provided references to work done in MS theses.

6. Numerical modelling. I think the last paragraph of the discussion on numerical modelling will be better in the result section. Also, I think that the authors should provide more information about their methodology, the origin of the permeability values,

the choice of the studied geometry and the boundary conditions.

We have moved the numerical modelling results to improve flow of the discussion.

Minor points 1. Mt. Simon or Mount Simon, both are used in the manuscript. – change made

2. l.204 "not the result of alteration due to weathering alone". I think this should be discussed further. – expanded explanation

3.The figure captions are often incomplete. – figure captions edited for completeness

4. Fig.2: What is A in the figure. There is no scale in B and C. – fixed typo

5. Fig. 3. There are no B, C and D in Fig. 3. I think the authors mean 4, 5 and 6. -change made Although there is no 6 in the figure?

6. Fig. 4: What is A, B and C. There is no scale in B. – 10 cm scale bar appears at bottom of core box photo 7. Fig. 6: B is not indicated in the caption.- added callout in caption

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