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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Effective damage zone volume of fault zones and initial salinity distribution determine intensity of shallow aquifer salinization in geological underground utilization" *by* M. Langer et al.

Anonymous Referee #1

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Overview

The M. Langer paper has some interest in the field of the potential impact of CO2 injection into deep saline aquifers. Salinization of shallow aquifers might be the result of upward brine movements through vertical faults due to pore pressure increase within reservoir. The aim of this study is to investigate the effect of fault length, the presence of an overlying reservoir and boundary conditions by using a 3D model at the regional scale.

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General comments

Firstly, the work presented here seems not to be entirely new even if there are some valuable conclusions. Simulation results demonstrate that overpressure within the reservoir governs the brine migration and thus the salinization of shallower aquifers. Then, results show that if the reservoir boundaries are closed, the overall injected fluid migrates into the shallow aquifer. Thus, at this stage, results are quite similar to the paper findings of one of the co-authors published in 2013.

Secondly, the value of the results are limited due to the assumption made: injection of water instead of CO2 injection. . . Considering, the literature cited by the author himself (table 1) and the previous work published by one of the co-author, it seems to be not insignificant approximation. Indeed, in the paper published in 2013 the study has been realized for the same site by using large-scale numerical multi-phase multi-component (CO2, NaCl, H2O) flow simulations. Thus, I suggest that you study the impact of CO2 injection with multiphase flow simulation. Perhaps, only one simulation in multi-phase flow to compare the results of the reference case might be sufficient to valid your results.

However, the paper is correctly organized and well written. From my point of view, new results are interesting but “limited” and could have been much more representative.

Specific comments

There are some details that, in my opinion, may improve the quality of the paper :

1- L19-20, p5704: the sentence “. . . only to retardation in brine displacement up to a factor of five and three, respectively” is not clear. Please, clarify the term “retardation”.

2- L13, p5705: Reference IPCC, 2005. And, ten years after ?

3- L15-17, p5705: Please, give a reference.

4- L20, p5709: You assumed that the caprocks are impermeable, but is it realistic ?

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5- L12-14, p5710: I understand that for grid regularity you neglected the dip angle. But, I think it would be very interesting to test the effect of the fault inclination in order to project the results of simulations as a generalization of the whole site.

6- L22-25, p5711: As conclusion, you specified that the initial salinity distribution is one of the most important condition. Nevertheless, your simulations are realized with an abrupt transition between freshwater and brine.

7- L5-8, p5712: As mentioned previously, I suggest multi-phase flow simulations as all recent papers.

8- L23-25, p5712: Please describe formulae and add reference accordingly.

9- Table 2: Please, can you justify the applied porosity for your faults. Please, give reference.

10- L19, p5716: “pressurization of ca.” ?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 5703, 2015.