Peer Review Report

Review Report on The importance of physiochemical processes in decarbonisation technology applications utilizing the subsurface: A review

Review, Earth Sci. Syst. Soc.

Reviewer: Andreas Busch
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EVALUATION

Q 1 Please summarize the main theme of the review.

This article discusses geoenergy applications (in the wider sense) that focus on carbon capture and storage, geothermal energy and radioactive waste storage.
Individual technologies are introduced and discussed as well as research gaps are summarised.

Q 2 Please highlight the limitations and strengths.

First of all, I would like to congratulate the authors to such a comprehensive review with lots of useful information and many really appealing figures.

The paper is rather long because it aims at creating a bridge across 3 different technologies (CCS, geothermal, radwaste). These technologies have plenty of things in common but of course also differ in terms of their THMC bevaviour. I think authors do a good job, especially in discussing the physico-chemical challenges and how this relates to mechanical properties. I also think that the sections about research recommendations are well addressed. I realise that the paper is quite lengthy already but what certainly still needs to be expanded is the section on the technologies. They require a better fundamental explanation to get the reader into the topic and to make the link towards these THMC processes. I am specifically referring to THMC processes, although authors add something about biological processes which however are not well covered or just not covered in sufficient detail. I would probably skip biological processes for simplicity. If this is not wanted, the section needs to be expanded significantly.

The title refers to decarbonisation. I wonder what radwaste storage has to do with decarbonisation? This needs to be discussed.
I would also like to see some discussion about time scales. Just because some mineral reactions have been observed in mudrocks over geological time scales, does not mean they would happen during a CCS or geothermal project. This is key and important to communicate.

Q 3 Does the review include a balanced, comprehensive and critical view of the research area?

Yes

Q 4 Check List

Is the English language of sufficient quality?
Yes.

Is the quality of the figures and/or tables satisfactory?
Yes.

Does this manuscript refer predominantly to published research? (unpublished or original research is non-standard for a review article, and should be properly contextualised by the author)

Yes.

Does the manuscript cover the topic in an objective and analytical manner
Yes.

Does the reference list cover the relevant literature adequately and in an unbiased manner?
Yes.

Does the manuscript include recent developments?
Yes.

Does the review add new insights to the scholarly literature with respect to previously published reviews?
Yes.

Q 5 **Please provide your detailed review report to the editor and authors (including any comments on the Q4 Check List):**

My specific comments are in the annotated pdf attached

QUALITY ASSESSMENT

Q 6 **Quality of generalization and summary**

Q 7 **Significance to the field**

Q 8 **Interest to a general audience**

Q 9 **Quality of the writing**

REVISION LEVEL

Q 10 **What is the level of revision required based on your comments:**

Moderate revisions.