

Interactive comment on “Qualitative and quantitative changes in detrital reservoir rocks caused by CO₂-brine-rock interactions during first injection phases (Utrillas sandstones, Northern Spain)” by E. Berrezueta et al.

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Dear Editor, The authors would like to thank the reviewer for her/his contributions to this manuscript. We must acknowledge that the incorporation of the recommended suggestions improved the quality of the manuscript. All referee's comments are answered bellow and included together with minor edition changes in the revised version of the manuscript (highlighted in red). Supplement: revised manuscript 1.pdf.

Comment: The article titled: Qualitative and quantitative changes in detrital reser-

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voir rocks caused by CO₂-brine-rock interactions during first injection phases (Utrillas sandstones, Northern Spain) present results obtained in short-term experiment of CO₂-brine-rock interaction for geological injection and storage needs. The article has some information perhaps useful for examination of such phenomena as CO₂-water-rock changes. Of course it has some new information therefore in my opinion it should be published in Solid Earth journal but after some changes and considerations mentioned below: The authors describe very short experiments and they observe some changes cause by CO₂-brine-rock interaction however they didn't mention about number of testing samples. Answer: The number of samples has been added in page 6 line 9: "For this study, we chose the more consolidated sandstones (3 samples), located in "Devesa 1", to guarantee the effectiveness of the analysis". Information also noted in Table 1 caption.

Comment: If the obtained results constitute some average values ????. Answer: Yes. The results presented in Table 1 show that average porosity values of the three samples were calculated. To clarify we have changed Table 1 caption to read "Table 1. Total porosity of Utrillas sandstones (3 samples), before and after SC CO₂-brine exposure, measured by Optical Image Analysis (OIA). Average % is the average porosity of the 3 samples. *Uncertainly (1.25%) given by Oviedo- IGME Laboratory. Difference % is calculated as the variation in porosity % before and after CO₂-brine injection. Total Average % is the average of the differences between Porosity % before and after CO₂-brine injection".

Comment: In my opinion it is difficult conclude based on such short experiments that presented so insignificant changes that are caused by experiments. Authors mentioned that testing samples before and after the experiments are not exactly the same samples. Therefore in the conclusion or discussion it will be worth mentioned that some changes results from inhomogenous of testing materials before and after the experiments (see similar test and conclusion in: Wdowin et al. 2014 Supplementary Studies of Textural and Mineralogical Changes in Reservoir and Caprocks from Selected Po-

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tential Sites Suitable for Underground CO₂ Storage. The Arabian Journal for Science and Engineering 39, (1), 295-309 as well as Tarkowski et al. 2011. Petrophysical and Mineralogical Research on the Influence of CO₂ Injection on Mesozoic Reservoir and Caprocks from the Polish Lowlands. Oil & Gas Science and Technology–Rev. IFP Energies nouvelles 66(1), 137-150). Answer: We agree that is difficult to conclude with these short-period experiments that the changes are chemically and physically important. The results allowed us to have a rough approximation of the CO₂-brine-rock interactions, and OIA is showed up as a capable technique to monitor and quantify the changes that were also identified by optical microscopy. On the other hand, the porosity changes could be due to initial heterogeneities of the samples as inferred by Wdowin et al. (2014) and Tarkowski and Wdowin (2011), but the study of two contiguous surfaces with a few mm separation (as described in page 7 lines 25 to 31) minimizes this effect favouring out interpretation that changes may be due to the experiments. This comment was included in the discussion section (page 14 line 20), including the references suggested. “The initial heterogeneity of the rock could condition the comparison of physical and chemical parameters between the before and after CO₂ injection tests samples, as described by Tarkowski and Wdowin (2011) and Wdowin et al. (2014b). In our study we tried to minimize this effect studying rock surfaces few millimetres separation and employing expert criteria in petrography”. Besides, we have included a new sentence (page 16 lines 15-19) in the conclusions section: “The results of this experiment show that the changes may occur due to physical process allowing a rough approximation of the CO₂-brine-rock interactions”. Furthermore, these changes may have an important impact on the behaviour of reservoir rocks during first injection phases of SC CO₂”.

Comment: Besides authors mentioned that the experiments are similar to carried out by Wdowin et al 2015 and Tarkowski et al 2015 so I think helpful for such interpretation will be mentioned above references where these authors carried out short-ther experiments. Additional for some interpretation useful will be others works for example: Fischer, S., Liebscher, A., Wandrey, M., the CO₂SINK group. 2010. CO₂-brine-rock
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interaction – First results of long-term exposure experiments at in situ P–T conditions of the Ketzin CO₂ reservoir. Chem. Erde – Geochemistry 70, S3, 155–164. Fisher, S., Liebscher, A., De Lucia, M., Hecht, L., the Ketzin Team. 2013. Reactivity of sandstone and siltstone samples from the Ketzin pilot CO₂ storage site–Laboratory experiments and reactive geochemical modeling. Envi. Earth Sci. 70, 3687 – 3708. Answer: We appreciate the suggestion. The references have been added to strengthen the introduction, discussion and conclusion sections. Tarkowski and Wdowin (2011), Fisher et al. (2013) and Wdowin et al. (2014).

Comment: In the text I have observed some incorrect English nomenclature that are not so good for describing some phenomena i.e. page 9 line 15 The rock is mainly grain supported... I suggest to write in such way: The rock is composed mainly by grain skeleton supported ...???? Answer: This sentence has been modified to read “The rock is composed mainly by grain skeleton supported with a small proportion of matrix...”.

Comment: In the text please use SI unit i.e. not "L" but "dm³" Answer: We have used the SI units i.e. MPa and dm³.

Please also note the supplement to this comment:

<http://www.solid-earth-discuss.net/7/C1203/2015/sed-7-C1203-2015-supplement.pdf>

Interactive comment on Solid Earth Discuss., 7, 2243, 2015.