Reply to the review of anonymous reviewer RC#1

Dear Mike Chandler,

We would like to thank you very much for your review and the comments you raised. They helped to improve the quality of our manuscript. Below, we present our changes and corrections according to your comments.

Kind regards,

Lisa Winhausen and co-authors

SPECIFIC COMMENTS

Reviewer: My only significant suggestion is that the paper might benefit from some discussion of the influence of the heterogeneous sample material on the Skempton B-checks used to determine the sample saturation. I was not previously aware of the method of B-checks, and having read around it a little, the relationship between B and saturation seems to assume a constant bulk modulus, porosity and permeability in the matrix? In Sections 2.1 and 4.2, the authors draw attention to the heterogeneity of the material presented here, and so I wonder if the authors could comment on how confident they are certain that the Skempton B-check is confirming the full saturation of the sample, or just the saturation of the more porous components? If there was a heterogeneous saturation state within the sample due to lower porosity/permeability regions (presumably with different bulk moduli), would this be likely to affect any of the deformation processes discussed in Section 4.2?

Answer: This is a very good question! Indeed, the absolute B-value is dependent on the bulk modulus and porosity. To maintain these two parameters in each individual B-value assessment, we increased the back pressure after each undrained loading step to keep the effective stress constant, so that also K and ϕ can be assumed constant. We are quite certain that all specimens have a very high degree of saturation. For lower porosity/permeability regions (of effective, connected porosity), the total stress increase leads to an increase in pore water pressure (bulk compression leads to a pore space compression) and an increase in saturation due to Boyle's law (volume of gas is reduced due to a pressure increase) in combination with Henry's law (possible gas is solved in the liquid phase with higher pressures). We agree that there might be regions of lower and higher porosity/permeability and that these require longer time periods for the pore water pressure diffusion to the specimen's end face. However, we can be certain that these effects are accounted for, since we waited for full pore water pressure equilibration at both top and bottom of the sample (usually less than 1 hour) and the back-pressure phase lasted usually 24 hours. Even if there were some non-saturated regions (e.g., S>99.5%), such as nano-sized gas bubbles trapped in isolated micro-cracks or void corners, their volume would be much smaller than the total volume in the pore space. We infer therefore that their existence does not invalidate neither full saturation nor the deformation behaviour. We included the missing information on the procedure in the text to underline its robustness.

Reviewer: It might also be worth putting the range of confining pressures in the abstract, as I see this as being quite a large differentiator between this study and the earlier papers of Amann et al.

Answer: Agreed. We included the range in the abstract.

TECHNICAL CORRECTIONS

Reviewer: I think there is a rogue "a" on line 294, and it should read something like " … failure on the microscale is less dilatant, forming a broader…"

Answer: Well-spotted! Redundant word deleted.