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Swelling behaviour of Early Jurassic shales when exposed to water vapour

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The presence of water in mudrocks has a largely negative impact on production of gas, due to the fact that water causes swelling of the rock. Removing the water from the mudrock on the other hand could potentially shrink the rock and increase the matrix permeability. Investigation of the swelling/shrinkage behaviour of the rock during exposure to water vapour is of key importance in designing and optimizing unconventional production strategies. We have used outcrop samples of the Whitby Mudstone and the Posidonia shale [1], potential unconventional sources for gas in North-western Europe, to measure the swelling and shrinkage behaviour. Subsamples, 1 mm cubes, were prepared by the Glass Workshop at Utrecht University using a high precision digitally controlled diamond wafering saw cooled by air. The mm cubes were then exposed to atmospheres with different relative humidities either in an Environmental Scanning Electron Microscope (ESEM) or in a 3D dilatometer. So that the sample responses to exposure of water vapour could be measured. Parallel to the bedding we found a swelling strain between 0.5 and 1.5 %, perpendicular to the bedding though swelling strain varied between 1 and 3.5%. Volumetric swelling strain varied between 1 and 2% at a maximum relative humidity of 95%. Volumetric swelling strains measured in the Early Toarcian Shales are similar to the ones found in coal [2], where the results suggest that it might be possible to increase permeability in the reservoir by decreasing the in-situ water activity due to shrinkage of the matrix.

[1] M.E. Houben, A. Barnhoorn, L. Wasch, J. Trabucho-Alexandre, C. J. Peach, M.R. Drury (2016). Microstructures of Early Jurassic (Toarcian) shales of Northern Europe, International Journal of Coal Geology, 165, 76-89.
[2] Jinfeng Liu, Colin J. Peach, Christopher J. Spiers (2016). Anisotropic swelling behaviour of coal matrix cubes exposed to water vapour: Effects of relative humidity and sample size, International Journal of Coal Geology, 167, 119-135.