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Dissolution experiments in halite cores: comparisons in cavity shape and controls between brine and seawater experiments

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There is an increasing need for underground storage of natural gas (and potentially hydrogen) to meet the UK's energy demands and ensure its energy security. In addition, the growth of renewable energy technologies, such as wind power, will be facilitated by the development of grid-scale energy storage facilities to balance grid demand. One solution lies in creating large-scale compressed-air energy storage (CAES) facilities underground. Whilst a number of lithologies offer storage potential, only three operational CAES facilities exist in the UK. They are constructed in specifically designed solution-mined salt (halite) caverns, similar to those currently used for natural gas storage. The influences exerted on salt dissolution by petrology, structure and fabric during cavern construction are not fully understood, with some occurences of caverns with non-circular cross-sections being less than optimum for gas storage and especially CAES.

We have performed dissolution experiments on five key end-member salt lithologies from the Triassic Preesall Halite Formation to assess factors affecting variability in dissolution behaviour and cavern geometry formation. Identical sets of experiments were carried out on each key lithology using two solution strengths: a brine with a concentration of 270 g/l NaCl, and seawater (24 g/l). A 4 mm diameter pilot channel was drilled in each core, and the solutions pumped through at a constant flow rate of 0.58 ± 0.02 ml/min and a fluid temperature of 23 ± 1 ^{o}C.

The results were compared using a combination of techniques including X-ray radiography and X-ray computed tomography, and various microscopy techniques. The brine experiments show that the sedimentary fabric and microstructure of the halite strongly influences the shape of the resulting solution cavity, each lithology type developing an entirely different void morphology. In contrast, the corresponding experiments using seawater all form similarly-shaped and uniform cavities indicating the influence of the petrology is minimal using more dilute fluid.