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Laboratory and modelling investigations of potential geochemical reactions upon seasonal heat storage in Danish geothermal reservoirs.

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Seasonal storage of excess heat in hot deep aquifers is considered to optimize the usage of commonly available energy sources. This study investigates the risk of damaging the reservoir through potential geochemical reactions induced by the increased reservoir temperature upon injection of heated formation water. Three core flooding experiments were performed at reservoir conditions and temperatures up to 150°C with cores from two potential Danish geothermal reservoirs and with synthetic brine as the flooding fluid. Two cores with different mineralogy from the Upper Triassic – Lower Jurassic Gassum Sandstone Formation and one core from the Lower Triassic Bunter Sandstone Formation were tested. For the calcium carbonate containing Bunter Sandstone formation, the experiments were performed with Ca-depleted synthetic formation water to avoid loss of injectivity by calcium carbonate scaling at elevated temperatures. The interpretation of the laboratory experiments was supported by petrographic analysis of the cores prior to and after the flooding experiments and by geochemical modelling. The results show that heating induced a series of silica dissolution/precipitation processes for all three sandstones, including dissolution of quartz, weathering of Na-rich feldspar to kaolinite, replacement of plagioclase with albite and precipitation of muscovite. These processes are not expected to significantly deteriorate the physical properties of the reservoir. However, for the Bunter Sandstone formation, flushed with Ca-depleted brine, a significant portion of the cementing calcium carbonate dissolved. In the reservoir, this may ultimately reduce the mechanical strength of the geological formation. Thus, this study suggests that heat storage in geothermal reservoirs can be technically feasible in typical Danish geothermal sandstone reservoirs. However, in reservoirs containing calcium carbonate, means for avoiding calcium carbonate precipitation during heat storage should be chosen with caution to minimise possible reservoir damaging side effects.