Title: Underground Hydrogen Storage: fundamental studies on hydrogen wettability

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Underground Hydrogen Storage (UHS) is considered a long-term storage solution which allows excess energy developed from renewable energy sources to be stored in form of hydrogen in the subsurface reservoirs and retrieved when energy demand increases. Research into UHS has been increasing in recent years, with a focus on determining the petrophysical properties of hydrogen interacting with fluid and subsurface rocks. UHS in porous media targets depleted gas reservoirs and aquifers. The focus of this work is to determine the wettability and Interfacial Tension (IFT) of the hydrogen-brine-quartz system using different methods for wettability, the captive bubble method and in-situ analysis using 3D micro-Computed Tomography (CT) imaging, and the pendant drop method for IFT. The captive bubble method provides the intrinsic contact angle which remained in the range 29-39° for pressures 1000-3000 psi and salinities from distilled water to 5000ppm NaCl brine. The in-situ method determines the macroscopic contact angle and contact angle distribution. The mean value of contact angle is 59.75°. The IFT is found to decrease with increasing pressure in distilled water from 72.45 mN/m at 1000 psi to 69.43 mN/m at 3000 psi. No correlation was found between IFT and salinity for the 1000ppm and 5000ppm brine. Our fundamental studies provide insights into physics of hydrogen displacement in the multiphase environments of subsurface reservoirs and can be used for modelling storage capacity and withdrawal rate of hydrogen.