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Healing/sealing and transport properties of wellbore cement in the presence of supercritical CO2

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The process and the rate of carbonation reaction of Class A wellbore cement exposed to CO2-saturated solution were investigated at confined conditions similar to those employed in geological storage of CO2. The main goal was to investigate whether reaction improves or degrades the sealing/healing capacity of fractured Type A cement plugs. Batch reaction experiments were performed for up to three months, on both intact and fractured Class A Portland cement cylinders, at a constant confining pressure of 30 MPa, a temperature of 80°C and a CO2 pressure of 10 MPa. The experiments were carried out on water-saturated samples, exposing them to the supercritical CO2 at one end. All samples were jacketed in sleeves to seal them from the high pressure confining medium. The results indicate that cement carbonation front advanced in time, leading to a densification of the material. Extrapolation of the reaction rates to 1-year period indicates a carbonation depth of about 1.38 mm, and about 7.56 mm after 30 years of exposure to CO2-saturated solution. Thermogravimetric analyses, Scanning Electron Microscopy observations and permeability measurements indicate that carbonation of wellbore cement leads to a decrease of the porosity of the material on the reaction front and moreover, has the potential for healing pre-existent fractures and for improving the sealing properties of good-quality cement samples in time, at reservoir conditions.