Microwave Treatment of Shales for Carbon Capture and Enhanced Oil Recovery

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Résumé

Global trends keep indicating the need to mitigate the effect of CO2 emissions through carbon storage and, thence, reservoir cap rocks with good sealing efficiency are vital. Microwaves are often used to enhance hydrocarbon recovery before carbon sequestration so their impact on reservoir permeability and seal efficiency needs to be studied. This study aims to determine the effect of microwave treatment on the Sleipner seal-rock, Nordland shale, thereby assessing whether it is still an appropriate sealing rock for carbon storage, and gas accumulation, after microwave treatment. Gas adsorption was used to characterise the pore structure of shales, while scanning electron microscopy and X-ray diffraction methods were used to determine the mineralogy of shale samples before and after microwave treatments. The fractal dimensions of the rock were determined from the nitrogen adsorption isotherms. The specific surface areas were also determined using the Langmuir and BET models. After microwave treatments, the quantity of gas adsorbed increased with increasing pressure thereby indicating the presence of larger pores, while the values of fractal dimensions, over all length-scales probed, were seen to increase following microwave treatments indicating increased rock heterogeneity. Gas uptake experiments also showed the impact of the evolved pore structure on transport properties, while SEM, and XRD analysis showed the impact of mineralogical changes on the pore structure of the Nordland Shales. High values of specific surface areas were observed after microwave treatments. Increasing heterogeneity of shale samples, as indicated by an increase in fractal dimensions after microwave treatments, is found significant for the changes to fluid migration rates following microwave treatment. A corresponding increase in porosity of shales is also important for oil and gas accumulation and subsequently an increased oil and gas recovery. This study therefore shows that microwave treatment of shales is useful for both carbon storage and enhanced oil recovery.

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