Investigation of CO_2 Migration in Saline Aquifers Using Real-Rock Microfluidic Experiments

Shadya Taleb[a,b], Seyyed A. Hosseini[b], Sahar Bakhshian[b], Susan D. Hovorka[b]

[a] Jackson School of Geosciences, The University of Texas at Austin, Austin, TX, USA

[b] Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin, Austin, TX, USA

Over the past decade, reducing carbon dioxide (CO_2) emissions has become critical to tackle climate change and its impacts on human life. While several efforts are being made worldwide to reduce emission levels, geological carbon storage represents a viable technology to sequester CO_2 from large-scale emission sources. However, the injection of CO_2 into subsurface porous rocks is a complex process and understanding multiphase flow processes is critical for the long-term and short-term assessment of the stored CO_2. This study focuses on understanding CO_2 migration and trapping at the pore scale. Synthetic microfluidic models allow precise control of the pore topology; however, they fail to reproduce rock-fluid interactions and cannot capture the effects of heterogeneous mineral distribution. We use real-rock microfluidic devices made of sandstone to estimate the saturation of trapped CO_2 in a brine-saturated porous medium. We first present our micromodel fabrication methodology that combines rock thin sections with nanofabrication techniques (e.g., soft lithography). Then, we obtain capillary pressure curves using fluorescence imaging and peripheral pressure measurements. Images obtained during the experiments are used to detect the phase saturation of each fluid (i.e., CO_2 and brine) in the micromodel in order to quantify the fluid distributions and the CO_2 sweep efficiency. These experimental results are compared with modeled capillary pressure curves that provide new insight into CO_2 flow behavior. Our experimental results can be used to calibrate two-phase flow numerical simulations and can allow to validate capillary pressure curves that predict multiphase flow migration processes at reservoir scale. By combining real rock thin sections with nanofabrication techniques and image analysis, this study provides a tool to understand fluid flow dynamics in subsurface storage operations.

Hosseini

____

Seyyed A. Hosseini

Thesis Supervisor