Ensuring Secure CO_2 Geologic Storage: Insights from Pore to Field Scale

Storage of carbon dioxide (CO_2) in geological formations is considered to be one of the most promising solutions for mitigating carbon emissions and, hence, global warming. However, ensuring the long-term security of CO_2 storage demands addressing various uncertainties related to reservoir performance, storage capacity, and potential risks associated with leakage. To address these uncertainties, we employ a combination of modeling and experimental approaches, covering pore-scale phenomena to field-scale observations. Pore-scale studies provide insight into CO_2 displacement behavior and trapping mechanisms (e.g., capillary and dissolution trapping) under varying pore-scale characteristics such as rock microstructural heterogeneity and wettability. This research has been extended to the reservoir scale to study the impact of depositional architectures in a composite confining system on long-term CO_2 migration and confinement.

Moreover, I will discuss a quantitative risk assessment study used to address leakage of CO_2 and brine through legacy wells, an issue that imposes an environmental, liability, and financial risk for CO_2 storage projects. Finally, the talk will conclude with an overview of a field-scale monitoring system tailored for detecting leakage from plugged and abandoned wells, providing a practical solution for real-time monitoring and early detection of potential leakage events.

Short Bio:

Sahar Bakhshian is an Assistant Professor in the Department of Earth, Environmental, and Planetary Sciences at Rice University. She earned her Ph.D. in Chemical Engineering from the University of Southern California. Before joining Rice, she spent six years at the Bureau of Economic Geology at the University of Texas at Austin, progressing from Postdoctoral Research Fellow to Research Assistant Professor. Her research integrates computational modeling, microfluidics experiments, and data analytics to investigate fluid flow in porous media, with an emphasis on energy-transition topics such as geologic carbon storage.