Multicomponent reactive transport of carbon dioxide in fluvial heterogeneous aquifers

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Abstract

Geochemical reactions are important for short and long-term fate of carbon dioxide (CO_2) during geological sequestration (GCS). The effect is more pronounced in formations with more reactive minerals. Use of reaction batch models as well as small-scale laboratory experiments are useful in providing a better understanding on how different types of reactions and minerals affect GCS. However, fully coupled multiphase flow and multicomponent reactive transport models can provide fundamental insights about the interactions between fluid flow processes and geochemical reactions. We modeled fully coupled thermodynamically-based multiphase flow of CO_2-brine with geochemical reactions at field-scale conditions for the CO_2 injection pilot project at Cranfield, MS. Results of our high-resolution flow and reactive transport models elucidate important features. We found that even slight changes in subsurface physical properties (e.g., permeability and porosity) through representing dominant geochemical reactions could significantly affect CO_2 fate and transport. This has important practical implications specially during history-matching using data on CO_2 breakthrough curves in observation wells. Additionally, pH drops due to increase of aqueous CO2 concentration and important geochemical reactions such as mineral dissolution mainly occur within connected networks of fluvial channels in formations with fluvial depositional systems. Physical and chemical properties of fluvial channels are the controlling factors in CO_2 fate and transport and their characterization is critical in designing future carbon storage projects.