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Numerical Modeling of CO_2 leakage through fracture with retardation due to matrix diffusion, adsorption and geochemical reactions

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One of the concerns related to CO_2 underground storage is the possibility of CO_2 leakage from the injection formation. Although CO_2 starts getting dissolved in brine after its injection in the reservoir yet there is risk of its leakage in dissolved form due to either increased reservoir pressure as a result of CO_2 injection or large-scale groundwater motion. The flow of brine through weaker zones like fracture may cause the transport of dissolved CO_2. The mobility and spreading of reactive solutes is however significantly affected by matrix diffusion, sorption on walls of the fracture, sorption within the rock-matrix and geochemical reactions with the rock-forming minerals. This study presents the results of numerical modeling of CO_2 leakage in dissolved form through fracture with retardation due to matrix diffusion, adsorption as well as permanent removal caused by mineralization. Solute spreading is analyzed in the form of breakthrough curves assisted by closed-form solutions to temporal moments describing travel time distributions. Coupled geochemical reactive transport modeling is performed using COMSOL Multiphysics assisted by MATLAB for geochemical reaction modeling.