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Experimental investigation of biofilm formation within a glass porous medium in the presence of carbon dioxide

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Capturing CO_2 emissions and storing them in properly selected deep geologic formations is considered a promising solution for the reduction of CO_2 in the atmosphere. However, if CO_2 leakage occurs from geologic storage formations due to permeability increases caused by rock-brine-supercritical CO_2 geochemical reactions or reactivation of existing fractures, the impact to groundwater quality could be significant. Dissolved CO_2 in groundwater can decrease the pH, which in turn can solubilize undesired heavy metals from the solid matrix with profound and severe implications to public health. Consequently, it is essential to fully understand the potential impact of CO_2 to shallow groundwater systems. In this study, a series of visualization experiments in a glass-etched micromodel were performed in order to estimate the effect of CO_2 on biofilm formation. All biofilms were developed using Pseudomonas (P.) Putida. Synthetic water saturated with CO_2 was injected through the micromodel through an inlet port, and CO_2 was measured at the outlet port. The transient growth of the biofilm was monitored by taking high-resolution digital photographs at various times, and the effect of CO_2 on biofilm growth was estimated. Furthermore, transient changes of effective permeability and porosity were measured and the effect of solution chemistry (e.g. pH, ionic strength, redox potential) on the rate of biofilm growth was evaluated.