Publication

# A reactive transport model for the quantification of risks induced by groundwater heat pump systems in urban aquifers

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shallow geothermal resources groundwater heat pumps reactive transport modeling clogging dissolution subsidence thermal-energy storage ebro basin artificial recharge karst temperature kinetics impacts spain precipitation management Shallow geothermal resource exploitation through the use of groundwater heat pump systems not only has hydraulic and thermal effects on the environment but also induces physicochemical changes that can compromise the operability of installations. This study focuses on chemical clogging and dissolution subsidence processes observed during the geothermal re-injection of pumped groundwater into an urban aquifer. To explain these phenomena, two transient reactive transport models of a groundwater heat pump installation in an alluvial aquifer were used to reproduce groundwater-solid matrix interactions occurring in a surrounding aquifer environment during system operation. The models couple groundwater flow, heat and solute transport together with chemical reactions. In these models, the permeability distribution in space changes with precipitation-dissolution reactions over time. The simulations allowed us to estimate the calcite precipitation rates and porosity variations over space and time as a function of existent hydraulic gradients in an aquifer as well as the intensity of CO2 exchanges with the atmosphere. The results obtained from the numerical model show how CO2 exolution processes that occur during groundwater reinjection into an aquifer and calcite precipitation are related to hydraulic efficiency losses in exploitation systems. Finally, the performance of reinjection wells was evaluated over time according to different scenarios until the systems were fully obstructed. Our simulations also show a reduction in hydraulic conductivity that forces re-injected water to flow downwards, thereby enhancing the dissolution of evaporitic bedrock and producing subsidence that can ultimately result in a dramatic collapse of the injection well infrastructure. 
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