Multiscale characterization and quantification of arsenic mobilization during injection of treated coal seam gas co-produced water into deep aquifers

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In Australia, coal seam gas production in coming decades will involve disposal of large volumes of co-produced water into deep aquifers. Prior to the implementation of large-scale injection schemes, it is important to perform short-term injection trials that generate sufficiently meaningful data sets that allow for a robust assessment of potential hydrological and geochemical impacts. The present work illustrates the use of reactive transport modeling for the analysis of an injection trial where arsenic (As) mobilization was observed. Such a modeling study requires integration of data and models from multiple scales with a relatively high uncertainty in parameter values. This parametric uncertainty can lead to significant uncertainties in the long-term groundwater quality predictions derived from a field-scale reactive transport model (RTM).

As sorption behavior was studied through laboratory experiments that underpinned the development of a surface complexation model (SCM). The laboratory-derived SCM was incorporated into a field-scale RTM to simulate the injection trial and to predict the long-term fate of As. We propose a new practical procedure for integration of laboratory and field-scale models in order to efficiently quantify predictive uncertainty. The results illustrate that both As desorption and pyrite oxidation most likely contributed to As mobilization. The predictive simulations show that the complete deoxygenation of the injectant will minimize the potential for pyrite oxidation and ensure very low As levels. The methodology is applicable to a wide range of groundwater studies that investigate the risks of metal(loid) or radionuclide contamination.