To understand reactive transport processes in complex porous media, it is necessary to identify and understand flow processes at microscopic (pore) scale, and then try to describe their manifestation at the macroscopic (core) scale and field scale. Due to limitations in measurements, an alternative way for transferring pore-scale information to larger scale and establishing relationships among the scales is to use pore-scale modelling. By doing that, one could simulate flow and transport in detail by explicitly modelling the interfaces and the mass flux through surfaces. Pore-network models have been widely used to explore a variety of phenomena related to multiphase flow and mass transport in porous media.

The aim of this research is to find an upscaled relation between macroscopic (Darcy scale) transport coefficients for a solute at the air-water interface. At the pore-scale the solute is transported by diffusion and advection and is consumed by adsorption at the solid surfaces as well as at the air-water interface.

The major goals have been:
- Generating a pore-network model which can mimic the major topological and geometrical properties of a real porous medium.
- Modelling solute transport and upscale from pore scale to core scale (under saturated and partially-saturated conditions).
- Finding the upscaled form of reactive transport parameters as a function of underlying pore-scale parameters (finding an appropriate governing equation describing solute transport at the macro scale).
- Finding the effect of physical and chemical heterogeneity on reactive solute transport, (under development); in collaboration with Dr. Eric Morales, Environmental Hydrogeology Group, Department of Earth Sciences, University of Utrecht, The Netherlands.
- Finding relative permeability-saturation curves by using a more accurate and complex scheme.
- Finding dispersion as a function of saturation, by taking into account limited mixing in pore spaces of porous media under partially-saturated conditions.
- Calculating solute adsorption to solid-water and air-water interfaces as a function of saturations.
- Constructing a network appropriate for colloid and surfactant transport under partially-saturated flow conditions, which includes the effect of drag forces on colloids, attachment and detachment (under development); in collaboration with Dr. Scott Alan Bradford, U.S. Salinity Laboratory, Riverside, CA.