3-D Numerical Modelling of an In Situ Field Scale Pulsed Pumping Process of a Large DNAPL Pool in a Keyed Enclosure

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Background/Objectives. Remediation of dense non-aqueous phase liquids (DNAPLs) represents a challenging issue because of their persistent behavior in the environment. In this context, the research and development SILPHES project manages the association of innovative characterization tools and emerging remediation technologies applied on chlorinated-contaminated groundwater. The main compound of DNAPL is hexachlorobutadiene, an emerging pollutant added in 2015 to the Persistent Organic Pollutants list edited by the Stockholm Convention (United Nations Environment Program). The study takes place in the vicinity of a chlorine-based chemistry factory still in operation in Tavaux, France from which historical pollution has spread accidentally at an estimated volume of around 30 000 m^3 of chlorinated compounds into the local alluvial aquifer. This field-scale study investigates, by means of in situ experiments and numerical modelling, the feasibility of the pulsed pumping process of a large amount of a DNAPL in a keyed enclosure set within the alluvial aquifer.

Approach/Activities. An in situ low-permeability keyed enclosure of 10 m x 10 m x 10 m was built at the location of the DNAPL source zone to isolate a finite volume of aquifer and a 3-month pulsed pumping process was applied inside the enclosure to exclusively extract the DNAPL. The water/DNAPL interface elevation at both the pumping and an observation well were recorded as well as the accumulated pumped volume of DNAPL. A total volume of about 20 m^3 of purely DNAPL was recovered since no water was extracted during the process. The numerical interpretation of the pumping process was performed with the three-dimensional and multiphase flow simulator TMVOC and a conceptual model was elaborated and generated with the pre/post-processing tool mView. A geometrical conceptual model consisted of 10 layers of variable thickness and 5060 grid cells. A simple well model was introduced to simulate the interface elevation data recorded on site.

Results/Lessons Learned. Numerical simulations reproduce the pulsed pumping process and show an excellent match between simulated and field data of DNAPL pumped volume and a reasonable agreement between modelled and observed data for the evolution of the water/DNAPL interface elevations at the two wells. This study offers a new perspective in remediation since DNAPL pumping system optimization may be performed where a large amount of DNAPL is encountered.