

Figure 1. Locations of shallow groundwater wells at Cranfield site (red dot in the inset) and UM-1 well for the push-pull test

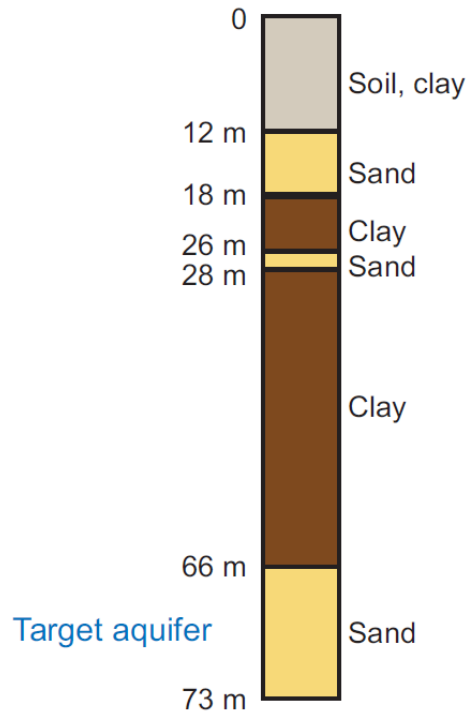


Figure 2. Schematic of sediment texture in well UM-1, which was used for push pull test at Cranfield site (water level in the borehole is about 27 m below the surface and the first two sand layers in unsaturated zone).

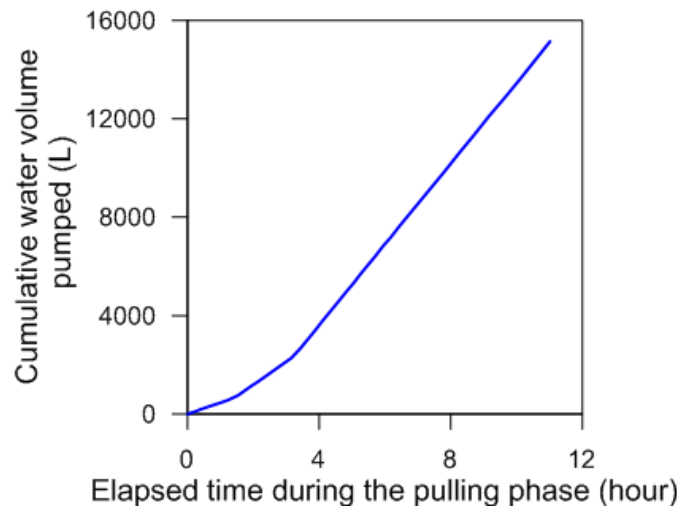


Figure 3. Plot of cumulative water volume pumped during the pulling phase.

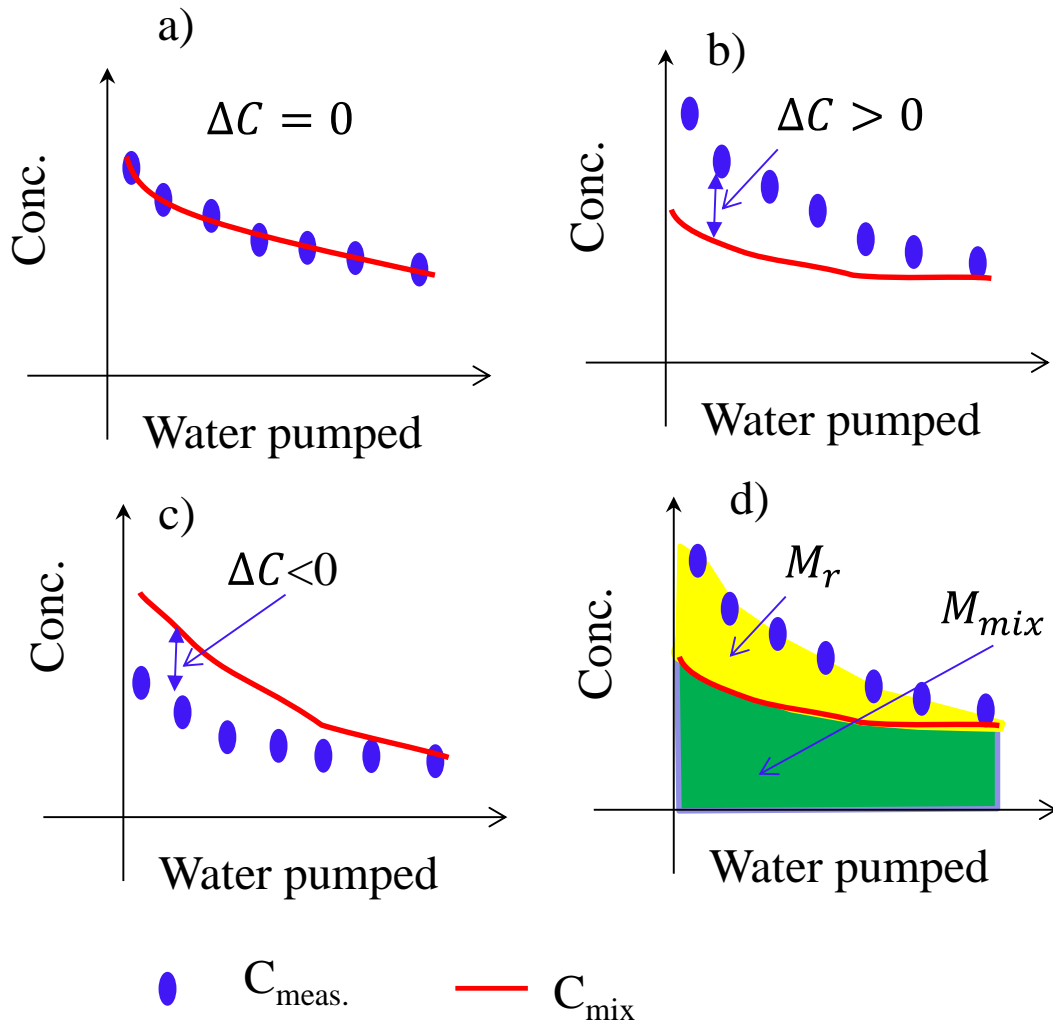


Figure 4. Schematic showing ion mobilization: (a) no chemical reaction, (b) from aquifer sediments to groundwater, (c) from groundwater to aquifer sediments, and (d) components of total recovery mass (mixing mass and reactive mass).

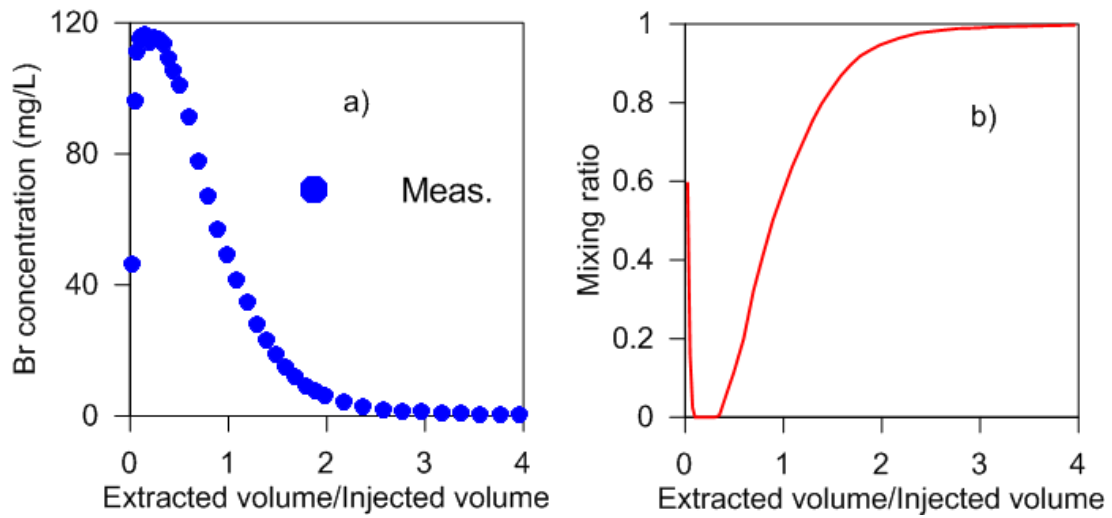


Figure 5 Plots of (a) Br concentration measured during pulling phase and (b) mixing ratio between injected water and background water (1 denotes background water end member whereas 0 denotes injected water end member)

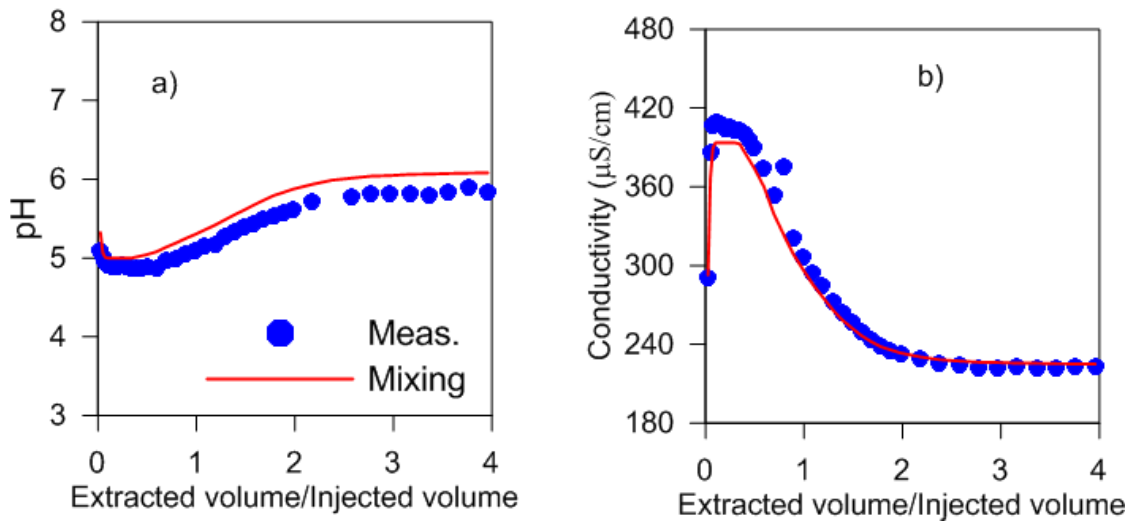


Figure 6. Plots of (a) measured groundwater pH and (b) electronic conductivity of groundwater during pulling phase (red lines are mixing values calculated using Eq. 2).

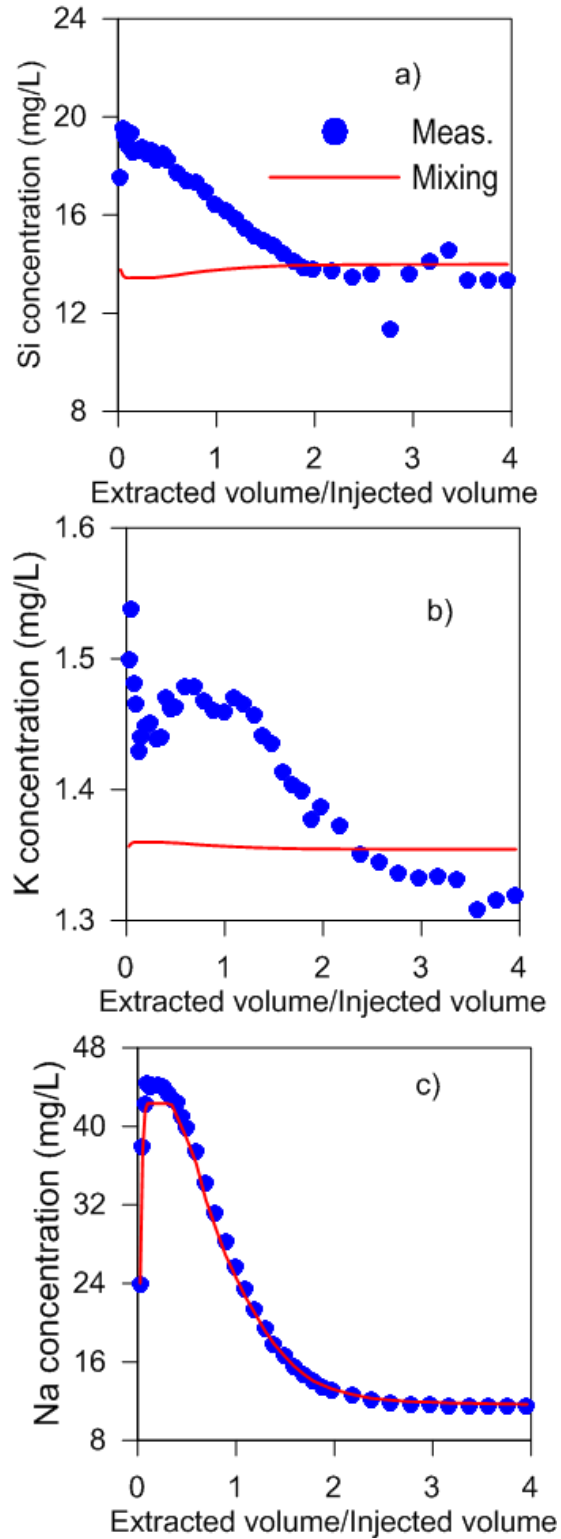


Figure 7. Plots of concentrations of (a) Si, (b) K, and (c) Na measured during the pulling phase (red lines are mixing values calculated using Eq. 2). Discrepancy between red line and blue dots represents groundwater-sediment interactions.

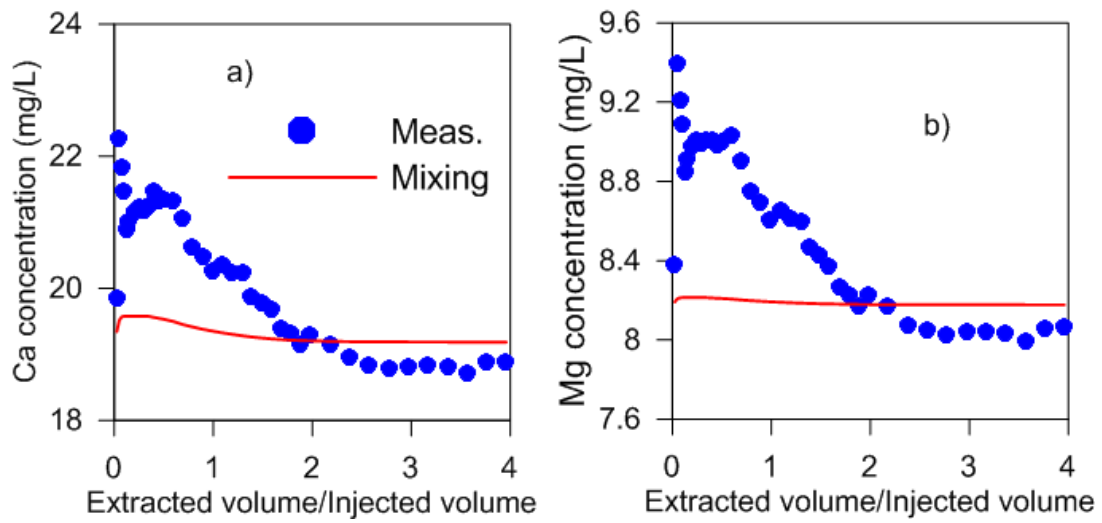


Figure 8. Plots of concentrations of (a) Ca, and (b) Mg measured during pulling phase (red lines are mixing values calculated using Eq. 2). Discrepancy between red line and blue dots represents groundwater-sediment interactions.

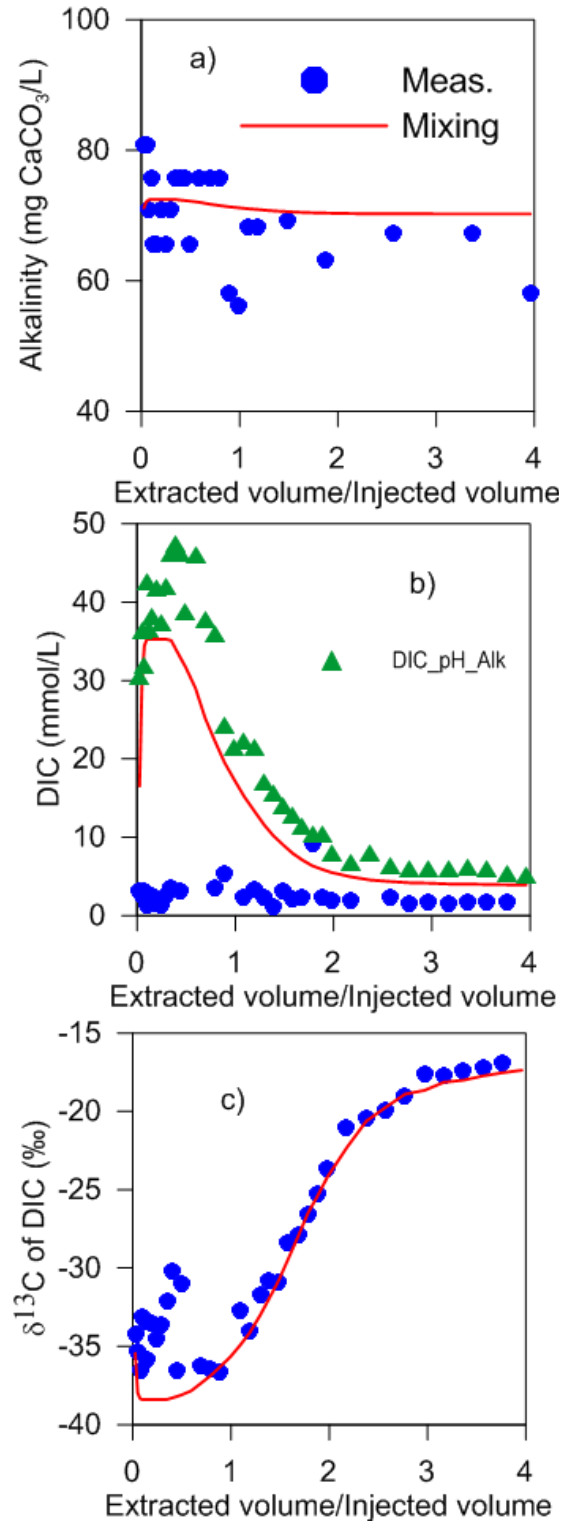


Figure 9 Plots of (a) alkalinity, (b) Dissolved inorganic carbon (DIC), and (c) $\delta^{13}\text{C}$ of DIC measured during pulling phase (red lines are mixing values calculated using Eq. 2 and green triangles in (b) are DIC values calculated from pH and alkalinity measurements using PHREEQC)

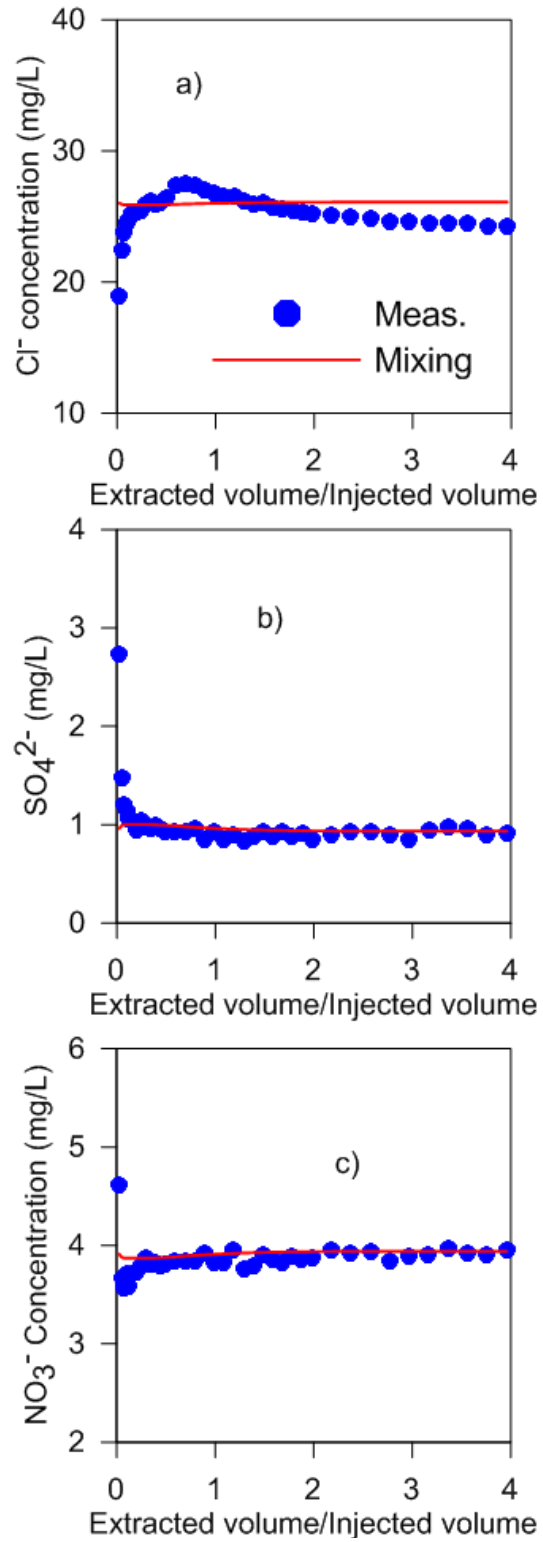


Figure 10. Plots of concentrations of (a) Cl, (b) SO_4 and (c) NO_3 measured during pulling phase (red lines are mixing values calculated using Eq. 2)

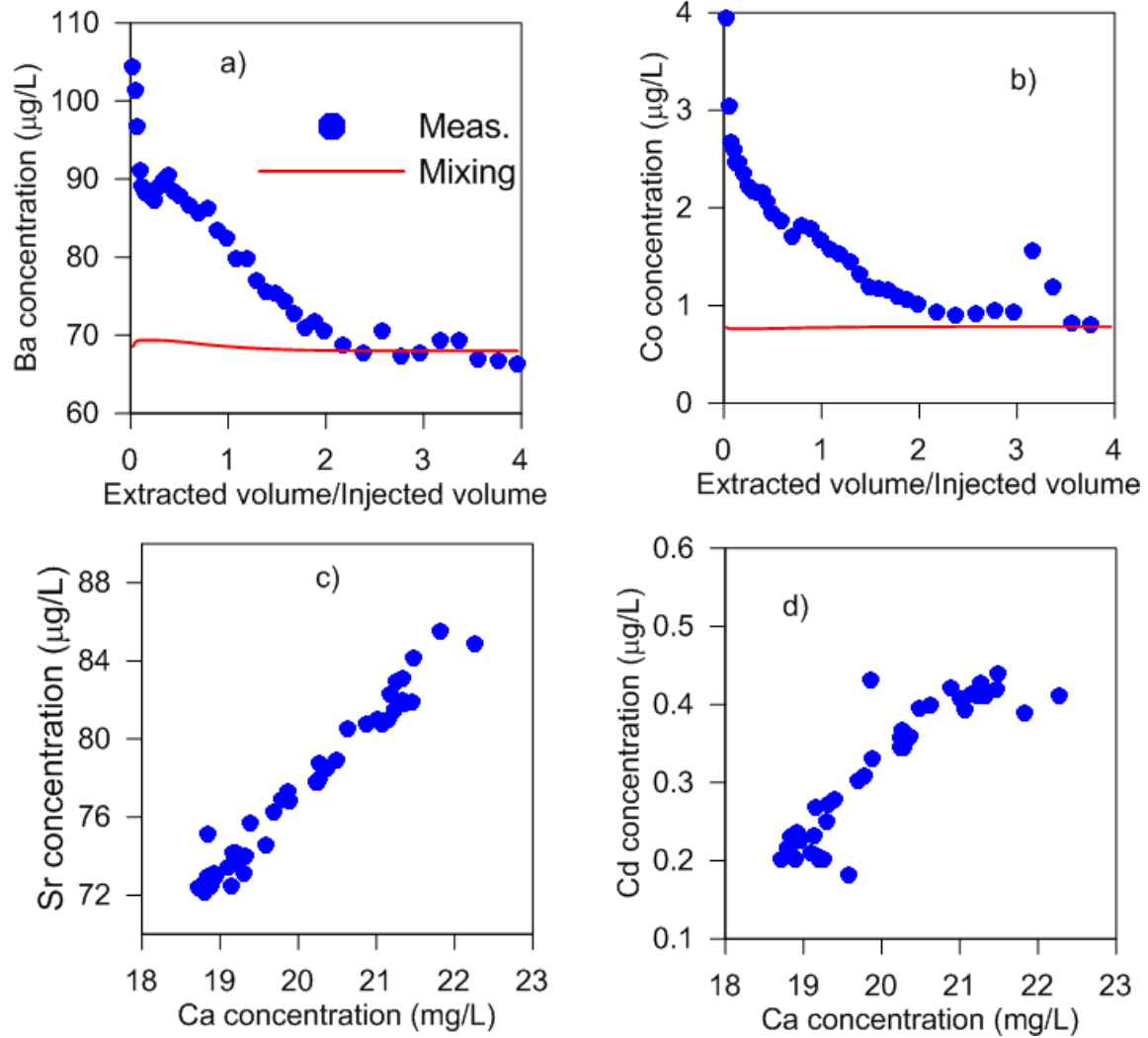


Figure 11. Plots of (a) Ba concentrations and (b) Co concentration measured during pulling phase; (c) Sr concentration measurements versus Ca concentration measurements and (d) Cd concentration measurements versus Ca concentration measurements (red lines are mixing values calculated using Eq. 2). Discrepancy between red line and blue dots represents groundwater-sediment interactions.

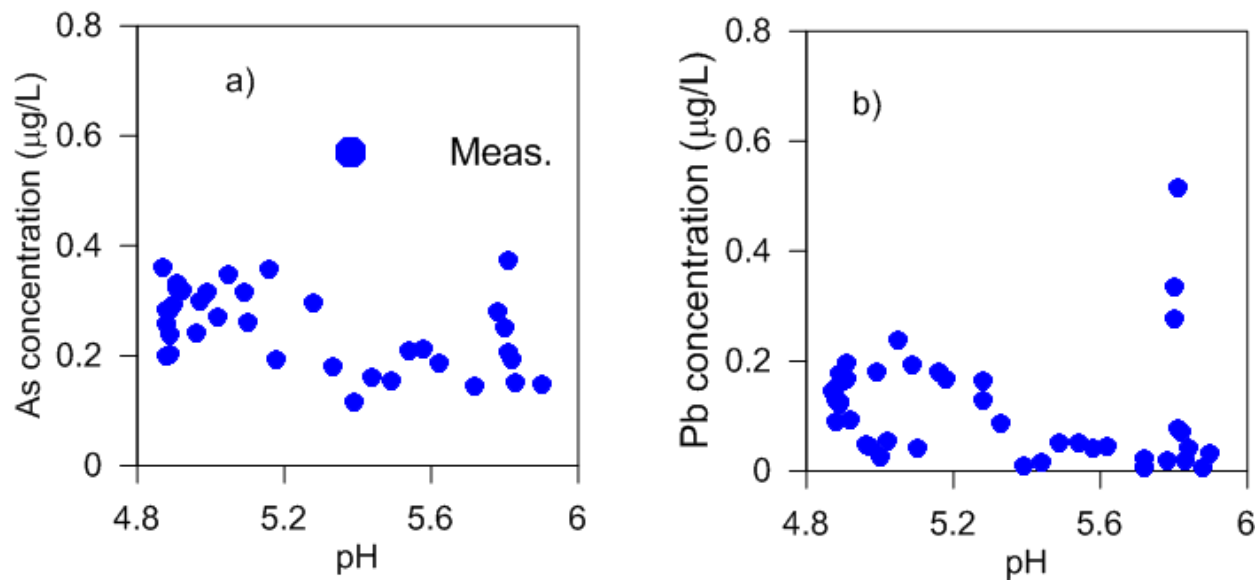


Figure 12. Plots of (a) As concentration measurements versus pH and (b) Pb concentration measurements versus pH.

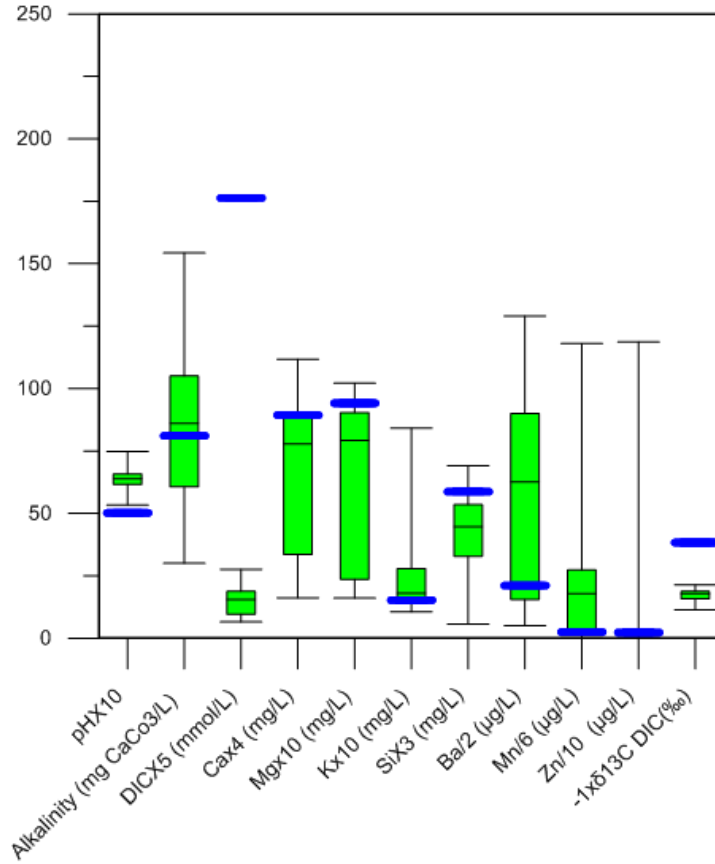


Figure 13. Box-Whisker plot of measurements of ion concentrations, pH, alkalinity, DIC, and $\delta^{13}\text{C}$ of DIC for water chemistry in Cranfield shallow aquifer from August 2008 to March 2012 and max ion concentrations observed in the push-pull test (the blue line) (for better visualization, pH, concentrations of Mg and K multiplied by 10, concentrations of DIC, Ca and Si multiplied by 5, 4 and 3, respectively, concentrations of Ba, Mn, and Zn divided by 2, 6, and 10, respectively, and $\delta^{13}\text{C}$ of DIC multiplied by -1).