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Effect of sequential release of NAPLs on NAPL migration in porous media

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NAPLs (Non-aqueous phase liquids) are common groundwater contaminants and are classified as LNAPLs (Light non-aqueous phase liquids) and DNAPLs (Dense non-aqueous phase liquids) according to relative density for water. Due to their low solubility in water, NAPLs remain for a long time in groundwater, and they pose a serious environmental problem. Therefore, understanding NAPLs migration in porous media is essential for effective NAPLs remediation. DNAPLs tend to move downward through the water table by gravity force because its density is higher than water. However, if DNAPLs do not have sufficient energy which breaks capillary force of porous media, they will just accumulate above capillary zone or water table. Mobile phase of LNAPLs rises and falls depending on fluctuation of water table, and it could change the wettability of porous media from hydrophilic to hydrophobic. This could impacts on the migration characteristics of subsequently-released DNAPLs. LNAPLs and DNAPLs are sometime disposed at the same place (for example, the Hill air force base, USA). Therefore, this study focuses on the effect of sequential release of NAPLs on NAPLs (in particular, DNAPL) migration in porous media. We have conducted laboratory experiments. Gasoline, which is known to change wettability of porous media from hydrophilic to intermediate, and TCE (Trichloroethylene) were used as LNAPL and DNAPL, respectively. Glass beads with the grain size of 1 mm and 2 mm were prepared for two sets of porous media. Gasoline and TCE was dyed for visualization. First, respective LNAPL and DNAPL of 10 ml were separately released into prepared porous media. For the grain size of 2 mm glass beads, LNAPL became buoyant above the water table, and DNAPL just moved downward through porous media. However, for the experiment with the grain size of 1 mm glass beads, NAPLs behaved very differently. DNAPL did not migrate downward below and just remained above the water table due to capillary pressure of porous media. To study the effect of subsequent release of NAPLs, as soon as LNAPL was released to porous medium with 1 mm of glass beads, being buoyant above water table, water table was lowered, which left residuals along the path of LNAPL. DNAPL was subsequently released. DNAPL was breaking through the water table now, which was opposed to only DNAPL release case. This study indicates that sequential release of NAPLs can leads to different migration characteristics of NAPLs, compared with the release of single phase NAPL into porous media.