C35 When is a DNAPL a DNAPL?

James S. Smith, PhD, Trillium, Inc., 28 Grace's Drive, Coatesville, PA 19320*

After attending this presentation, attendees will understand that the USEPA rule of thumb for the presence or absence of a DNAPL is not always valid.

This presentation will impact the forensic community and/or humanity by demonstrating the need for an environmental forensic scientist to use analytical chemistry methodologies that detect and identify hydrocarbons associated with chlorinated organic chemicals.

The USEPA and hydrogeologists have for a considerable length of time considered the presence of a chlorinated solvent as a dense nonaqueous phase liquid (DNAPL) in an aquifer when the groundwater concentration of the chemical exceeds 1% of the equilibrium solubility of that chemical.[1] For example, the equilibrium solubility of trichloroethene (TCE) in water is 1,100 mg/L (ppm). Therefore, if TCE is found above a concentration of 11,000 µg/L (ppb) in a monitoring well, then it is reasonable to conclude that the TCE is present in the aquifer as a DNAPL. Certainly, if the TCE is a DNAPL and is sinking through the aquifer material, then remediation is going to be difficult at best and impossible at worst.

But, is the high "hit" really a TCE DNAPL? Everyone seems to agree that TCE is more dense than water with a density of 1.47 g/mL. Also, most environmental professionals know that TCE and other chlorinated solvents have been and are used as degreasers. Many of these degreasing uses have been in metal fabricating industries where the chlorinated solvents were used in vapor degreasers. This use was usually followed by a recycling of the solvent by distillation leaving a hydrocarbon-solvent mixture waste. If this mixture is the material in the environment, then there could be three completely different scenarios:

1. The mixture density is less than 1 g/mL. This material is a light non-aqueous phase liquid (LNAPL). The LNAPL contains TCE, for example, at concentrations exceeding 11,000 µg/L yet it is not a DNAPL.
2. The mixture density is greater than 1 g/mL. This material is a DNAPL, but it will act differently than a pure TCE DNAPL. For instance, a TCE-alkane wax mixture will act like a DNAPL with a high viscosity whereas pure TCE would move further and faster due to its low viscosity.
3. The mixture starts being transported on the water table as an LNAPL because the mixture has a density less than 1 g/mL. As the mixture is transported, the hydrocarbon aerobically biodegrades and the density of the mixture changes to a value greater than 1 g/mL and begins to sink into the aquifer. The smear zone can promote this phenomenon.

The environmental professional should always test the hypothesis that there may be a hydrocarbon portion of a chlorinated solvent release to the environment. Remediation costs depend on it. Several case studies will be discussed where high concentrations of chlorinated solvents in groundwater are not due to DNAPLs. Also, the use of the chemical concept of partition coefficient will be used to show the fate and transport of the chlorinated solvent.

Reference:

1. USEPA Evaluation of the Likelihood of DNAPL Presence at NPL Sites National Results, EPA 540-R-93-073, PB93-963343, page xi, September 1993.

Chlorinated Solvents, DNAPL, LNAPL

** Presenting Author*