Negative Ion Sensors for Real-Time Downhole DNAPLs Detection

Cleanup
CU-1089

Background:

Location of dense non-aqueous phase liquid (DNAPL) sources and reliable estimates of their masses are crucial for cost-effective cleanup. The ability of available methods to accurately and efficiently define the subsurface distribution of chlorinated solvent DNAPLs is limited.

Objective:

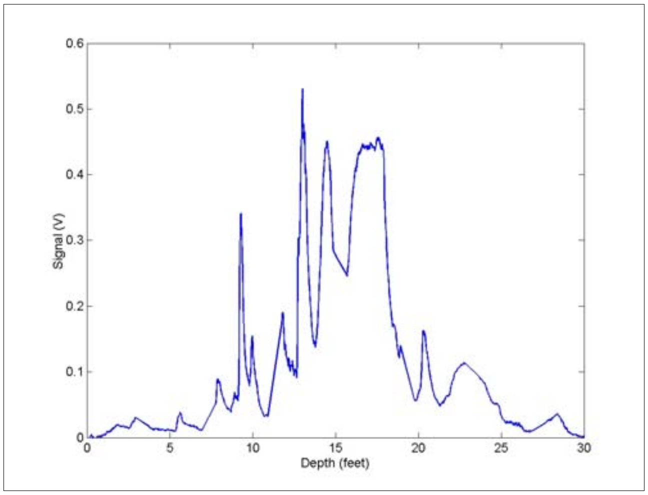
The objective of this project was to develop a tool that could detect, locate, quantify, and determine the subsurface distribution of DNAPLs and be deployed via the Site Characterization and Analysis Penetrometer System (SCAPS) and other direct push platforms. Key probe elements included a heated membrane interface and a sensitive, fast-responding downhole detector. All performance objectives were met, including sensor responsiveness to all common organochlorine compounds, a vapor detection limit of 100 ppbv, selectivity greater than 5000:1 relative to fuel hydrocarbons, a response time of less than 3 seconds, and automatic operation as the probe is advanced.

Summary of Process/Technology:

The sensor system, now named the Haloprobe, consists of a halogen specific detector integrated with the Membrane Interface Probe (MIP™, Geoprobe Systems). The hot surfaces of the MIP heat the surrounding soil, vaporizing volatile organic compounds (VOCs) adsorbed on the soil matrix, in the dissolved phase, or present as a free phase. The VOCs pass through the sampling membrane into the interior of the MIP, where a carrier gas stream transfers them to the halogen detector via a short (approximately one foot) transfer line. Oxidative reactions occurring at the 1000° C temperature of the Haloprobe reactor core convert halogenated compounds to halogen ions, water, and carbon dioxide. The resulting ions are drawn to biased electrodes to produce a voltage that is subsequently read by a data acquisition system located uphole. Real-time logs of total halogen signal versus depth are available as the probe is continuously advanced into the subsurface. The probe can be optimally configured for measurements over the entire concentration range from less than 100 ppb dissolved phase to free product.

Benefit:

Using today's technology, the cost to remediate Department of Defense sites alone is estimated at $35 billion. Annual costs greater than $500,000 for the containment and monitoring of a single DNAPL plume are typical. The Haloprobe offers much higher spatial resolution for delineation of DNAPL source terms, lower sensor acquisition and operating costs, and can be operated in concert with other chemical and physical sensors. Reliable knowledge of the source term location translates into improved remediation design and more rapid cleanups.



Real-time log of chlorinated solvent contamination versus depth collected with the Haloprobe.

Accomplishments:

The Haloprobe was successfully demonstrated at Offutt Air Force Base in Omaha, Nebraska. Twelve pushes were completed over a two-day period to depths of greater than thirty feet. The Haloprobe data agreed extremely well with groundwater sampling data previously acquired at much greater expense. Because the marginal cost of extending the probing to greater depths is low, the Haloprobe uncovered a previously unknown deeper contaminant zone. The Haloprobe has transitioned to the demonstration/validation phase under the auspices of the Environmental Security Technology Certification Program. Commercial release of the Haloprobe is expected in Spring 2003. This project was completed in FY 2001.

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