# Accessing Difficult Geology for Characterization and Injection Using the New GeoTAP™ Method

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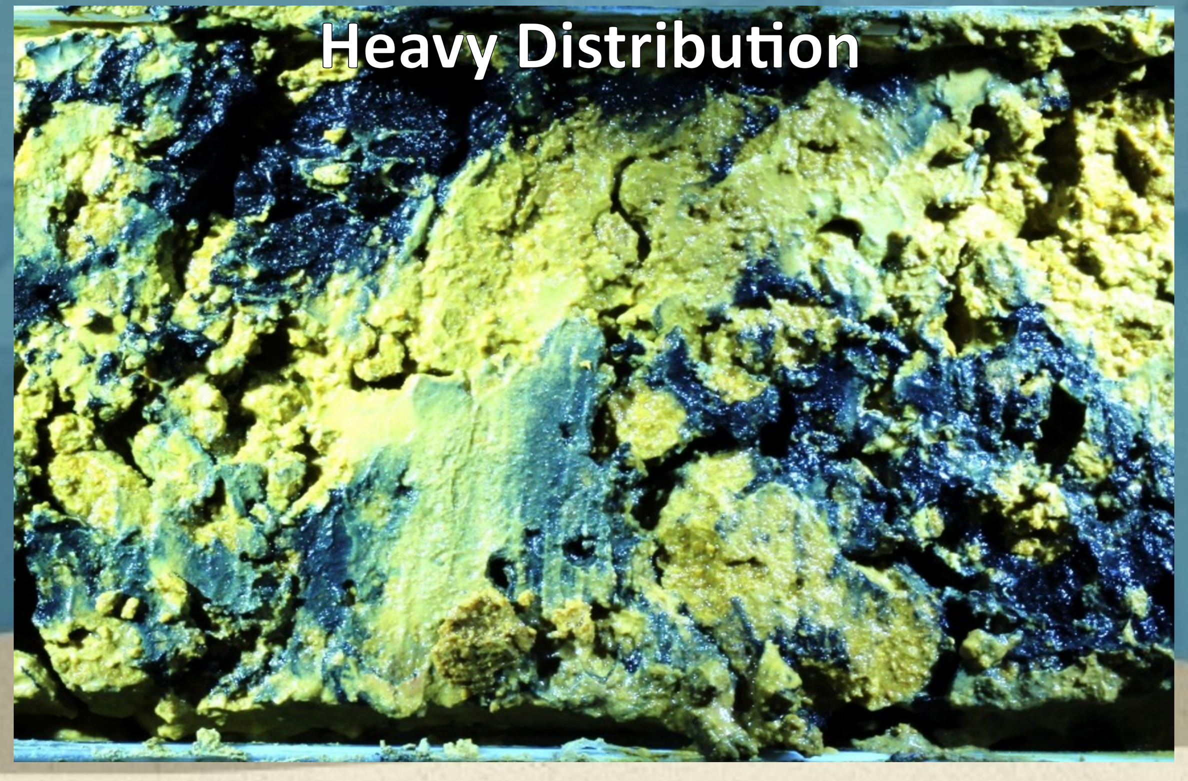
## Access Problems

It has been difficult or impossible to access various geologic zones, such as till, weathered rock, saprolite, and urban fill at remediation sites using commonly available drilling equipment, such as direct push technologies (DPT). However, by using a sequential combination of drilling methods and an engineered backfill process, GeoTAP™ allows environmental practitioners to target and treat these zones using DPT injection with various reactants and reagents.

The GeoTAP method has now been successfully demonstrated on numerous projects and in varied geologic settings across the United States to treat groundwater impacted with petroleum hydrocarbons (PAHs), chlorinated solvents (CVOCs), and heavy metals.

Here, as an example, a viscous slurry was installed in a silty-sand unit and a glacial till unit at significant depth without the use of soil mixing or hydraulic fracturing. This transect application was a contemporary modification to conventional source and permeable reactive barrier (PRB) options. This installation was preferred for this phase of the project when compared to other alternatives, such as excavation and direct mixing.

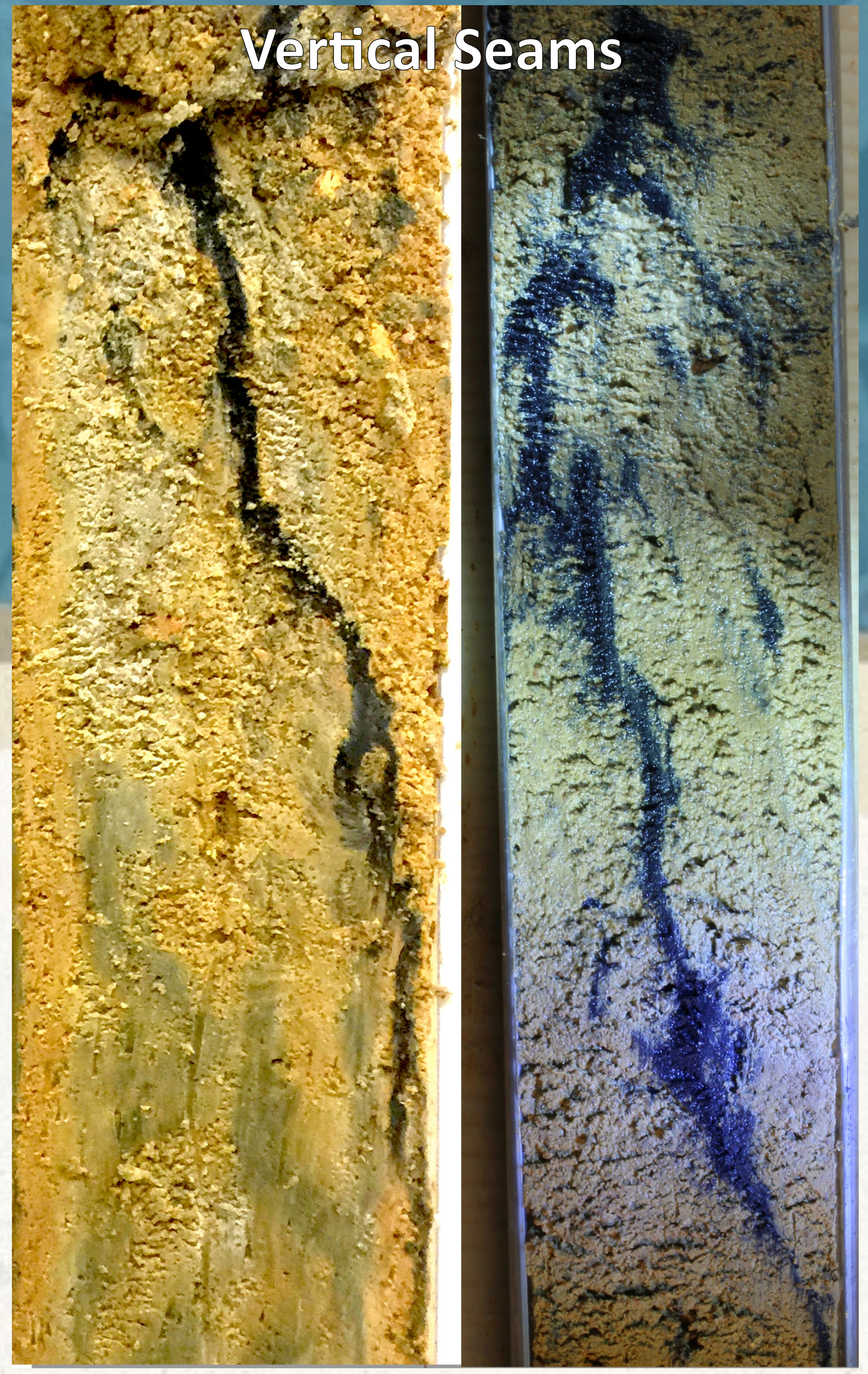




## Design

A viscous slurry reactant was chosen for this site due to the investigation results. The remedial design characterization (RDC), which is an evaluation of soil and groundwater mass and mass flux, indicated a significant mass of reactant was needed to install reactive transects in the phreatic zone with a ~30 year lifespan. This RDC process was critical to selecting the reactant and calculating the necessary loadings to install at each transect and at specific verticals intervals within those transects.

Historically, environmental practitioners have been hesitant to recommend treatment protocols based upon the injection of viscous slurries. This incertitude is based upon a misconception that installation of these types of injectates may adversely affect the subsurface hydrological conditions in the targeted formation or are unfeasible for installation (e.g., promote pore clogging; reduced distribution). A high-energy installation method, which is also used with GeoTAP, is well suited for this application. This approach can install slurries via radial mixing, seam insertion, or fracturing.




## Approach

Site geology precluded traditional DPT from being utilized for injection, due to dense silty sands, gravels, and glacial till at depth. An innovative proprietary drilling and injection process (GeoTAP™) was used to access targeted depths. This process also provided a complete soil profile, which allowed the determination of succinct top and bottom injection spans for each injection point within the transect.

Injection locations were installed using roto-sonic ("sonic") drilling technology, which allowed for expeditious advancement of borings. At each location, after logging and photographing the soil to target depth, the evacuated borehole was backfilled in lifts with an engineered hydrated bentonite blend to prepare the borehole for high-energy injections. Drilling activities took five weeks to complete and were conducted with a four-week lead time over injection activities.

Depending on the location and product loading, injection point spacing was determined by the transect-specific groundwater flux (from the RDC) and injectate slurry loadings, typically 15 to 30 feet apart.

To deliver injectate, a DPT rig was used to drive 2.25" injection rods, fitted with a geology-specific injection tip, through the bentonite column to the targeted injection interval (typically 30 to 70 ft-bgs). Installation was completed using a custom high-flow/high-energy Triplex injection system capable of flow rates up to 280 gpm and sustaining injection pressures as high as 2,000 psig.

## Lessons Learned

The initial design was based on previous experience injecting viscous slurries at depths reaching ~170 ft-bgs. At this site, we attempted a decreased flow rate and/or lower pressures while still affecting injectate distribution.

A total of ~34,000 gal of injectate was installed across 2,340 linear ft (lf) during four weeks of activities. Injectate distribution was assessed by placing transducers in existing monitoring wells and piezometers, and by monitoring changes in groundwater geochemistry. Groundwater monitoring continued on a weekly interval post-injection until moving to quarterly monitoring.

In the end, it was determined that the optimal operating rage of this system with the injectate was 50 to 200 psig and 300-gallon shots per injection interval. However, at shallower depths and to control daylighting, similar distribution could be affected at 50 to 80 psig by conducting separate, sequential shots of 200 and 100 gallons. These two approaches provided the greatest effective distribution of injectate depending on spacing and depth.

In the future, for larger projects, it would be useful to pilot the 1-shot and 2-shot approach if time allows. However, adjusting the installation process in the field proved just as effective.