



# Potentially Applicable Tools



**EPA**

United States  
Environmental Protection  
Agency

Thanks to:

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# Overview

- ◆ **Tools for unconsolidated environments**
  - » Shallow
  - » Deep
- ◆ **Tools for fractured or porous media environments**
- ◆ **Tools for non-depth-specific applications**
- ◆ **Tools for groundwater and surface water interface environments**



# Tools for Shallow Unconsolidated Environments

## Preview

- Soil coring
- Hydrostratigraphic tools
- Qualitative tools for contaminants
- Sampling and quantitative tools for contaminants

# Soil Coring

# Soil Coring

- ◆ **Soil coring provides samples of the actual porous medium and, ideally, of the pore fluids**
  - » soil cores are the baseline (or ground truth) against which other methods are evaluated.
- ◆ **A wide variety of techniques to obtain cores are available**
- ◆ **A wide variety of types analyses of soil cores can be performed**

# Essential Information from Cores

- ◆ **Geologic/hydrogeologic features**
- ◆ **Physical, chemical & microbial properties**
- ◆ **Contaminant mass distributions (high & low K zones)**
- ◆ **Concentration gradients/diffusive fluxes**
- ◆ **Effectiveness of remedial technologies**

# Desirable Traits in a Coring Tool

- ◆ **100% recovery and retention**

- » allow the core to enter the core barrel (diameter, cutting shoe)
- » core must not expand in volume (clays) or fall out (sand)

- ◆ **Known depth of origin**

- ◆ **Minimal disruption of the structure of the strata**

- ◆ **Retention of pore fluids**

**The core one sees at the surface should be as accurate a representation of the subsurface conditions as possible.**

# Minimal Disruption of the Strata

## 9 x 9 m Cell DNAPL Migration in Aquitard Microbeds





# Structure and Pore Fluids Intact

## 9 x 9 m Cell DNAPL Migration in Aquitard Microbeds

Sand microbed

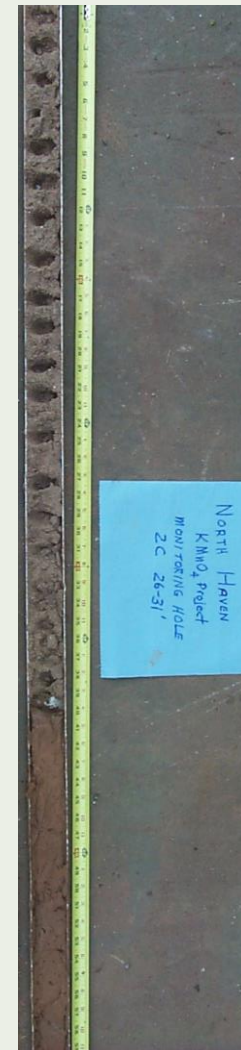
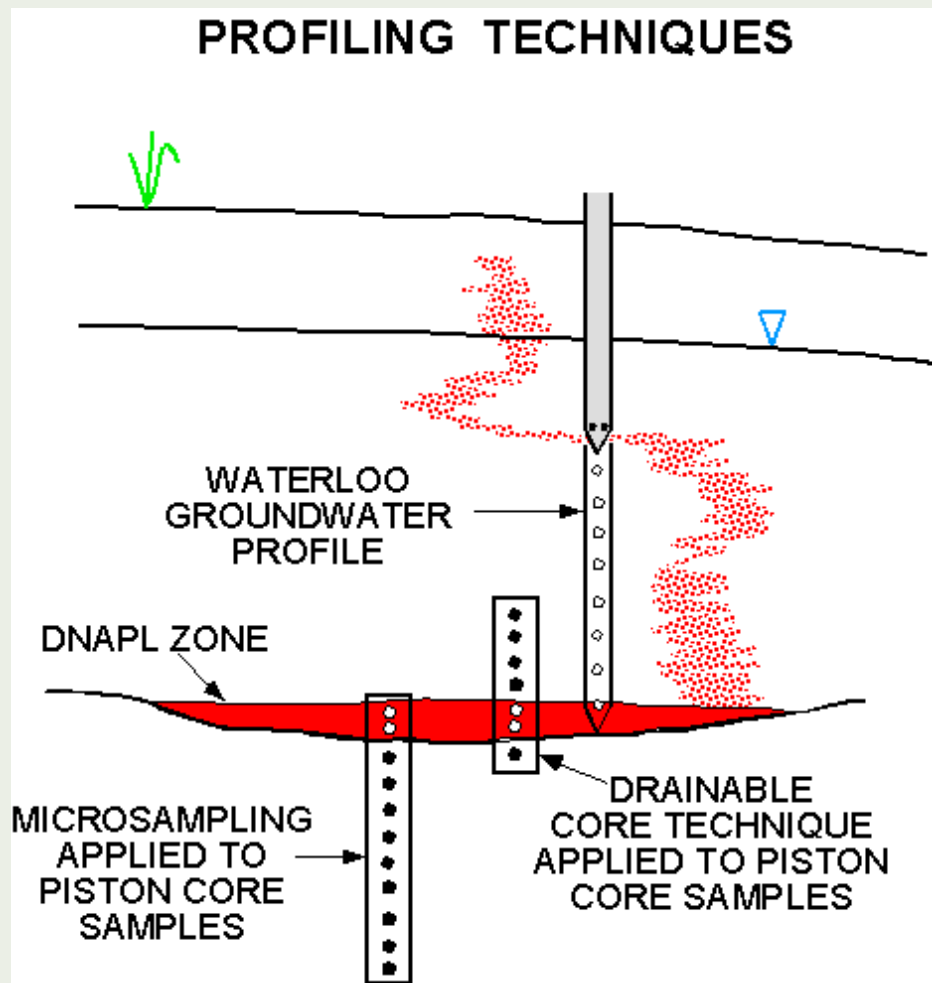


DNAPL (red) migration  
in sand microbed



# Retention of Pore Fluids

## DNAPL "Pool" vs Residual Mapping in North Haven, CT





# Coring Platforms

- ◆ **Sonic methods**

- » Very high frequency vibration

- ◆ **Direct Push methods**

- » Variable Percussion and downpressure

- ◆ **Auger/Rotary Methods**

- » Low frequency percussion



# Coring Tools: Single Rod Samplers

- ◆ Single rod tool
- ◆ Entire tool tripped each run
- ◆ May sample “slough” from shallower depths
- ◆ Susceptible to cross contamination
- ◆ Susceptible to “heave” below water
  - » Can be used in piston mode



Shelby Tube



Geoprobe MC5 MacroCore



Split Spoon

# Coring Tools: Dual Tube

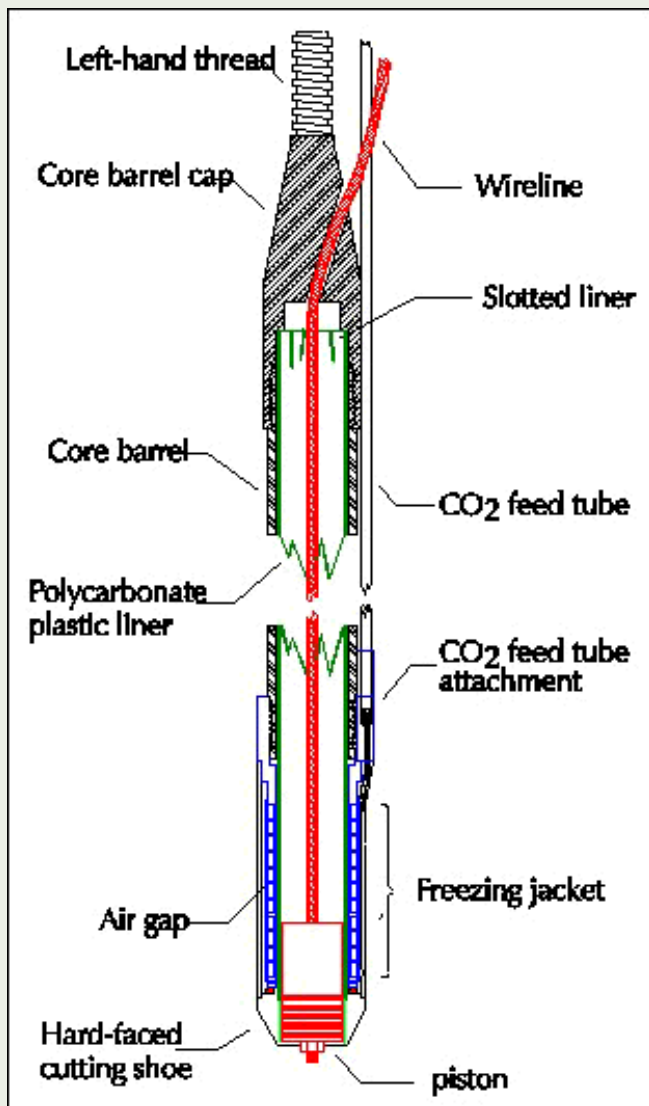


- ◆ **Outer casing stays in place, core barrel tripped**
- ◆ **Geoprobe (DT) Sampling System**
  - » Three system sizes:
    - › DT22 (2.25-in x 48-in length) 1.125-inch core
    - › DT325 (3.25-in x 48 or 60-in length) 1.85-inch core
    - › DT45 (4.5-in x 48 or 60-in length) 3-inch core
- ◆ **High quality core**
- ◆ **Minimal cross contamination**
- ◆ **Susceptible to “heave” below water table**
  - » Can be used in piston mode
- ◆ **Envirocore no longer commercially available**





# Freezing Core Downhole to Retain Sample



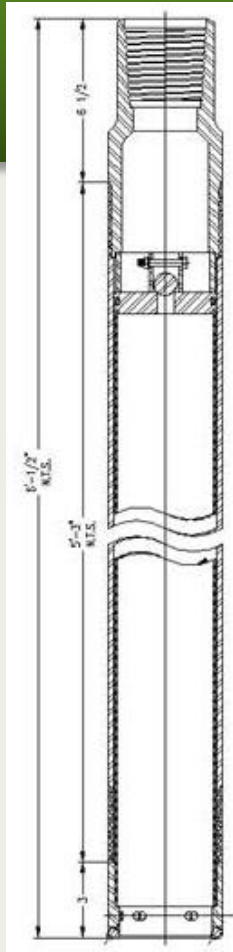
USGS modification of Solinst (Zapico)  
coring tool  
Freezes bottom 3-inches of core



# Sonic Coring

MMR – Cape Cod, MA

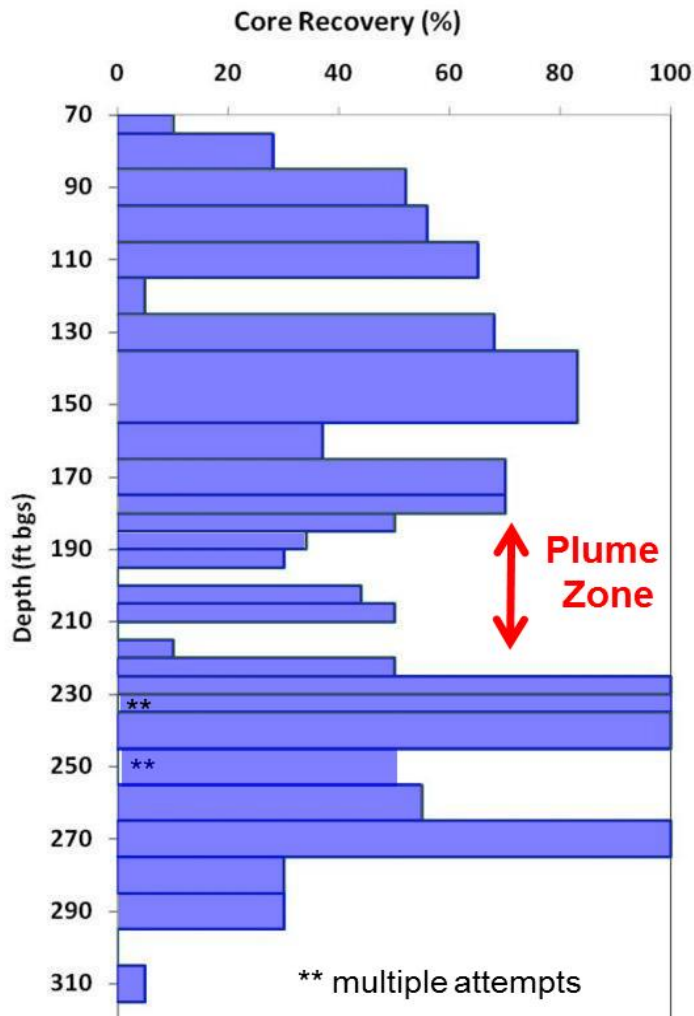
**Split core barrel w/  
Lexan liner (5 ft cores)**



**Continuous cores water table to  
bedrock 70 – 315 ft bgs**



# Sonic Coring Issues



## ◆ Poor recovery

- » flowing sands

## ◆ Heaving conditions

- » water used to minimize effects
  - › approx. 4000 gal total (~20 gal/ft)
- » water flushes through cores
  - › no check valve
  - › significant negative bias for VOCs

## ◆ Core samples highly disturbed

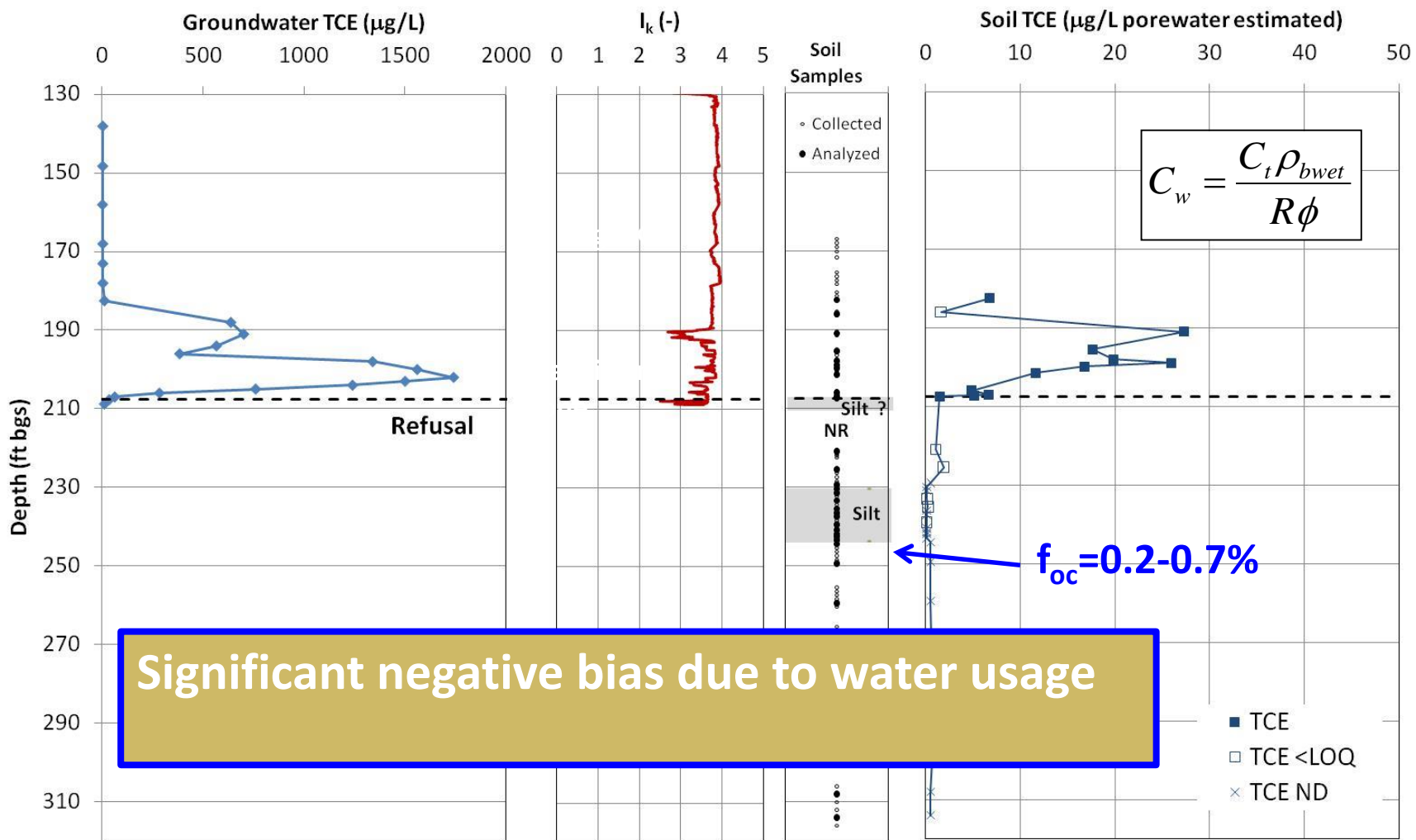
- » limited insight on detailed stratigraphy
- » inadequate for VOC sampling



# Mass Distribution Via Core Subsampling (limited number of samples collected/analyzed)



## Sonic Core



# Hydrostratigraphic Tools

# Cone Penetrometer Technology (CPT)

- ◆ **Continuous stratigraphic profiling**

- » Can be combined with numerous direct sensing devices (such as LIF, MIP, TarGOST)

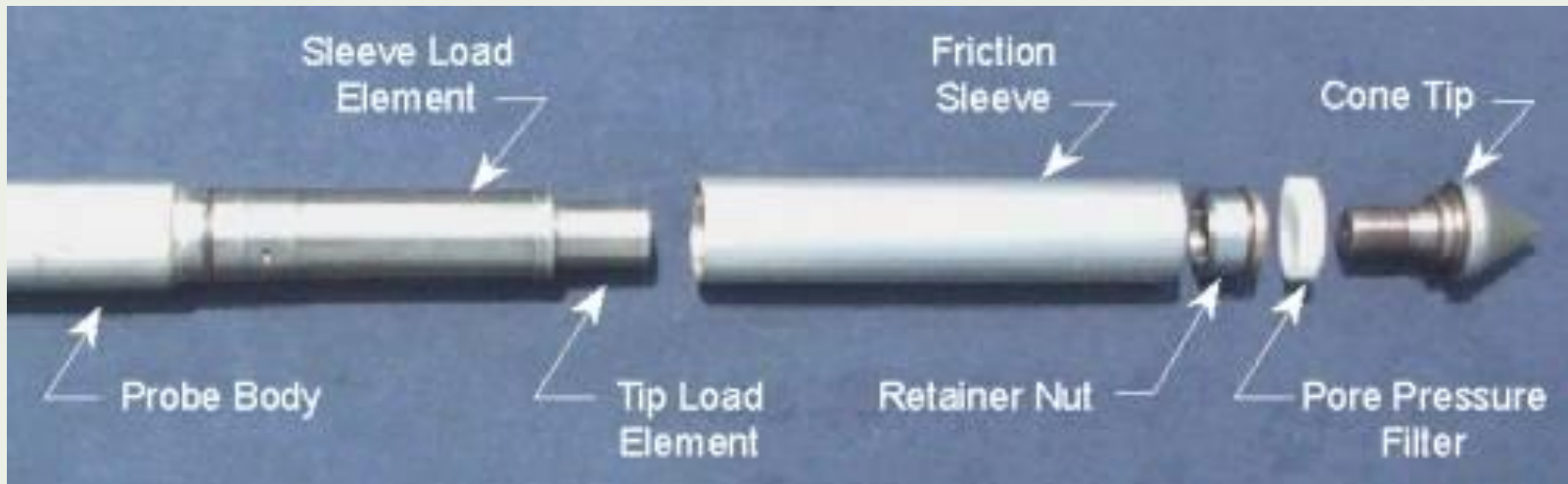
- ◆ **Describes stratigraphy on the basis of strain gauge ratios**

- ◆ **Real-time data generation**

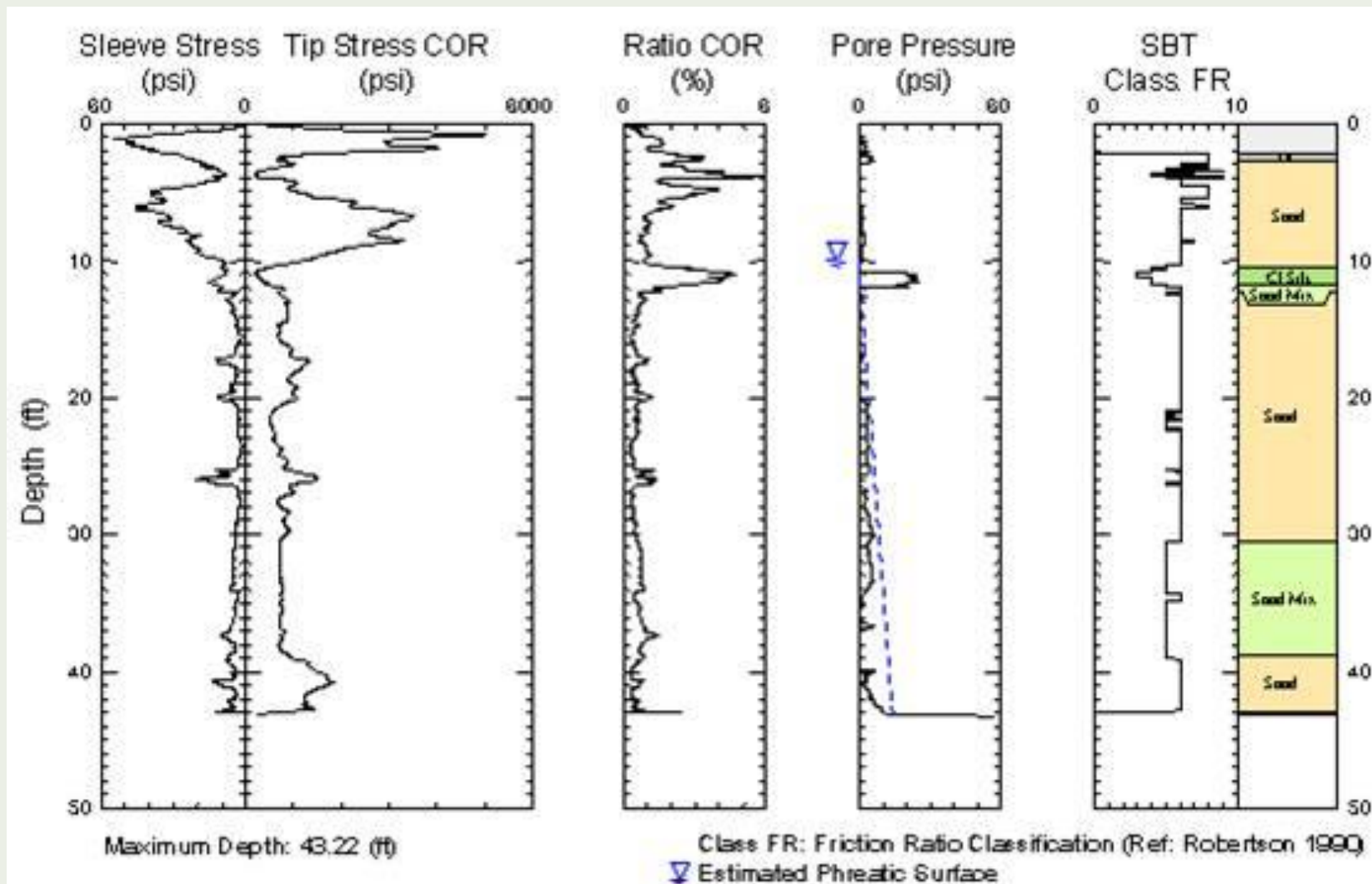
- ◆ **Static push only**

# Cone Penetrometers

- ◆ Static push (no percussion or vibration)
- ◆ Large heavy trucks
- ◆ Real-time data from *in situ* sensors
- ◆ Variety of sensors



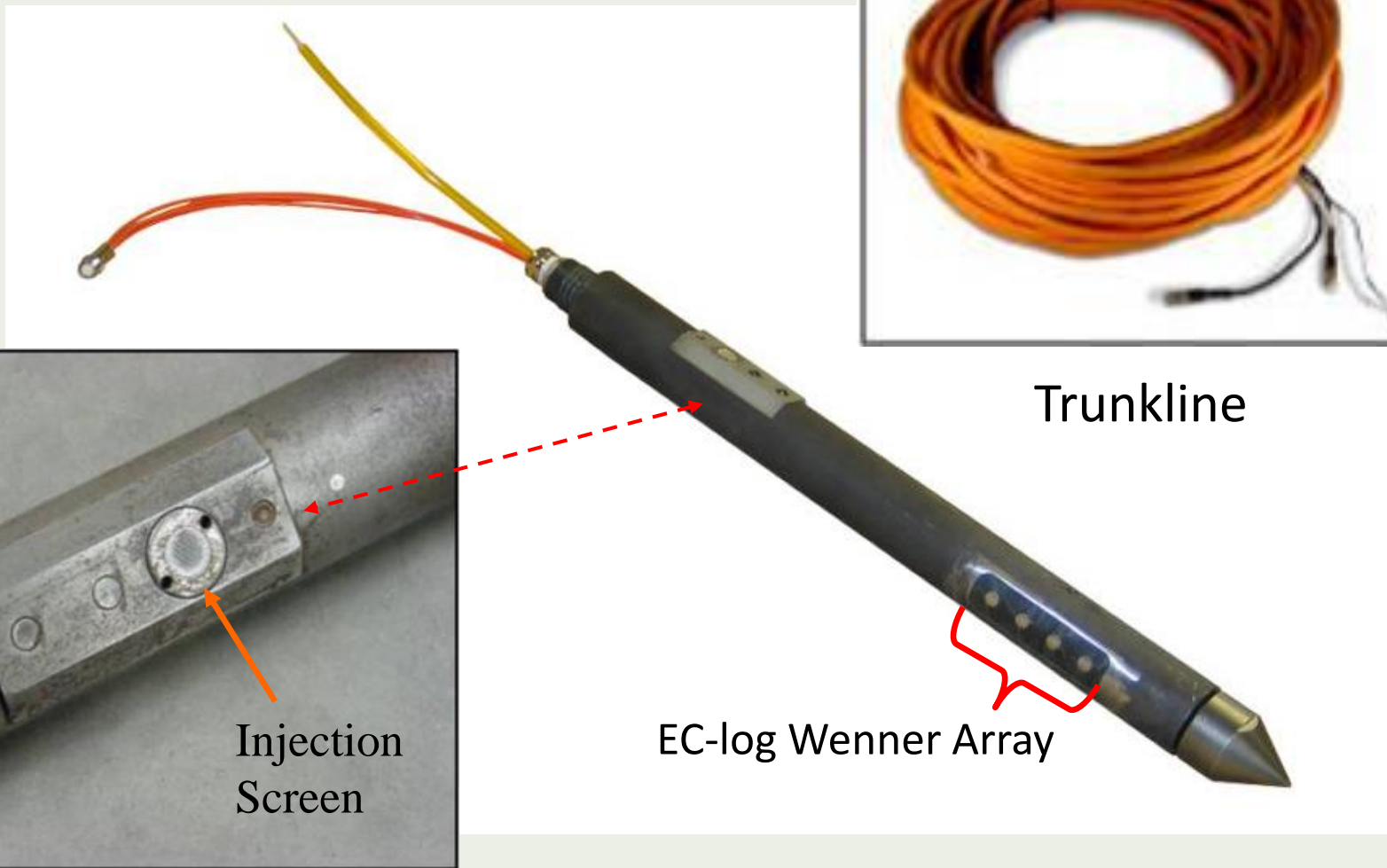
# Data from Piezocone from ARA



# Geoprobe Hydraulic Profiling Tool (HPT)

- ◆ **Continuous hydrostratigraphic data profiling**
- ◆ **Describes hydrostratigraphy on the basis of the flow of water into the formation**
- ◆ **Real-time data generation**
- ◆ **Direct push (percussion and vibration or static push)**

# HPT Components





# HPT Set Up



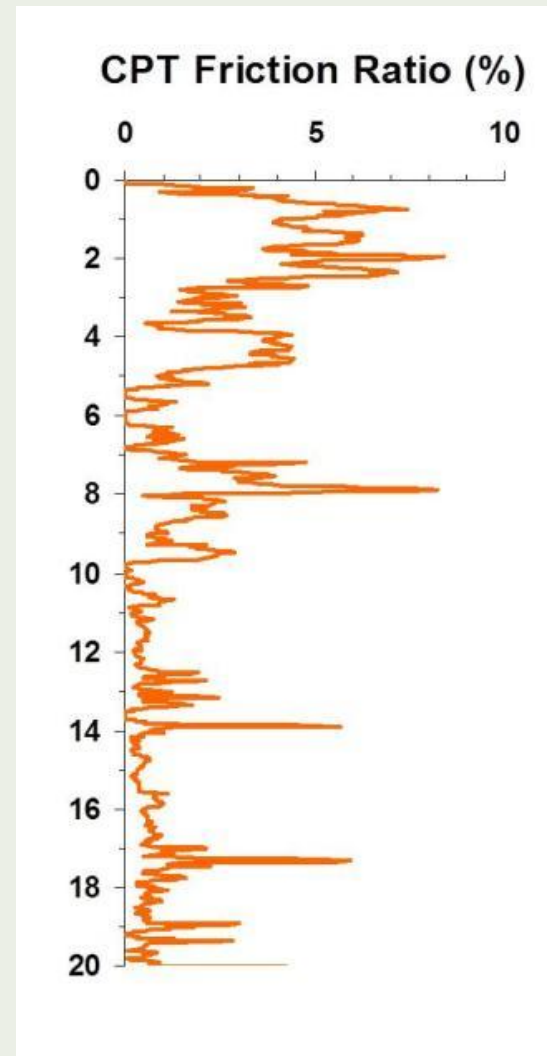
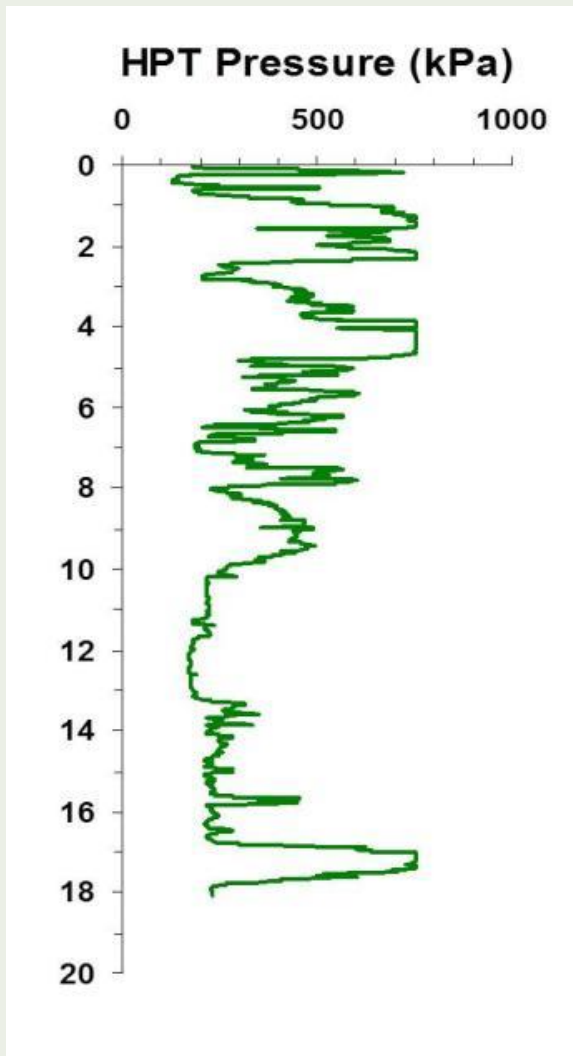
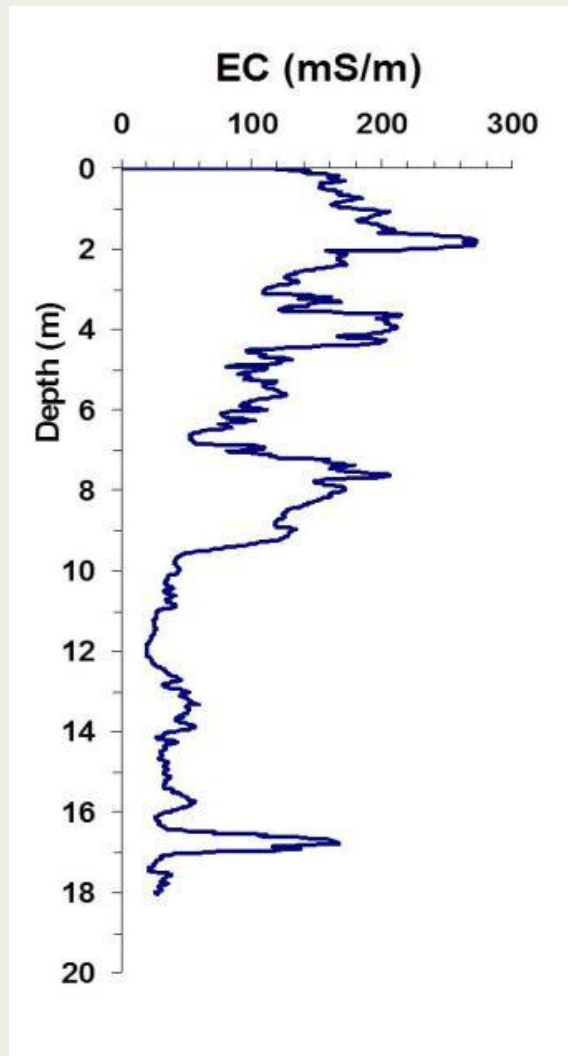
← Field Computer

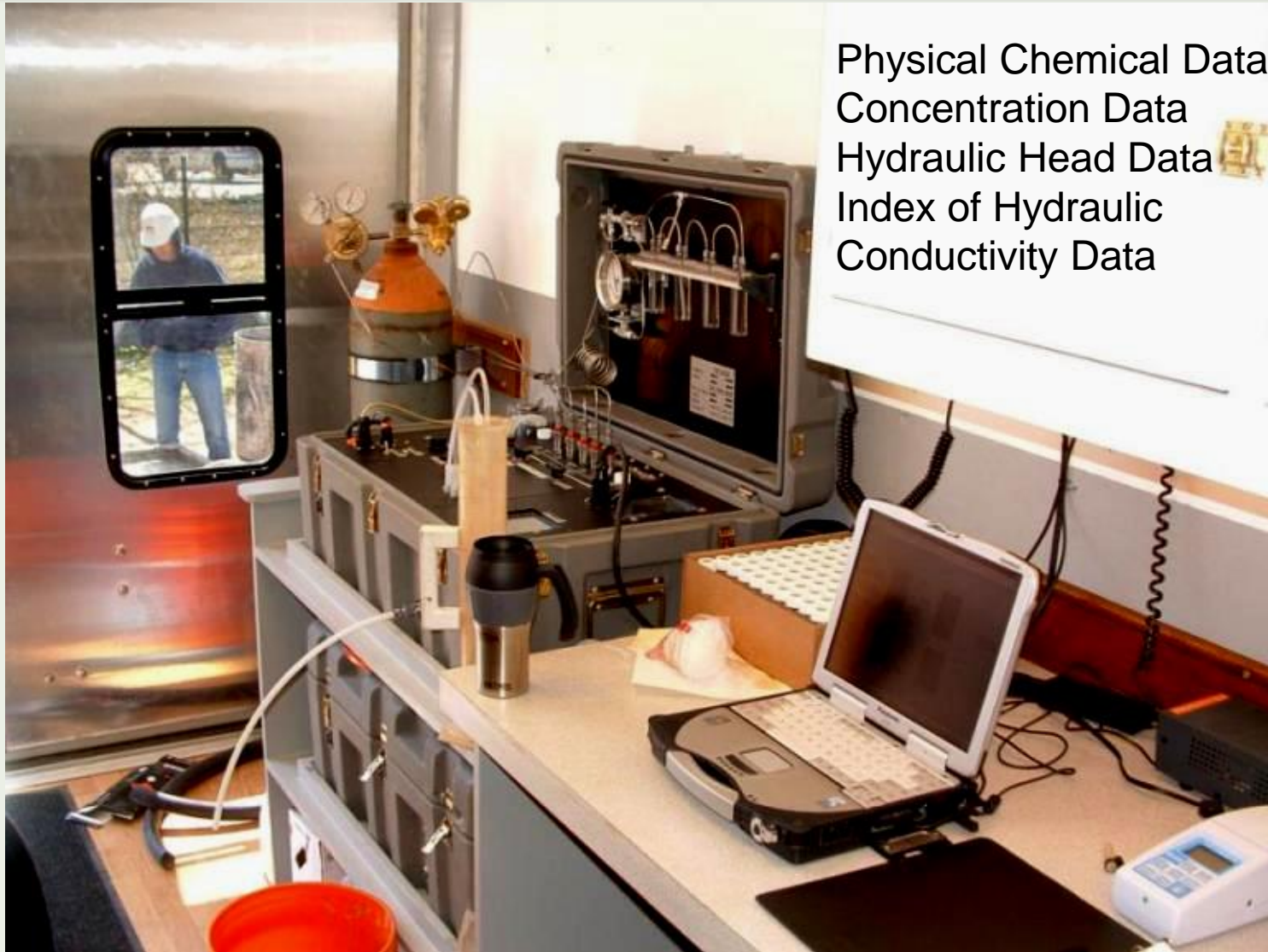
← HPT Controller

← HPT Pump



# Comparison of Logs





Physical Chemical Data  
Concentration Data  
Hydraulic Head Data  
Index of Hydraulic  
Conductivity Data

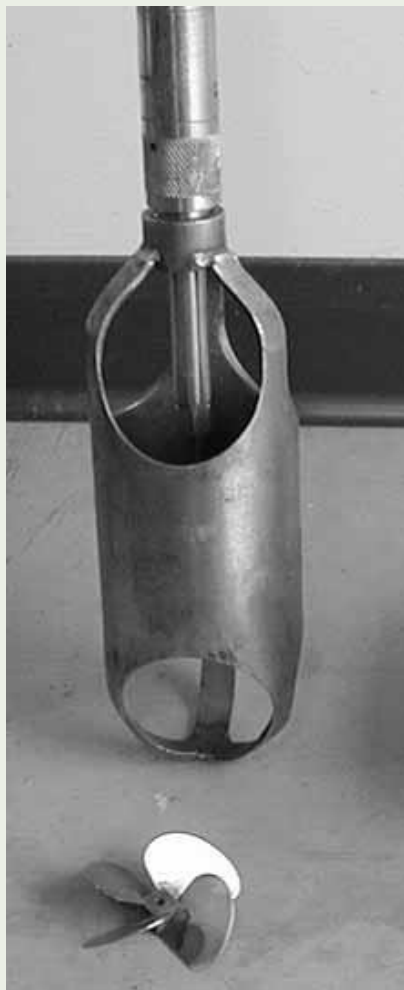
# Borehole Flowmeters

- ◆ **Require existing wells**
- ◆ **May require use of packers**
- ◆ **Pumping during logging and waste handling required**
- ◆ **Affected by well construction (skin effects)**
- ◆ **Data analysis relatively complicated**

(continued)

# Borehole Flowmeters

**Impeller**



**Heat Pulse**



**Electromagnetic**



See: <http://water.usgs.gov/ogw/bgas/flowmeter/>

# Questions?



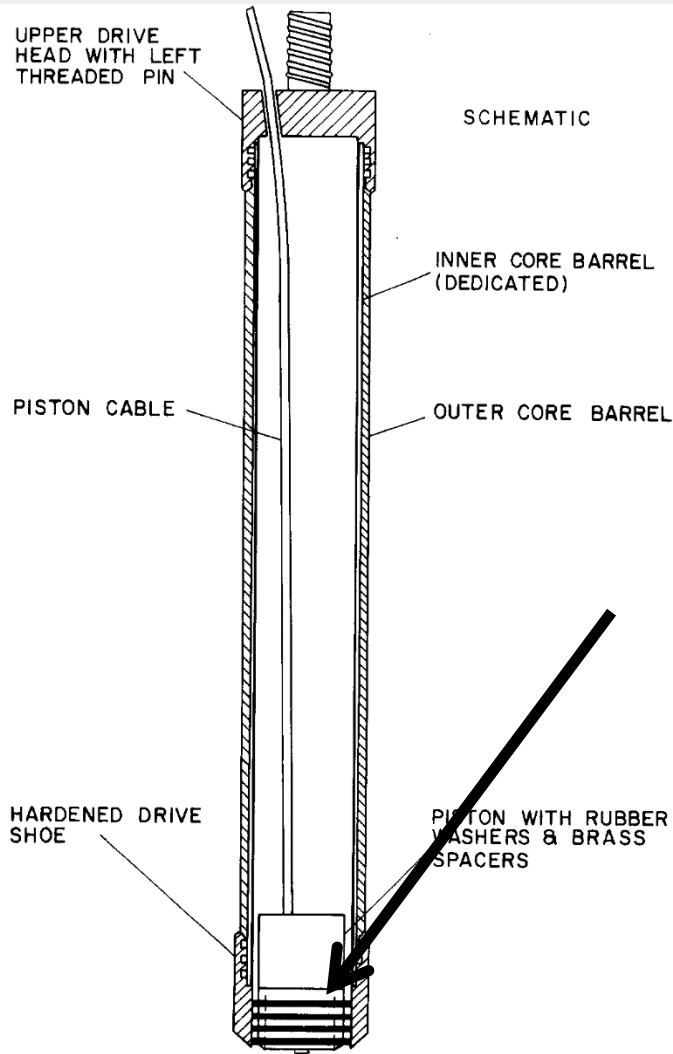
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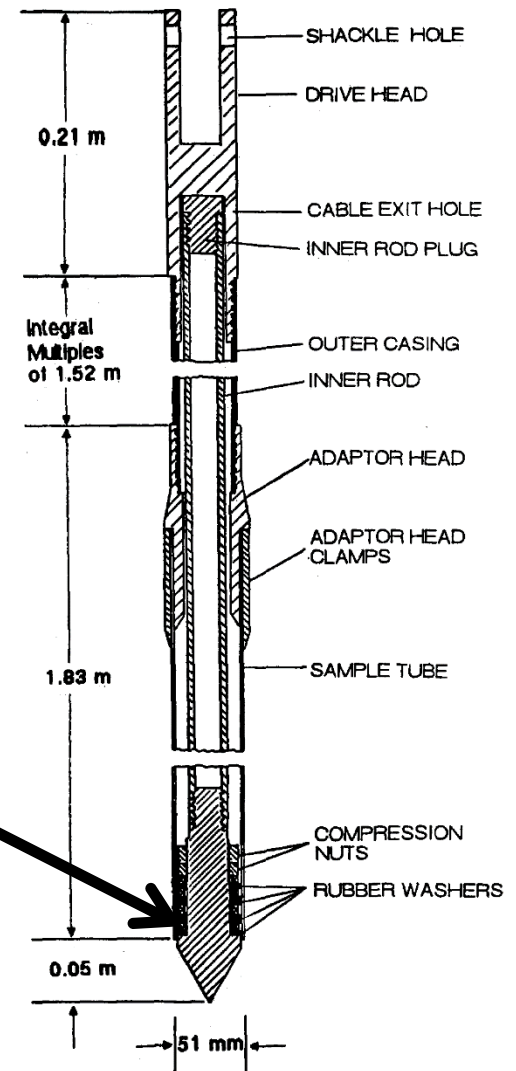


# Coring Tools: Waterloo Piston Tools

Zapico et al., 1987



Starr & Ingleton, 1992



Piston is stationary and acts as a syringe, holding the low cohesion soils in the barrel