An overview of the MIHPT and OIP probes from Geoprobe® and their impact on modern hydro-geo-environmental investigations

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An overview of the MIHPT and OIP probes from Geoprobe® and their impact on modern hydro-geo-environmental investigations

1. Context
2. The MIHPT probe
3. Example of MIHPT deployment
4. The OIP probe
5. Examples of OIP deployment
6. Conclusions & challenges

1. Context :

US experience in soil environmental investigations

- 1970's : rise of environmental awareness
- 40+ years of experience in site management

  (from dump sites, brownfields, chemical plants, gas stations, .. to dry-cleaner facilities ...)
- Market is maturing in the management cycle of polluted sites (investigation/characterization/remediation)

1. Context :

US experience in soil environmental investigations

New paradigms and new vocabulary :

1980's :

- *Expedited Site Characterization* (DOE)
- *Conceptual Site Model* (*CSM*)
- *Direct Push, Geoprobe®..*

2003 : *TRIAD approach (→ CSM)*

- Systematic Work Planning
- Dynamic Workplan Strategies
- *Real-time Measurement Technologies*

Challenges for remediation :

- Sites can be complex :
  - Heterogeneities in the geology
  - Great differences in the mobility of the contaminants of concern

- Complexity complicates remediation

➢ Understanding COC mass distribution
vs geology and hydrogeology is a key to remedial success

1. Context :

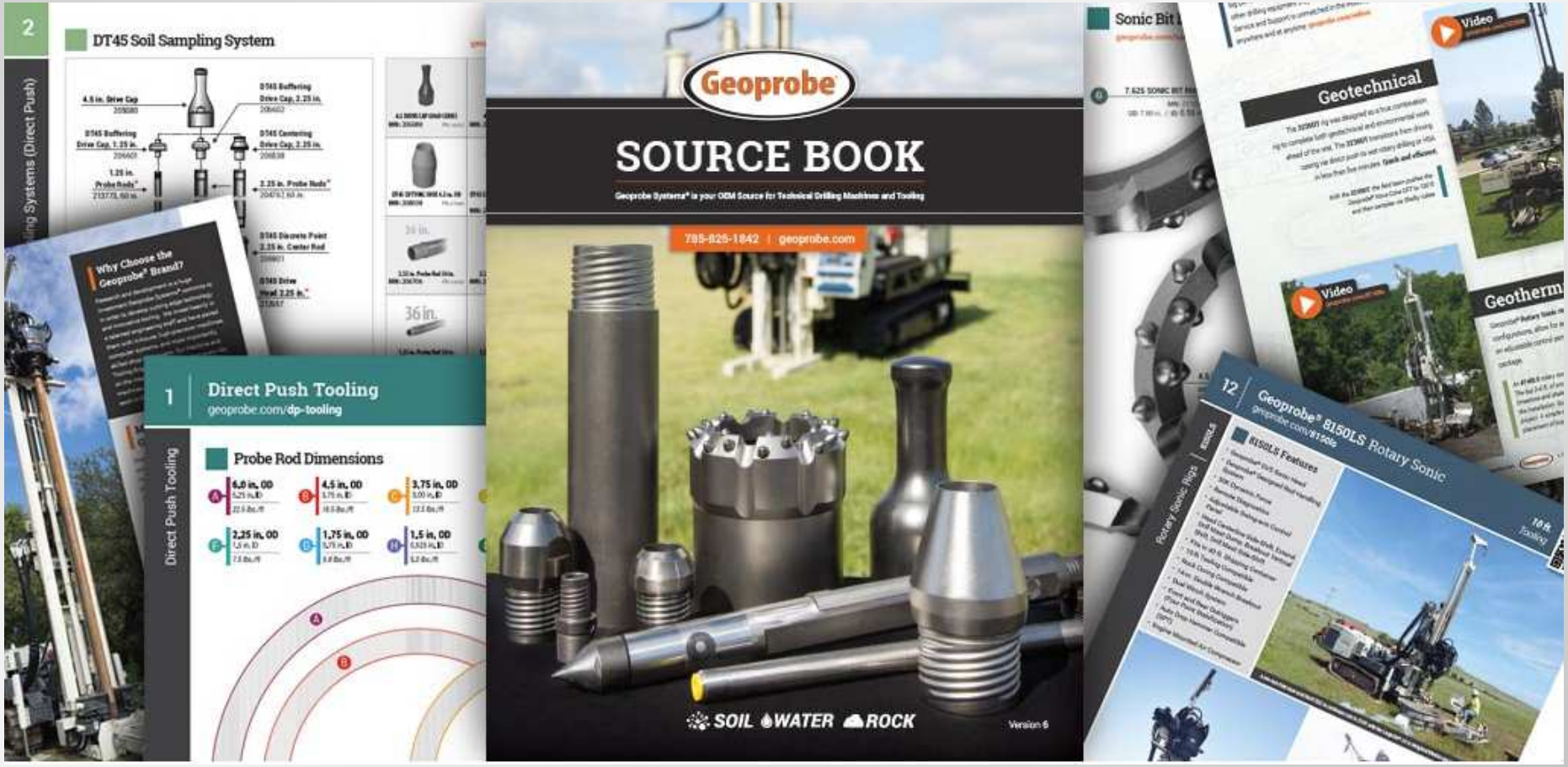
US experience in soil environmental investigations

- High Resolution Site Characterization (HRSC)
  - US EPA focus area (2012)
  - State-of-the–science strategies & techniques for Environmental Site Characterization
  - Scale-appropriate measurements and sample density to better define contaminant distribution and physical context in which they reside with greater certainty
  - Faster and more effective/surgical site cleanup *especially as the use of in-situ treatment technologies is increasing*

Geoprobe® *Direct Push* Machines

Model 7822DT

Geoprobe® *Direct Push* Tools



Geoprobe® *Direct Image®* probes

- Direct Sensing Technologies available from Geoprobe® for Real-Time Measurements :
  - EC
  - MIP
  - HPT
  - MIHPT
  - HPT-GWS
  - OIP (new)
  - OI-HPT (new)
  - OI-CPT (new)

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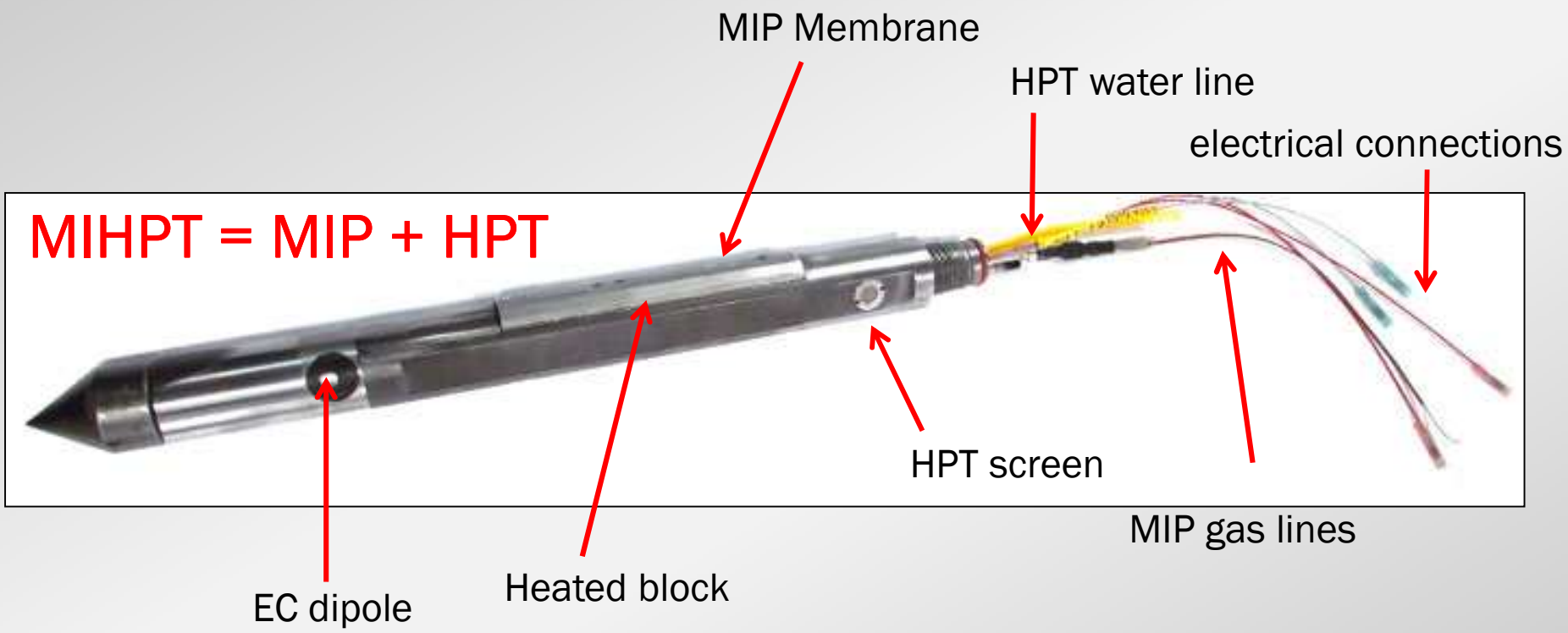
2. The MIHPT probe

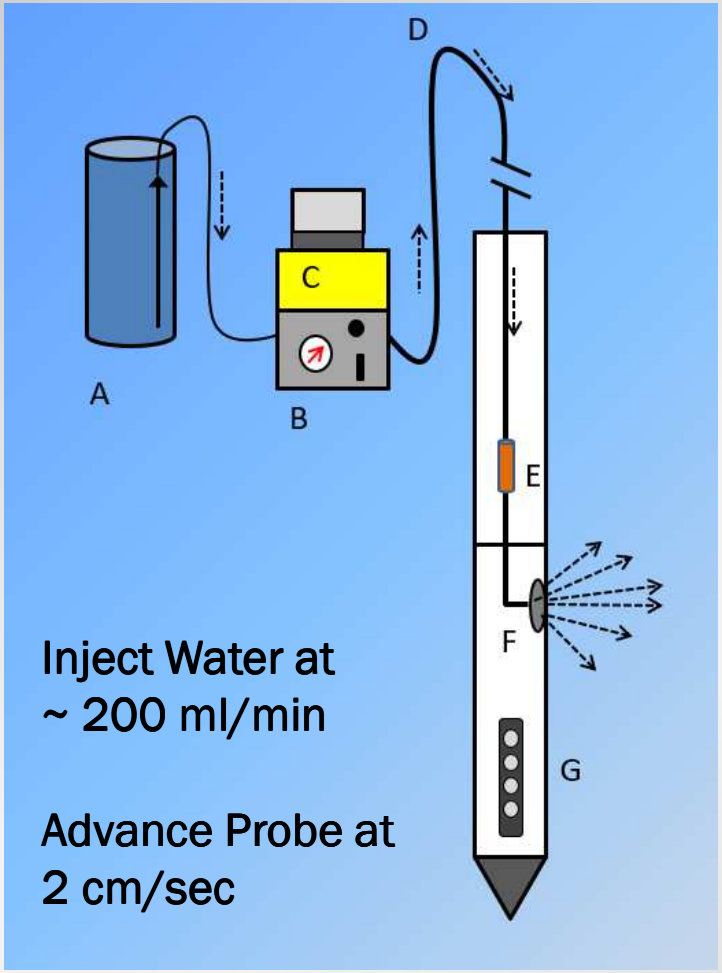
Membrane Interface Hydraulic Profiling Tool (MIHPT)



- MIP : detection of Volatile Organic Compounds (VOCs)
- HPT : relative permeability of unconsolidated aquifers

2. The MIHPT probe

HPT principle



A) Water Tank

B) Pump & Flow Meter

C) Electronics/computer

D) Trunkline

E) Pressure Sensor

F) Screened Injection Port

G) EC Array

Darcy's law :
K ~ Q/P
K ~ 1/P if Q is constant

2. The MIHPT probe

- VOC distribution
  - chlorinated solvents, BTEX, light hydrocarbons ..
- Quick estimation of K [m/day] to the cm scale
- HPT data confirms EC data
  - Detection of ‘’anomalities’’
- Modelling of plume migration
  - Precious tool for risk management
  - Precious tool for remediation scope

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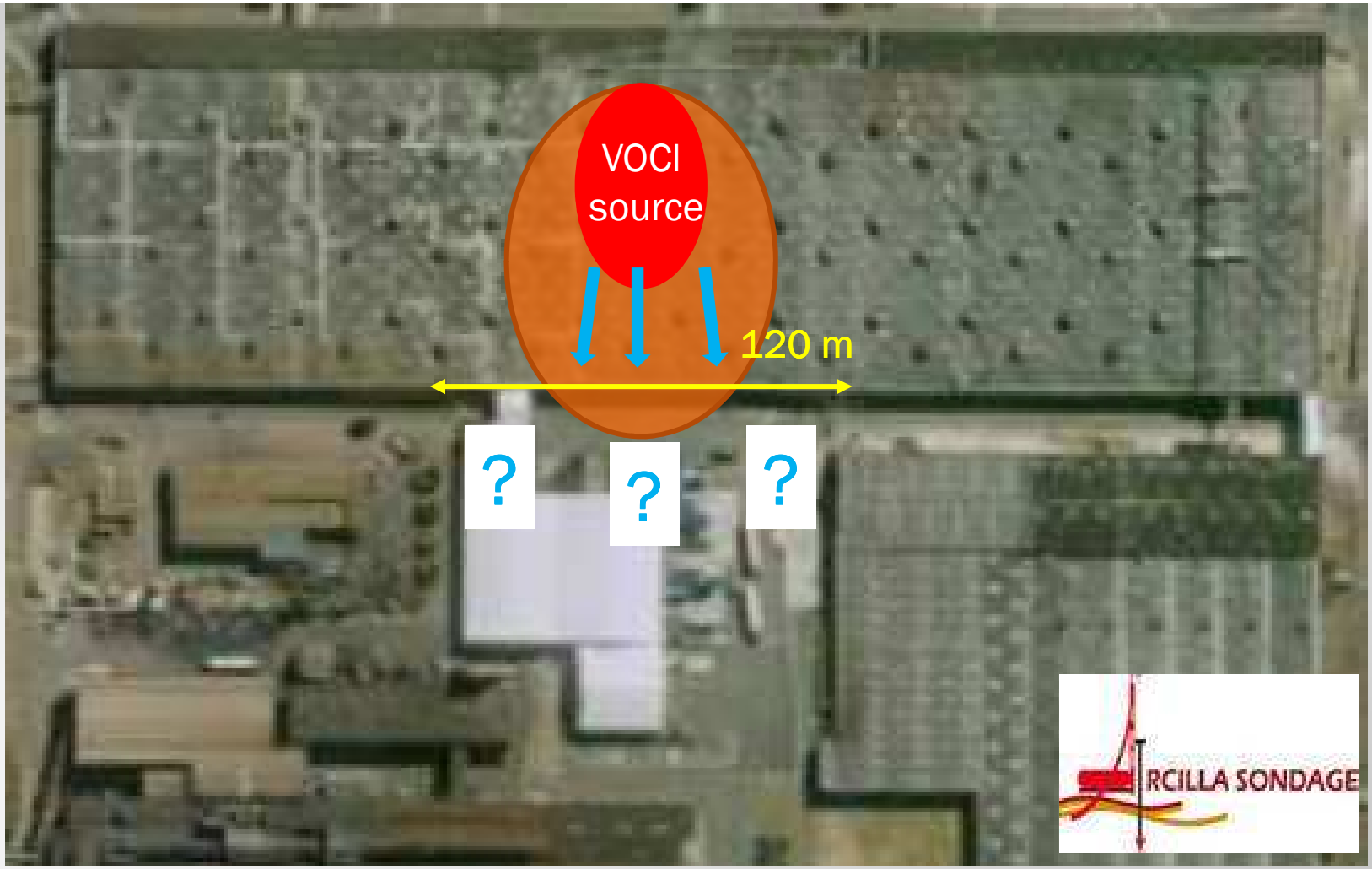
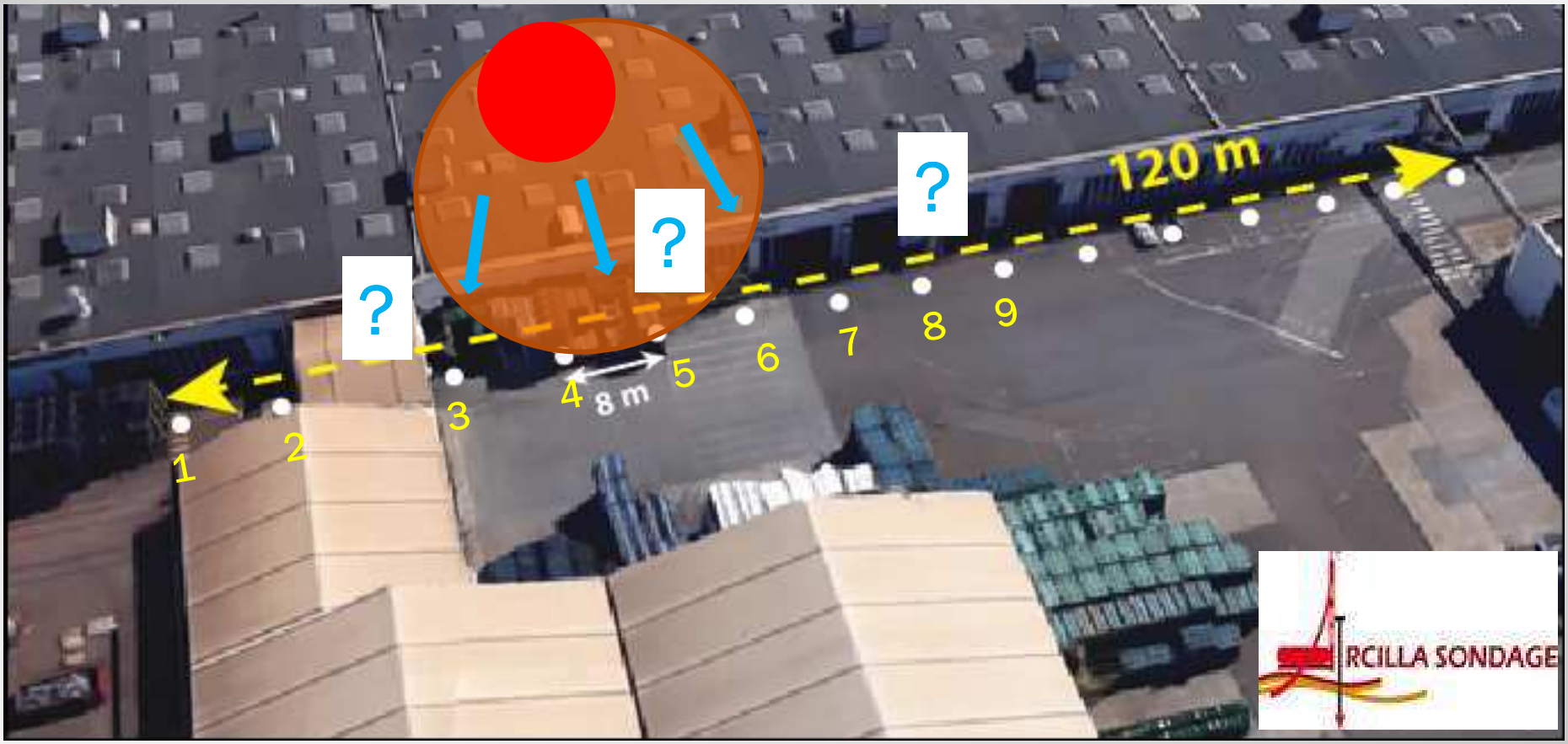
3. Example of MIHPT deployment

Site in France



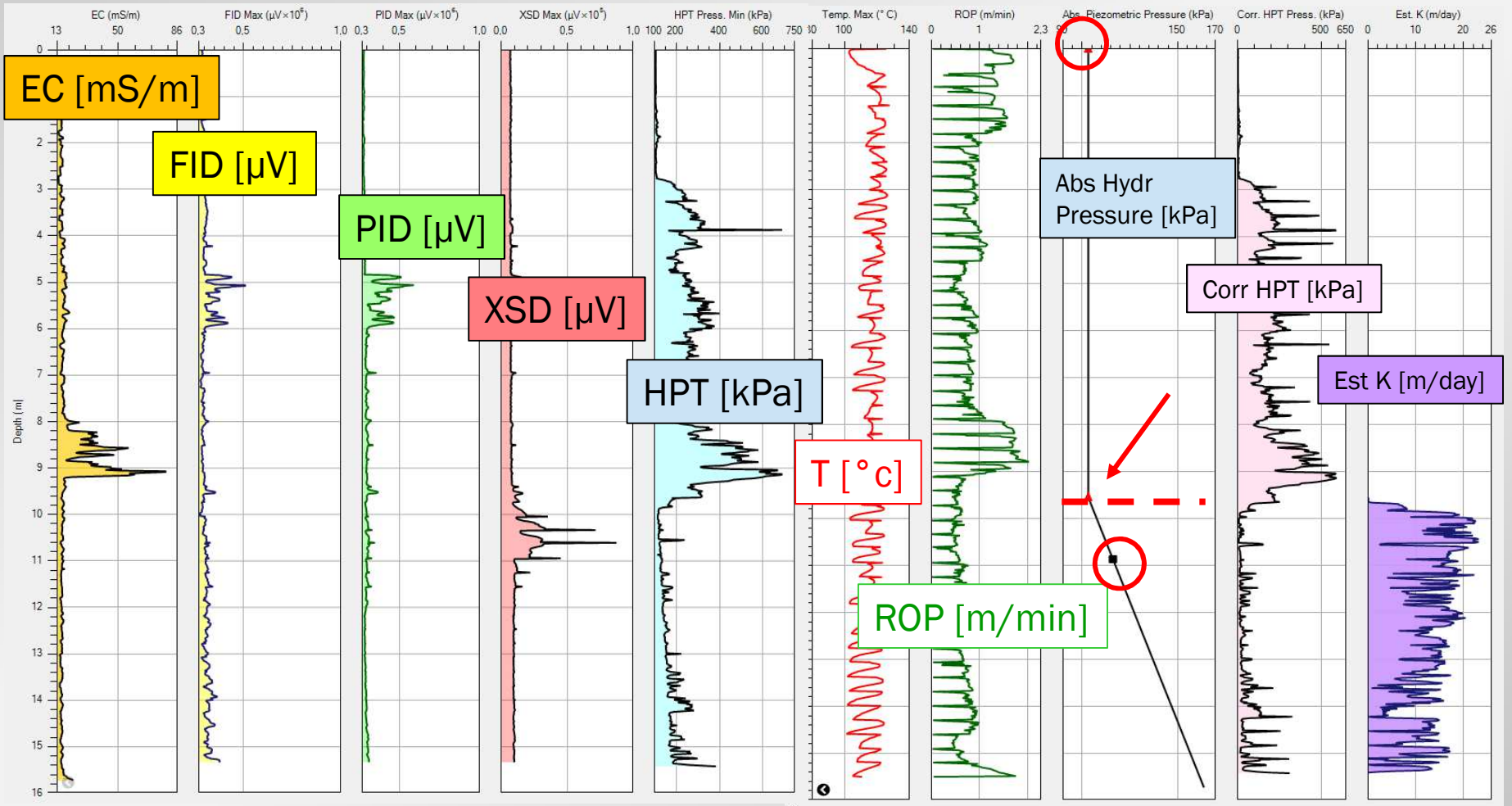
3. Example of MIHPT deployment

Site in France



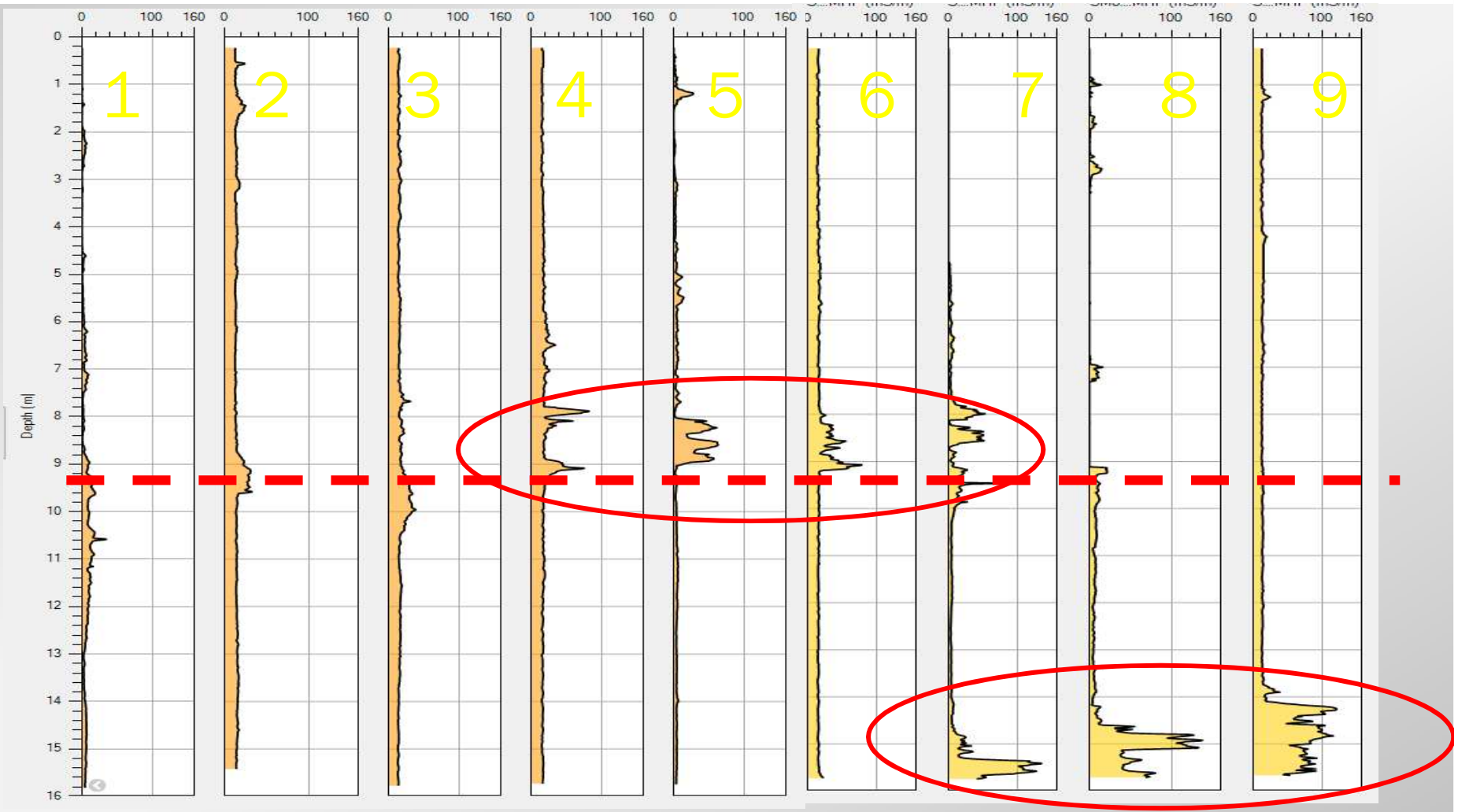
3. Example of MIHPT deployment

Main MIHPT parameters (LOG 4)



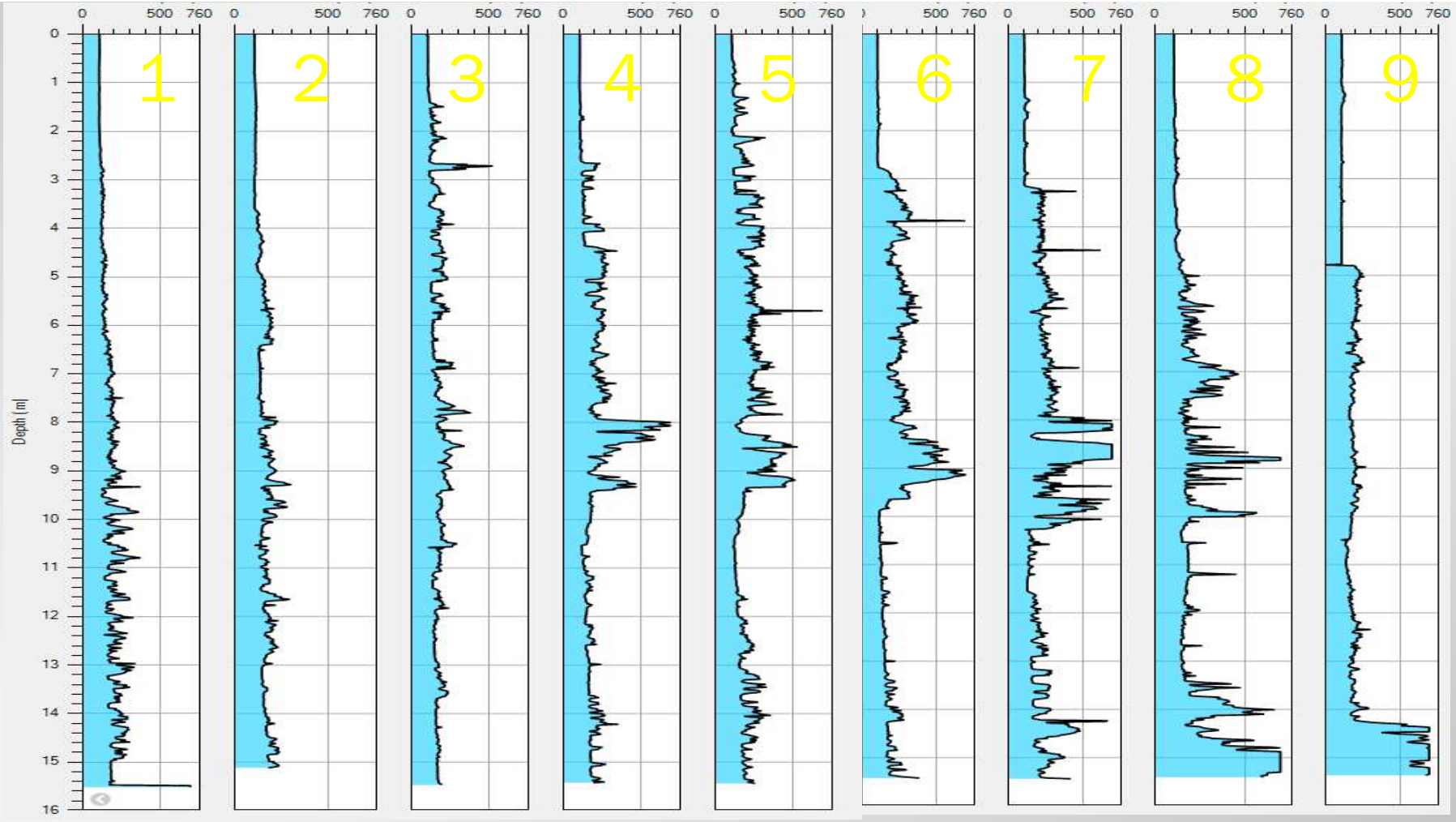
3. Example of MIHPT deployment

EC Cross Section
[mS/m]
LOGS 1 to 9



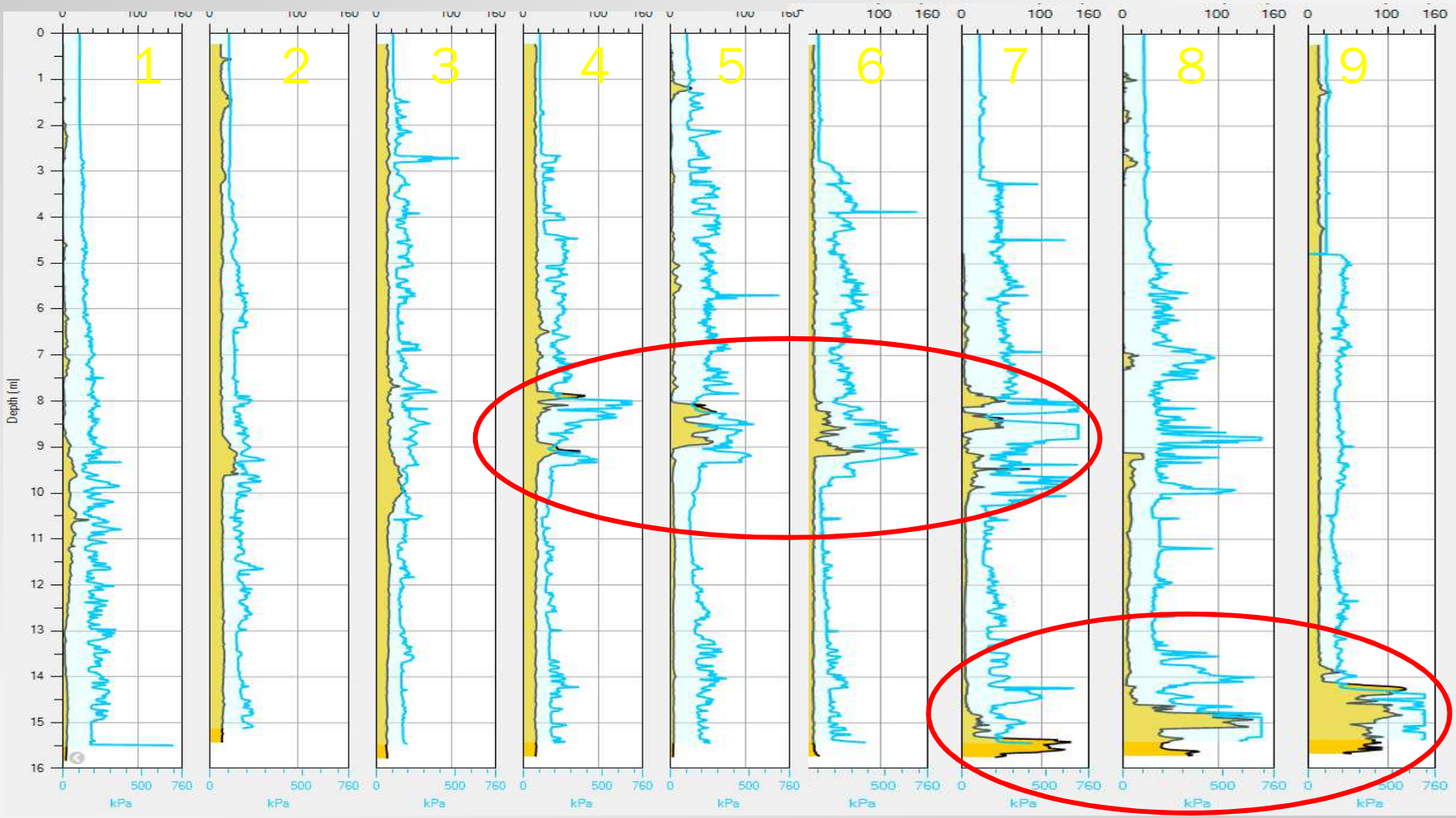
3. Example of MIHPT deployment

HPT pressure [kPa]
Cross Section
LOGS 1 to 9



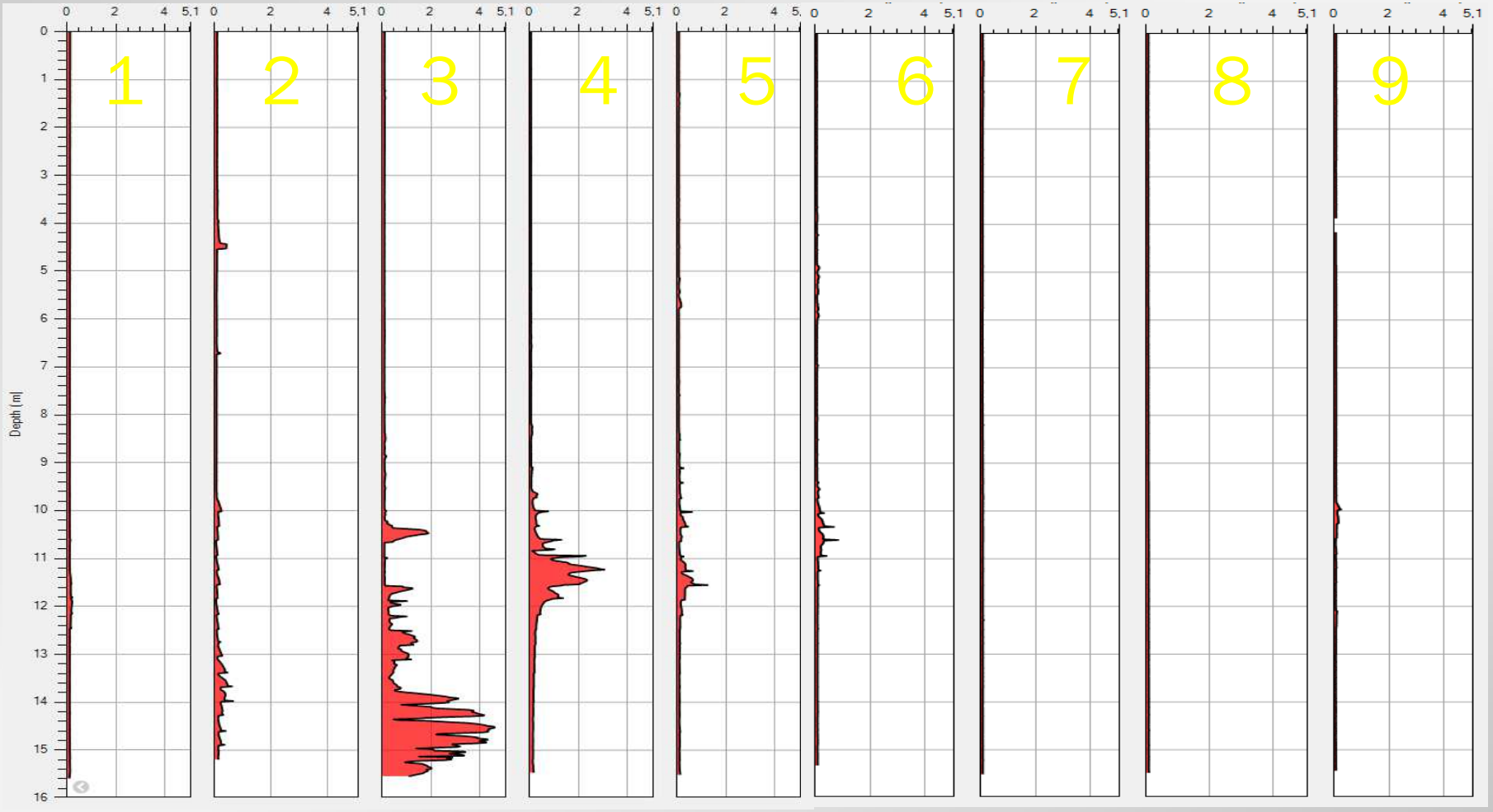
3. Example of MIHPT deployment

EC & HPT press
Cross Section
LOGS 1 to 9



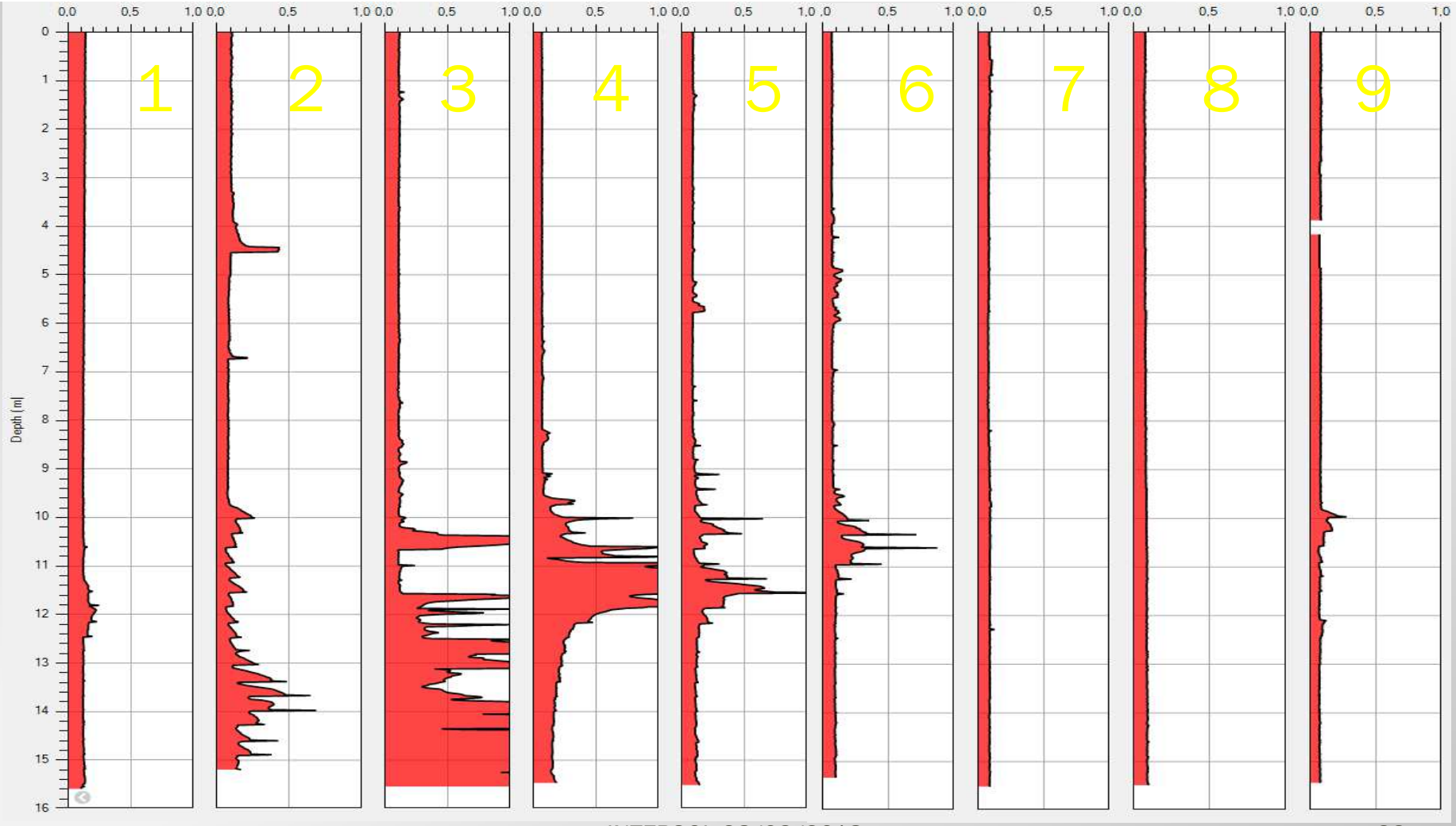
3. Example of MIHPT deployment

XSD [µV]
Cross Section
LOGS 1 to 9



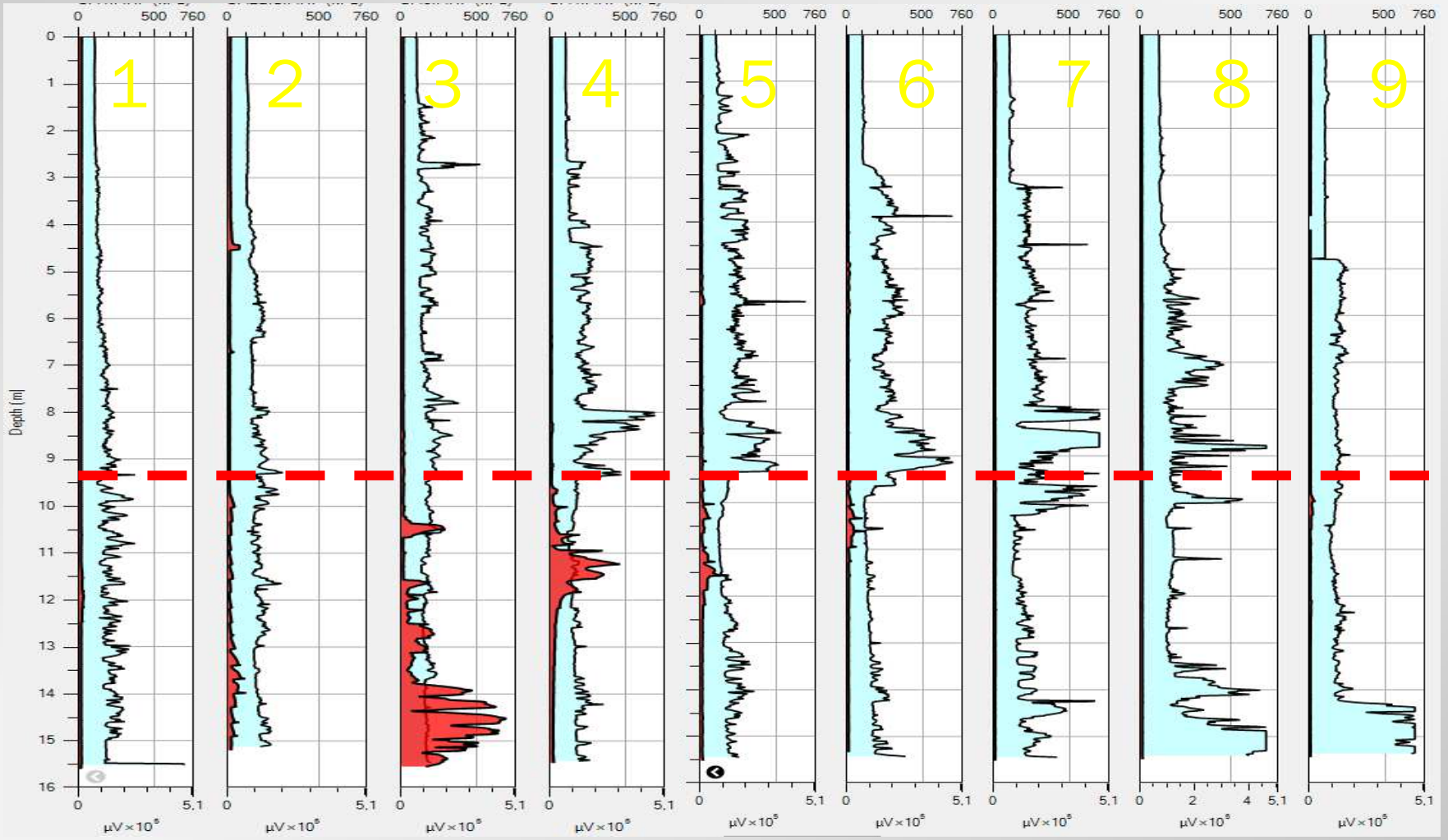
3. Example of MIHPT deployment

XSD [µV]
Cross Section
LOGS 1 to 9



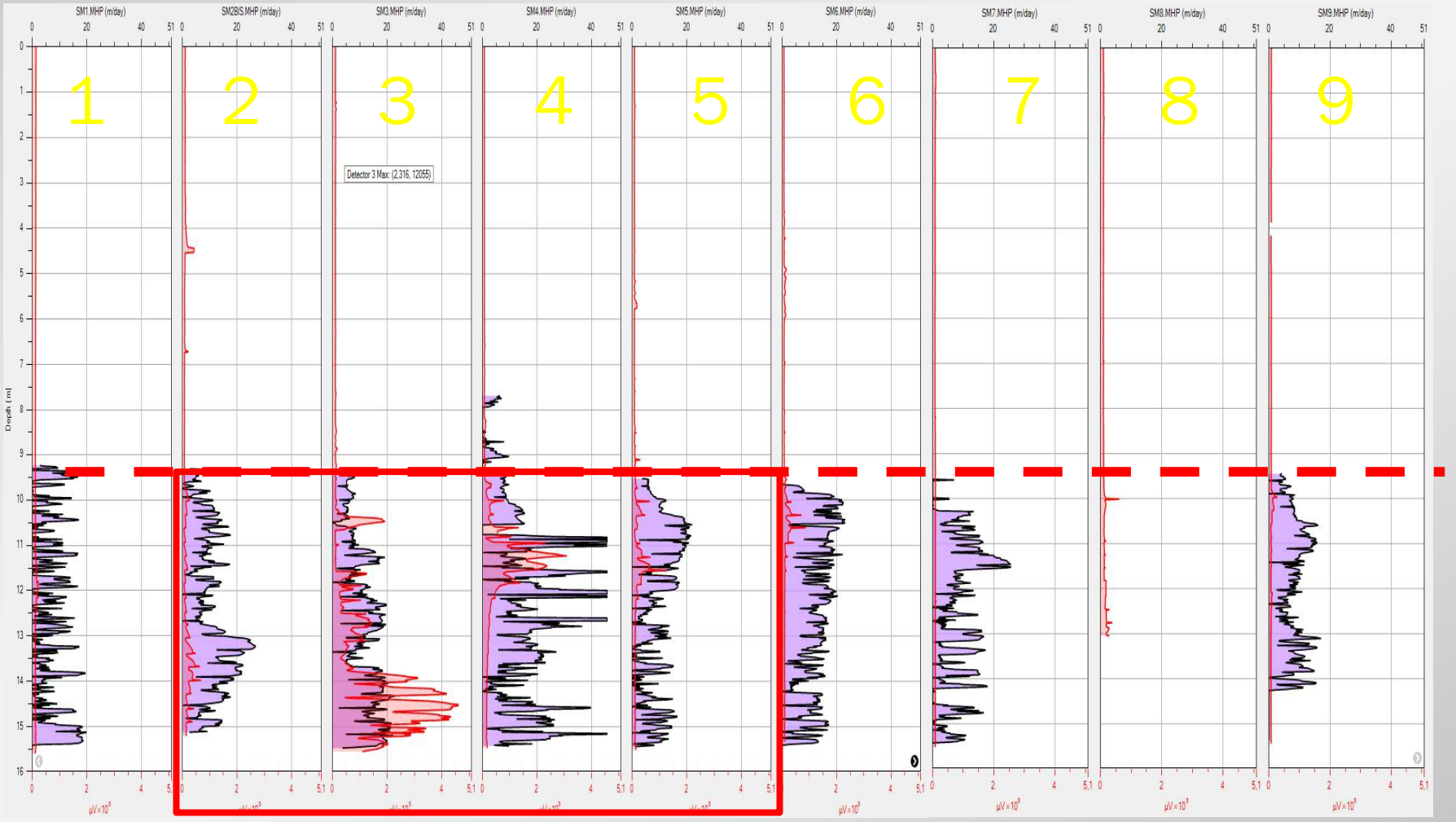
3. Example of MIHPT deployment

HPT press and XSD
Cross Section
LOGS 1 to 9



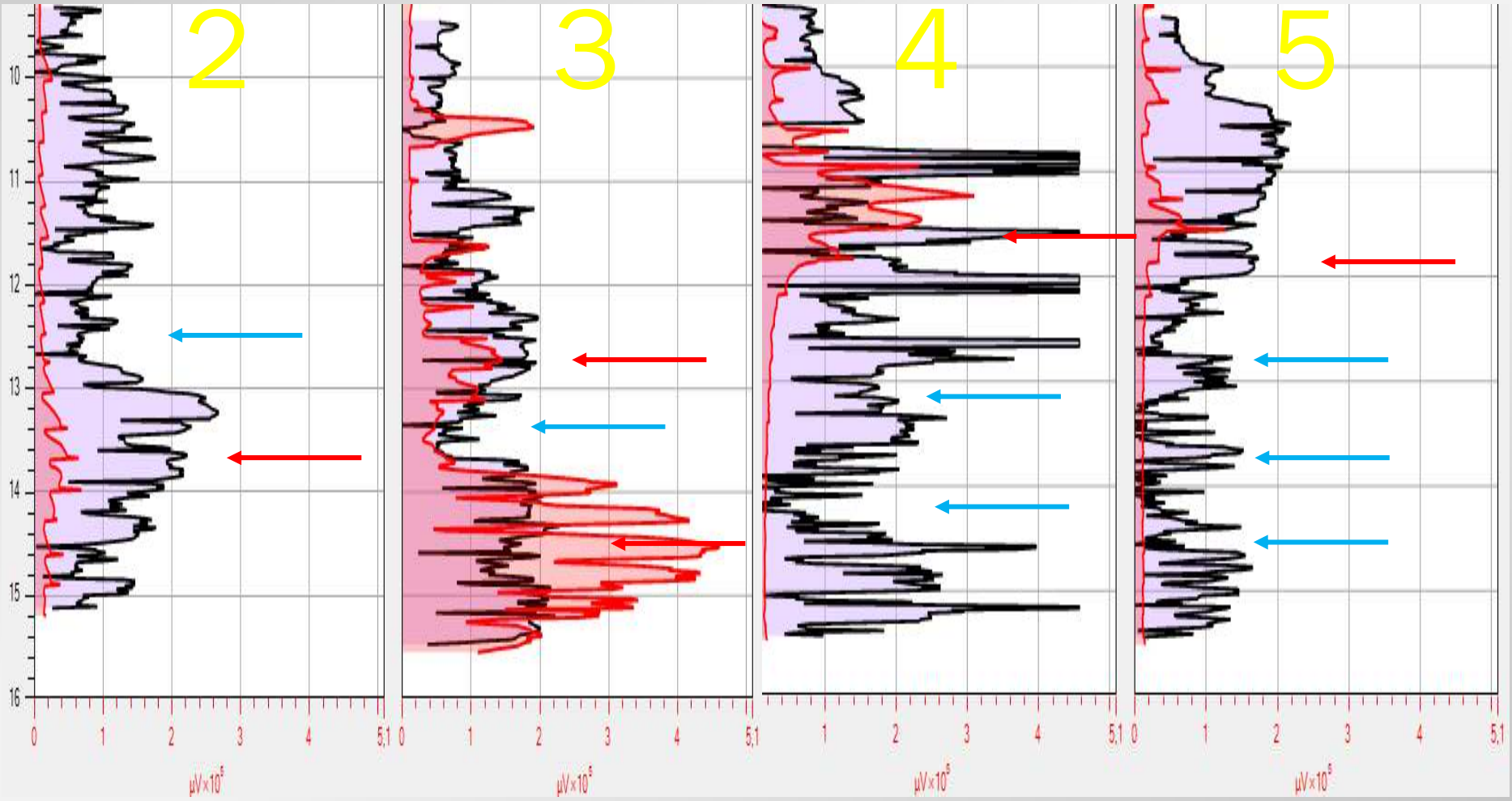
3. Example of MIHPT deployment

Est. K and XSD
Cross Section
LOGS 1 to 9



3. Example of MIHPT deployment

ZOOM on XSD and Est. K
LOGS 2 to 5



3. Example of MIHPT deployment

- In 5 days :
  - Identification of subsurface conditions :
    - ✓ Geology
    - ✓ Hydrogeology
    - ✓ VOCl contaminants distribution
  - True guide in the sampling & monitoring effort
  - Optimization of the remediation scheme

3. Example of MIHPT deployment

MIHPT reference literature

Groundwater Monitoring&Remediation

Issued 05/2014

Field Application of the Combined Membrane-Interface Probe and Hydraulic Profiling Tool (MiHpt)

by Wesley McCall, Thomas M. Christy, Daniel Pipp, Mads Terkelsen, Anders Christensen, Klaus Weber, and Peter Engelsen

Abstract

The Membrane-Interface Probe and Hydraulic Profiling Tool (MiHpt) is a direct push probe that includes both the membrane interface probe (MIP) and hydraulic profiling tool (HPT) sensors. These direct push logging tools were previously operated as separate logging systems for subsurface investigation in unconsolidated formations. By combining these two probes into one logging system the field operator obtains useful data about the distribution of both volatile organic contaminants (VOCs) and relative formation permeability in a single boring. MiHpt logging was conducted at a chlorinated VOC contaminated site in Skuldelev, Denmark, to evaluate performance of the system. Formation cores and discrete interval slug tests are used to assess use of the HPT and electrical conductivity (EC) logs for lithologic and hydrostratigraphic interpretation. Results of soil and groundwater sample analyses are compared to the adjacent MiHpt halogen specific detector (XSD) logs to evaluate performance of the system to define contaminant distribution and relative concentrations for the observed VOCs. Groundwater profile results at moderate to highly contaminated locations were found to correlate well with the MiHpt-XSD detector responses. In general, soil sample results corresponded with detector responses. However, the analyses of saturated coarse-grained soils at the site proved to be unreliable as demonstrated by high RPDs for duplicate samples. The authors believe that this is due to pore water drainage observed from these cores during sampling. Additionally, a cross section of HPT pressure and MiHpt-XSD detector logs provides insight into local hydrostratigraphy and formation control on contaminant migration.

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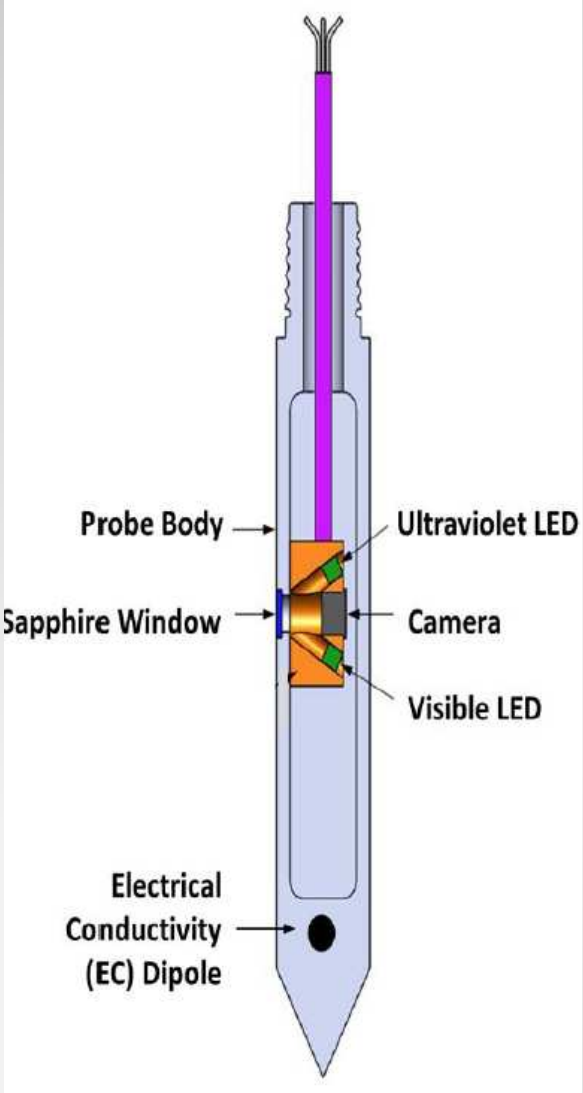
4. Optical Image Profiler (OIP)

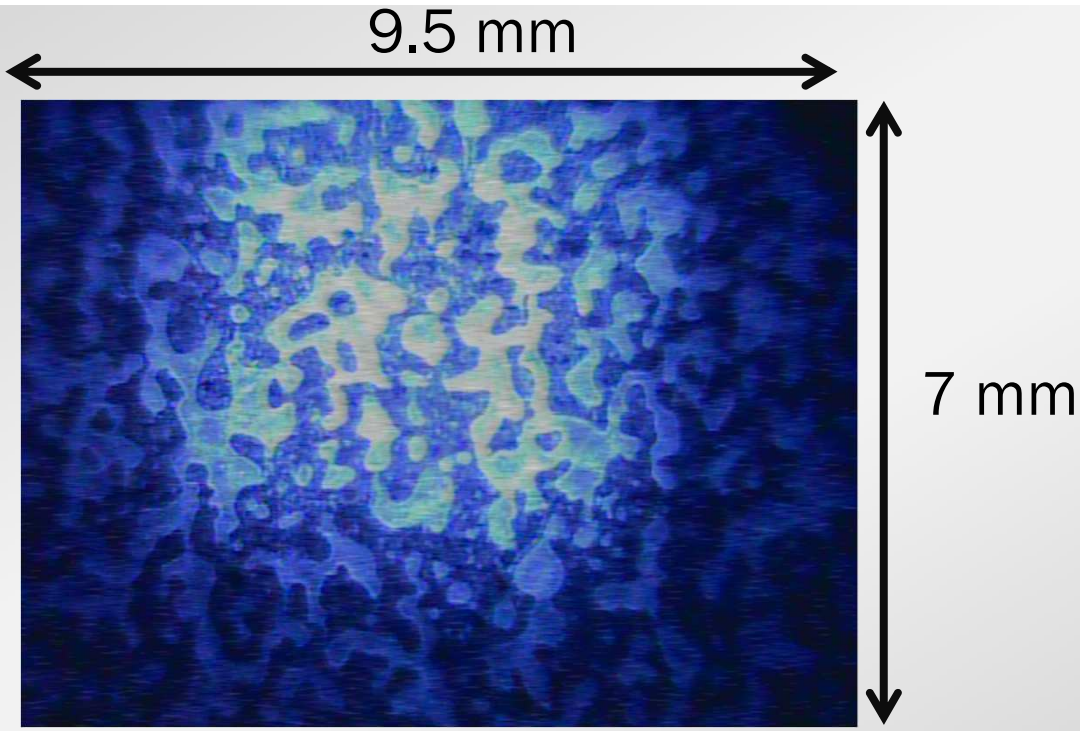
The OIP probe



- UV light (275nm) is directed at the soil through a sapphire window while the probe is being pushed down at max 2cm/sec
- A camera captures 30 digital images of the soil every second
- PAHs molecules fluoresce, emitting visible light
- Those images are analyzed instantly for fluorescence
- A frame grabber selects one representative image and records it in a file at every 15mm depth increment (cm-scale resolution)
- Visible images of the soil can be captured as desired to help in the description of the soil colour and texture

4. Optical Image Profiler (OIP)

OIP image resolution

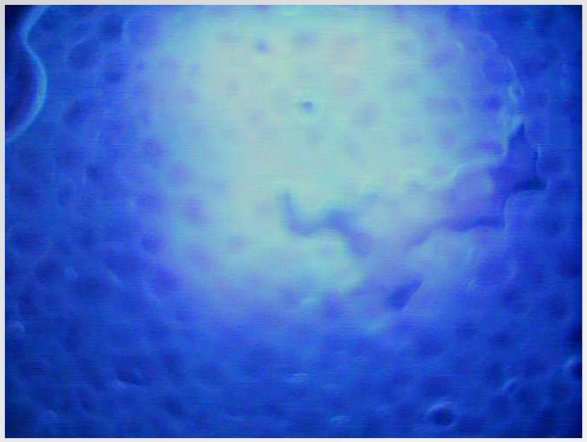


Typical Image of fluorescence from fuel hydrocarbons in soil illuminated by OIP-UV source

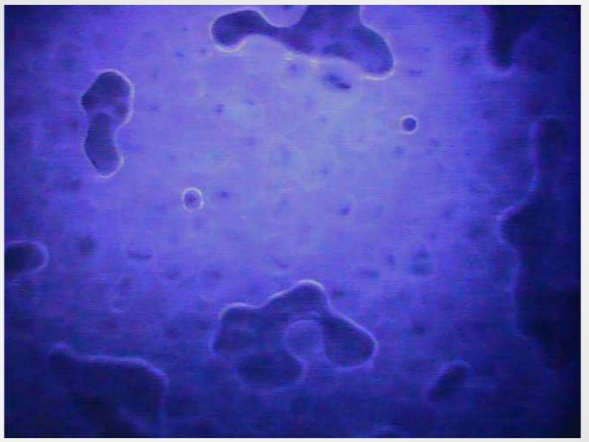
Resolution : 640 x 480 (307.200 pixels)
Frequence : 30 fps
1 image is saved every 15mm → 20m log = 1320+ images

4. Optical Image Profiler (OIP)

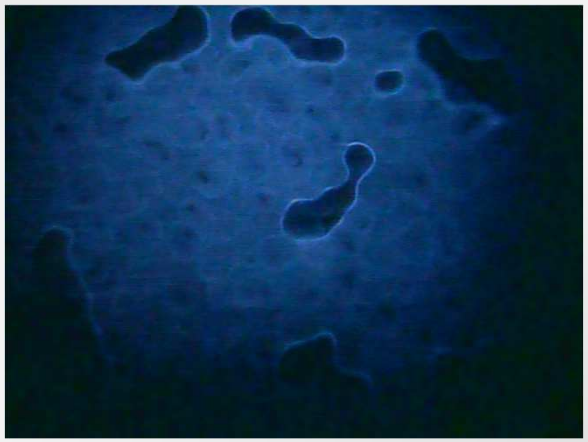
OIP UV images



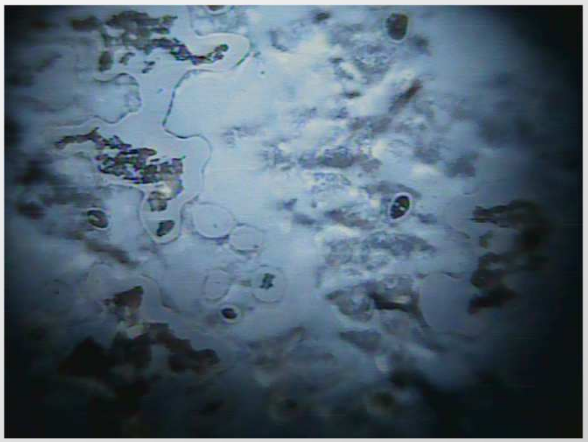
Engine oil SAE 30



Diesel



Gasoline

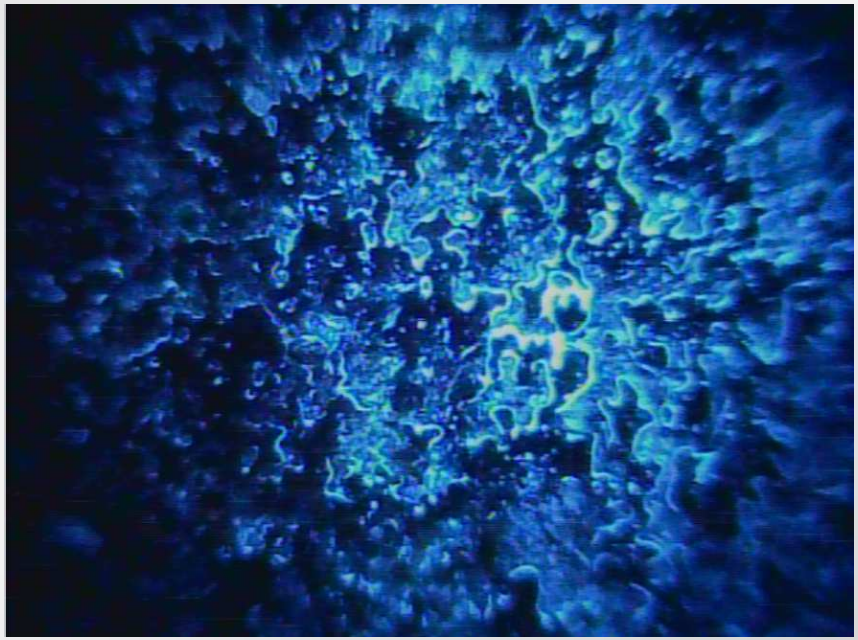


Crude oil

4. Optical Image Profiler (OIP)

OIP still images

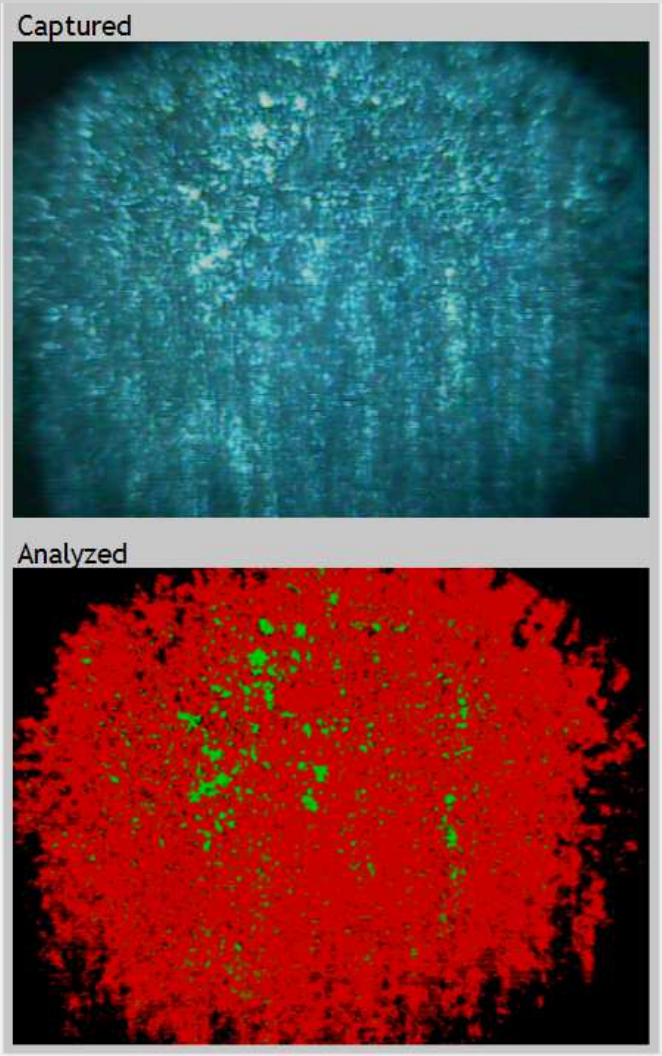
Visible still image



UV still image

4. Optical Image Profiler (OIP)

OIP UV image analysis



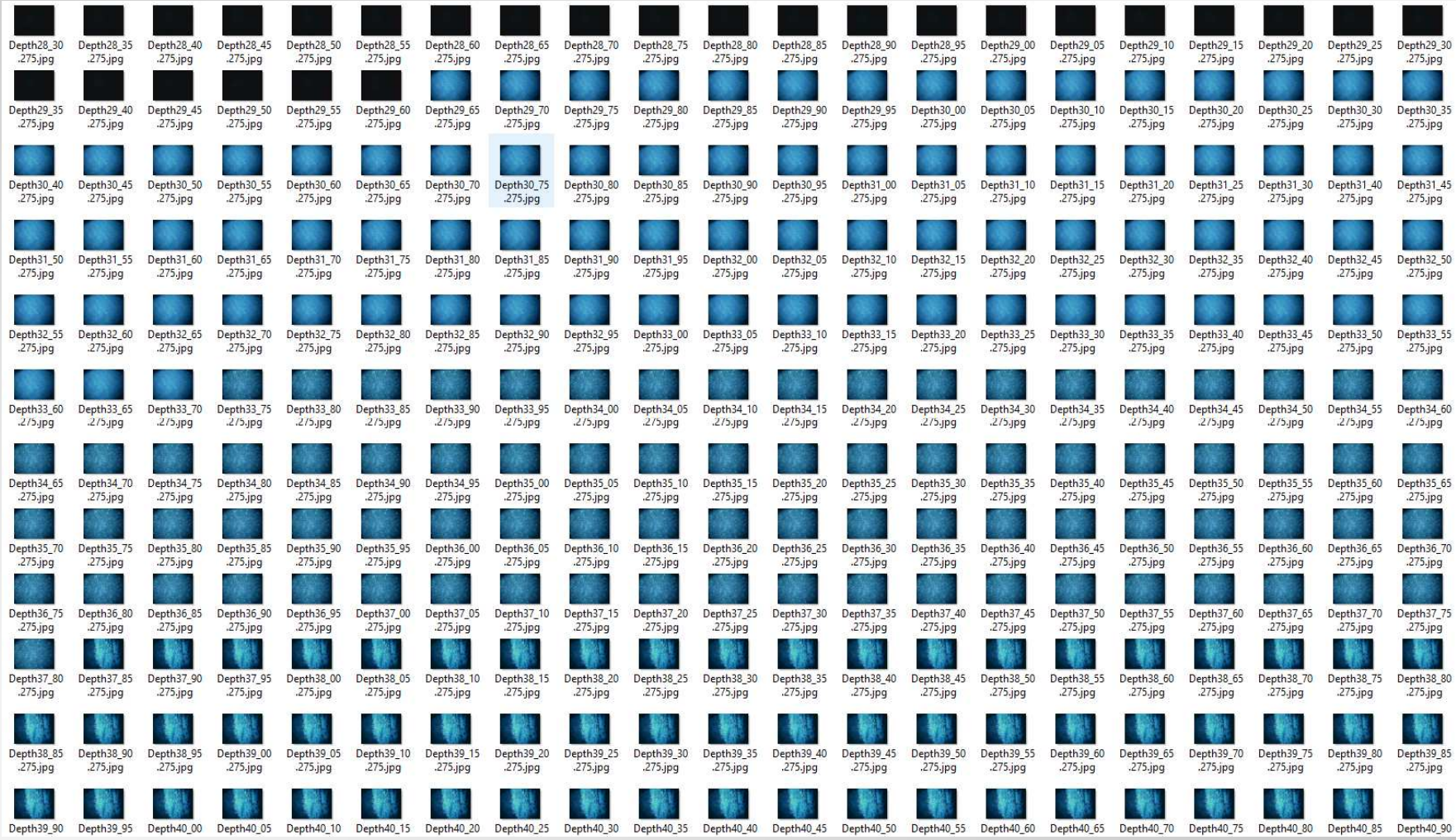
The colour of the digital UV image captured is analyzed for fluorescence using Hue, Saturation and Value (HSV) settings.

- Filter 1 (red pixels) :
  - looks at pixels high in colour typical of hydrocarbon fluorescence
- Filter 2 (green pixels)
  - Dependent from F1 (1% threshold)
  - looks at pixels with high value (brightness)

Fluorescence = % of total image area

4. Optical Image Profiler (OIP)

UV images



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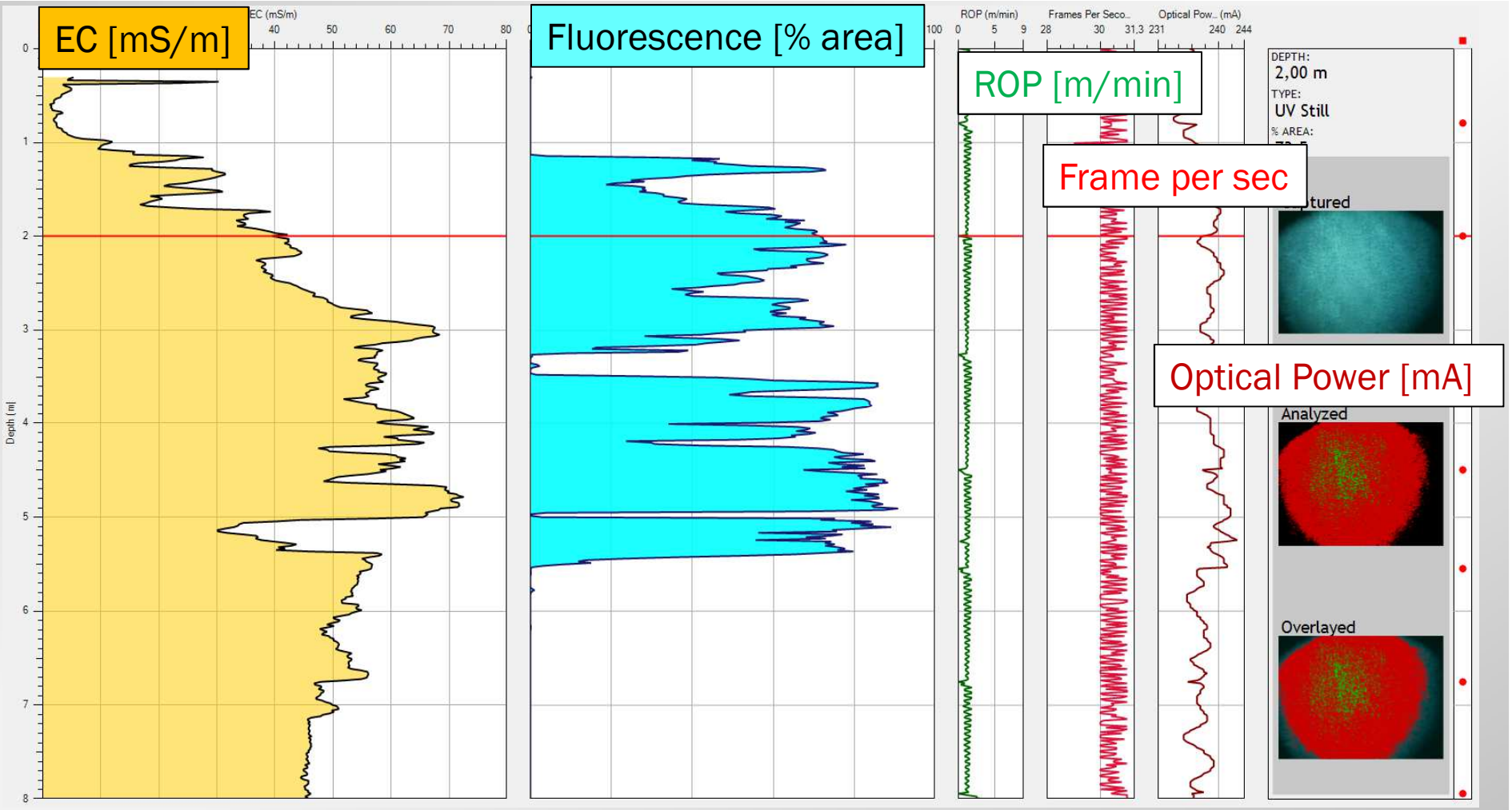
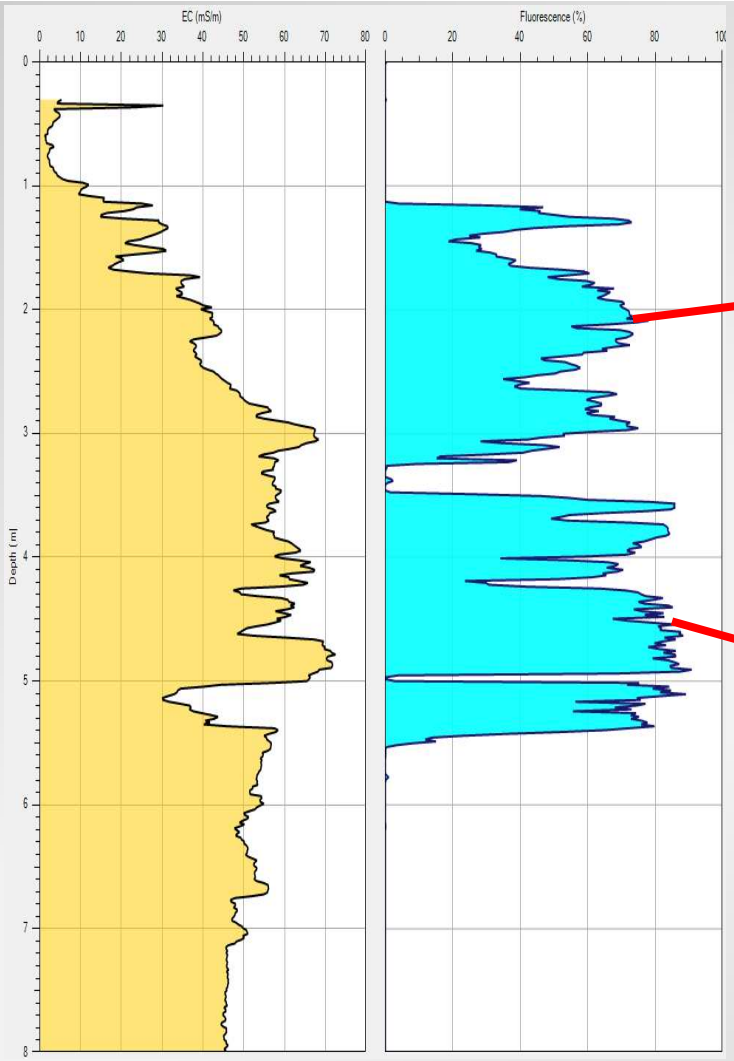
5. Examples of OIP deployment

Site in Belgium

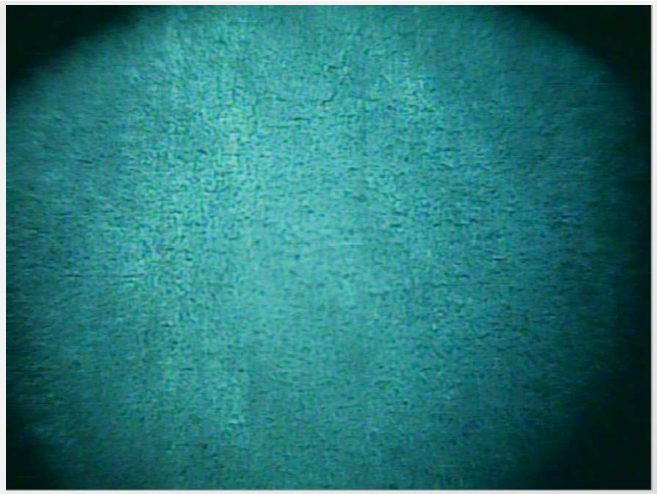


5. Examples of OIP deployment

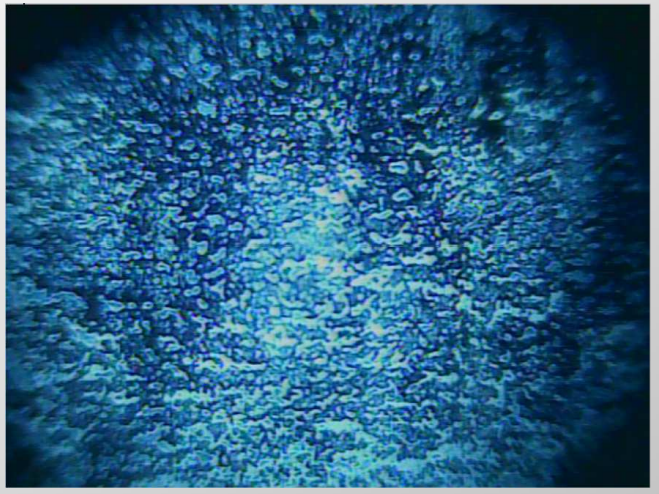
Site in Belgium



2,0m bgs



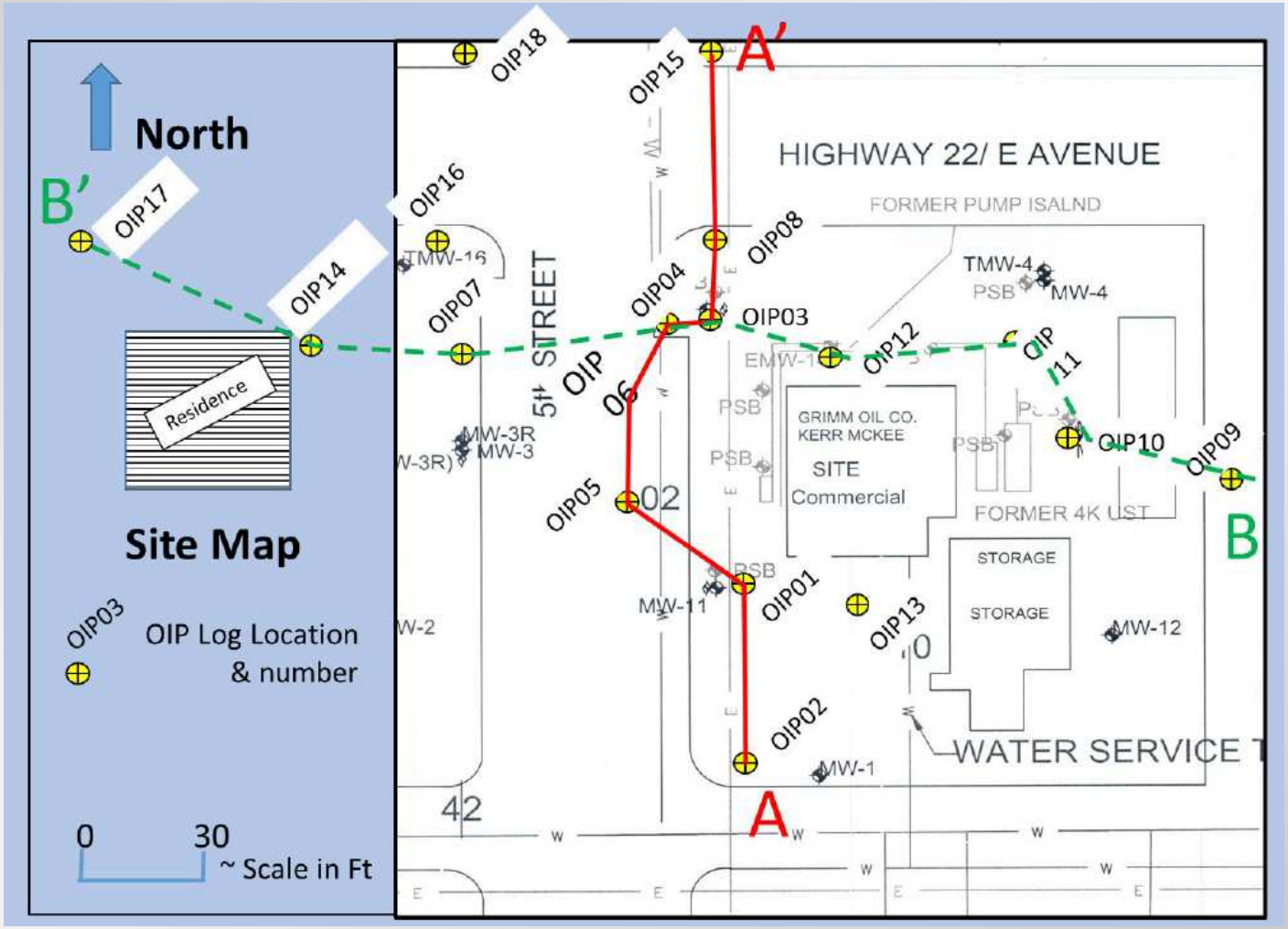
4,5m bgs



- Weathering ?
- Mixed NAPLs ?

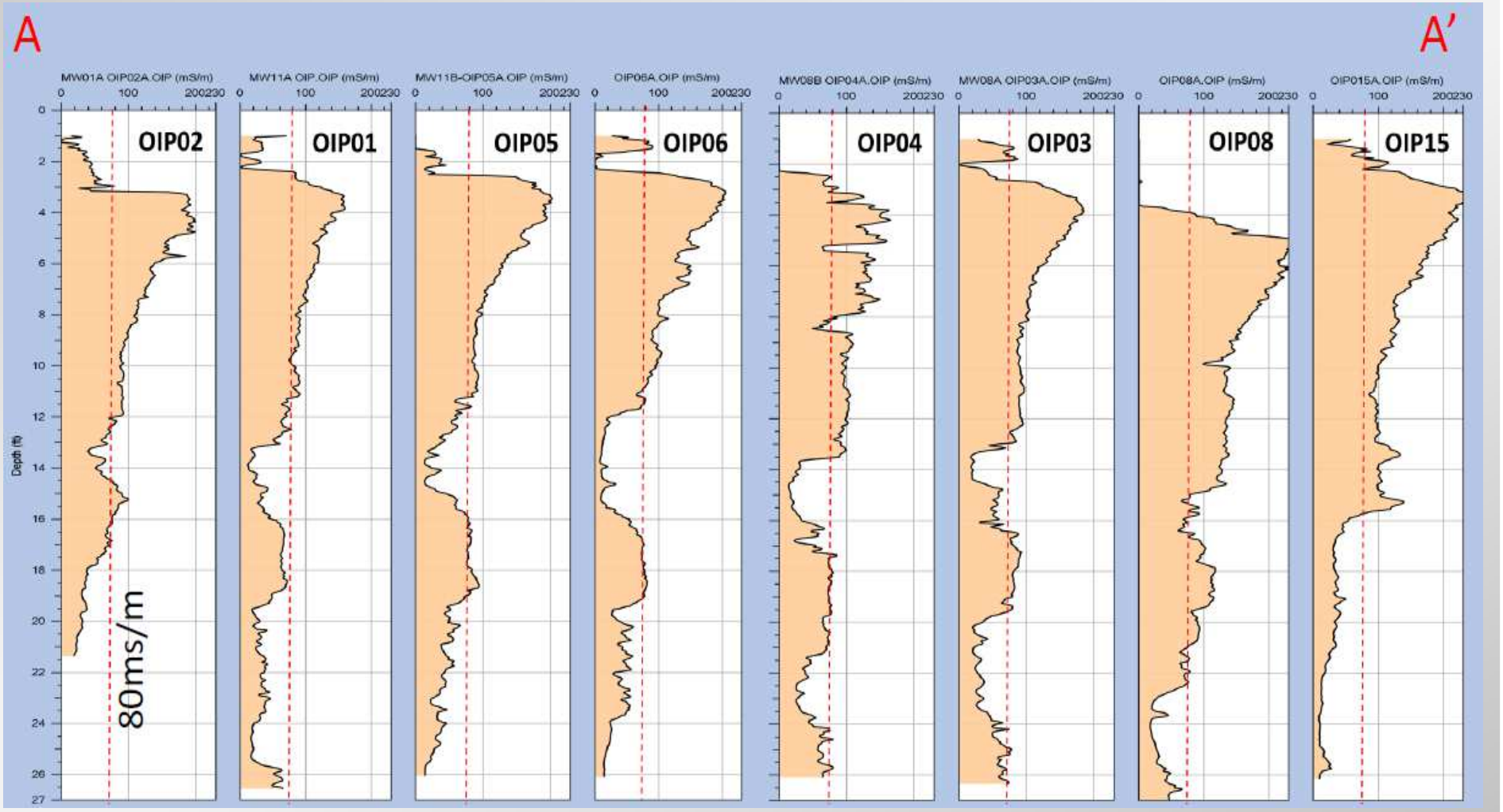
5. OIP deployment

Site in Iowa (USA)



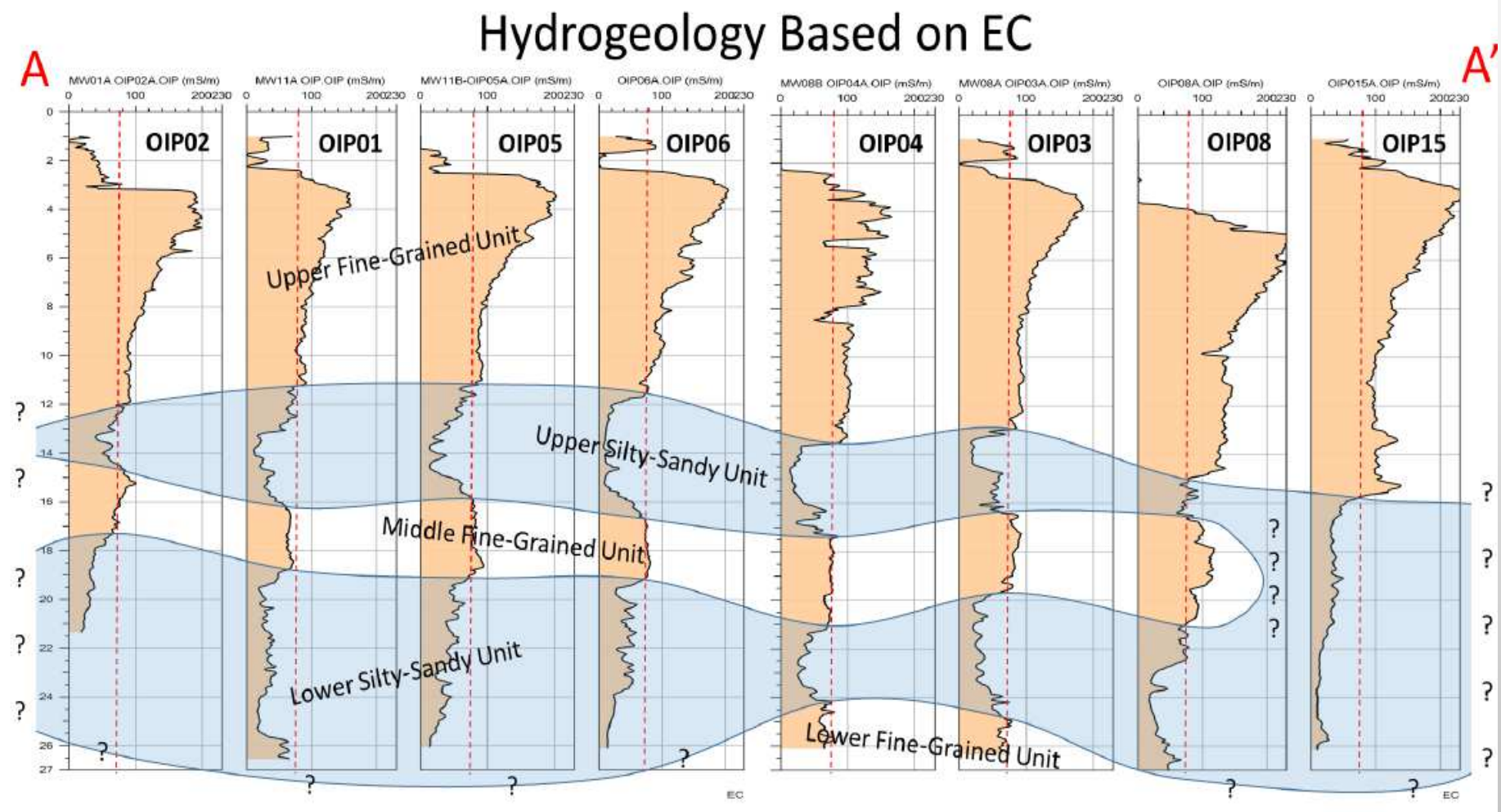
5. Examples of OIP deployment

Site in Iowa
EC cross section



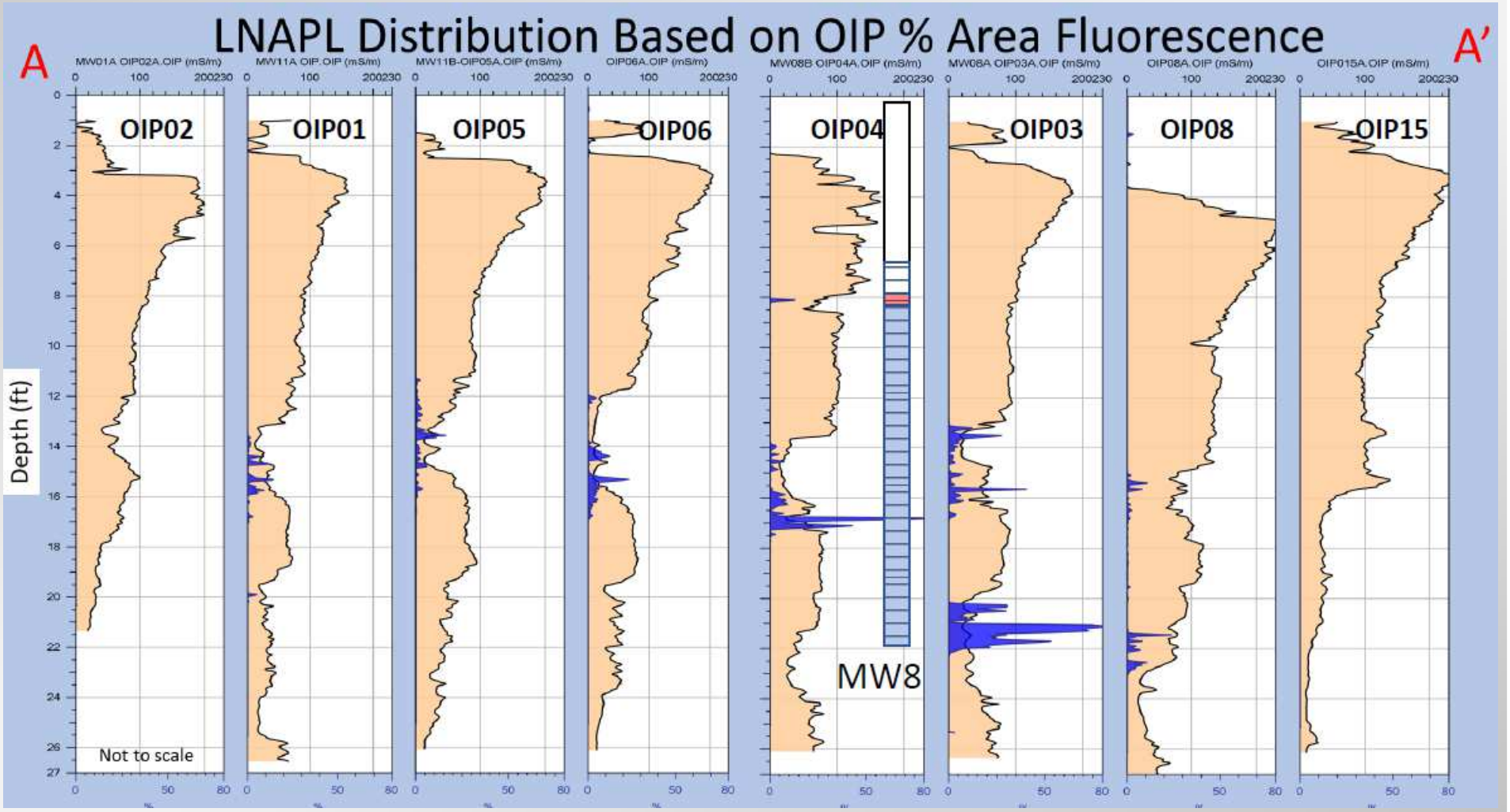
5. Examples of OIP deployment

Site in Iowa
EC cross section

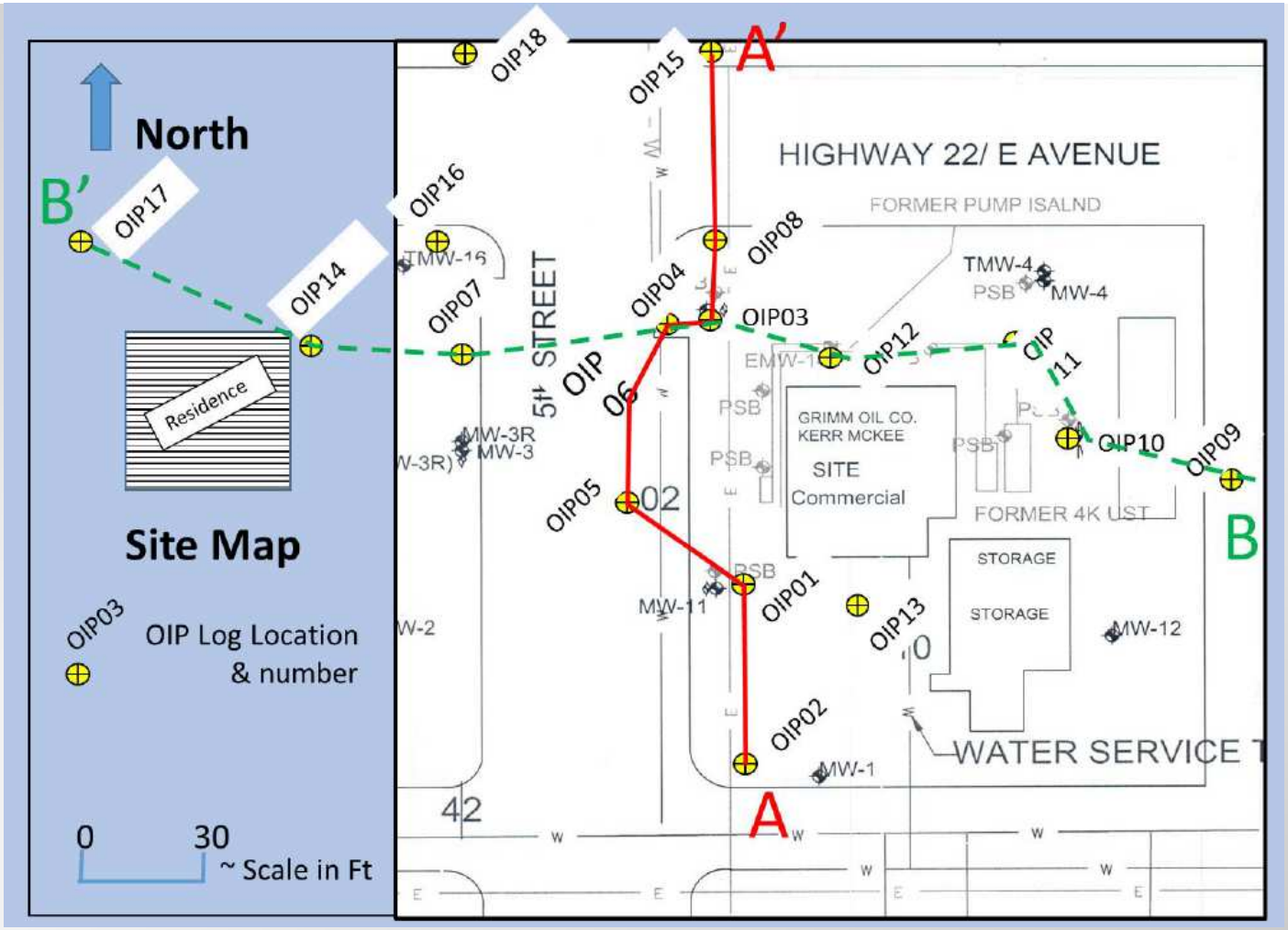


5. Examples of OIP deployment

Site in Iowa
EC + fluorescence
cross section

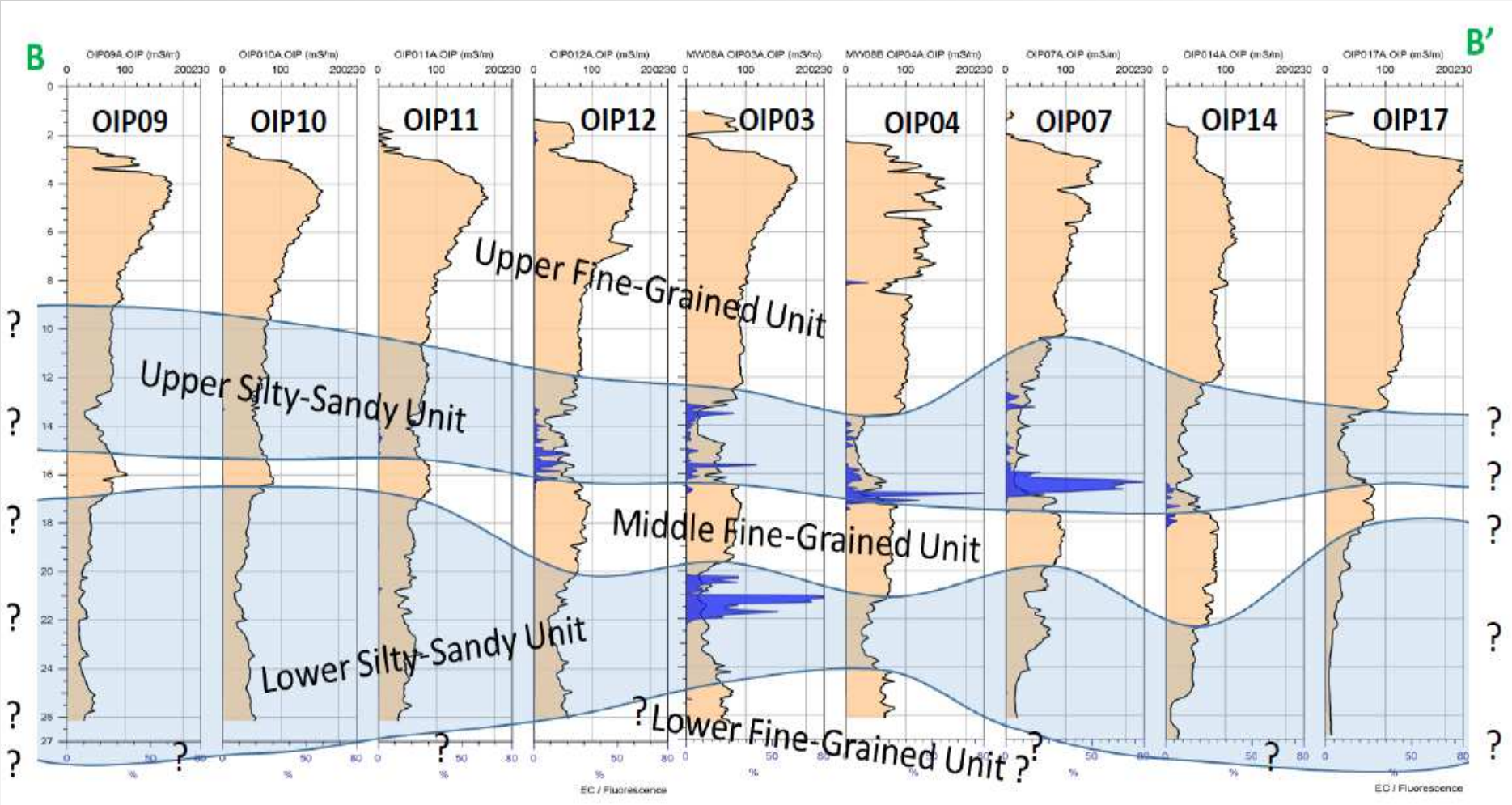


5. OIP deployment



5. Examples of OIP deployment

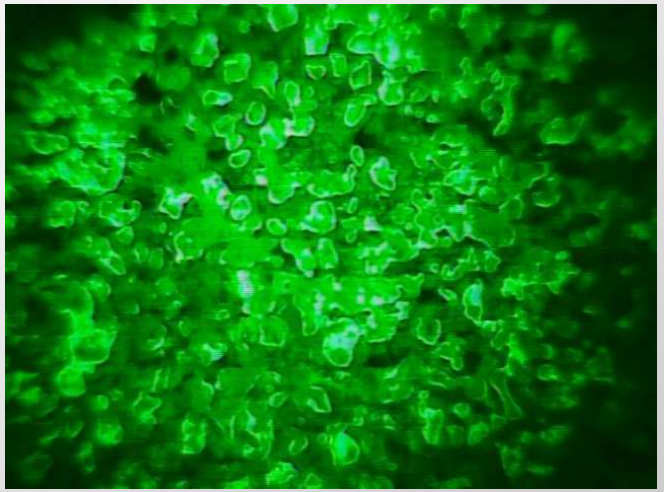
Site in Iowa



4. Optical Profiling Tool (OIP)

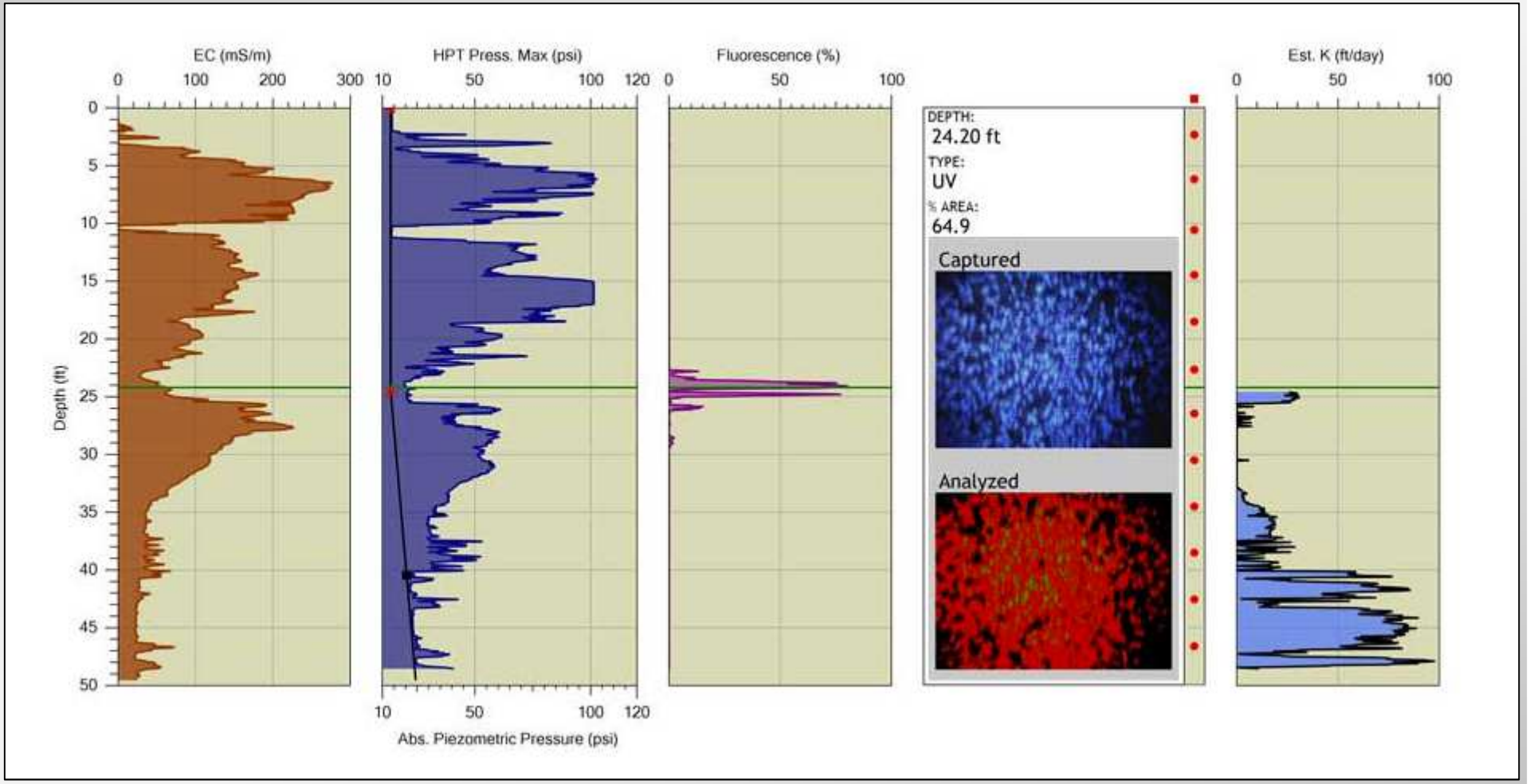
Current applications include :

- Fuel NAPLs (gasoline, diesel, kerosene/aviation fuels ..)
- Oils (motor, waste, hydraulic, crude ..)
- Tar oil, creosote (with other lightsource)
- Fluorescent tracers
- Geoarchaeology (visible light)



5. OIP deployment

OI-HPT log



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Conclusions

- The MIHPT and OIP are tools that collect a huge amount of data as they are advanced into unconsolidated soils
  - High-resolution data is readily available
- They are a step forward in the (fast) understanding of subsurface conditions
  - Mobility of the contaminants of concern can be quickly evaluated
- They help decrease costs associated to site management because :
  - Much less mobilizations to site by allowing on-site decisions
  - Guidance for the sampling effort
  - Guidance for the remediation actions

6. Conclusions & challenges

Challenges

- Progressive switch from classical methodologies to modern methods

- Approval of new approaches and new technologies :

  - ✓ by decision-makers (challenge = to overcome the mistrust about new technologies)
  - ✓ by society (challenge = education)

THANK YOU INTERSOL 2018
FOR THIS EDUCATIONAL PLATFORM

THANK YOU FOR YOUR ATTENTION

For more information
please visit

www.geoprobe.be
www.geoprobe.com
http://geoprobe.com/probing-times

or contact Fabian De Weirdt
fabian.deweirdt@geoprobe.be