ARCADIS Design & Consultancy for natural and built assets

INTERSOIL 2018
MONITORING VAN GRONDWATERKWALITEIT
MONITORING DE LA QUALITÉ DE L'EAU SOUTERRAINE

Brussels, 13 november 2018
Wouter Gevaerts
Director contaminated land Europe and Middle East

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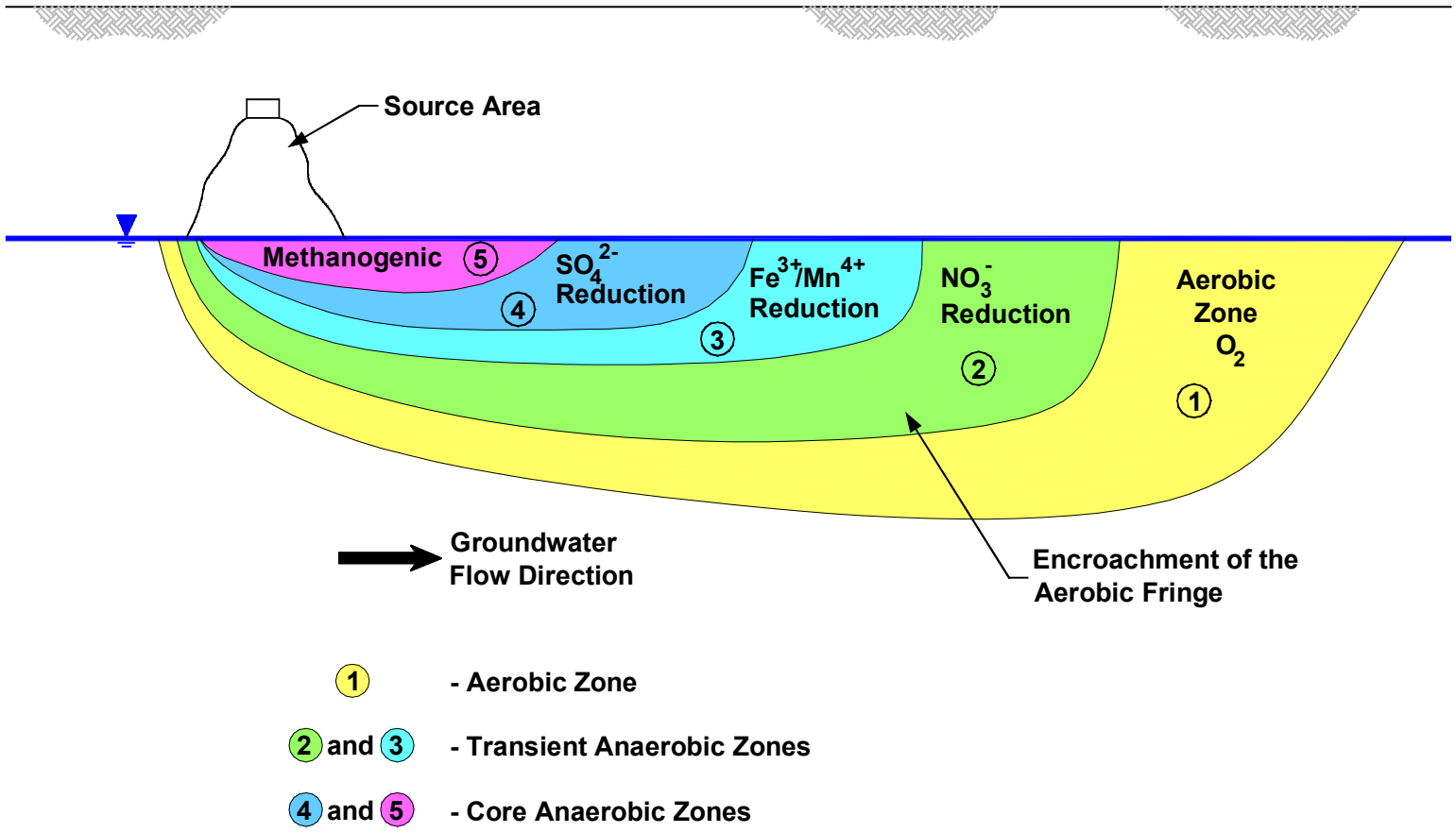
Conceptual Site Model (CSM) : scale ?

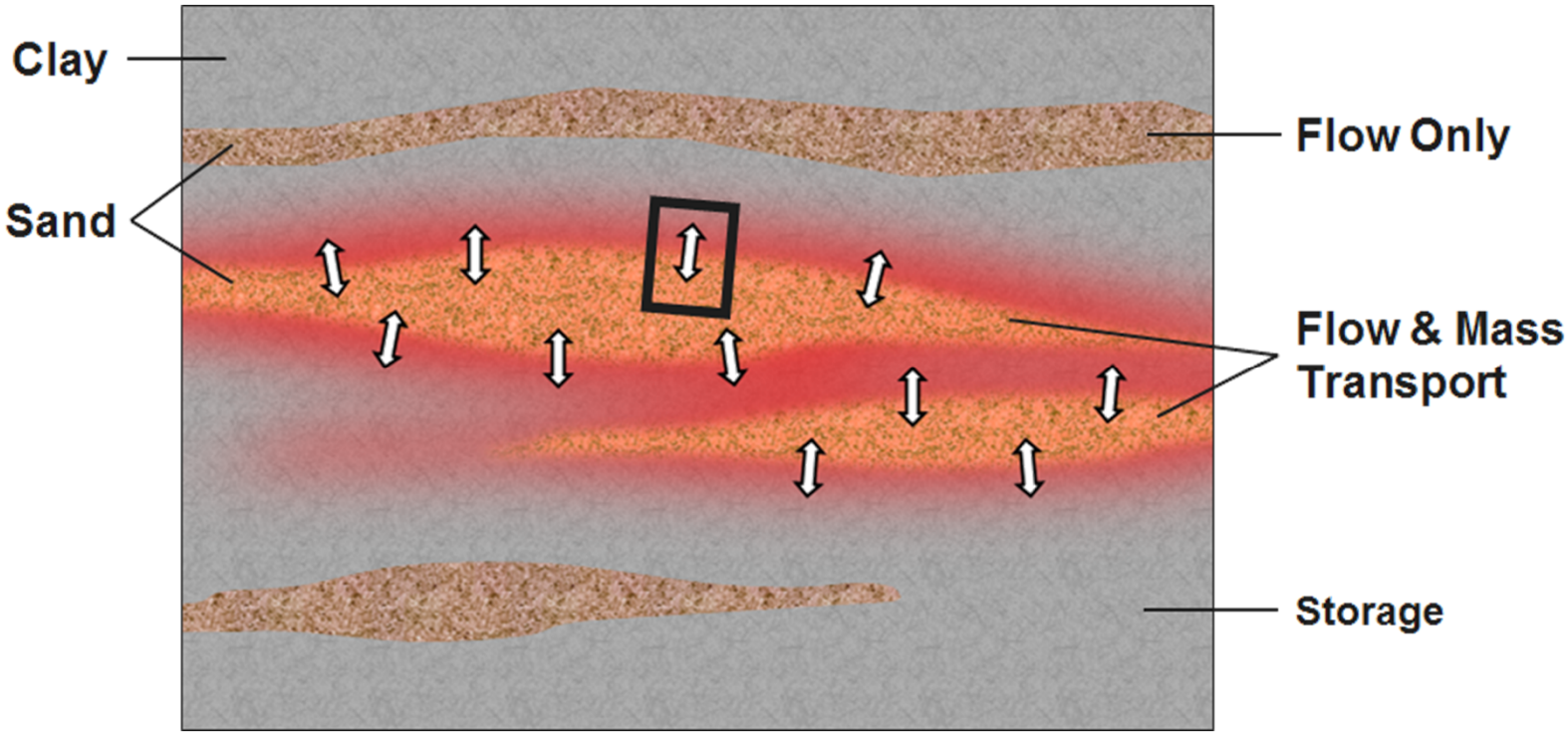


1 - Aerobic Zone

2 and 3 - Transient Anaerobic Zones

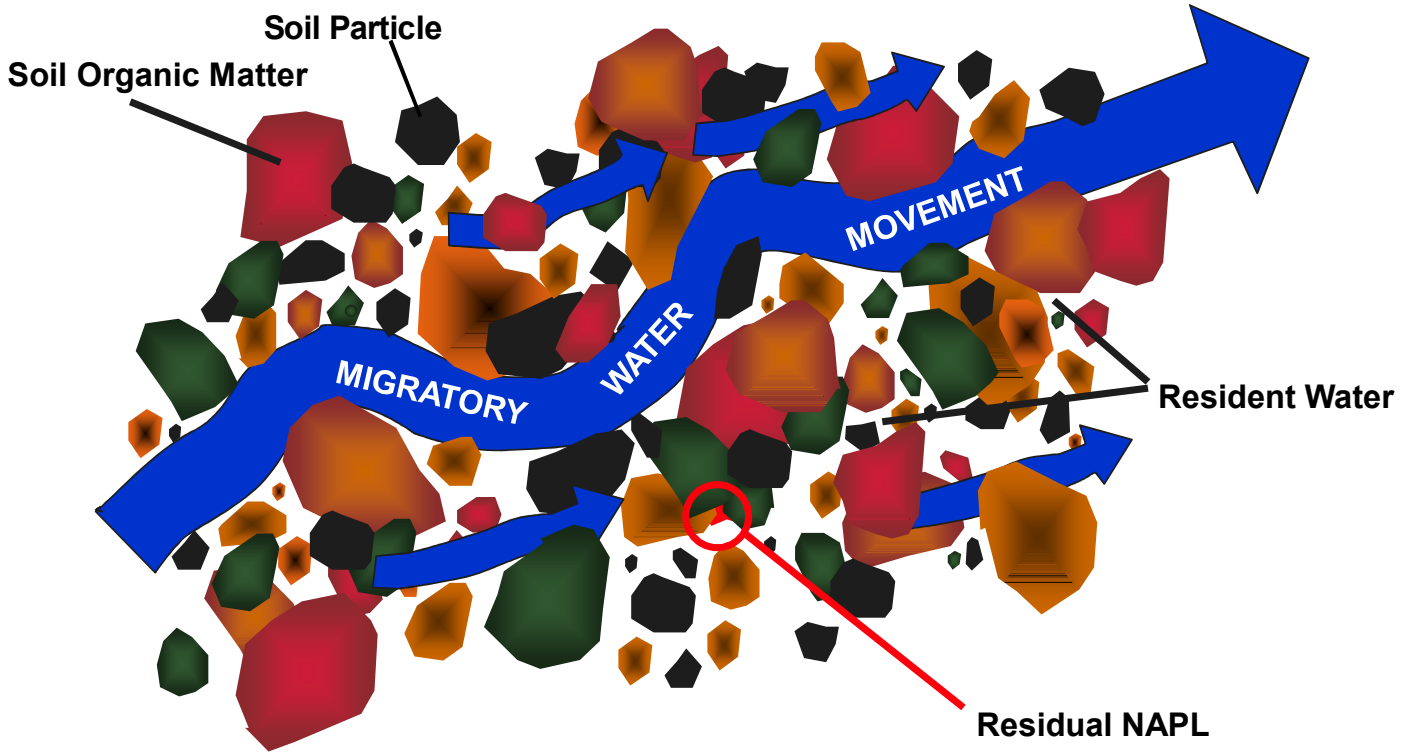
4 and 5 - Core Anaerobic Zones

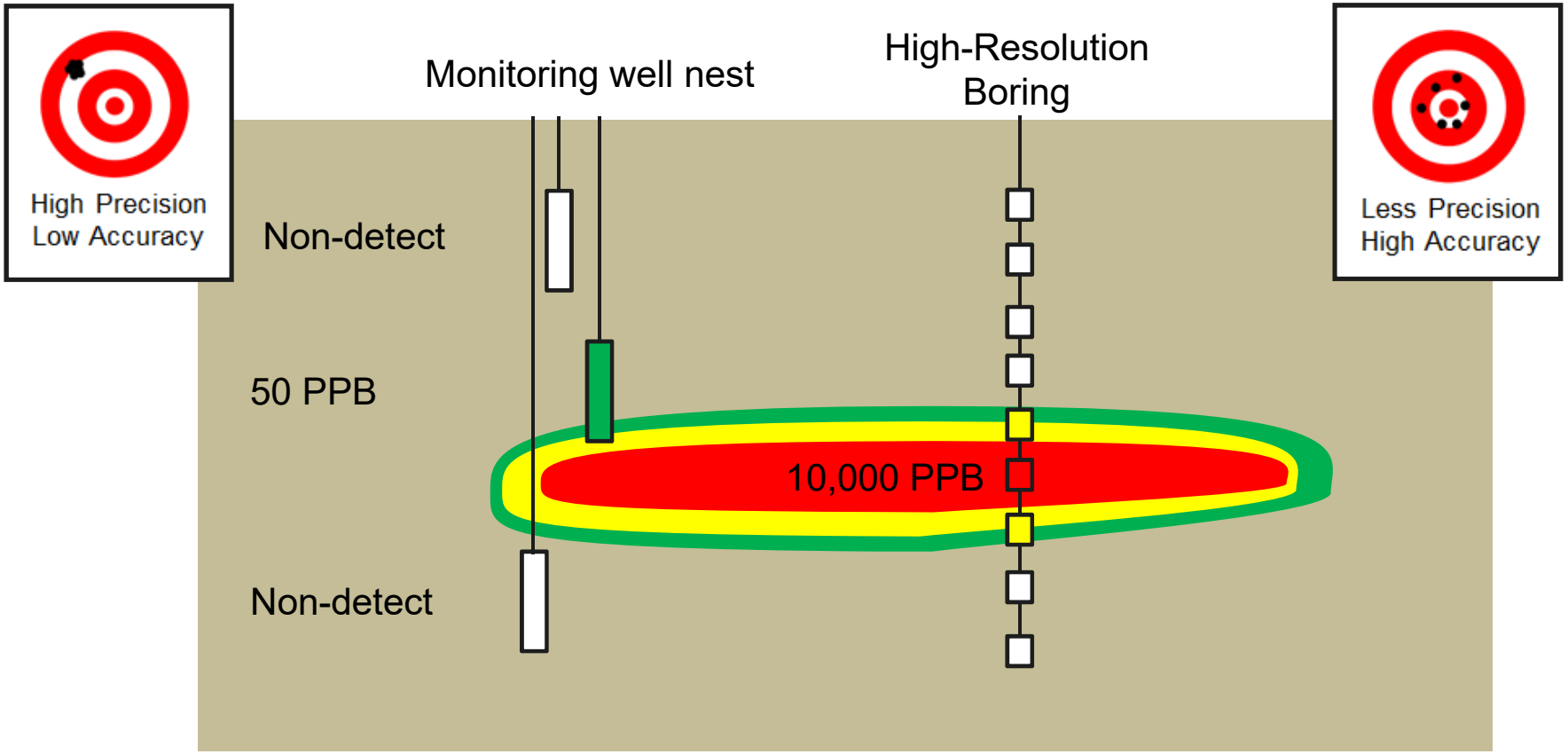
CSM : scale ?



⟺ Diffusion-dominated transport

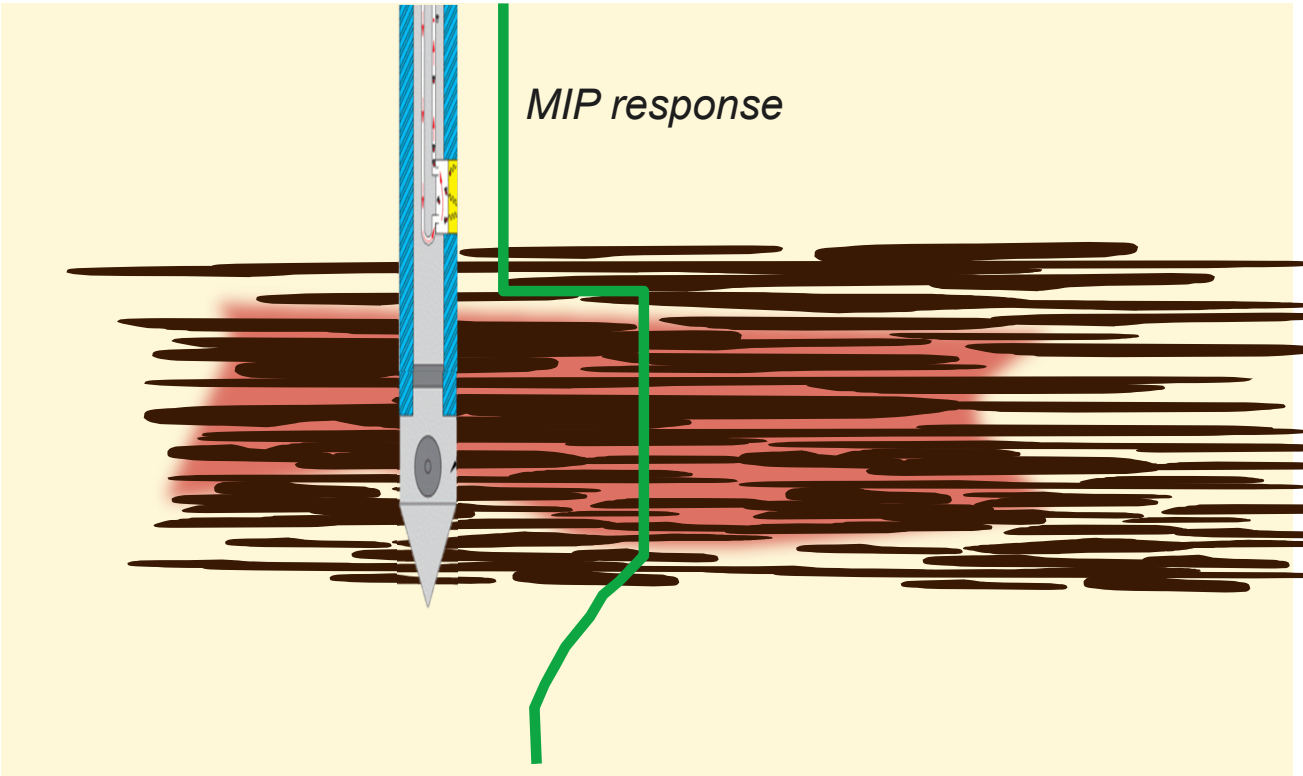
CSM : scale ?





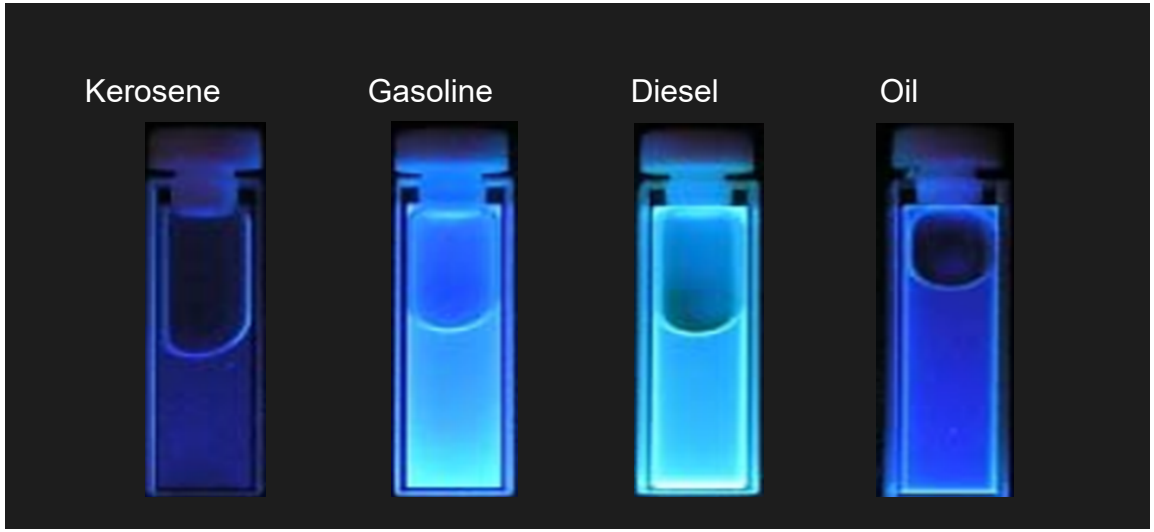
High resolution techniques : MIP

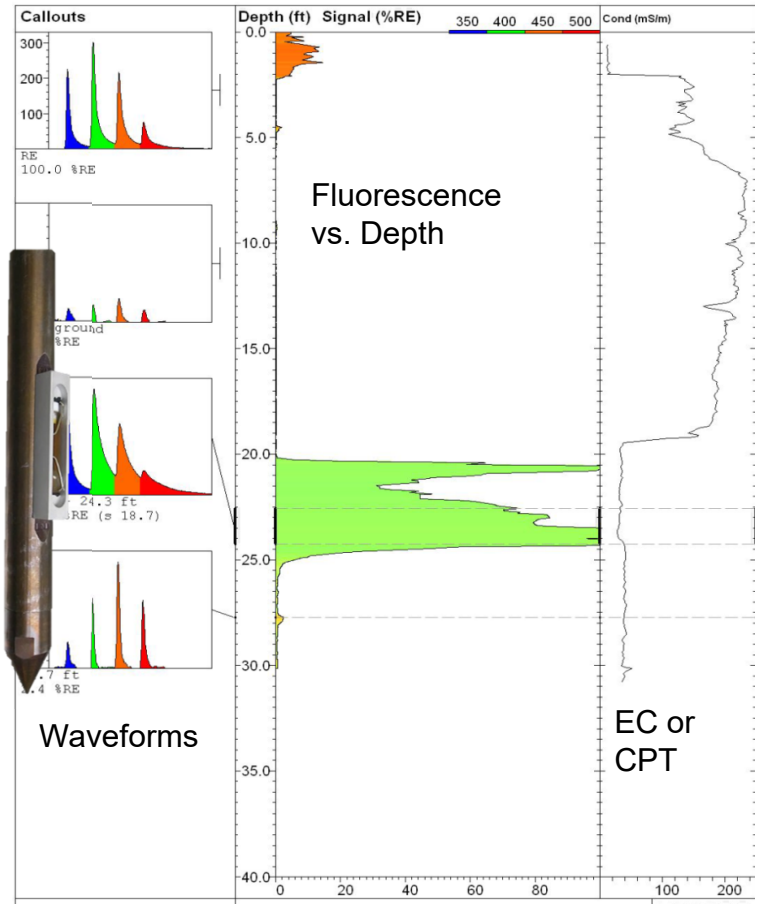
- Membrane interphase probe (MIP) can be used to measure semi-quantitively concentrations of:
  - Mineral oil
  - BTEX
  - VOCl

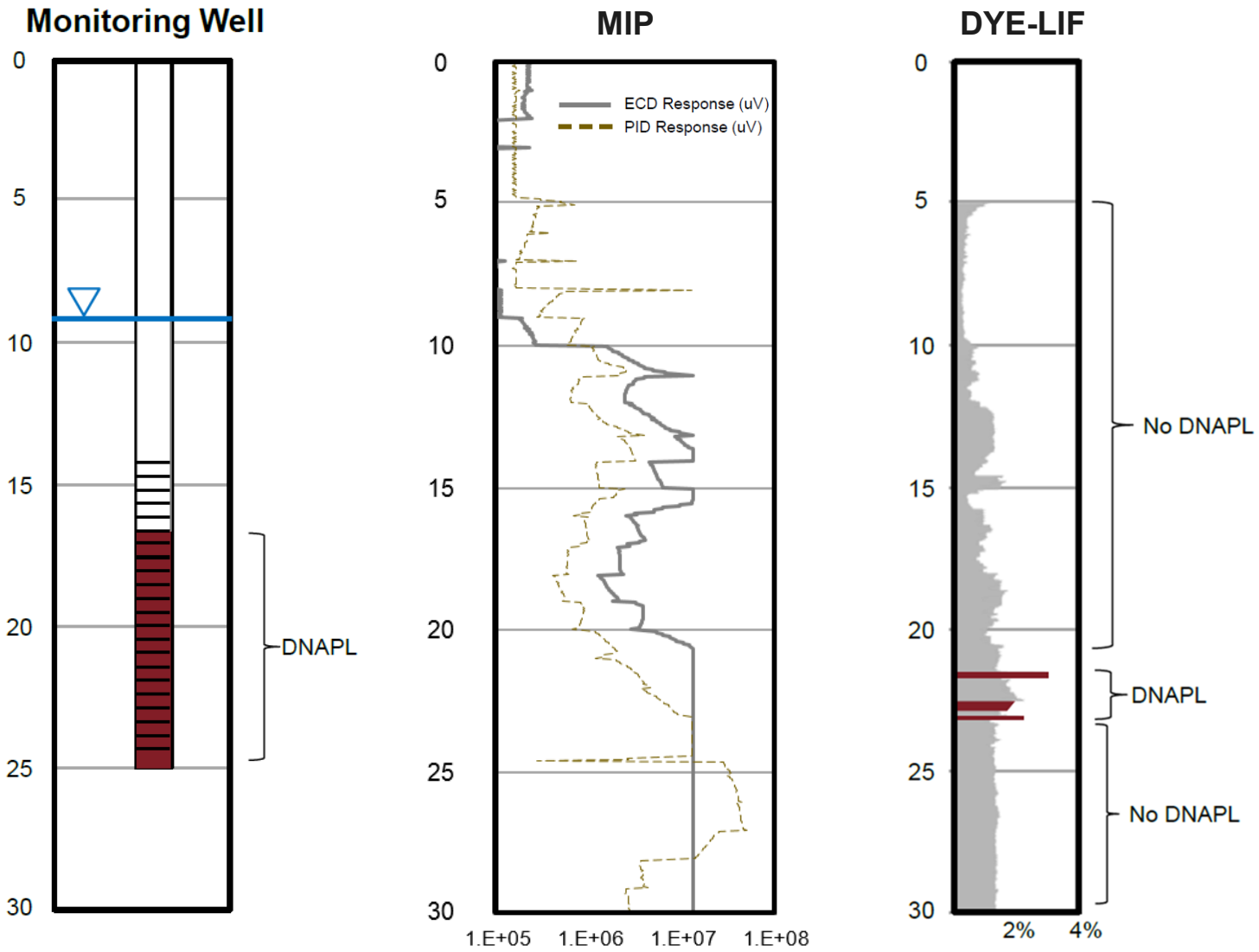


High resolution : Laser Induced Fluorescence (LIF)

Polycyclic aromatic hydrocarbons (PAHs) fluoresce in response to excitation by specific wave-lengths of light







Active sampling : Different types of pumps

Choice of type of pump

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Selection based on :

- Cross contamination
- Taking samples or only cleaning a well ?
- Depth of the groundwater table
- Risk for degassing
- Chemical characteristics of contaminant

Mainly two types :

- Over-pressure
  - The over-pressure capacity of the pump defines how deep the groundwater level can be in the well
  - Be aware that – depending on the speed of the turbine – foam can be created (eg pfas)
- Underpressure
  - Defines if the max depth of 9 m can be reached, or less
  - Defined as well by the type of tubes used
  - Be aware of degassing (impact on volatiles)

Passive sampling No-Purge Sampling Devices: Mechanical “Grab” Samplers

Without a well :

- BAT sample

With a well :

- Bailer
- HydraSleeve®
- Passive diffusion bag
- Snap Sampler™
- Kemmerer Well Sampler
- Discrete Interval Sampler
- Pneumo-Bailer™
- Kabis Sampler

BAT Sample

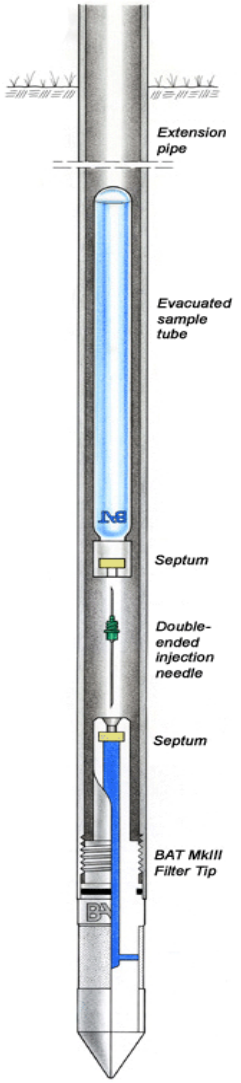
1. Tool is pushed into the soil (eg by a CPT rig)
2. open the system
3. groundwater is flowing into the vial

Is also called a “temporary well”

Good to combine with MIP measurements

No risk for degassing

Depth is limited to CPT depth (about 20 to 30 m)



Bailer Grab Sampling

Pros

- Simplest – lower to midpoint of screen and retrieve
- Lowest cost overall
- No analyte limitations
- Large sample volume – up to 1.2 L in 2” well
- Disposable – good for QA

Cons

- Water flows through bailer on the way down
- Risk of mixing with stagnant casing water upon retrieval, if screen significantly submerged
- May be viewed as “too”

Caution

- Should not be used in wells screened

HydraSleeve®

Pros

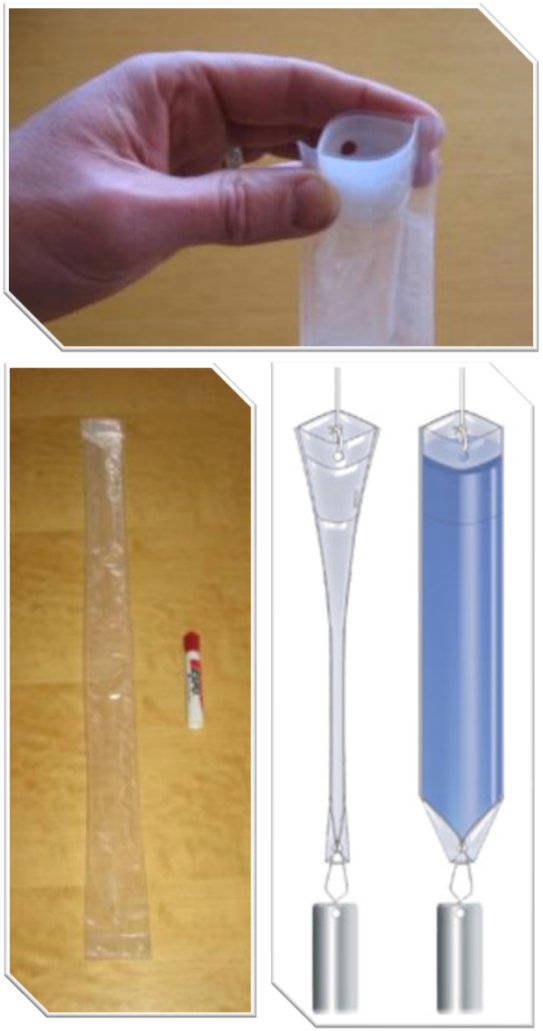
- Simple – deploy, allow to equilibrate, pull up to fill and retrieve
- Low cost
- No analyte limitations
- Minimal risk of mixing with casing water
- Disposable – good for QA/QC
- Good volume – up to 1 L in 2” well
- Vertical profiling is possible

Cons

- Required equilibration time not “cut and dry”

Caution

- Deployment may temporarily



Passive Diffusion Bag (PDB)

Pros

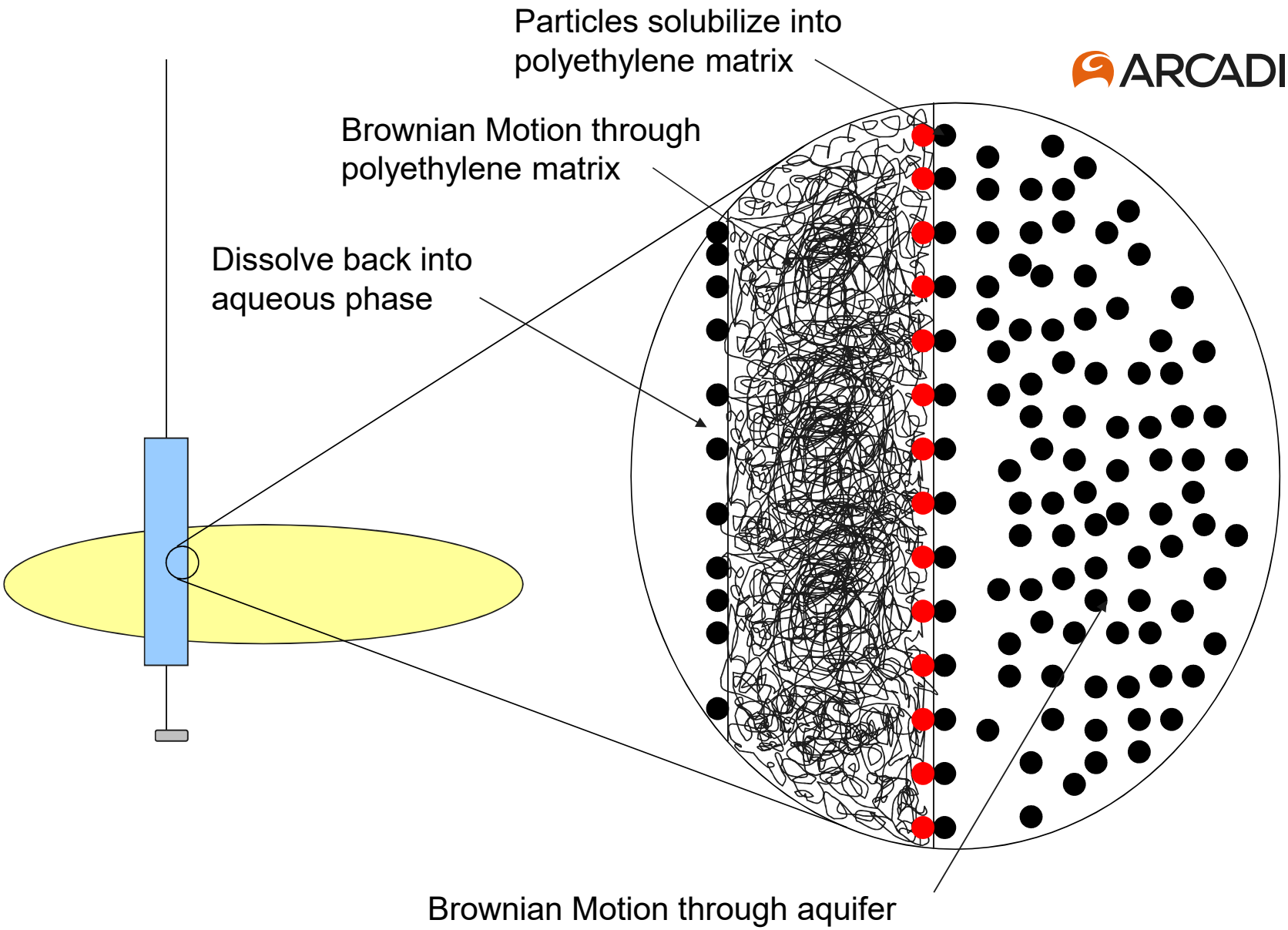
- Longer term average
- Relatively simple to use
- No turbidity issues
- Disposable – good for QA/QC
- Longest history of testing/verification
- Vertical profiling is possible
- Can be custom made

Cons

- Analytes limited to non-polar VOCs and a few SVOCs
- Commercial sampler volume limited (typically 200-350 mL)
- Equilibrium not instantaneous

Caution

- Long deployment (3+ months) may allow microbes to colonize outside of PDB and impact results



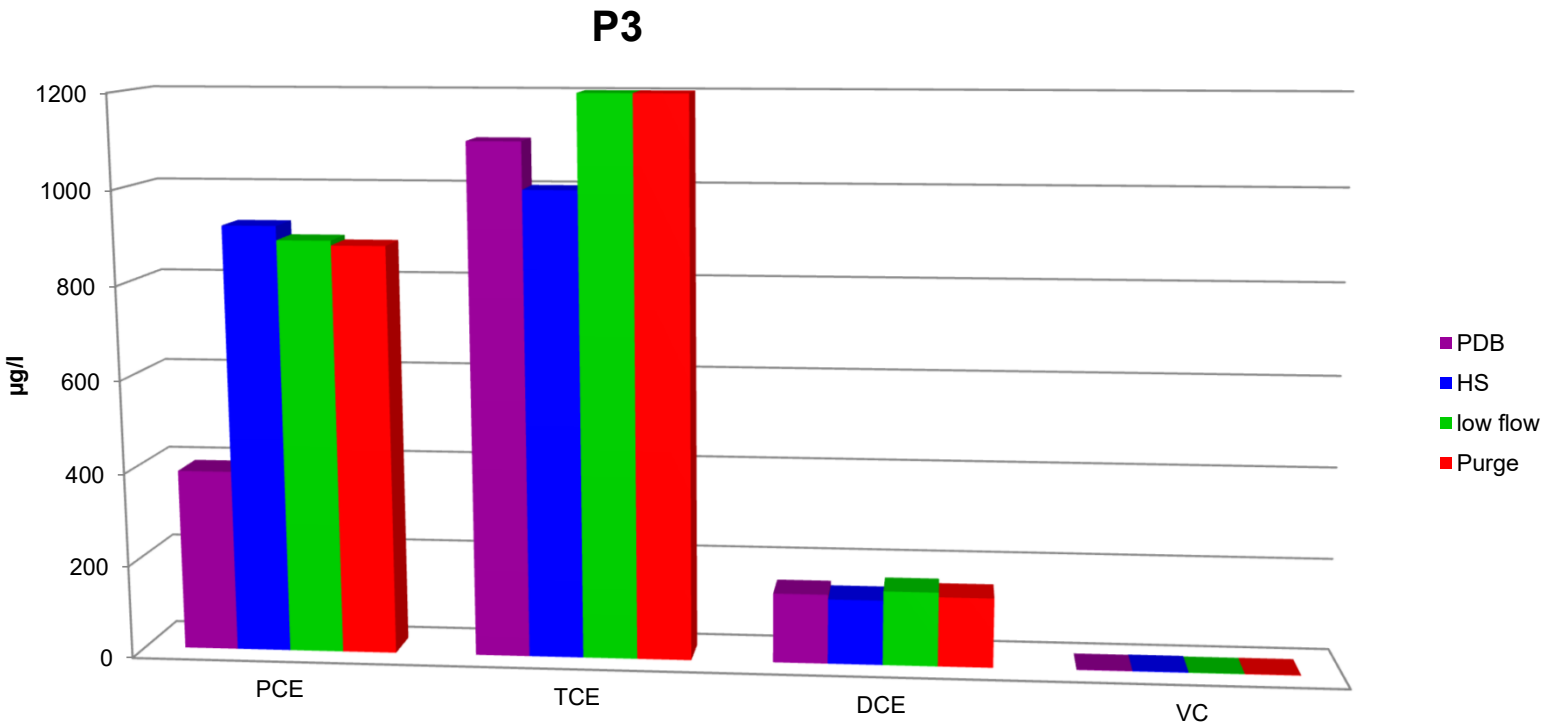
Comparison of sampling techniques

- High flow sampling
- Low flow sampling
- PDB
- Hydrasleeve (HS)

⇒ Focus on contaminant distribution

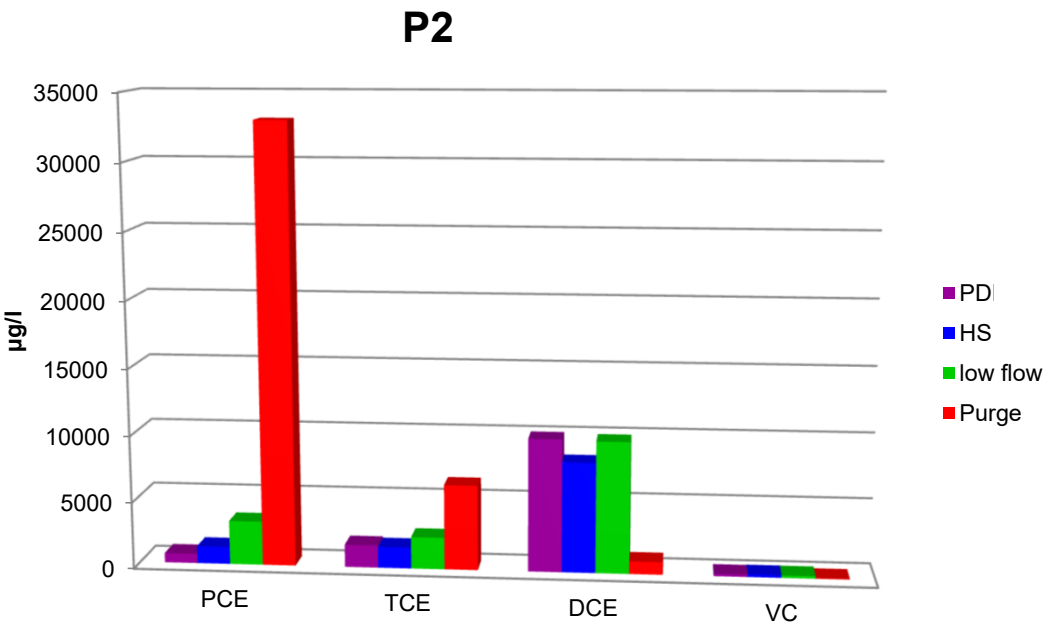
- High K (permeability) zones
- Low K zones
- Vertical profiling

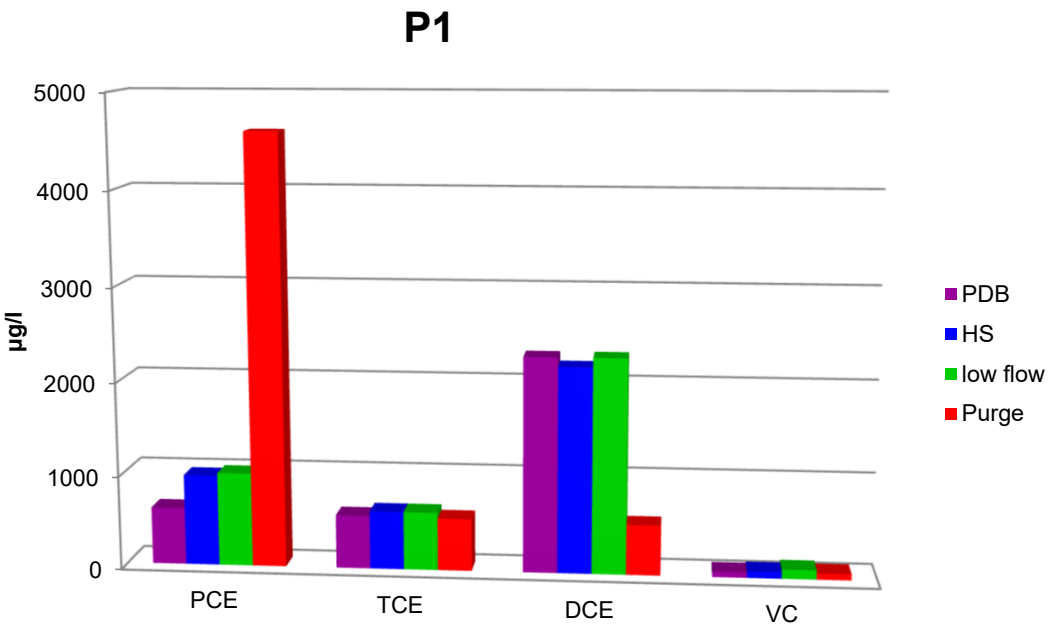
High K zones



Good correlation between different sampling techniques

Low K zones





Bad correlation with high volume purge

- Higher PCE
- Lower DCE

Profiling with PDBs

		PCE		TCE		cisDCE		VC	
Filter screen	Depth PDB	**PDB**	**conv**	**PDB**	**conv**	**PDB**	**conv**	**PDB**	**conv**
m-bgs	m-bgs	µg l-1		µg l-1		µg l-1		µg l-1	
38 - 42	38 - 38.5	76	54000	440	5800	6100	120	23	57
	39 - 39.5	250		58		16000		19	
	40.5 - 41	570		200		11000		13	
	40.5 - 41	240		240		14000		23	
	41.5 - 42	190		140		14000		22	

- No significant differences across screen
- Does **NOT** give explanation for differences between
  (high volume) purge and no purge sampling techniques

Heterogeneity

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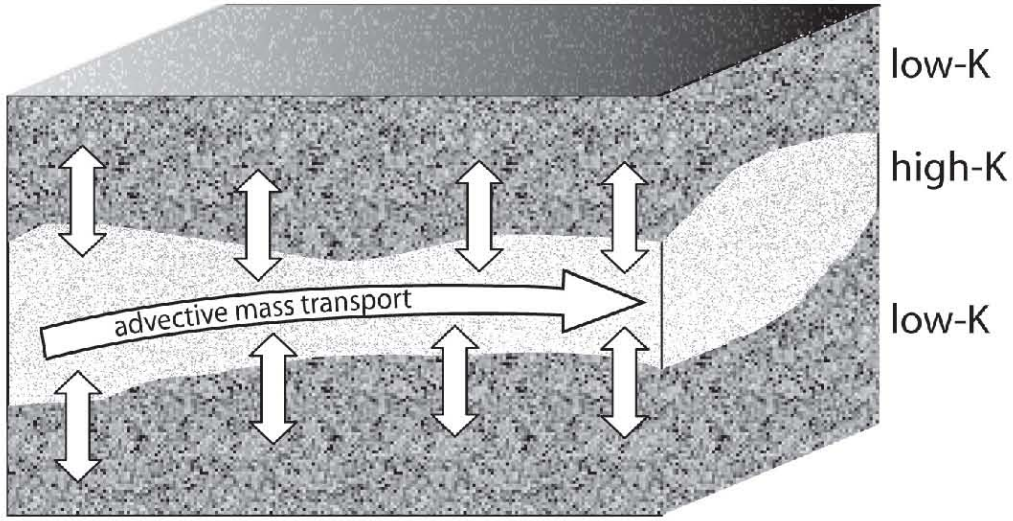
Subsurface (and also low K zones) consist of higher and lower K zones

- Advective transport through high-K zones
- Diffusive interaction with low-K zones



Measuring Flux : Passive flux meter

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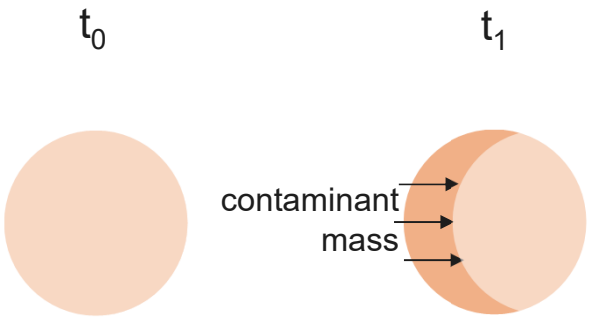
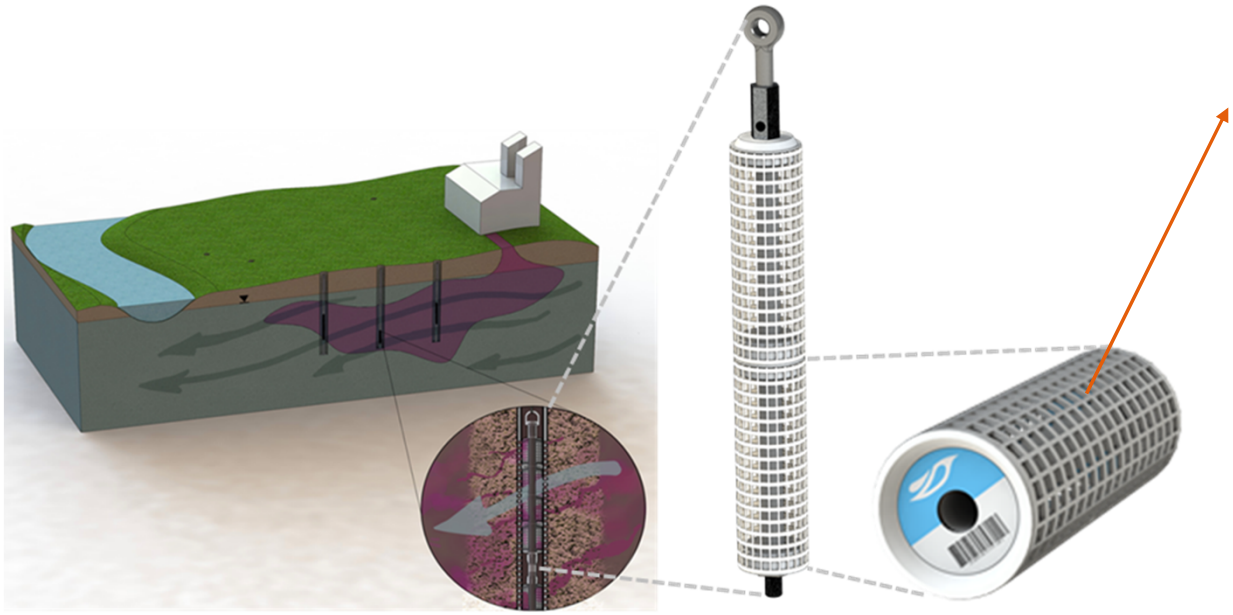
- Permeable sorbent
  - Contaminant adsorbed onto the passive flux meter over time to get concentration (C)
  - Accumulated mass = *f* (flow and concentration)



- Soluble tracers
  - Tracer desorbs from passive flux meter over time to get flow (q_0)
  - Tracer loss= *f* (groundwater velocity and flow convergence)

Mass flux: $J_C = q_0.C$

An example of passive flux meter : iFlux



iFLUX cartridge

- Length: 14,1 cm
- Diameter: 50 mm
- Commercially available cartridges
  - Volatile Organic Compounds (VOCs, BTEXN, PAHs)
  - Nutrients (NO_3^-, SO_4^-, NH_4^+)
  - Heavy metals
- Groundwater deflection!

Limitation: only possible in monitoring wells with diameter of ≥ 63 mm

Passive flux meter (iFLUX): advantages and disadvantages

+	-
Groundwater flow and concentration measured simultaneously	Method-specific issues (influence of groundwater deflection)
Less sensitive to fluctuations	Only applicable for VOC, heavy metals and nutrients
Easy to install in the field	
Limited amount of waste	

Future

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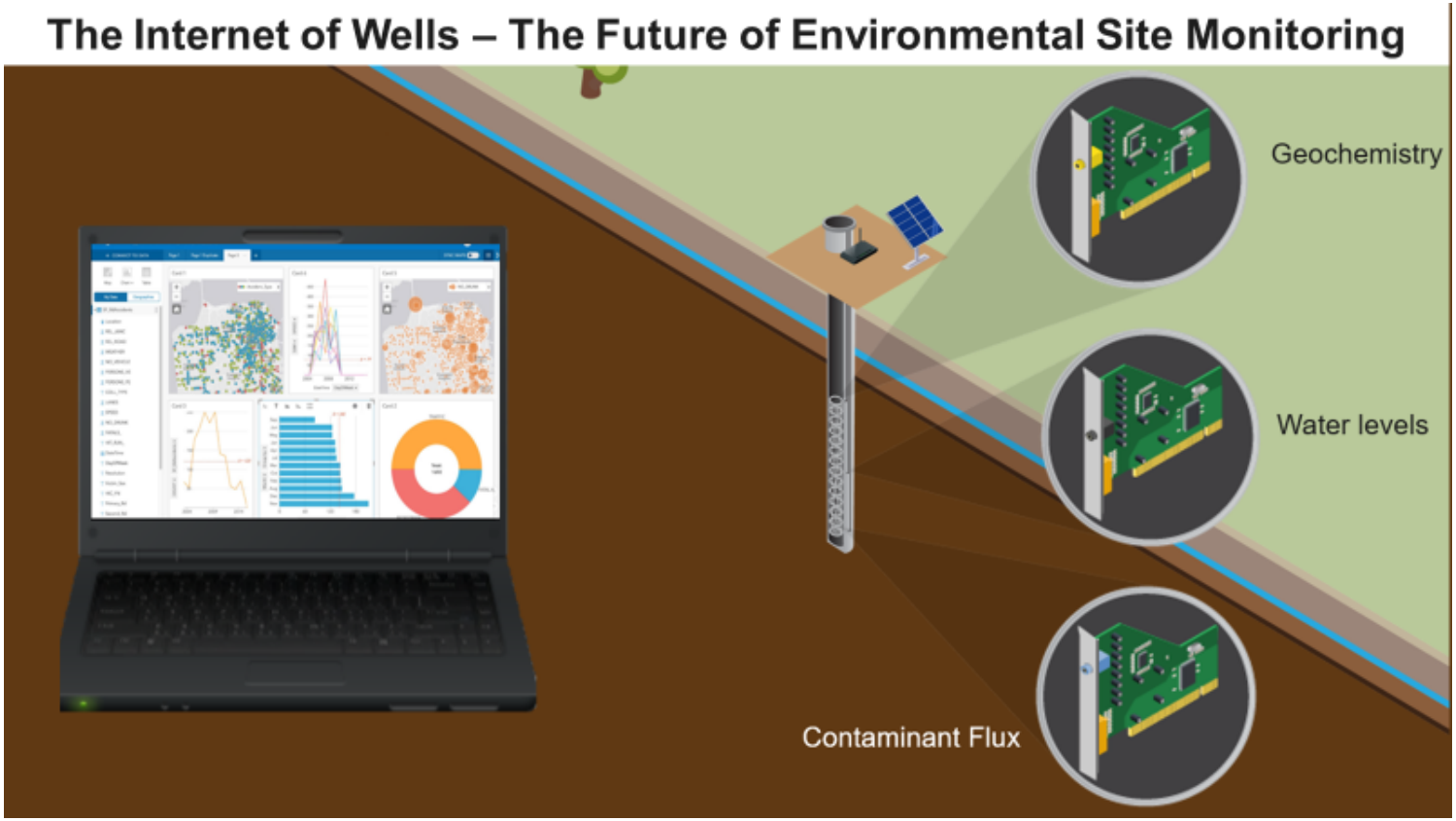
Sensors to measure groundwater quality, LNAPL thickness, gas concentrations,…

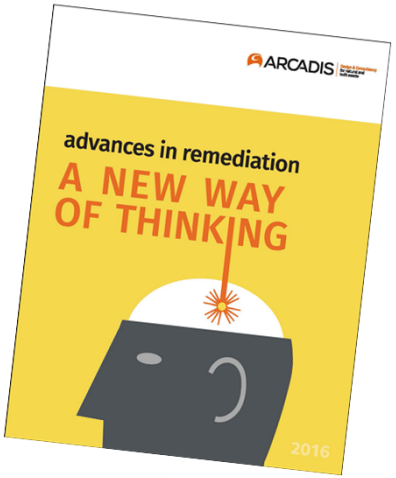


Find Out More

http://arcad.is/air2016Event2

And

https://www.arcadis.com/en/united-states/our-perspectives/a-better-way-forward-new-technologies-and-treatment-methods-for-remediation-of-emerging-contaminants/



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