Spatial distribution and temporal evolution of chlorinated solvents in a drinking water ressource

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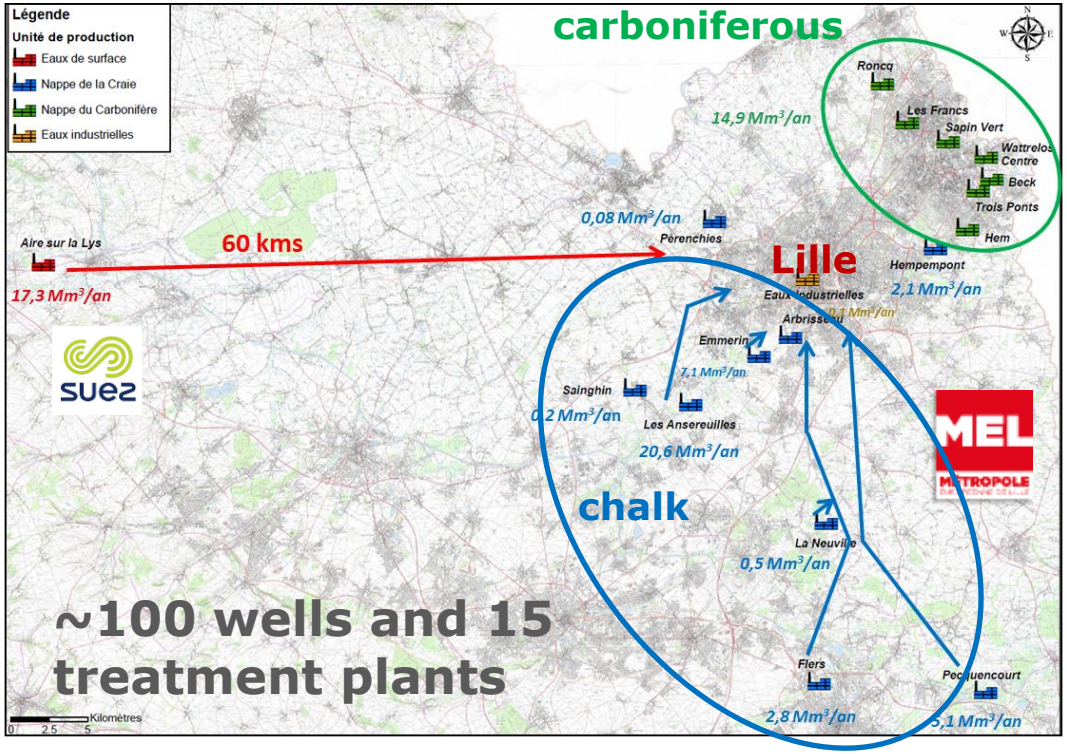
Context: Lille Metropolis (France)

- **1.2 million inhabitants (4th in France)**
- **In 2018 : production of 70.8 million m³ of drinking water (200 000 m³/d)**

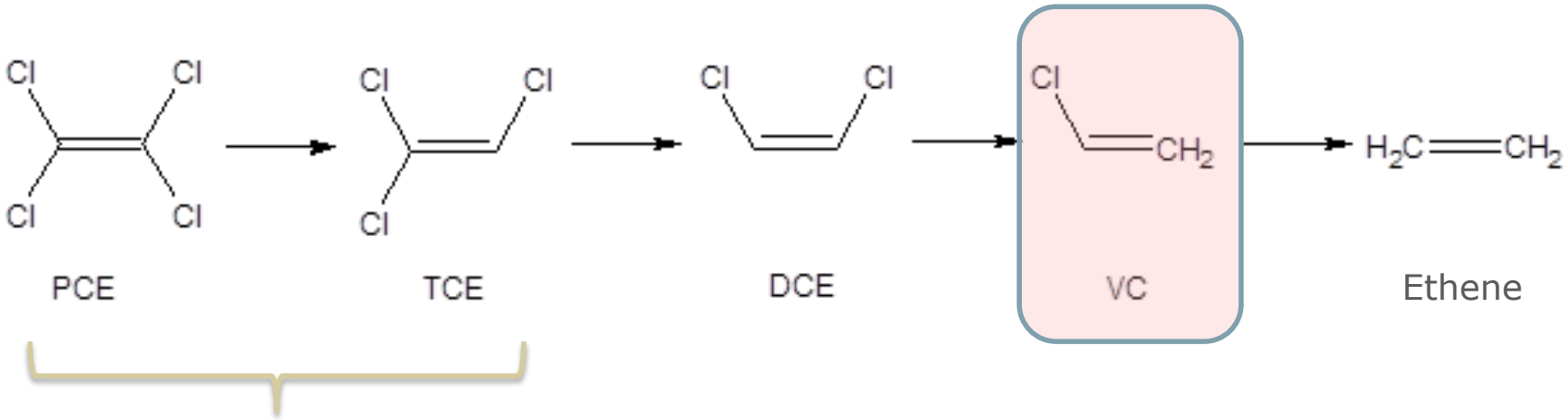
Surface water *(Lys River – 24 %)*

Groundwaters *(76%)*

- **« Available water »: 120%**
- **40% of the ressource is impacted by chlorinated solvents from former industries**



Simplified scheme of tetrachloroethylene degradation:



EU Drinking water regulation

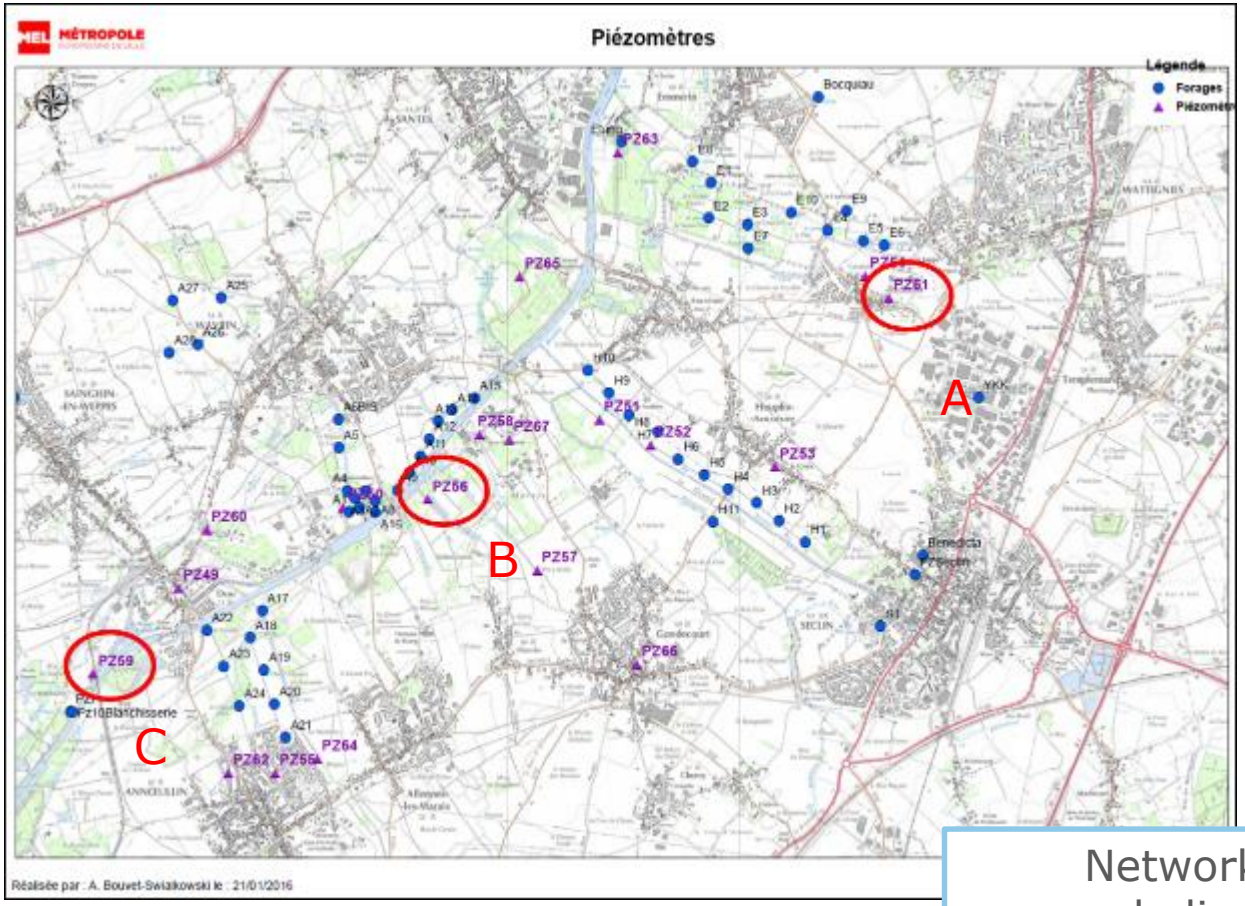
∑ tetrachloroethylene + trichloroethylene
< 10 µg L^{-1}
respected by dilution

Vinyl chloride
< 0.5 µg L^{-1}

Is this water ressource sustainable ?

- Presence of multiple sources of PCE, TCE, DCE,…
- DCE has been detected at concentrations > 350 µg L^{-1} in this aquifer

Localization



- Production wells
- Monitoring piezometers dedicated to VOC

9 VOCH analysed:

tetrachloroethylene
trichloroethylene
Cis-1,2-dichloroethylene
Trans-1,2-dichloroethylene
1,1-dichloroethyene
vinyl chloride
dichloroethane
trichloroethane

Network of 19 piezometers dedicated to monitoring

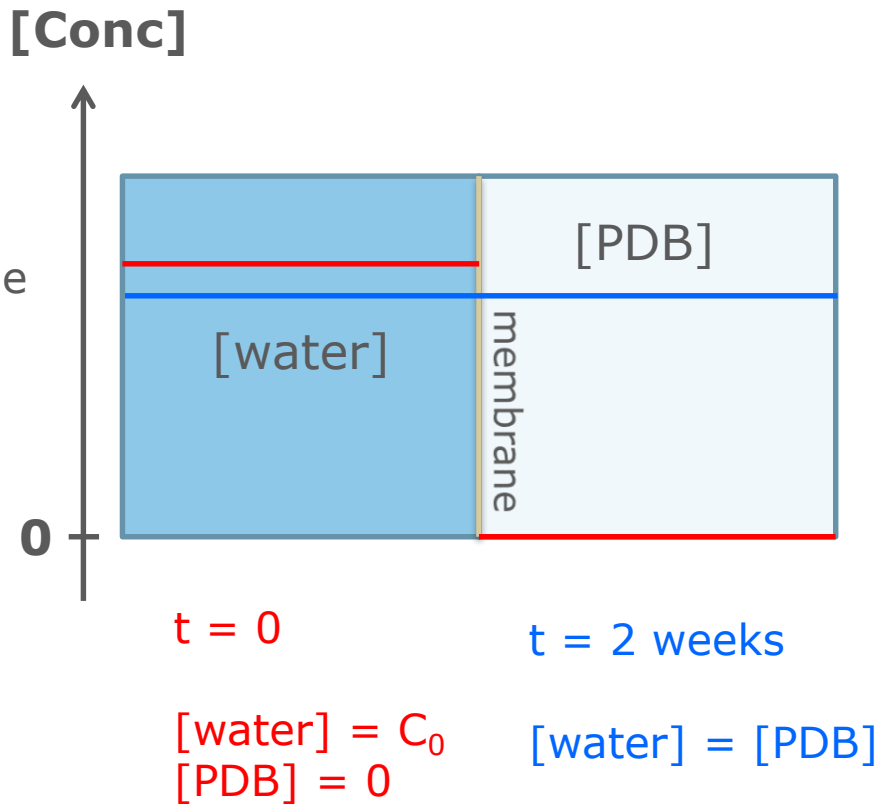
diameter: 168.3 mm – stainless still (to avoid vinyl chloride leaching)

Equilibrium based passive sampler (no accumulation)

PDB = Polyethylene Diffusion Bag

- Membrane: low density polyethylene
- Filled with ultrapure water
- Thickness: 100 µm
- 90 cm high,
- 4 cm large
- Volume: 300 mL

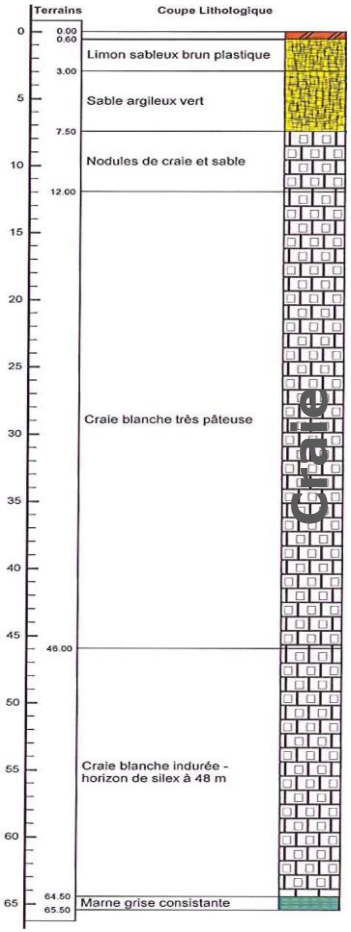
4 campaigns /year
PDB at different depths

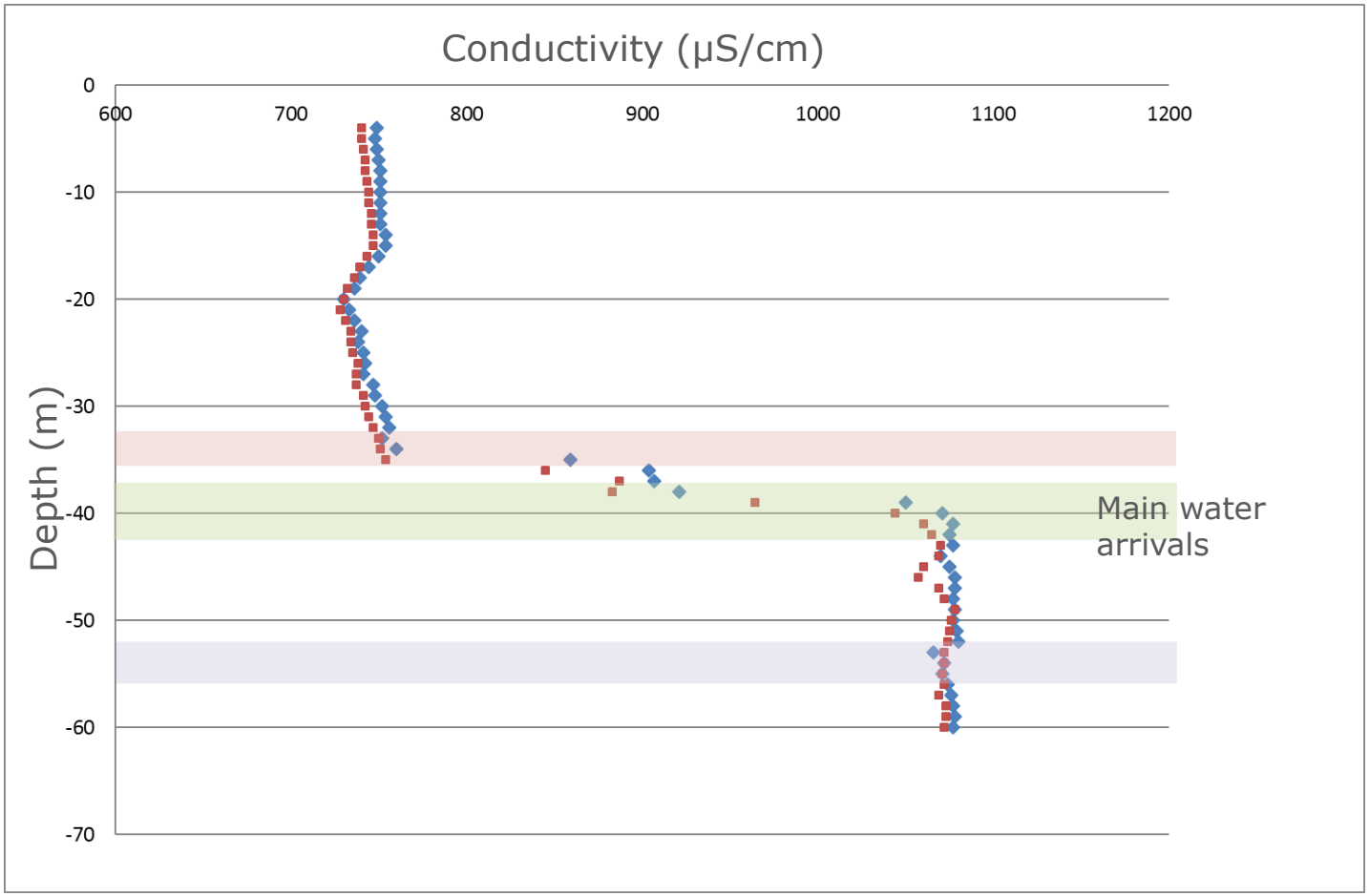


Extra characterization in function of depth:
- dissolved oxygen, conductivity, t°
- anions, cations, trace metals and pesticides

Poster n°105
Billon et al.

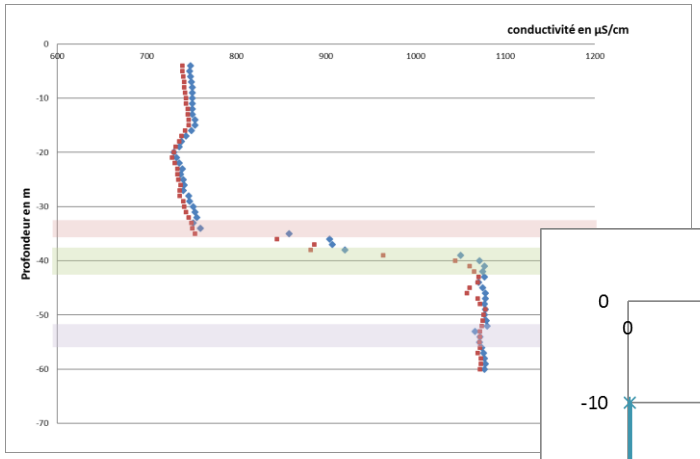
PZ A

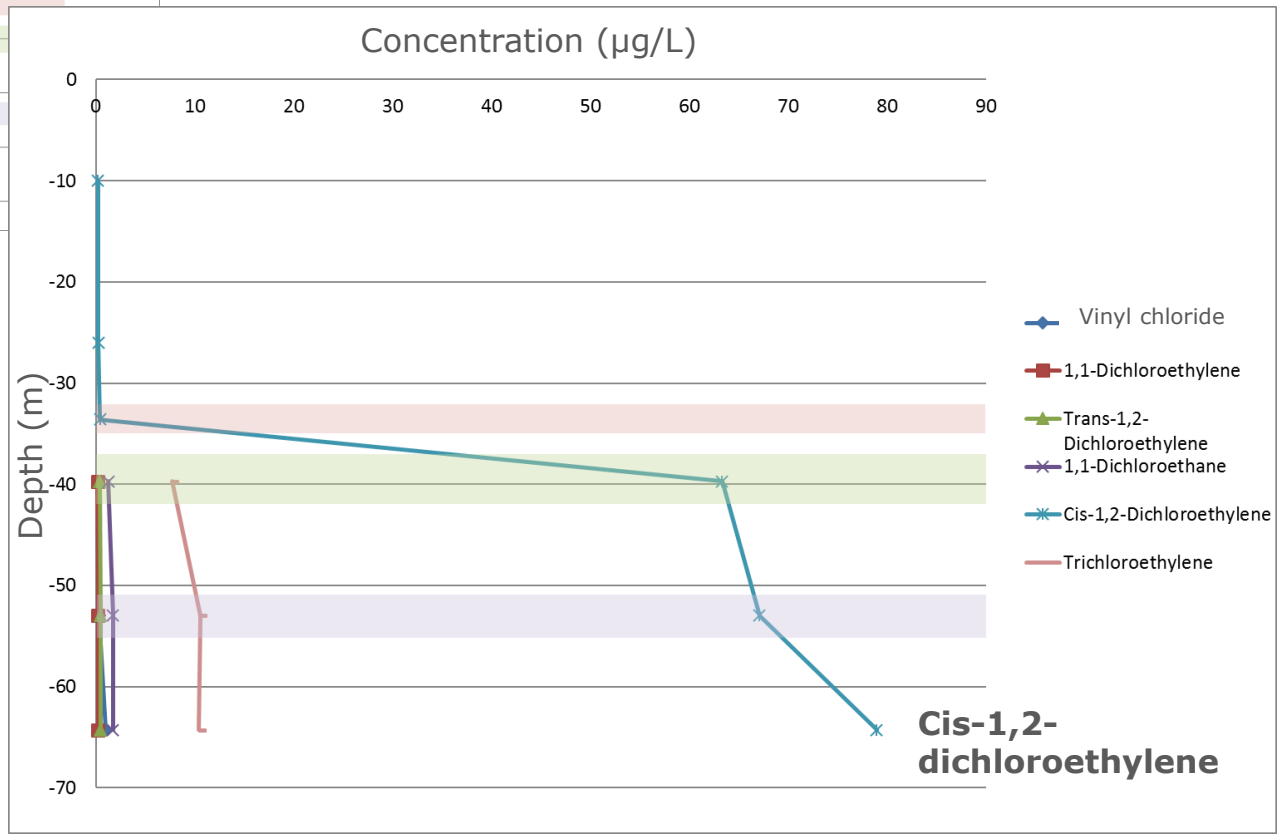




- Sudden change of water caracteristics:
  sampling with dialysis cells: $[Ca^{2+}]$ from 100 to 180 mg/L
  $[Na^{+}]$ from 60 to 80 mg/L
- No mixing of the water column with classical sampling

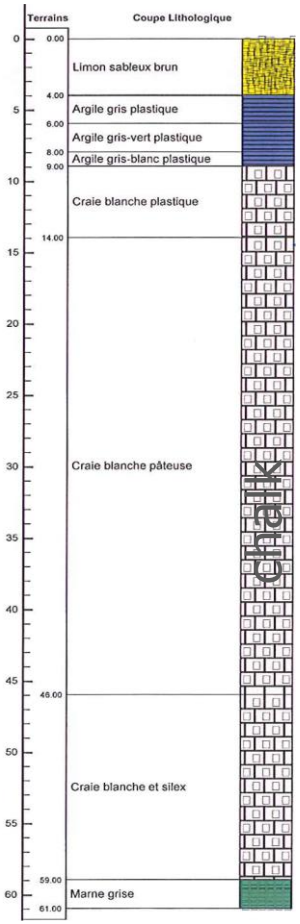
PZ A

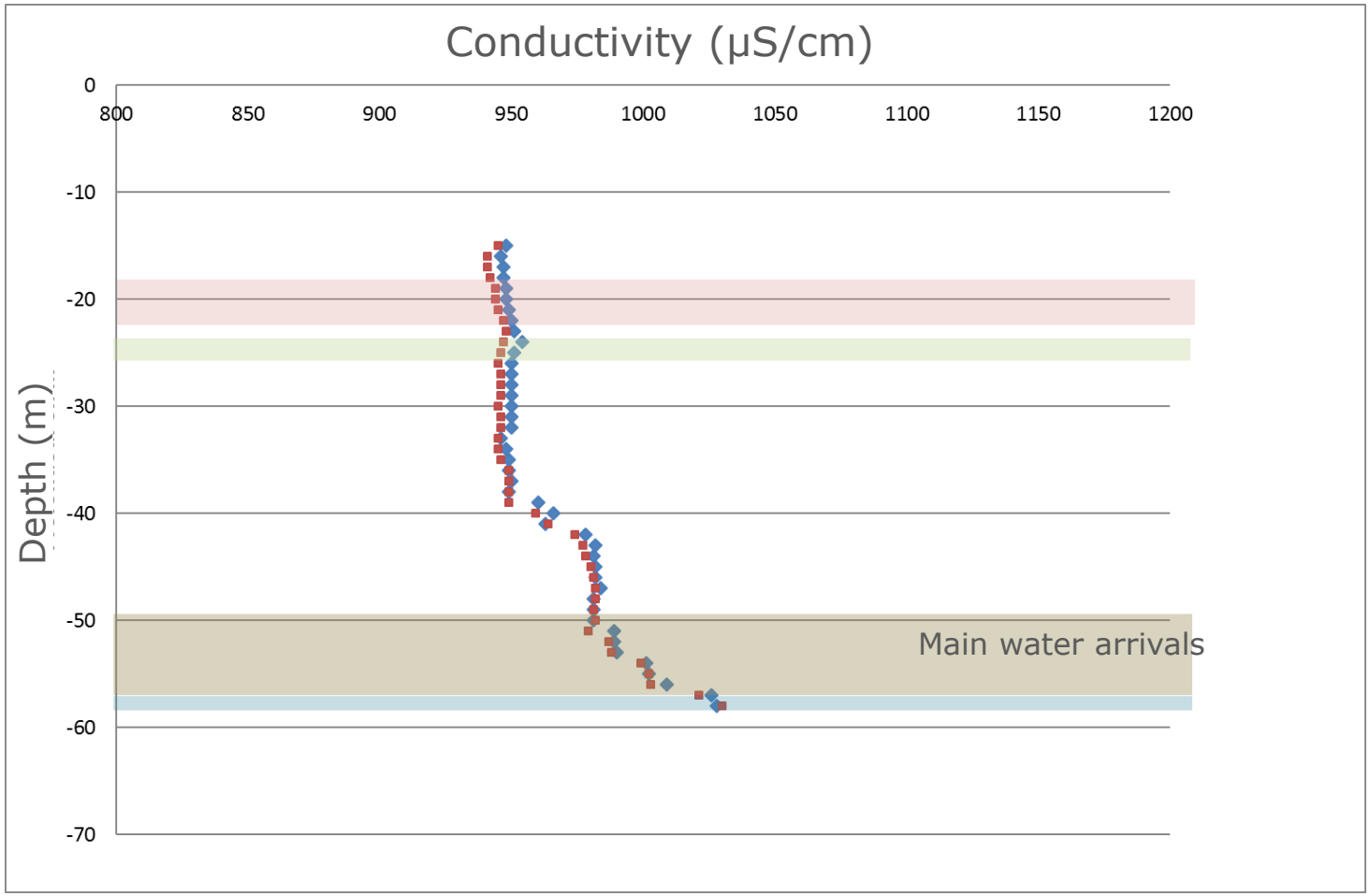




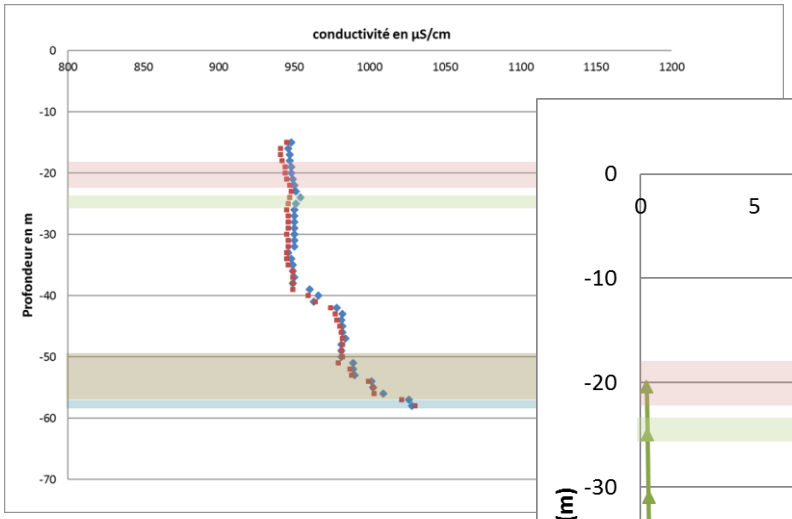
- High concentration of cis-1,2-dichloroethylene (80 µg/L)
- Vinyl chloride from 0.3 to 1 µg/L

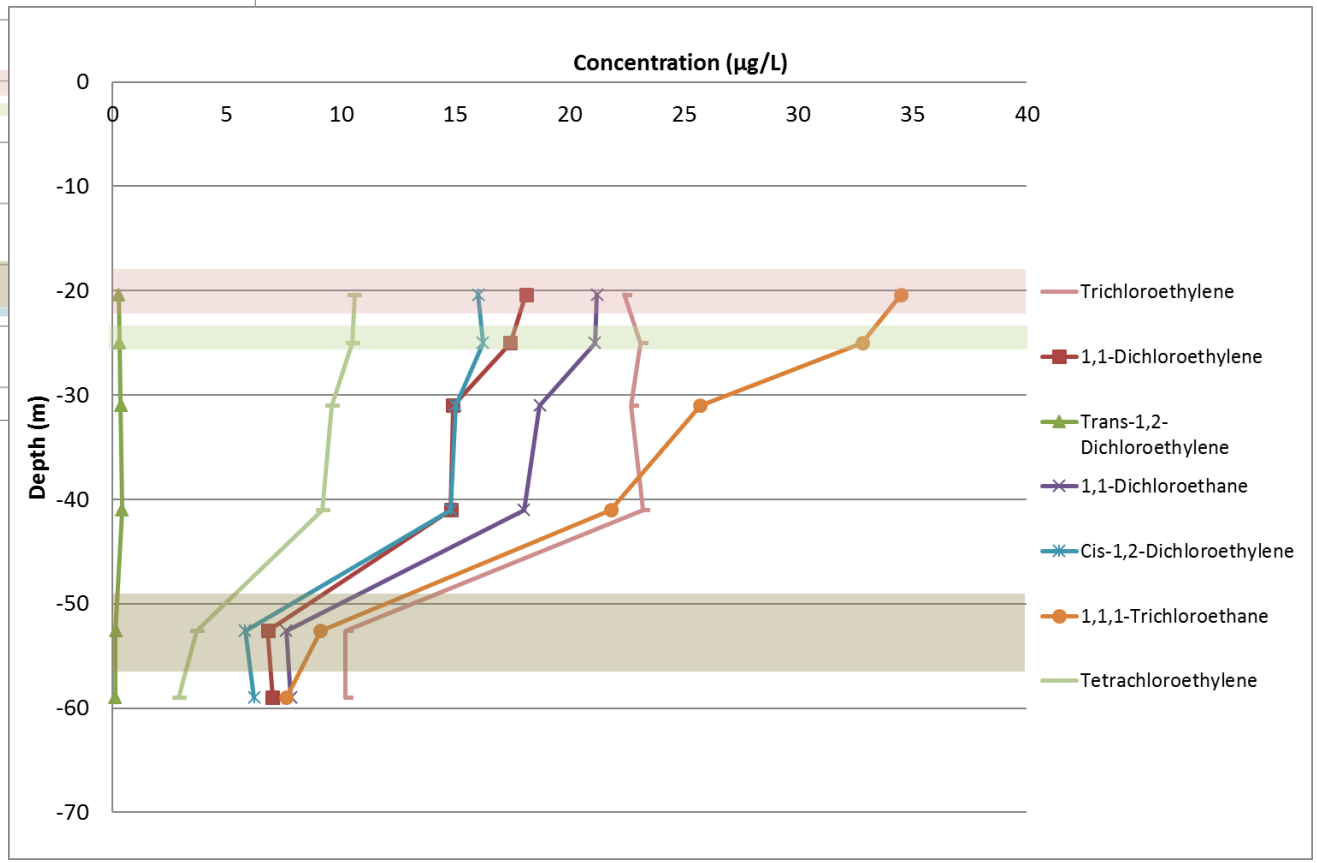
PZ B


Terrains
Coupe Lithologique
0.00
Limon sableux brun
4.00
Argile gris plastique
6.00
Argile gris-vert plastique
8.00
Argile gris-blanc plastique
9.00
Craie blanche plastique
14.00
Craie blanche pâteuse
46.00
Craie blanche et silex
59.00
Marne grise
61.00
chalk


Conductivity (µS/cm)
0
800
850
900
950
1000
1050
1100
1150
1200
-10
-20
-30
-40
-50
-60
-70
Depth (m)
Main water arrivals

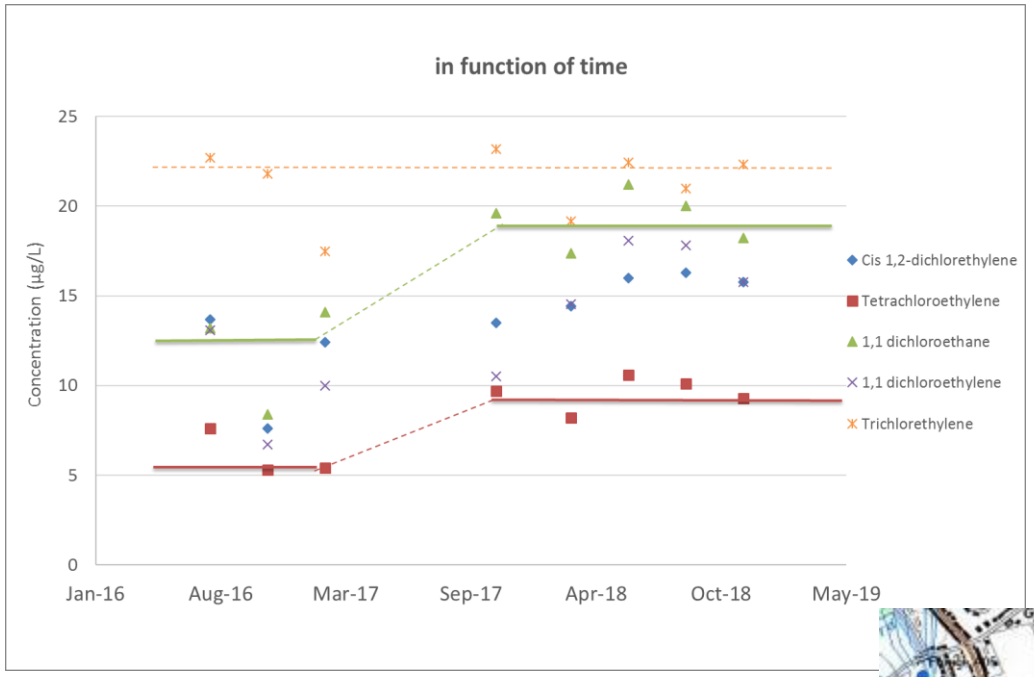
PZ B





7 / 9 compounds detected
Similar behaviour for all compounds
Lower with depth

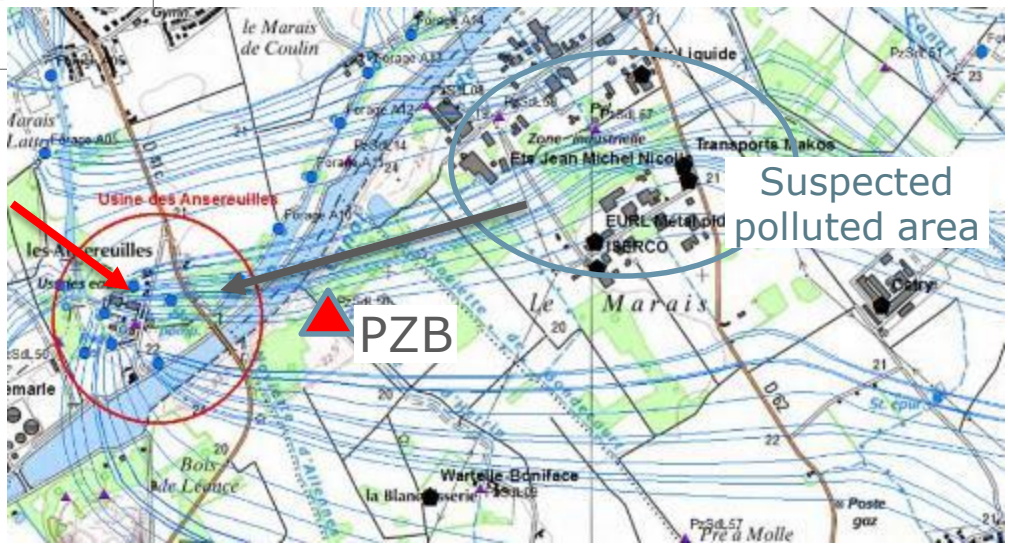
PZ B: temporal evolution



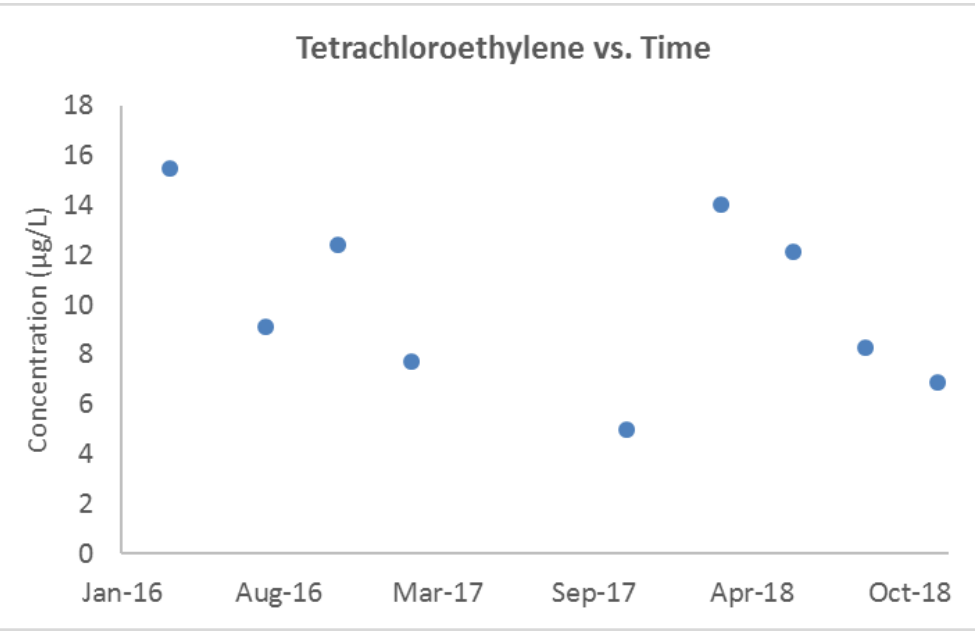
- Increase of chlorinated solvent levels since 2016
- Except for trichloroethylene
- Existing correlation between the concentrations of the different substances except trichloroethylene

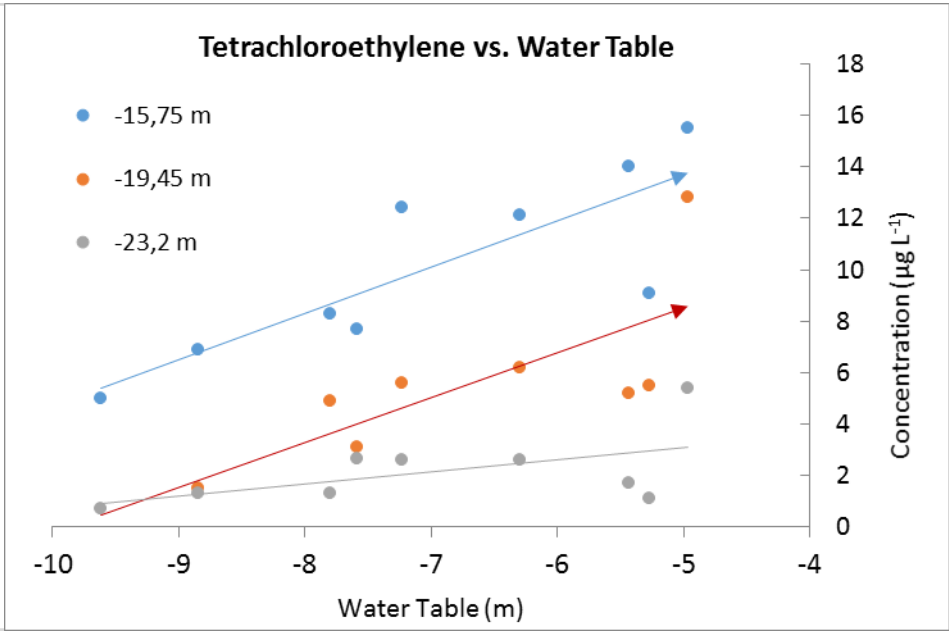
- Increase of the water demand in this area
- Higher transfer form a suspected polluted area

Water treatment plant



PZ C: evolution with water table

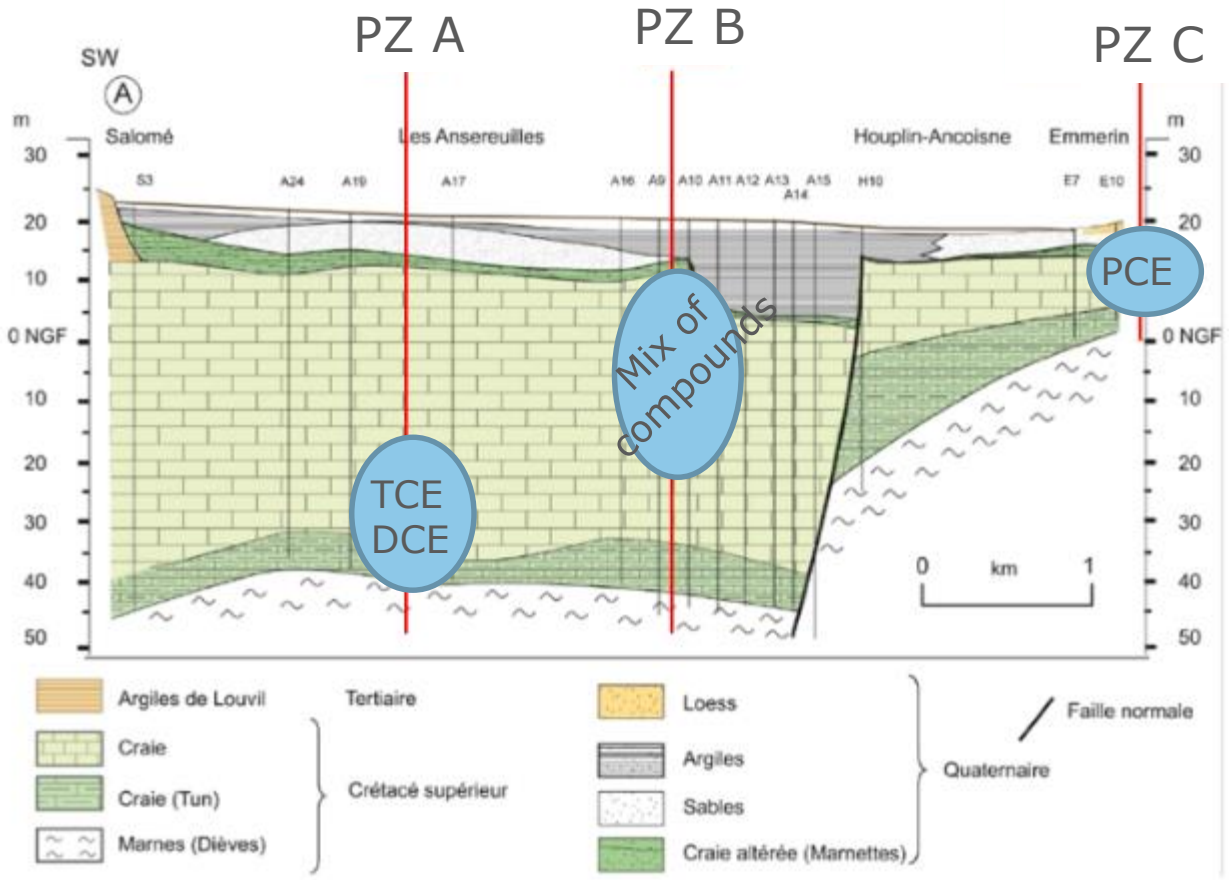




- No particular evolution of concentrations in function of time
- No clear seasonnal effect

- The concentrations of chlorinated solvent increase with the increase of water table
- Remobilization of chlorinated solvents during aquifer recharge

Conclusion



- Passive sampler: usefull tool to better characterize the aquifer
- Highly heterogeneous pollution / multiple sources
- Further work needed to predict the evolution of the aquifer

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Thank you

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