Fast on-site monitoring of gasoline-related compounds at contaminated sites using differential mobility spectrometry

Feng Liang

IWW Water Center

Overview

- Introduction & Research Motivation
- Basic Research

  Selection of target compounds in gasoline detected by DMS

  Comparison of ionization sources
- Results
  1. quantification monitoring
  2. simulation monitoring
- Conclusion & Outlook

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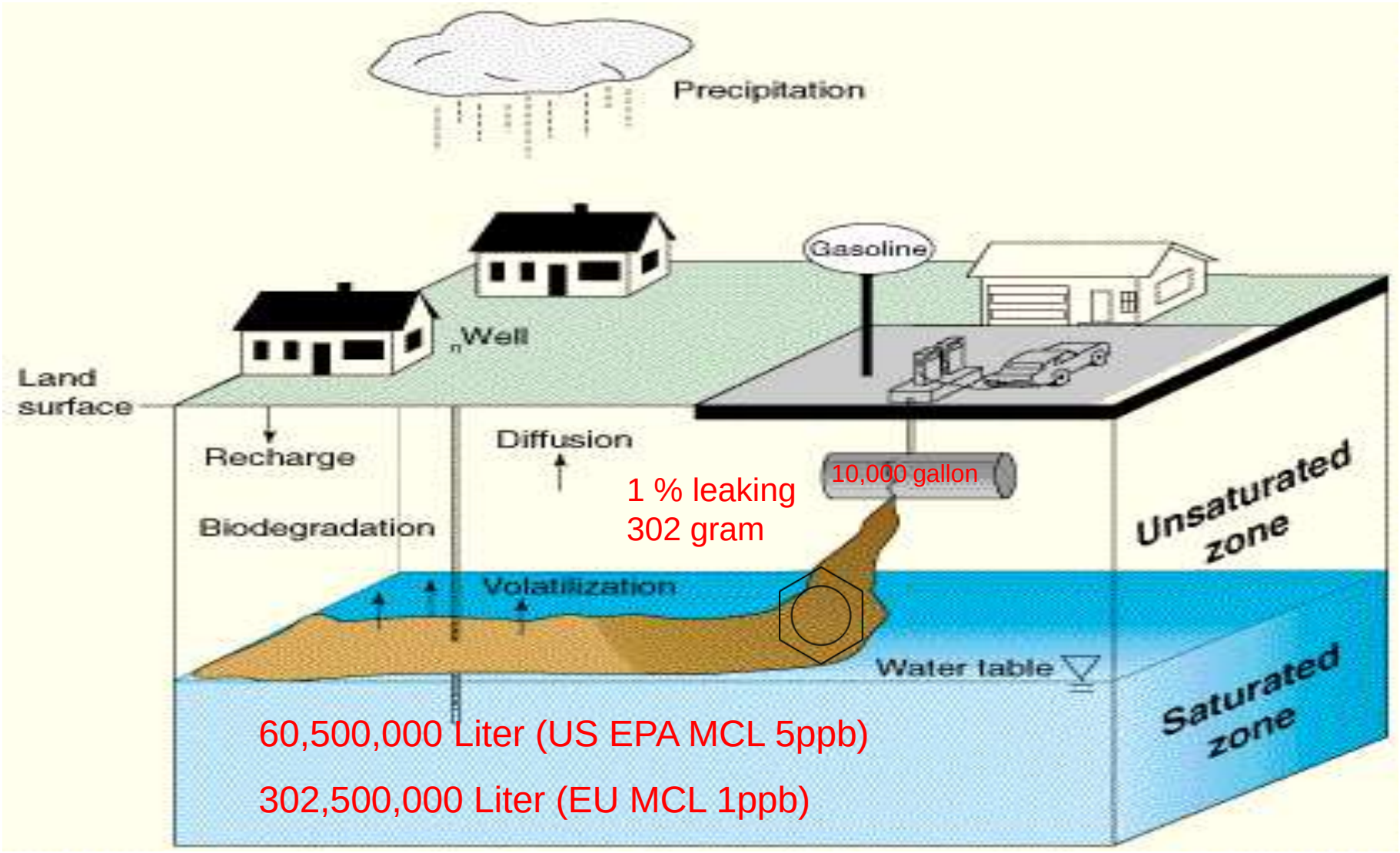
Gasoline Contaminates Groundwater



Conventional Monitor Groundwater Contamination

on site sampling

sample transport

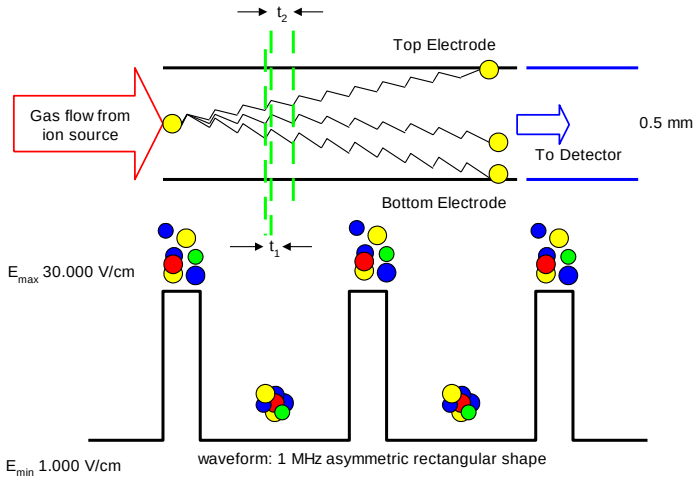
sample preparation

Time: 1 to 2 weeks
Cost: 110 $ per Sample

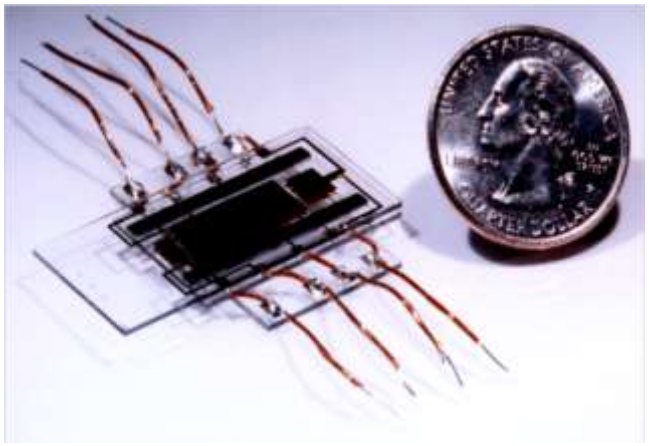
PLOF
(**P**ortable,**L**ow cost, **O**n-site/line, **F**ast)

GCMS measurement

Differential Mobility Spectrometry (DMS)



Principle of DMS 1970s

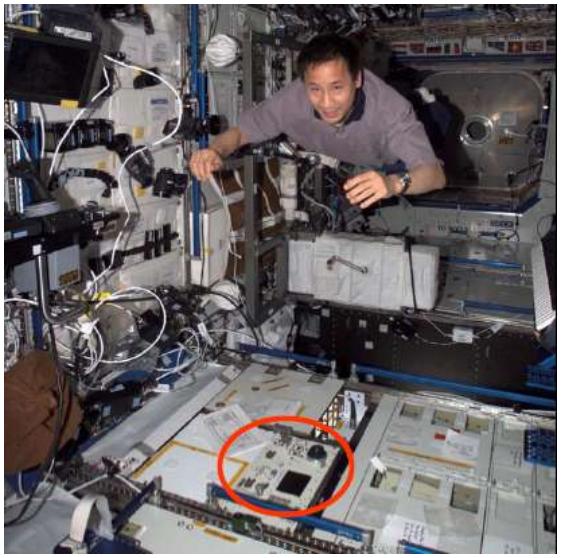


DMS Chip 2000

Microanalyzer 2008

Water monitoring ???

Introduction of IMS



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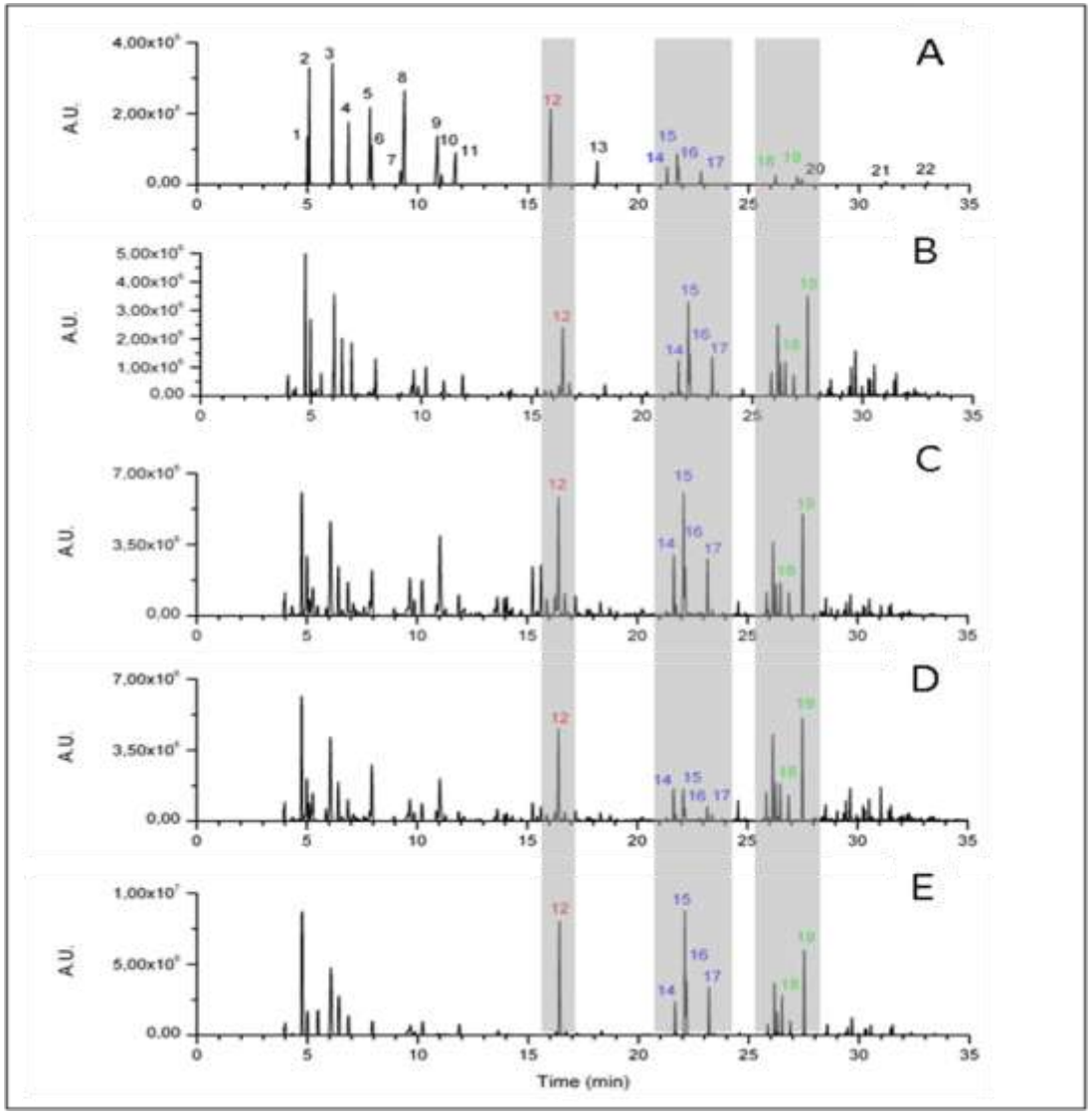
Gasoline compounds Analysis

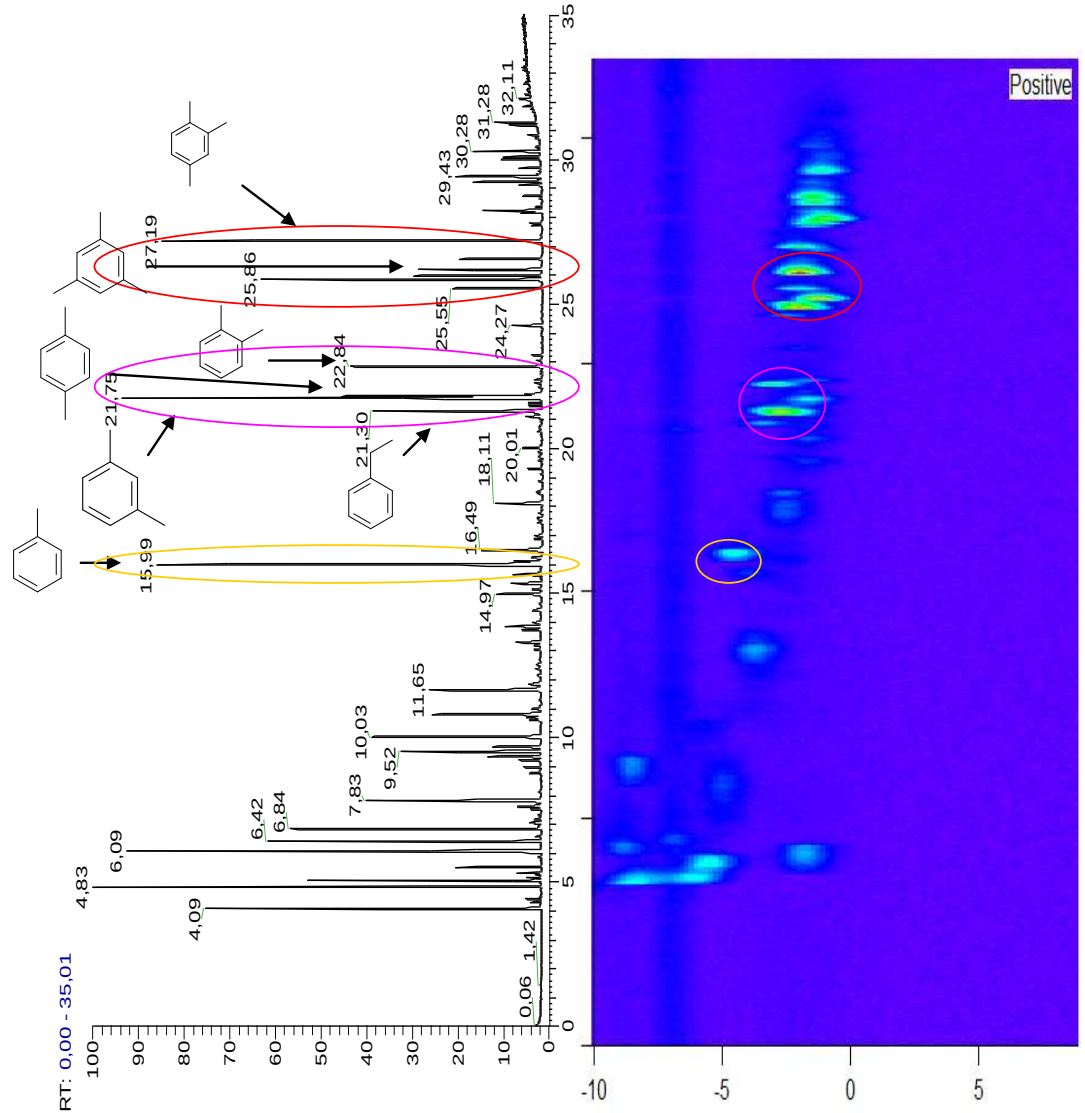


a 5% diphenyl-/95% dimethyl-polysiloxane GC column (60 meter, 0.25 mm i.d., 0.25 µm film thicknesses

The GC oven temperature: 35 ° C(11 min)--- ramp 5 °C/min 120°C --- ramped 10 °C /min to 160 °C---160 °C 3 min.

GC-MS chromatograms of groundwater spiked with: (**a)** NIST gasoline (SRM 2294), (**b)** Aral gasoline, (**c)** Shell gasoline, (**d)** Star gasoline and (**e)** Gasoline without additives

Spectra (GCMS and DMS) of groundwater spiked with gasoline



Groundwater spiked with gasoline (Super, Aral) by GC DMS(left) and MS(right). The DMS parameters were: sensor temperature of 60°C, flow rate of 300 ml/min, RF-voltage of 1000 V (20 kV/cm)

Benzene,
Toluene,
Ethylbenzene,
m/p/o-Xylene,
1,2,4,-Trimethylbenzene

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Ionization source of DMS

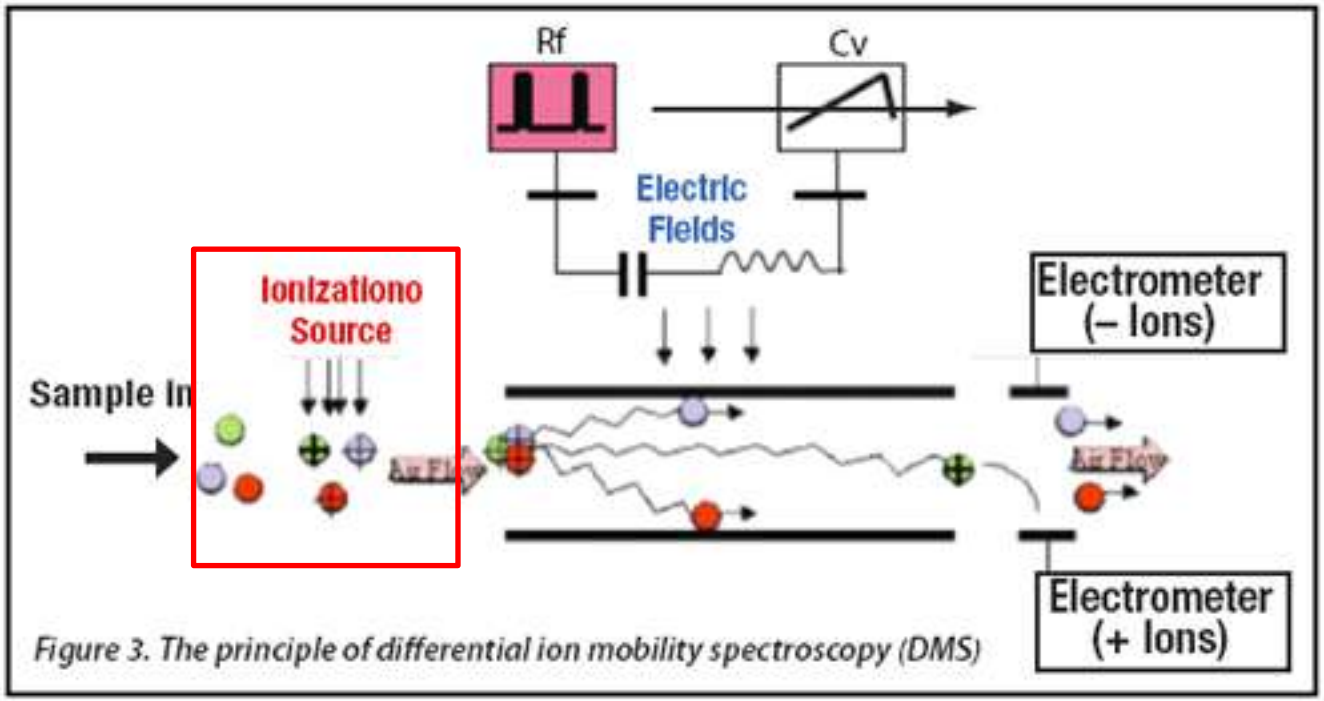

Figure 3. The principle of differential ion mobility spectroscopy (DMS)

Ni^{63}

UV lamp

performance of miniature GC DMS with different ionisation sources(UV and Ni63)

Compounds	RT(s)	CV(V)		LOD		Water Quality Guideline WHO(ug/mL)
		UV	Ni63	UV (ug/mL)	Ni63 (ug/mL)	
Benzene	23,3	-6,5	-6.2	0,079	2018,0	0,010
Toluene	38,3	-3,9	-3.6	0,065	50,3	0,700
Ethylbenzene	47,7	-2,7	-2.7	0,037	9,5	0,300
m-Xylene	49,8	-2,2	-2.0	0,038	6,2	
p-Xylene	48,5	-2,5	-2.5	0,067	8,5	0,500
o-Xylene	55,6	-2,6	-2.3	0,056	4,8	
1,2,4-Trimethylbenzol	103,1	-1,3	-1.2	0,056	1,3	-

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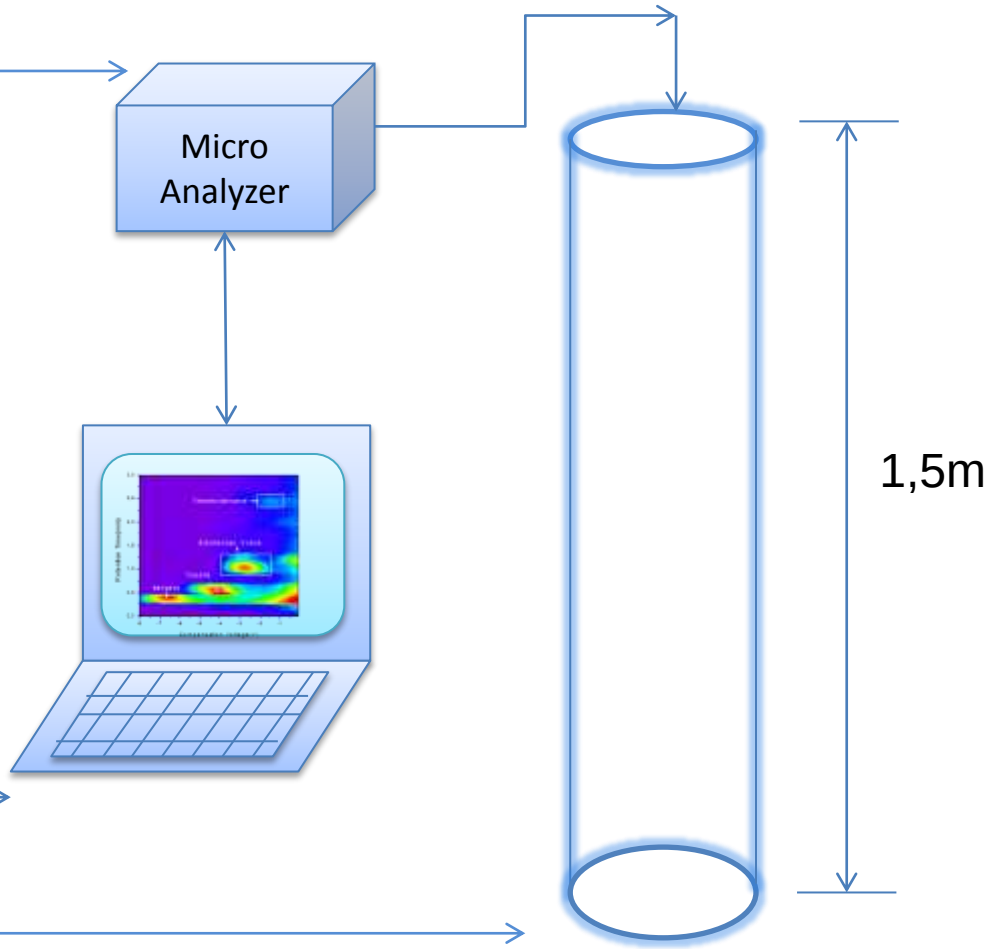
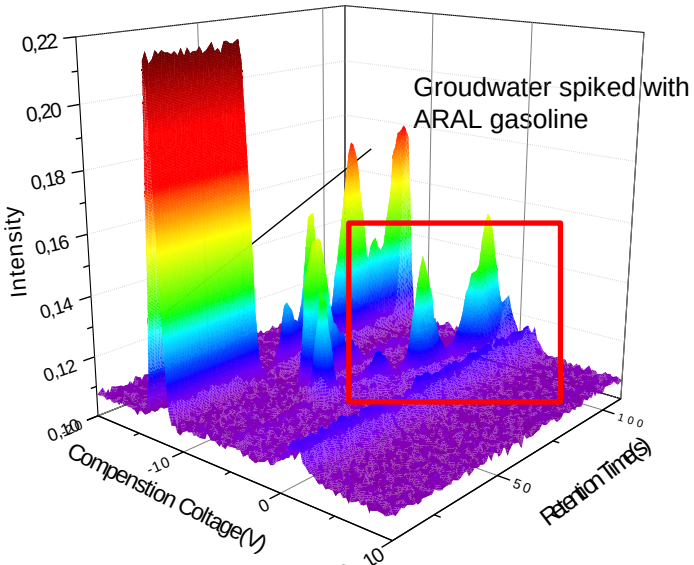
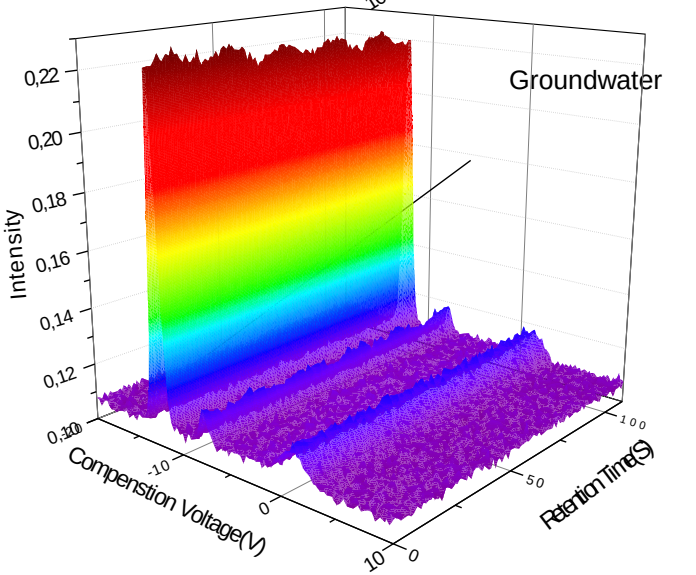
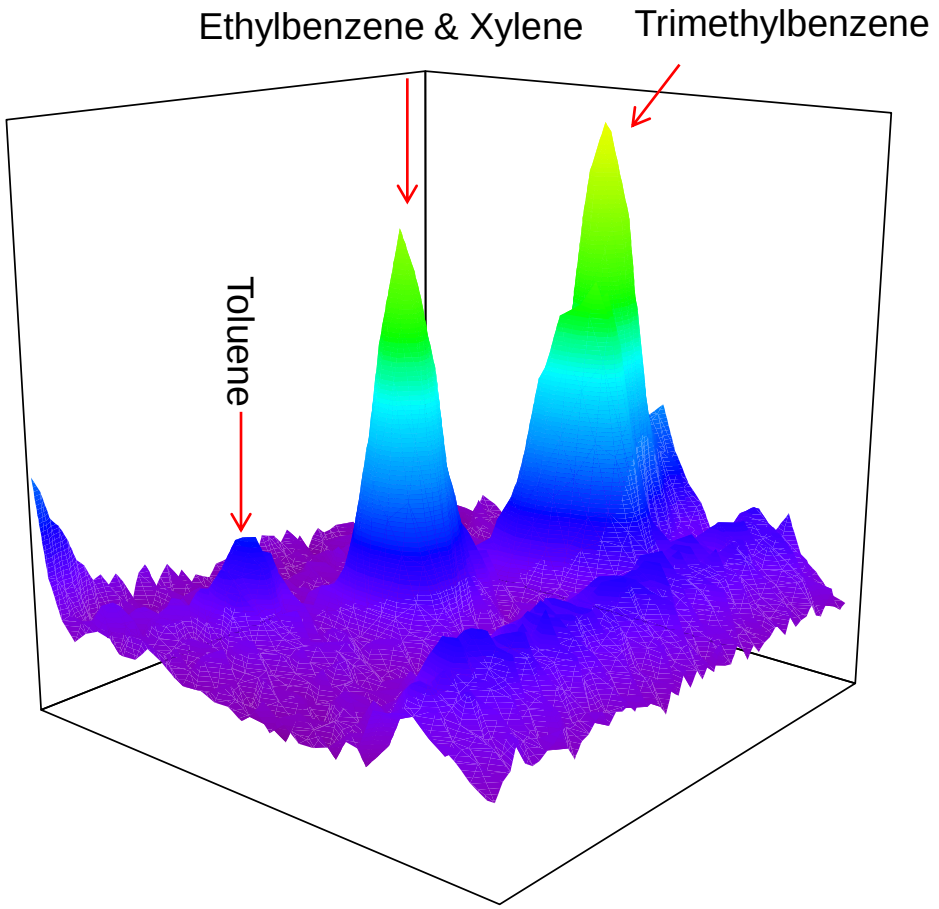
Monitor groundwater simulation setup



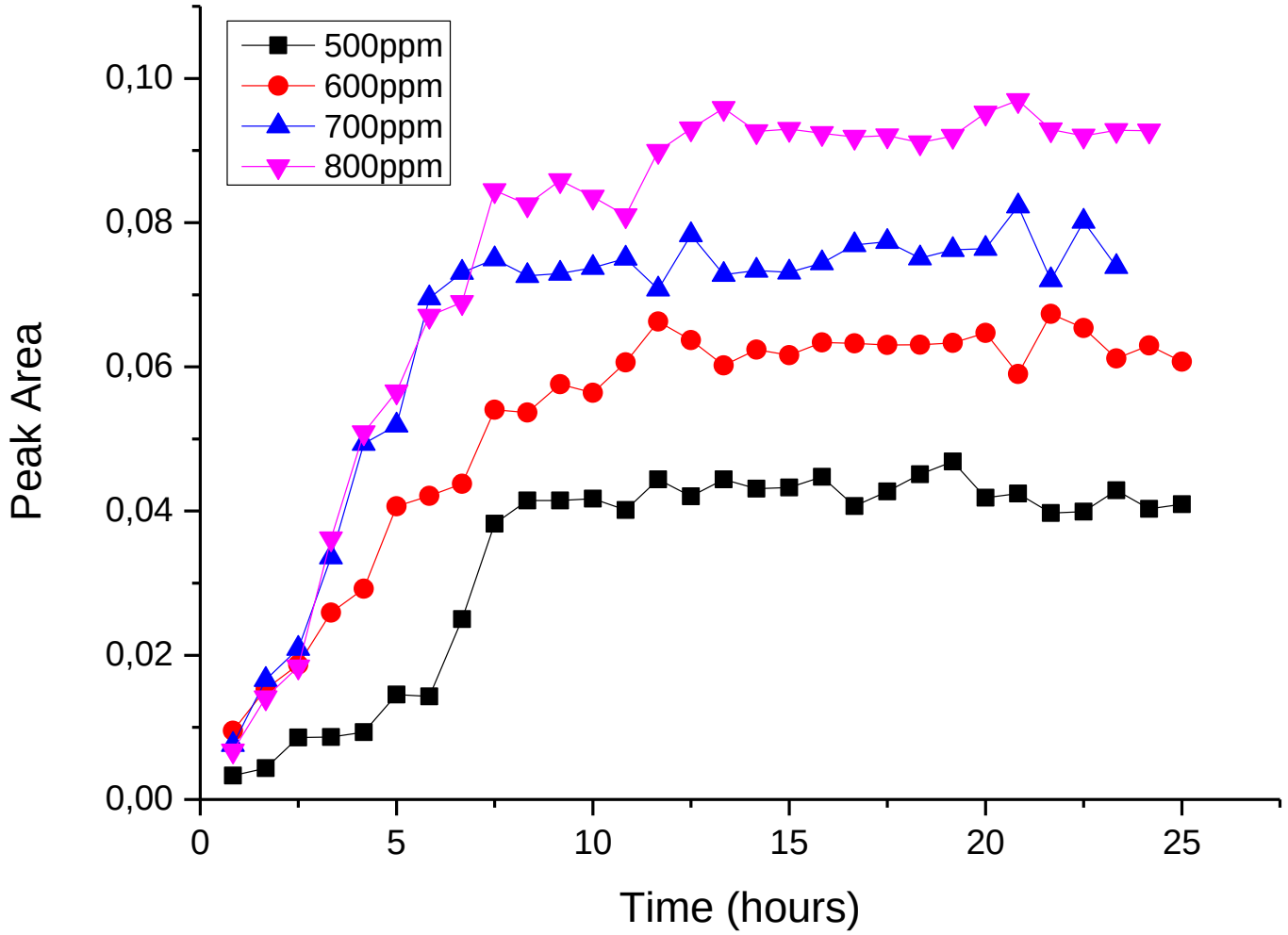
3D comparison between contaminated and clean groundwater







Diffusion Experiment of BTEXT in Groundwater within 24 Hours



Conclusion

- A miniaturized GC-DMS system was used for online monitoring gasoline contaminated groundwater.

- First simulation experiments were carried out.

Outlook

- Simulation experiments with soil and sand as matrix are still running

- Real samples from different contaminated sites will be analyzed by optimized method.

Thank you for your attention