Diffusive Monitoring – A cost effective and quantitative approach to environmental monitoring

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Sorbent tubes: Sampling techniques

- Active sampling
- Passive sampling

Which method to use?

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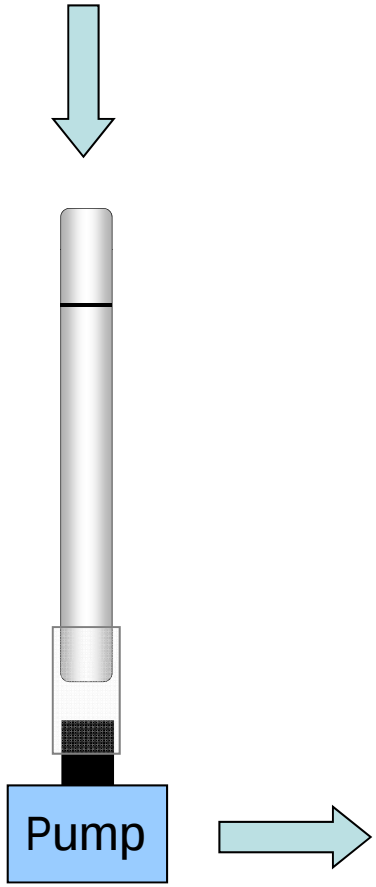
Active (pumped) sampling

- Pump air through sorbent tube
- Flow rate = 20–100 mL/min
- Volume = 500 mL to 100 L
- Much faster than diffusive sampling
- Important – do not exceed breakthrough volume for a compound on a given sorbent



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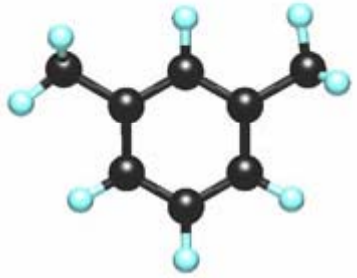
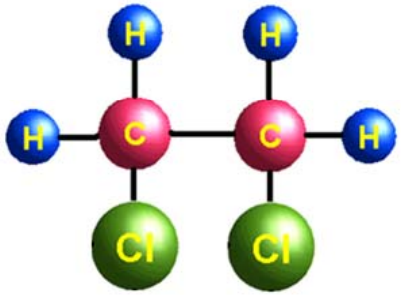
Sorbent Selection

Sorbent selection for both tubes and focusing trap are very important

Semi-volatile compounds – Weak sorbent
Helps prevent retention of unwanted compounds



Very volatile compounds – Strong sorbent
Prevents breakthrough of light compounds



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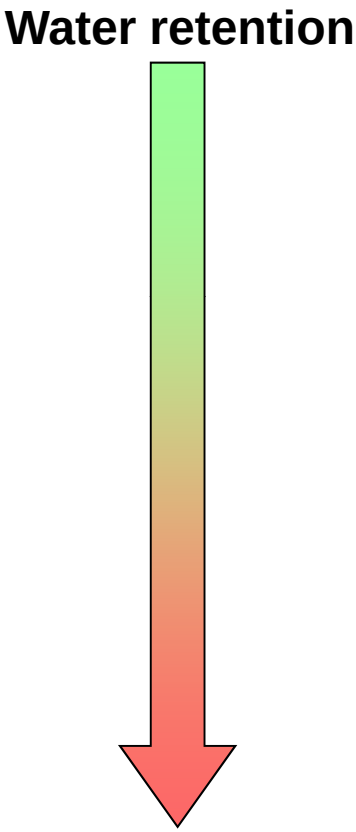
Common sorbents

Sorbent name	Volatility range
Quartz wool / silica beads	$C_{30} – C_{40}$
Tenax TA	$C_7 – C_{30}$
Carbograph 2TD	$C_8 – C_{20}$
Carbograph 1TD	$C_{5/6} – C_{14}$
Carbograph 5TD	$C_{3/4} – C_{6/7}$
SulfiCarb	$C_3 – C_8$
Carboxen 1003	$C_2 – C_5$
Carbosieve SIII	$C_2 – C_5$



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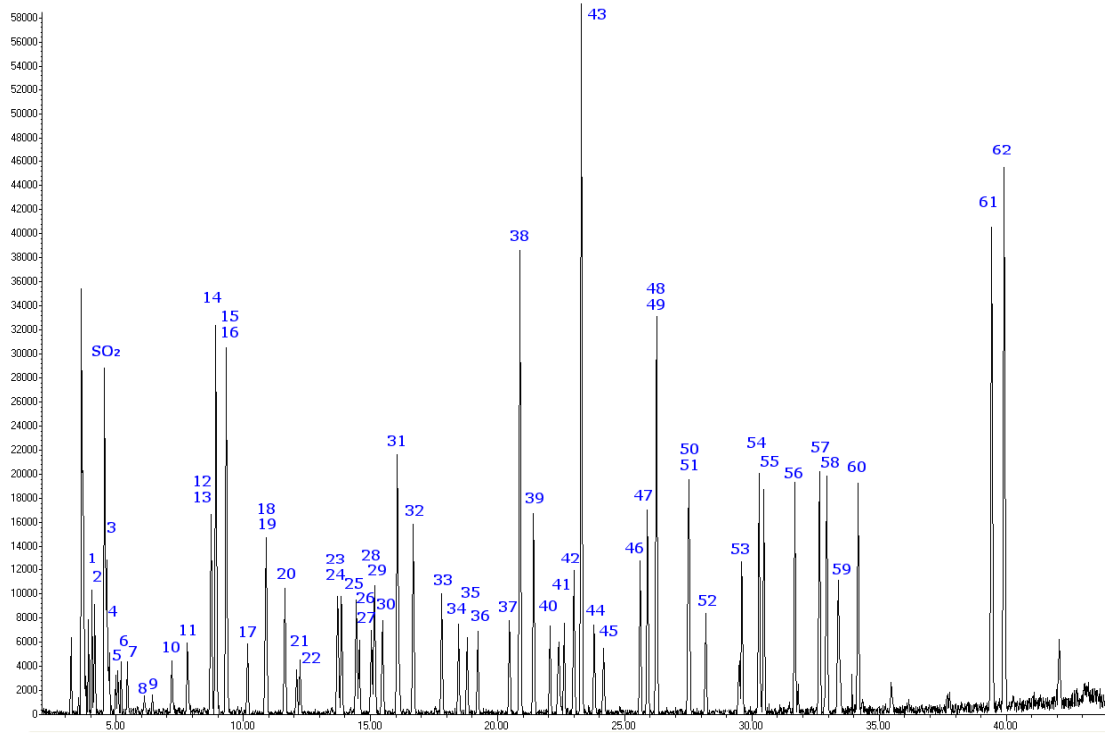
A complex example (US EPA TO-17)

1 Propylene
2 Dichlorodifluoromethane
3 1,2-Dichlorotetrafluoroethane
4 Methyl chloride
5 1,2-Dichloroethane
6 1,3–Butadiene
7 Vinyl chloride
8 Methyl bromide (bromomethane)
9 Chloroethane
10 Trichlorotrifluoroethane (Freon® 113)
11 Ethanol
12 1,2,-Dichloroethylene
13 1,1,2-Trichlorotrifluoroethane
14 Acetone
15 Carbon disulfide
16 Isopropyl alcohol
17 Methylene chloride
18 Tert-butyl methyl ether
19 *n*-Hexane
20 1,1-Dichloroethane
21 Vinyl acetate
22 Cis-1,2-Dichloroethylene
23 Methyl ethyl ketone
24 Ethyl acetate
25 Tetrahydrofuran
26 Chloroform
27 1,1,1-Trichloroethane
28 Cyclohexane
29 Carbon tetrachloride
30 Benzene
31 *n*-Heptane
32 Trichloroethylene
33 1,2-Dichloropropane
34 1,4-Dioxane
35 Bromodichloromethane
36 Trans-1,3-dichloropropene
37 Methyl isobutyl ketone
38 Toluene
39 Cis-1,3-Dichloropropene
40 Trans-1,2-Dichloroethylene
41 1,1,2-Trichloroethane
42 Tetrachloroethylene
43 Methyl *n*-butyl ketone
44 Dibromochloromethane
45 1,2–Dibromoethane
46 Chlorobenzene
47 Xylene
48 Xylene
49 Xylene
50 Styrene
51 Tribromomethane
52 1,1,2,2-Tetrachloroethane
53 1,2,4-Trimethylbenzene
54 1,3,5-Trimethylbenzene
55 1-Ethyl-4-methyl benzene
56 Ethylbenzene
57 1,2-Dichlorobenzene
58 1,3-Dichlorobenzene
59 Chloromethylbenzene (alpha)
60 1,4–Dichlorobenzene
61 1,2,4–Trichlorobenzene
62 Hexachloro-1,3-butadiene

Splitless desorption of ‘Air toxics’ tube loaded with 1 L of 1 ppb std GC/MS

Source: Application Note TDTS 86



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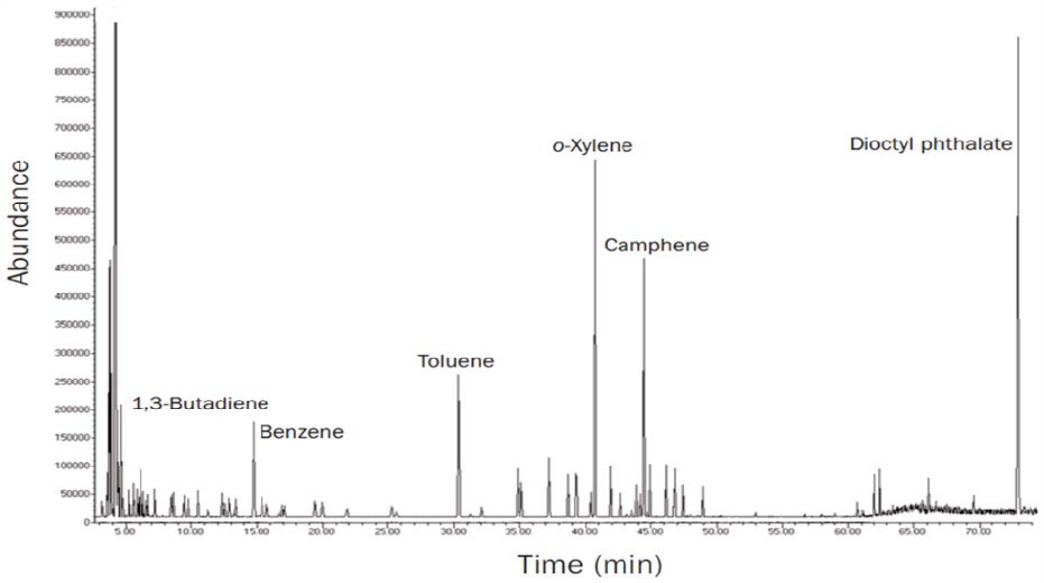
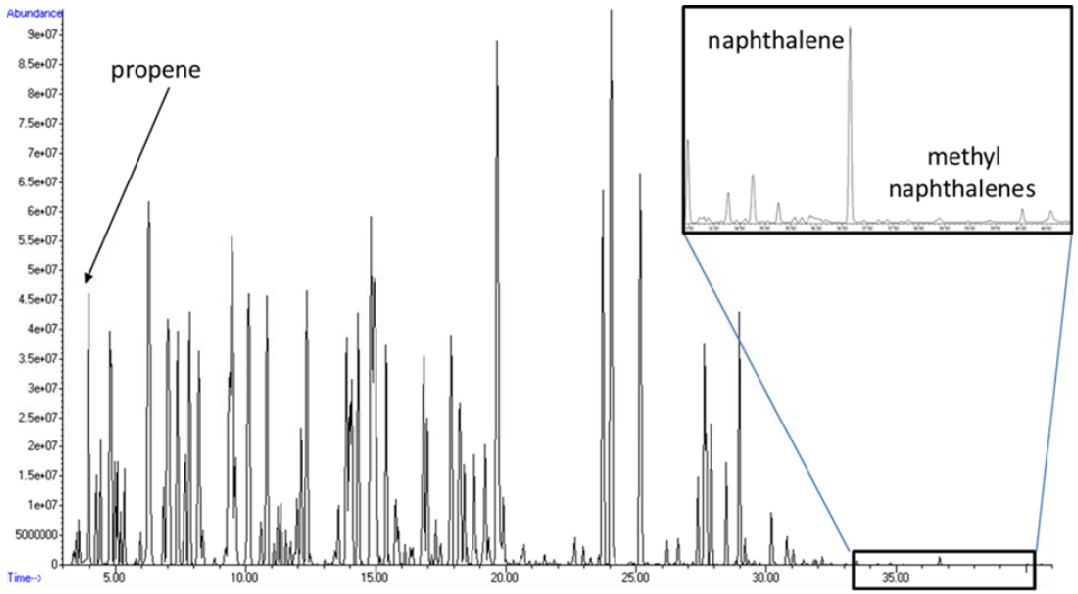
EPA TO-17 and beyond…





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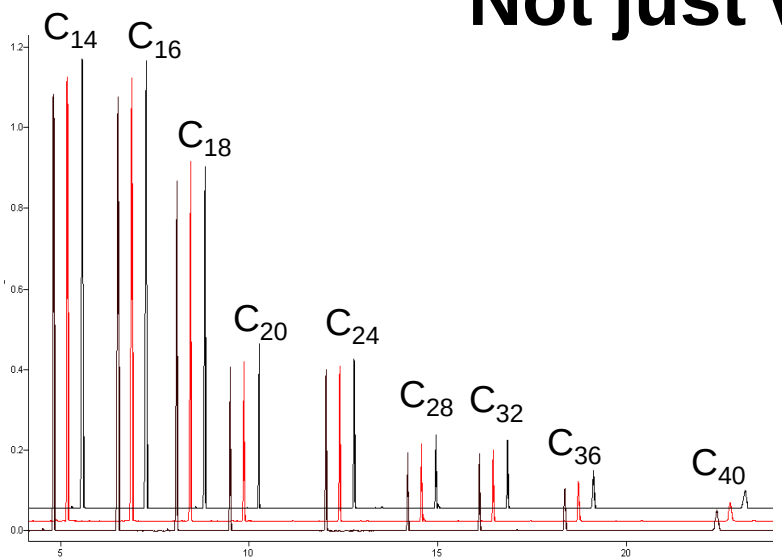
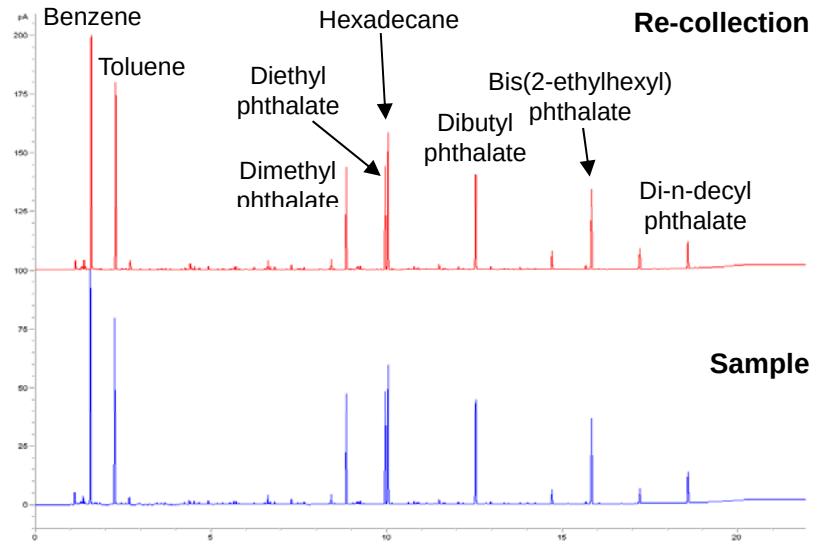
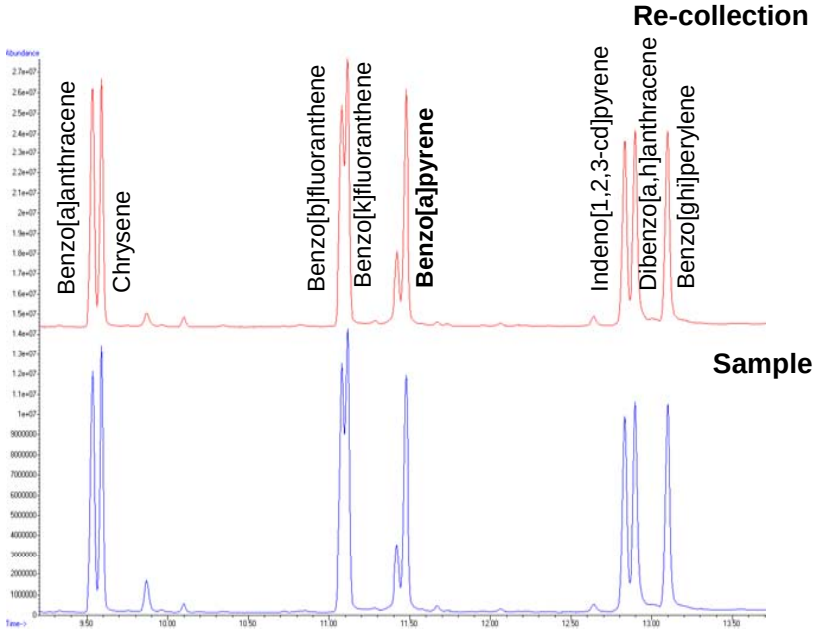
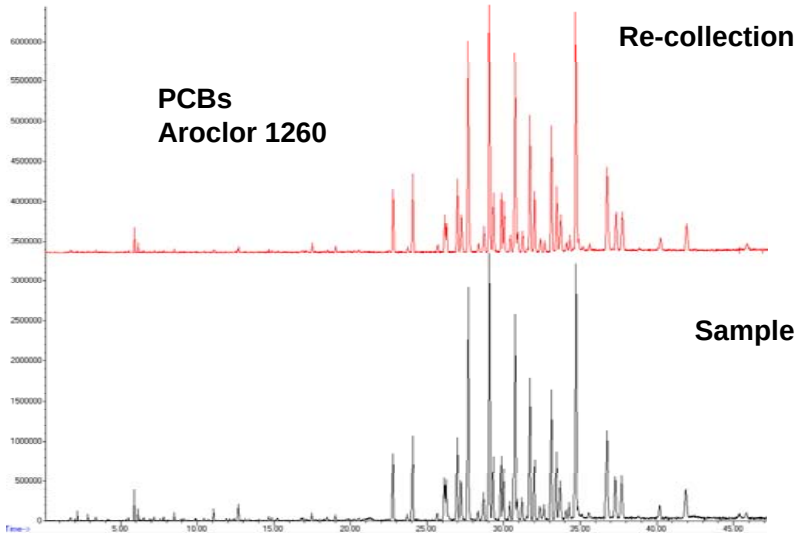
Not just volatiles...









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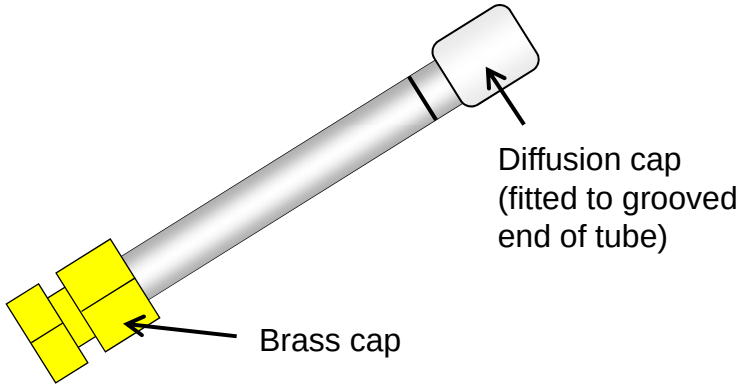
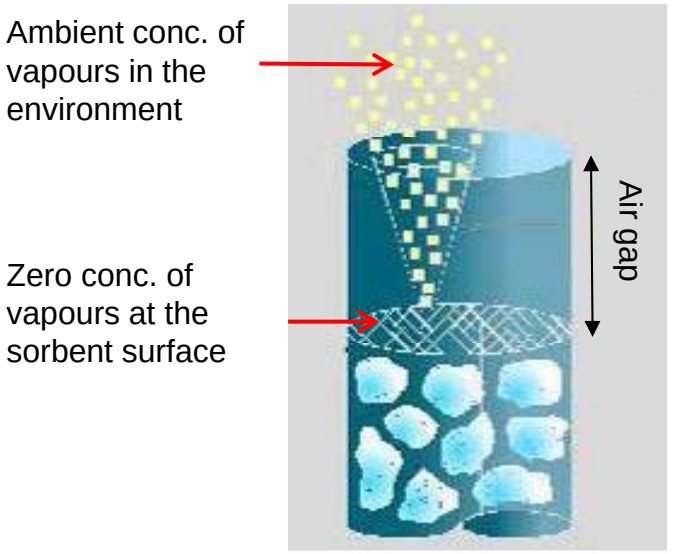
Passive (diffusive) sampling

- Diffusive sampling = a simple and cost-effective method of collecting the large number of samples required in many air monitoring programmes
- Vapours migrate across the air gap at a constant ‘uptake rate’
- Diffusive sampling is a slow process – typically sample for days





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When should I use diffusive sampling?

- ✓ You know the compound that you are looking for
- ✓ There is a validated uptake rate available for that compound
- ✓ The test atmosphere is not heavily contaminated with a wide range of other organic compounds at much higher concentrations
- ✓ The expected concentration of analyte in the atmosphere is such that the desired sampling time (usually between 4–8 hours (occupational) and 1–4 weeks (environmental)) will result in a mass on the tube which is above the limit of detection of the TD–GC(MS) method
- ✓ You are looking for several compounds of the same volatility

- x You are using a multi-bed sorbent tube
- x You are sampling a completely unknown atmosphere
- x You want to sample two (or more) compounds of widely differing volatilities (*e.g.* acetone and toluene)
- x There are no uptake rates available for the compounds of interest

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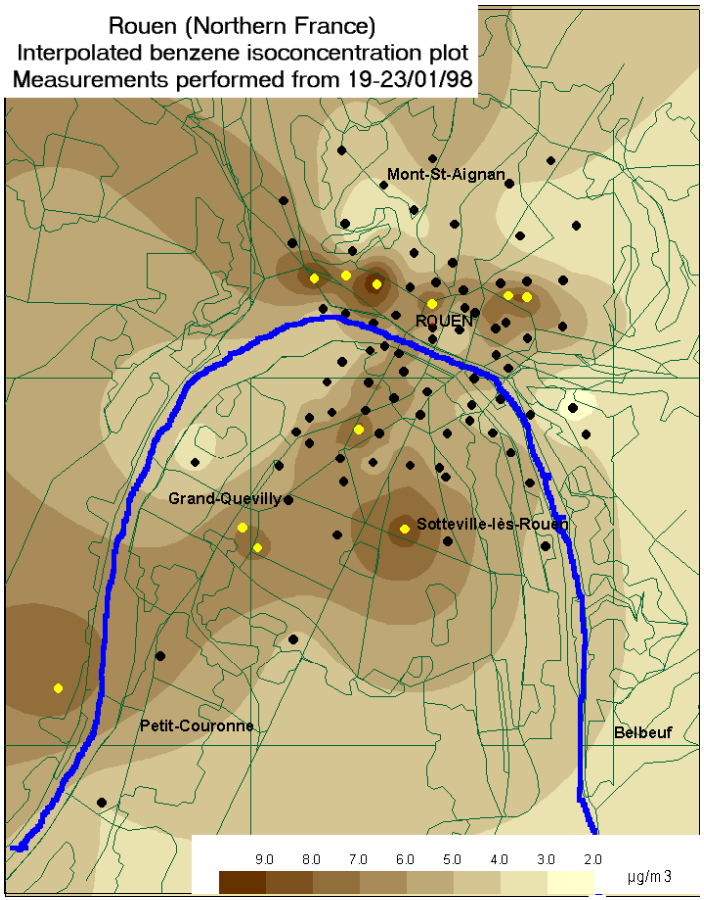
Using sorbent tubes for diffusive sampling of outdoor air

Mapping urban pollution concentrations with low-cost diffusive (passive) sampling[1]

- Black dots = 100 sampling sites
- Yellow dots = pollution hotspots



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[1] Application Note TDTS 10 – Use of diffusive sampling with TD–GC for ambient air monitoring

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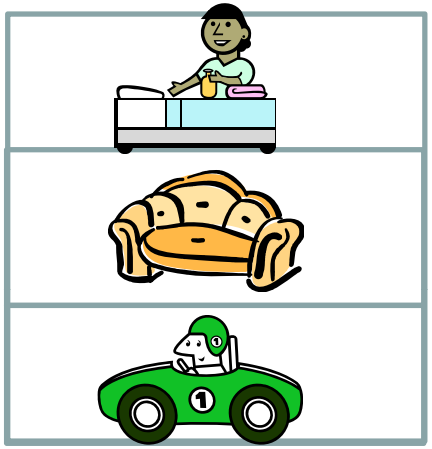
Indoor Air and Personal Exposure

- TD-GC/MS is used for several applications relating to poor IAQ and ‘sick building syndrome’.
- In this case residents were complaining of poor air quality in their home.

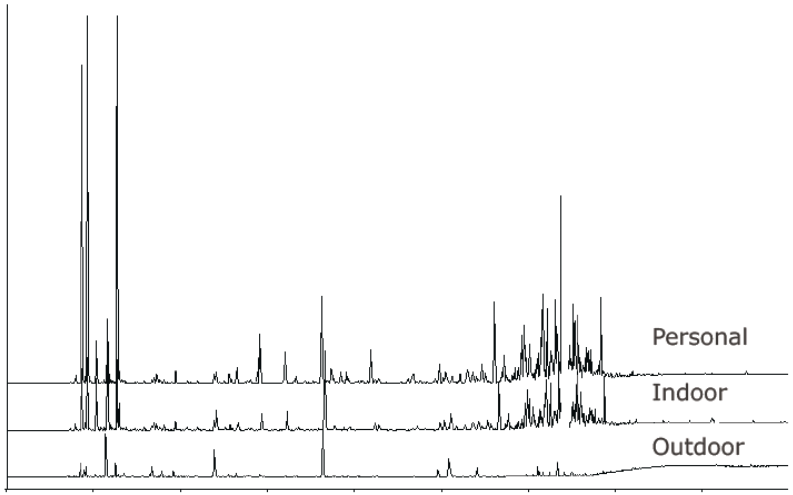
– Diffusive sampling with ‘axial’ sorbent tubes was used to monitor indoor & outdoor air quality at the house and to monitor the personal exposure of residents.



3rd floor Living Quarters

2nd floor

1st floor Garage



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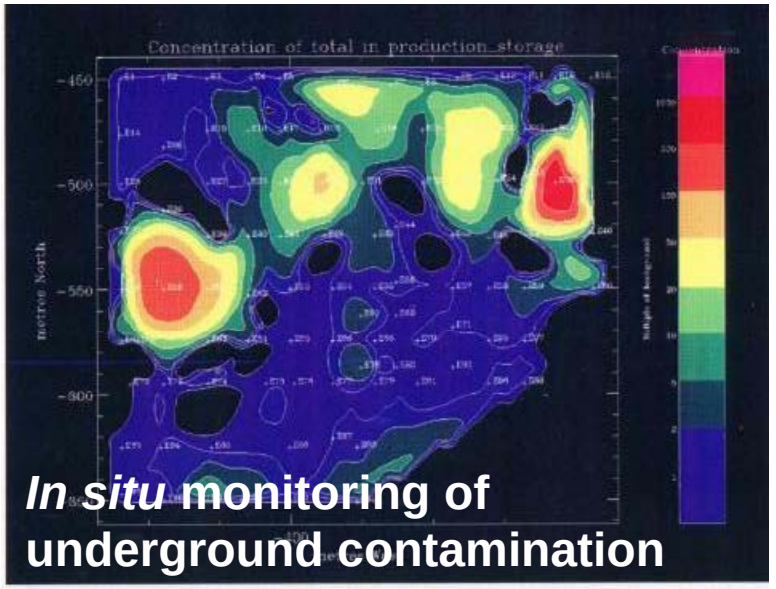
Typical applications: Passive sampling for air monitoring in industry



Monitoring guidelines (sorbents, uptake rates, sampling volumes, etc.) available from standard methods (and from Markes)

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