

Air Monitoring :

Environnement

PROBLEM : They are more than 300 Identified compounds in the air that have an impact on human health : e.g. Benzene and 1,3 butadiene are carcinogenic compounds.

VOC Monitoring Market:

- Atmospheric air pollution networks
- Electronic industry : control of atmosphere of manufacturing clear room
- Pure gas suppliers: control of purity
- Industrial Hygiene

Concerning the ozone precursors (VOC and Nox,) the European directive 2002/3/CE advises a measurement on 31 volatile organic compounds.

U.S. Environmental Protection Agency proposes to monitor 56 VOC and 3 compounds (formaldehyde, acetaldehyde, acetone) in his PAMS programme (Photochemical Assessment Monitoring Stations) or 58 VOC for Japan (α pinene and β pinene) .

SOLUTION : AIRMOZONE

Technical choice :

- 2 instruments (19" rack format)
- AirmoVOC C2 – C6 (cycle time : 30 or 60 min.)
- AirmoVOC C6 – C12 (cycle time: 30 or 60 min.)
- H2 Generator, Zero air generator
- Calibration unit: bottle or permeation
- PC+ WindowsTM based software

RESULTS : An improved monitoring with a daily result validation, analysis follow up.

AirmoPure & AirmoPump



← Multiplexer & Calibration

← Supervisor

← AirmoVOC C₆-C₁₂

← AirmoVOC C₂-C₆

COV C6-C10 : comparison

N°	Takachiho cylinder (58 VOC)	Matheson cylinder (56 VOC)	PM	BP (°C)	Rt
1	Ethane	Ethane	30,07	-88	
2	Ethene	Ethene	28,05	-104	
3	Acetylene	Acetylene	26,04	-84	
4	Propane	Propane	44,1	-42,1	
5	Propene	Propene	42,08	-47,7	
6	Isobutane	Isobutane	58,12	-12	
7	n-butane	n-butane	58,12	-0,5	
8	t-2-butene	t-2-butene	56,11	1	
9	1-butene	1-butene	56,11	-6,3	
10	c-2-butene	c-2-butene	56,11	3,7	
11	isopentane	isopentane	72,15	30	
12	1-pentene	1-pentene	70,14	29,9-30,1	
13	n-pentane	n-pentane	72,15	35-36	
	1,3-butadiene		54,09	-4,5	
		2-methyl-2-butene	70,14	35-38	
		Cyclopentene	68,12	44-46	
14	t-2-pentene	t-2-pentene	70,14	37	
		3-methyl-1-butene	70,14	20	
15	cyclopentane	cyclopentane	70,14	50	
16	c-2-pentene	c-2-pentene	70,14	37-38	
17	2-methyl-1,3-butadiene	2-methyl-1,3-butadiene (isoprene)	68,12	34	
18	2,2-dimethylbutane	2,2-dimethylbutane	84,16	50	
		4-methyl-1-pentene	86,18	53-54	
19	2,3-dimethylbutane	2,3-dimethylbutane	86,18	58	
20	2-methylpentane	2-methylpentane (isohexane)	86,18	62	
21	3-methylpentane	3-methylpentane	86,18	64	
22	2-methyl-1-pentene	2-methyl-1-pentene	84,16	62	
	1-hexene		84,16	64	
23	n-hexane	n-hexane	86,18	69	
		trans-2-hexene	84,16	68-69	
		cis-2-hexene	84,16	68-70	
24	methylcyclopentane	methylcyclopentane	84,16	72	
25	2,4-dimethylpentane	2,4-dimethylpentane	100,21	80	
26	benzene	benzene	78,11	80	
27	cyclohexane	cyclohexane	84,16	80,7	
28	2-methylhexane	2-methylhexane	100,21	90	
29	2,3-dimethylpentane	2,3-dimethylpentane	100,21	89-90	
30	3-methylhexane	3-methylhexane	100,21	91	
31	2,2,4-trimethylpentane	2,2,4-trimethylpentane (isooctane)	114,23	98-99	
32	n-heptane	n-heptane	100,21	98	
33	methylcyclohexane	methylcyclohexane	98,19	101	
34	2,3,4-trimethylpentane	2,3,4-trimethylpentane	114,23	113-114	
35	toluene	toluene	92,14	110,6	
36	2-methylheptane	2-methylheptane	114,23	116	
37	3-methylheptane	3-methylheptane	114,23	118	
38	n-octane	n-octane	114,23	125-127	
39	ethylbenzene	ethylbenzene	106,17	136	
40	m-xylene	m-xylene	106,17	138-139	
41	p-xylene	p-xylene	106,17	138	
42	styrene	styrene	104,15	145-146	
43	o-xylene	o-xylene	106,17	143-145	
44	n-nonane	n-nonane	128,26	151	
45	isopropylbenzene	isopropylbenzene (cumene)	120,20	152-154	
46	α pinene	α pinene	136,24	155-156	
47	n-propylbenzene	n-propylbenzene	120,20	159	
48	m-ethyltoluene (3-)		120,20	158-159	
49	p-ethyltoluene (4-)		120,20	162	
50	1,3,5-trimethylbenzene	1,3,5-trimethylbenzene (mesitylene)	120,20	162-164	
51	o-ethyltoluene (2-)		120,20	164-165	
52	β pinene	β pinene	136,24	164-165	
53	1,2,4-trimethylbenzene	1,2,4-trimethylbenzene	120,20	168	
54	decane		142,29	174	
55	1,2,3-trimethylbenzene		120,20	175-176	
56	m-diethylbenzene (1,3-)		134,22	183	
57	p-diethylbenzene (1,4-)		134,22	184	
58	undecane		156,31	196	

Note : In bold letter : PAMS European list

In blue : analysed compounds on airmoVOC C₂-C₆

Analytical Conditions :

Analytical column : MXT30CE ; 25 m

Carrier gas: Hydrogen (5.6) to 150 hPa pressure at the head of the column (35)

Air FID $\approx$ 180 ml/min with 3 bars

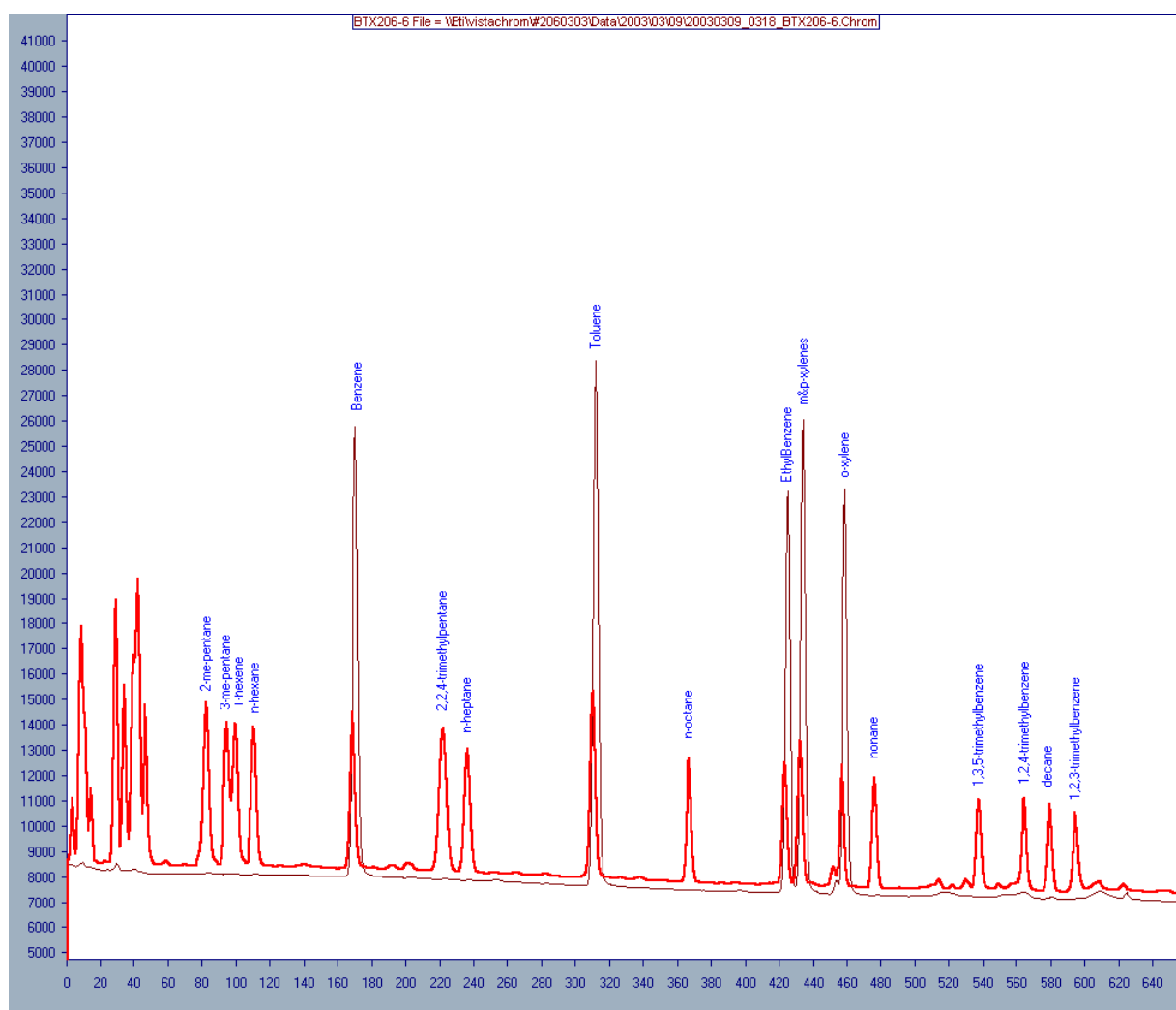
Hydrogen FID $\approx$ 22 ml/min with 2 bars

Temperature FID = 150°C

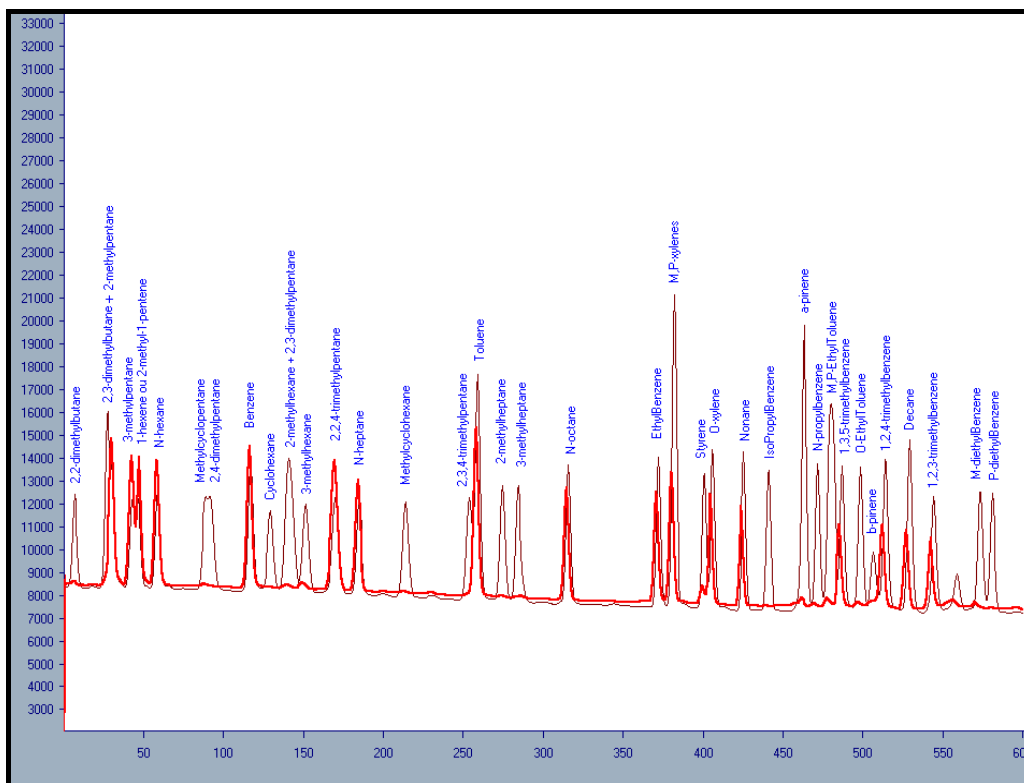
Trap = 1 phase

Critical orifice : 100 μ m

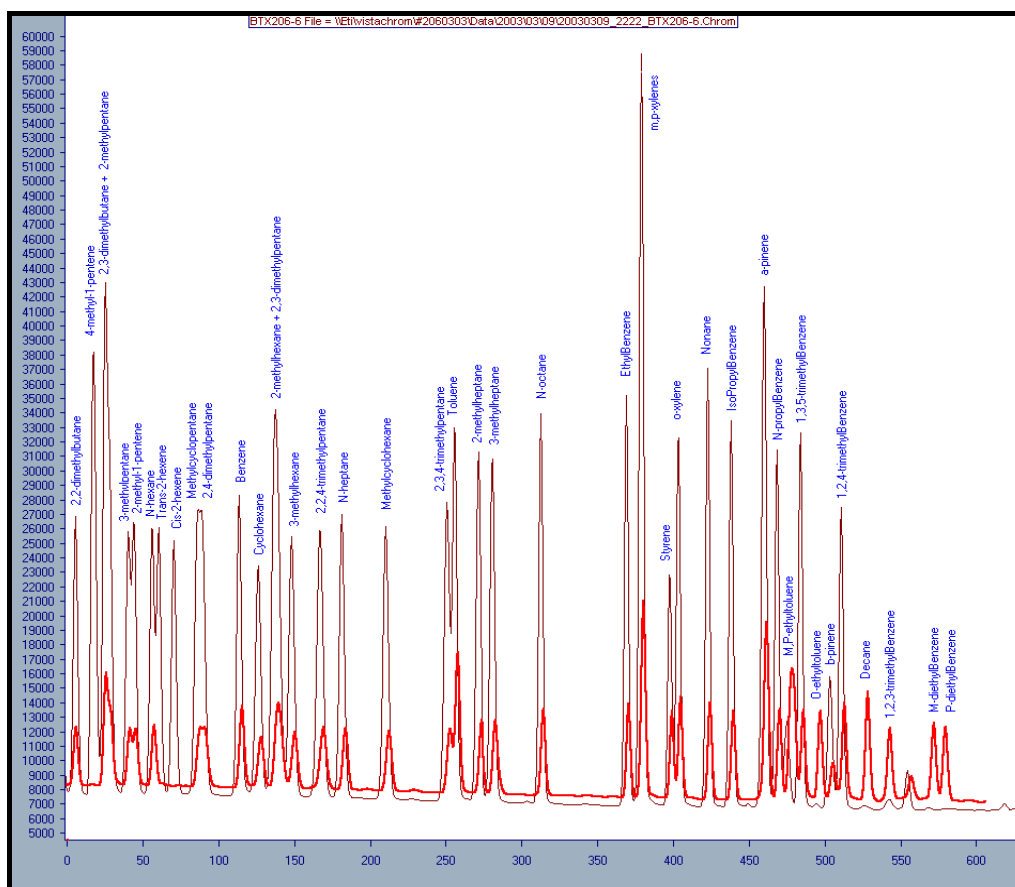
Comparison between BTEX and 34 VOC (Air Liquide=List 31 VOC + 2 + 3-MEpentane + decane)



Comparison between 34 VOC and 58 VOC



Comparison between 56 VOC and 58 VOC



The "airmOzone" analytical system

The airmoVOC : analyse of standard compounds (C6-C12)

Application 3.0

Analytical conditions :

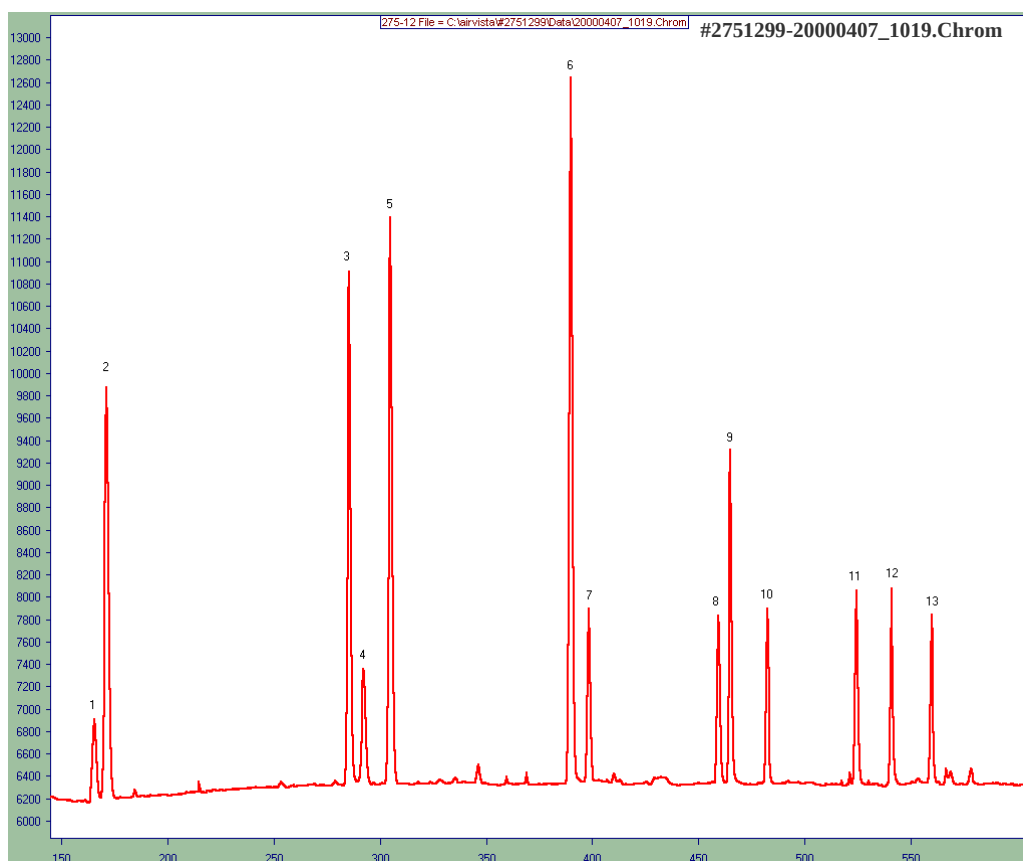
Sample : Volume : 500ml; Standard compound cylinder (cf. table) (double stage pressure regulation).

Carrier gas : H₂, head column pressure : 400 hPa.

Oven : Column DB-624, L : 20m, ID : 0.20mm, film : 1.12µm.; Temperature : 40°C (4 min) to 170°C (6 min) at 20°C/min.

Detection limit : 0,05 ppb

Typical chromatogram :



Peak number	Compound	Concentration (in ppb)	Retention time (in s)	Peak surface (in count)
1	1-hexene	1	166	1522
2	n-hexane	5	171	8169
3	benzene	5	286	8243
4	iso-octane	1	292	2250
5	heptane	5	305	9693
6	toluene	5	390	10070
7	octane	1	398	2292
8	ethyl-benzene	1	460	2305
9	m-&p-xylene	2	465	4598
10	o-xylene	1	483	2307
11	1,3,5-TMB	1	525	2539
12	1,2,4 TMB	1	541	2739
13	1,2,3 TMB	1	560	2325

The "airmOzone" analytical system

The Chromatrap : analyse of standard compounds (C2-C6) – Application 3.1

Analytical conditions :

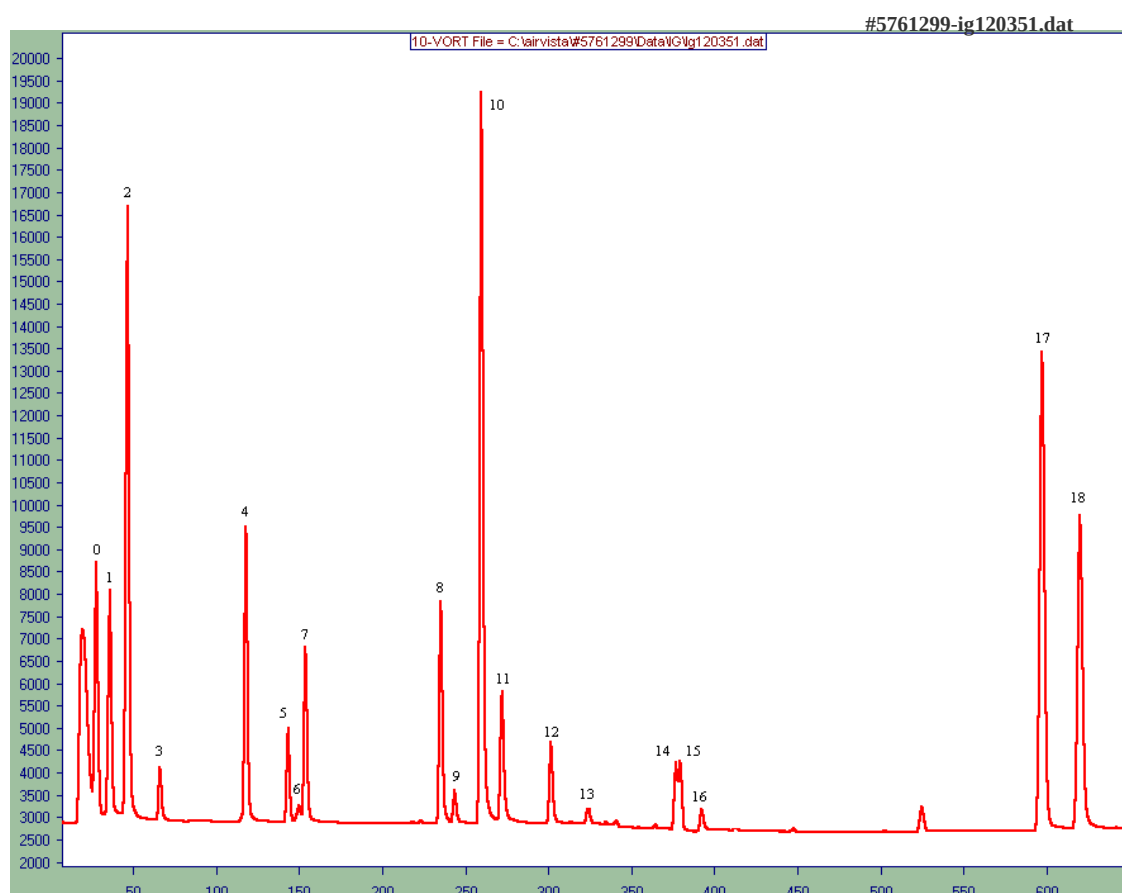
Sample : Volume : 200ml; Standard compound cylinder (double stage pressure regulation).

Carrier gas : H₂, head column pressure: 120 hPa.

Oven : Column Al₂O₃ / KCl, L : 25m, ID : 0.53mm, film : 10µm.; **Temperature** : 40°C (0 min) to 200°C (12 min) at 20°C/min.

Detection limit : 0,05 ppb

Typical chromatogram :



Peak number	Compound	Concentration (in ppm)	Retention times (in s)	Peak surface (in count)
0	CH ₄	200	67,9	-
1	C ₂ H ₆	5,3	75,9	11193
2	C ₂ H ₄	-	86,3	30031
3	C ₃ H ₈	1,8	106,4	2381
4	C ₃ H ₆	12,8	158,1	13857
5	i-C ₄	2,4	183,0	4108
6	C ₂ H ₂	26	190,3	823
7	n-C ₄	5,1	194,1	8152
8	iso-butene	6,4	275,0	11020
9	cis-2-butene	0,91	284,0	1426
10	i-C ₅	20,1	299,8	37698
11	n-C ₅	3,8	312,0	6962
12	1,3-butadiene	2,8	341,8	3997
13	trans-2-pentene	0,60	363,8	910
14	2 methylpentane	1,8	416,5	3118
15	3 methylpentane	1,7	419,1	3773
16	n-C ₆	0,8	432,6	1138
17	benzene	10,7	637,3	35295
18	MTBE	8,7	660,5	24399

The "airmOzone" analytical system
The airmoVOC C2C6 : ambient air VOC analysis; Saint-Antoine, France –
Application 3.1bis

Analytical conditions :

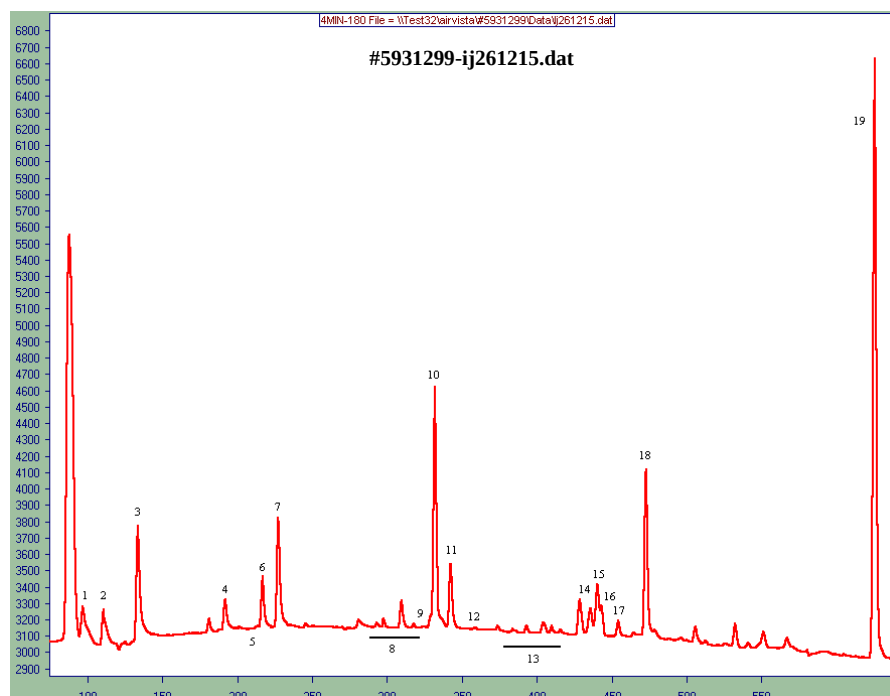
Sample : 200ml; ambient air; Saint-Antoine, near Bordeaux, France

Carrier gas : H₂, ≈5ml:min.

Oven : Column Al₂O₃ / KCl, L : 25m, ID : 0.53mm, film : 10µm.; **Temperature :** 40°C (0 min) to 200°C (10 min) at 20°C/min.

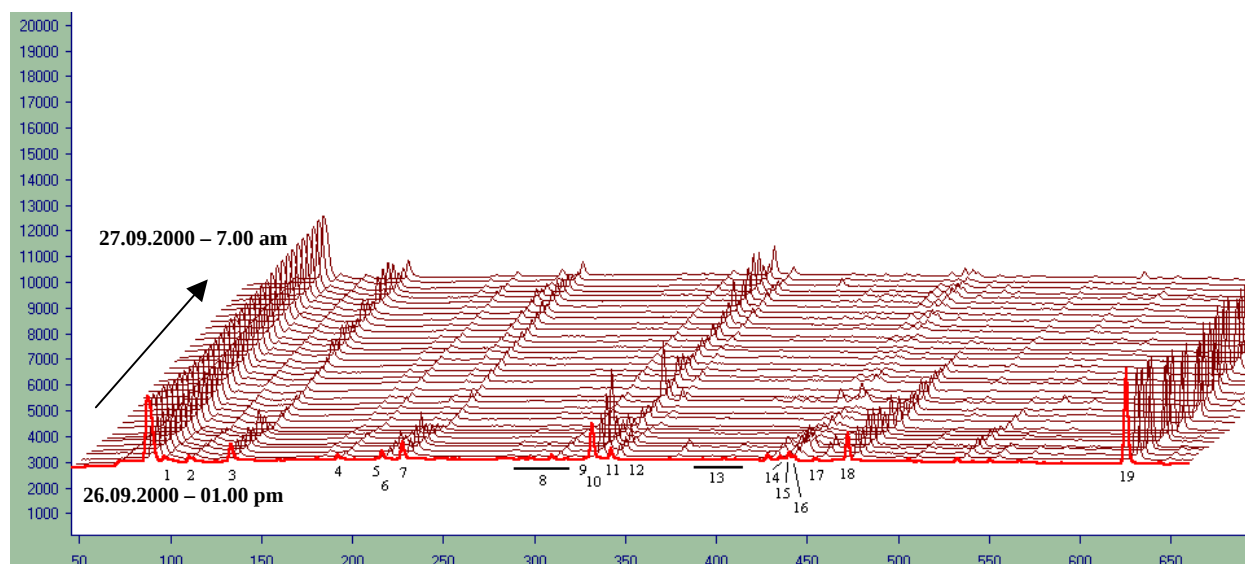
Detection limit : 0,05 ppb

Typical chromatogram :



Peak n°	Compound
1	Ethane
2	Ethene
3	Propane
4	Propene
5	Acetylene
6	Iso-butane
7	n-butane
8	Butenes
9	Cyclo pentane
10	Iso-pentane
11	n-pentane
12	1,3 butadiene
13	Pentenés
14	Cyclohexane
15	2 methyl pentane
16	3 methyl pentane
17	Hexane
18	Isoprene
19	Benzene

Ambient air VOC concentration evolution on a period of 18 hours (Vistachrom viewer) :



The "airmOzone" analytical system: PAMS List. EPA (year 2000)

