Cost-effective source tracing of hydrocarbon contamination

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11.03.2026, MUTKU, Joensuu

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Goal

- Discuss different purposes of investigations
- Give examples of the tools that exist
- Motivate to an increased curiosity
- Start a conversation about the suitability of the tools being used

Agenda

- Analytical results vs. criteria
- Tools
  - Most important point!
- Soil package +
  - Case 1: New spill from the same oil tank
  - Case 2: Spill or leakage?
  - Data quality
- Questions?

Analytical results vs. criteria

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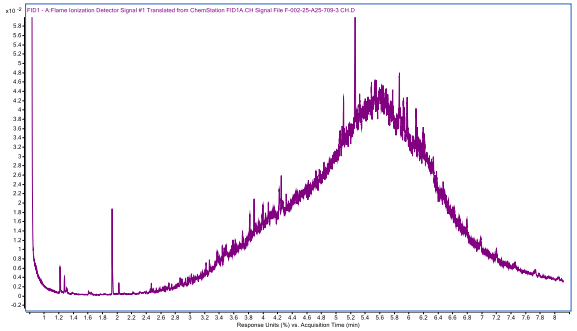
Analyserapport



[List of straight-chain alkanes - Wikipedia]

Antall C-atomer	Molekylformel	Antall isomerer
6	C_6H_{14}	5
10	$C_{10}H_{22}$	75
15	$C_{15}H_{32}$	4347
20	$C_{20}H_{42}$	366319
25	$C_{25}H_{52}$	36797588
30	$C_{30}H_{62}$	4111846763
35	$C_{35}H_{72}$	493782952902

9 data points

> 25 000 data points

Theoretical?!

What is necessary depends on the purpose

Analytical results vs. criteria

Compliance assessment:

17(ish) data points

Substance (symbol)	Natural concentration[1] mg/kg	Threshold value mg/kg	Lower guideline value mg/kg	Higher guideline value mg/kg
Aromatic hydrocarbons				
Benzene (p)		0,02	0.2 (t)	1 (t)
Toluene (p)			5 (t)	25 (t)
Ethylbenzene (p)			10 (t)	50 (t)
Xylenes[3] (p)			10 (t)	50 (t)
TEX[4]		1		
Polycyclic aromatic hydrocarbons				
Anthracene		1	5 (e)	15 (e)
Benzo(a)anthracene		1	5 (e)	15 (e)
Benzo(a)pyrene		0,2	2 (t)	15 (e)
Benzo(k)fluoranthene		1	5 (e)	15 (e)
Phenanthrene		1	5 (e)	15 (e)
Fluoranthene		1	5 (e)	15 (e)
Naphthalene		1	5 (e)	15 (e)
PAH[5]		15	30 (e)	100 (e)

Substance (symbol)	Threshold value mg/kg	Lower guideline value mg/kg	Higher guideline value mg/kg
Petroleum hydrocarbon fractions and oxygenates			
MTBE-TAME[11]	0,1	5 (t)	50 (t)
Petrol fractions (C5-C10[12])		100	500
Middle distillates (>C10-C21[12])		300	1000
Heavy petroleum fractions (>C21-C40[12])		600	2000
Petroleum fractions (>C10-C40[12])	300		

Site characterization

Are 17 data points sufficient?

What is the conceptual understanding?

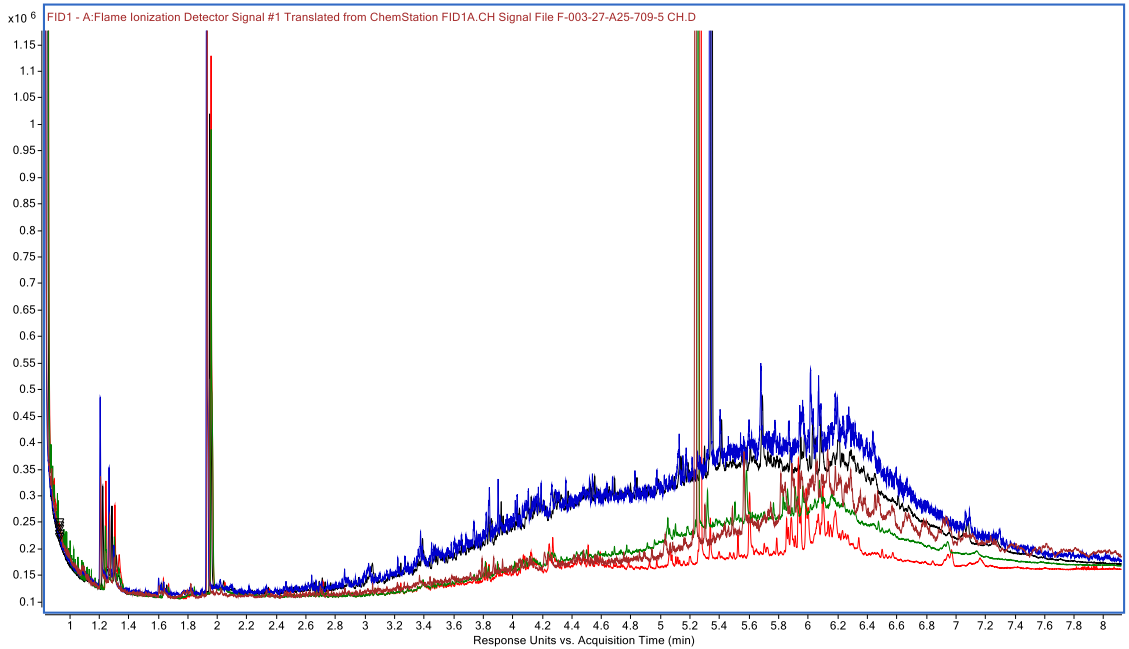
Is the conceptual understanding challenged?

What is/are the source(s)?

Is it the same source for all the contamination you are observing?

How was the area contaminated?

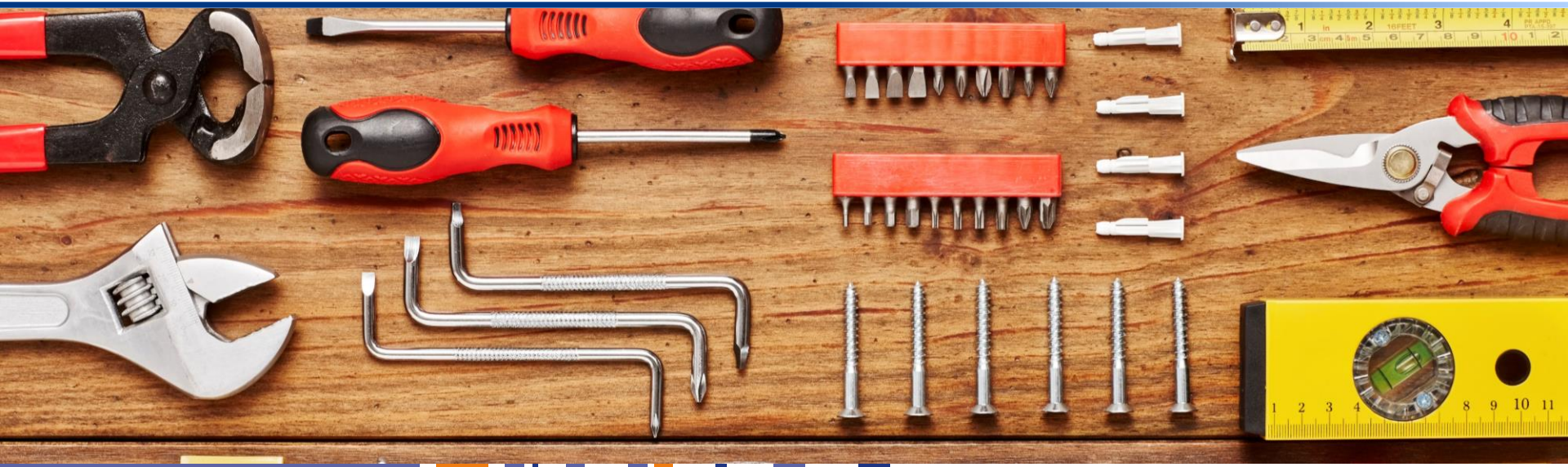
Site characterization



Much can be done with the data we already have

Correct data quality

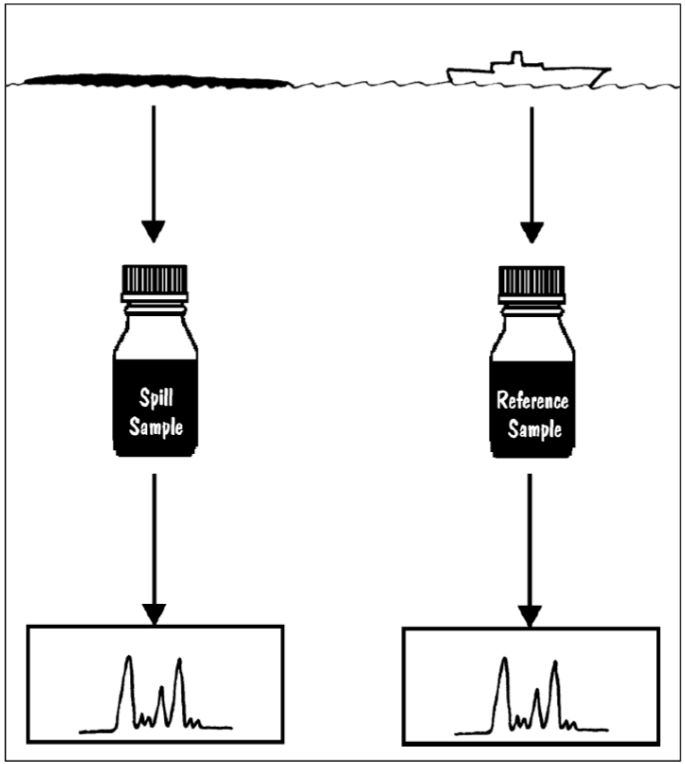
Future proof – What if there are additional questions in the future?



Tools

THE MOST IMPORTANT POINT!

Tools – reference sample



- The main challenge is always the interpretation of the data
- It is much easier to conclude if you have a source sample!

1. Secure a sample of the source(s)

2. Analyse

3. Store

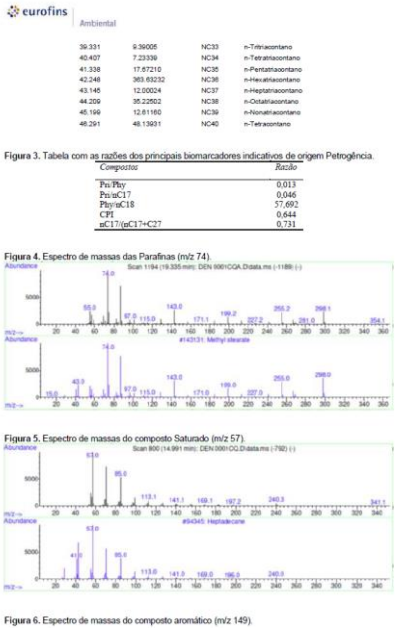
Tools – +++++

Chemfing Soil / - Air

Udvidet indikatorforbindelser

Parameter	Enhet	Prøve 1	Prøve 2	Parameter
17a(H)-diahopane	ug/kg	D	12,00	C3-Fluorenes
A1-C20TAS	ug/kg	Nd	D	C3-Naphthalenes
A2-C21TAS	ug/kg	Nd	D	C3-Naphthobenzothiophenes
A3-C26TAS(20S)	ug/kg	Nd	D	C3-Phenanthrenes/anthracenes
A4-C26/C27TAS	ug/kg	Nd	24,00	C4-Benzanthrene/chrysenes
A5-C27TAS(20R)	ug/kg	Nd	18,00	C4-Dibenzothiophene
A6-TAS(20S)	ug/kg	Nd	19,00	C4-Fluoranthrenes/pyrenes
A7-TAS(20R)	ug/kg	Nd	16,00	C4-Naphthalenes
Acenaphthene	ug/kg	340,00	Nd	C4-Phenanthrenes/anthracenes
Acenaphthylene	ug/kg	Nd	Nd	Cholestane
Anthracene	ug/kg	55,00	Nd	Chrysene
Benzo(a)anthracene	ug/kg	Nd	Nd	cis/trans Decalin
Benzo(a)pyrene	ug/kg	Nd	Nd	Dibenz(a,h)anthracene
Benzo(b)fluoranthene	ug/kg	Nd	D	Dibenzofuran
Benzo(e)pyrene	ug/kg	Nd	9,90	Dibenzothiophene
Benzo(g,h,i)perylene	ug/kg	Nd	9,80	Fluoranthene
Benzo(k)fluoranthene	ug/kg	Nd	Nd	Fluorene
Biphenyl	ug/kg	16,00	10,00	Indeno(1,2,3-cd)pyrene
C1-Benzanthrene/chrysenes	ug/kg	Nd	21,00	1-Methylnaphthalene
C1-Dibenzothiophene	ug/kg	220,00	Nd	2-Methylnaphthalene
C1-Fluoranthrenes/pyrenes	ug/kg	85,00	Nd	Naphthalene
C1-Fluorenes	ug/kg	620,00	Nd	Naphthobenzothiophene
C1-Naphthalenes	ug/kg	97,00	23,00	Perylene
C1-Naphthobenzothiophenes	ug/kg	Nd	25,00	Phenanthrene
C1-Phenanthrenes/anthracenes	ug/kg	1,10	18,00	Pyrene
C2-Benzanthrene/chrysenes	ug/kg	Nd	27,00	Retene
C2-Dibenzothiophene	ug/kg	160,00	Nd	S14-Cholestane(20R)
C2-Fluoranthrenes/pyrenes	ug/kg	33,00	Nd	S15-Cholestane(20S)
C2-Fluorenes	ug/kg	480,00	Nd	S18-Ethyldiacholestane
C2-Naphthalenes	ug/kg	130,00	53,00	S19-Ethyldiacholestane
C2-Naphthobenzothiophenes	ug/kg	Nd	48,00	S20-Methylcholestane
C2-Phenanthrenes/anthracenes	ug/kg	680,00	34,00	S22-Methylcholestane(20R)
C3-Benzanthrene/chrysenes	ug/kg	Nd	22,00	S23-Methylcholestane(20S)
C3-Dibenzothiophene	ug/kg	60,00	Nd	S24-MethylCholestane
C3-Fluoranthrenes/pyrenes	ug/kg	nd	nd	S25-EthylCholestane

Assessment report



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Ambiental

39.331	9.39005	NC33	n-Tritriacontano
40.407	7.23339	NC34	n-Tetratriacontano
41.338	17.67210	NC35	n-Pentatriacontano
42.246	383.65232	NC36	n-Hexatriacontano
43.146	12.00024	NC37	n-Heptatriacontano
44.209	35.22502	NC38	n-Octatriacontano
45.199	12.61160	NC39	n-Nonatriacontano
46.291	48.13931	NC40	n-Tetracontano

Figura 3. Tabela com as razões dos principais biomarcadores indicativos de origem Petrogênica.

Compostos	*Razão*
Pri/Phy	0,013
Pri/nC17	0,046
Phy/nC18	57,692
CPI	0,644
nC17/(nC17+C27	0,731

Figura 4. Espectro de massas das Parafinas (m/z 74).

Figura 5. Espectro de massas do composto Saturado (m/z 57).

Figura 6. Espectro de massas do composto aromático (m/z 149).

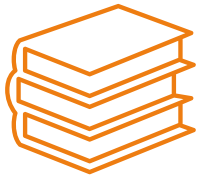
Soil package +

Make available:

Analysis of source samples

Extended storage of source material

Project based adaptations



More information:

Pri/Phy

C17/Pri

C18/Phy

PAH(16)

Extended service:

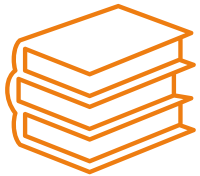
Technical discussions

Reproducible conditions

Dilutions / re-analyses

Soil package +

Make available:



More information:

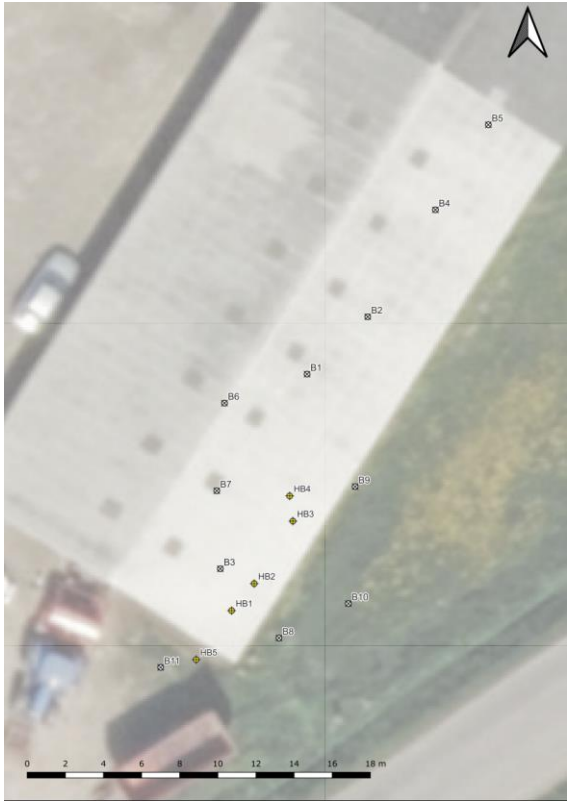
Extended service:

Cost-effective:
Maximize added value
vs.
cost

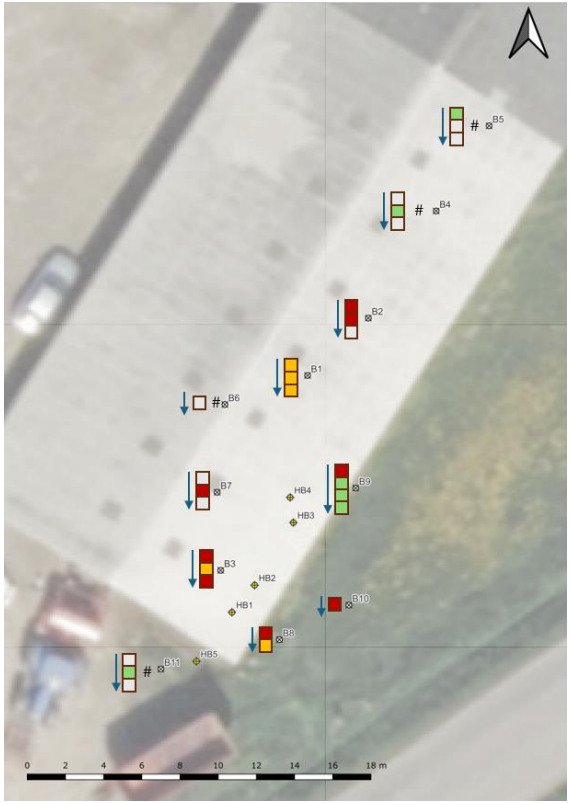
Tools – Soil package +

Reference sample (oil)	Soil package+ (soil)
“Screening” (standard parameters)	(indicators + PAH(16))
Can be archived until the project is completed	Minimises uncertainty between samples within the same project

Case 1: New spill from same oil tank



Case 1: New spill from same oil tank



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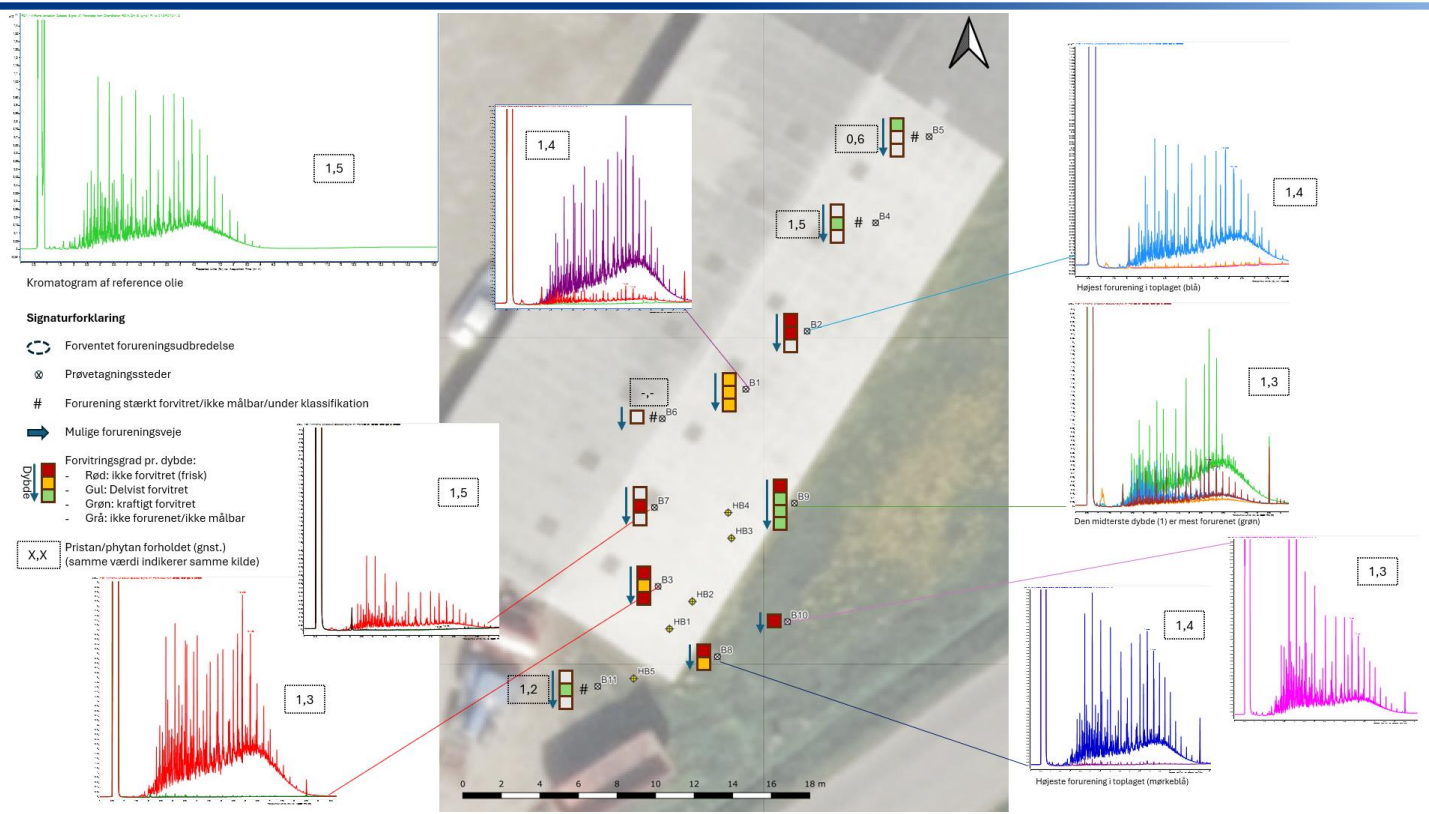

Case 2: Spill or leakage

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1
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III

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Rapportdato: 07.10.2025
Sagsnr.:
Sagsnavn:

07.10.2025
Rapport version: 1

Vurderingsrapport - Jordpakke+

Bestemmelse af nedbrydningsgraden af jordforurening
Sagsidentifikation:

Case 2: Spill or leakage

What does the degree of weathering in the source mean?

Some checks have to be made

Case 2: Spill or leakage

What does it mean if it have a stable degree of weathering?

Case 2: Spill or leakage

What does it mean if it have an increasing degree of weathering?

Case 2: Spill or leakage


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Vurderingsrapport - Jordpakke+

Bestemmelse af nedbrydningsgraden af jordforurening
Sagsidentifikation:

- Ikke forvitret (frisk): n-C17/pristan > 1 (1,0-1,5 empirisk).
- Delvist forvitret: n-C17/pristan < 1.
- Stærkt forvitret: n-C17 er helt nedbrudt

n-C17/pristan-, n-C18/phytan- og pristan/phytan-forholdet fremgår af tabel 2.1

Tabel 2.1: Oversigt over forholdene benyttet til bestemmelse af nedbrydningsgraden.

Prøvenr.	Prøvenavn	Dybde m.u.t	C17/pristan	C18/phytan	Pristan/phytan	Forvitrings grad	Um (%)
862-2025-04857**201**	HB4	1,0	1,7	2,3	1,4	Ikke forvitret (frisk)	10
862-2025-04857**202**	HB4	1,5	0,5	0,2	1,2	Delvist forvitret*	10
862-2025-04857**203**	HB4	2,0	0,0	0,1	1,2	Stærkt forvitret	10
862-2025-04857**204**	HB5	1,0	0,3	0,2	1,1	Delvist forvitret*	10
862-2025-04857**205**	HB5	1,5	1,3	1,3	1,3	Ikke forvitret (frisk)	10
862-2025-04857**206**	HB5	2,0	1,5	1,6	1,3	Ikke forvitret (frisk)*	10

Case 2: Spill or leakage

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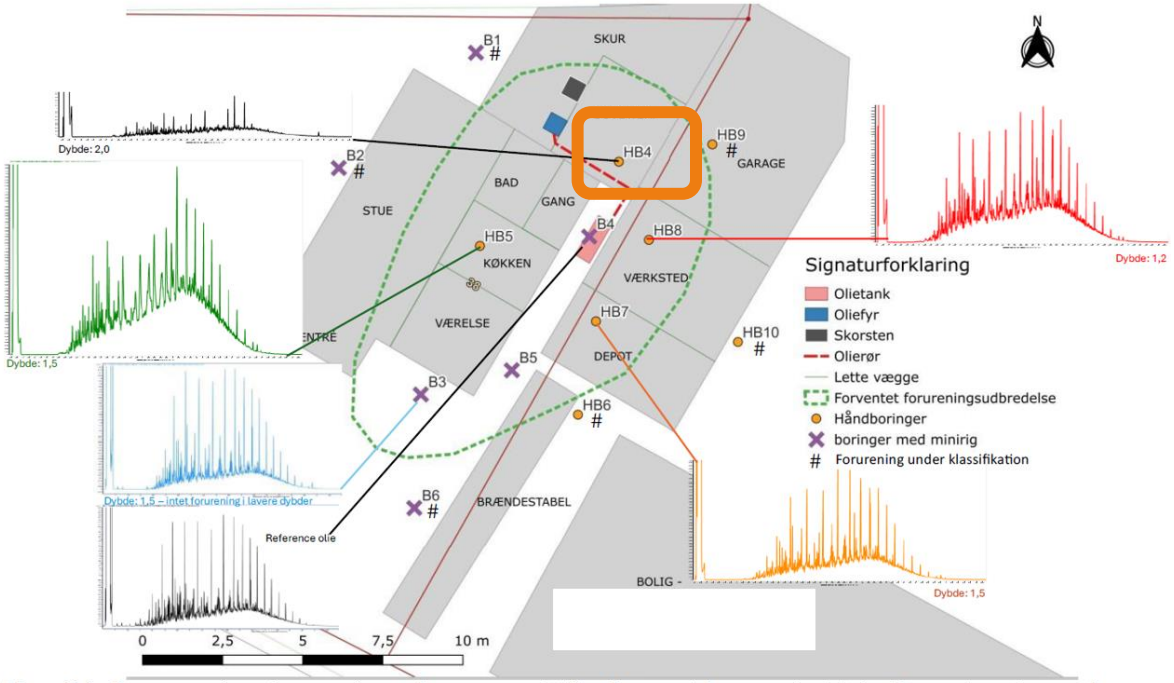
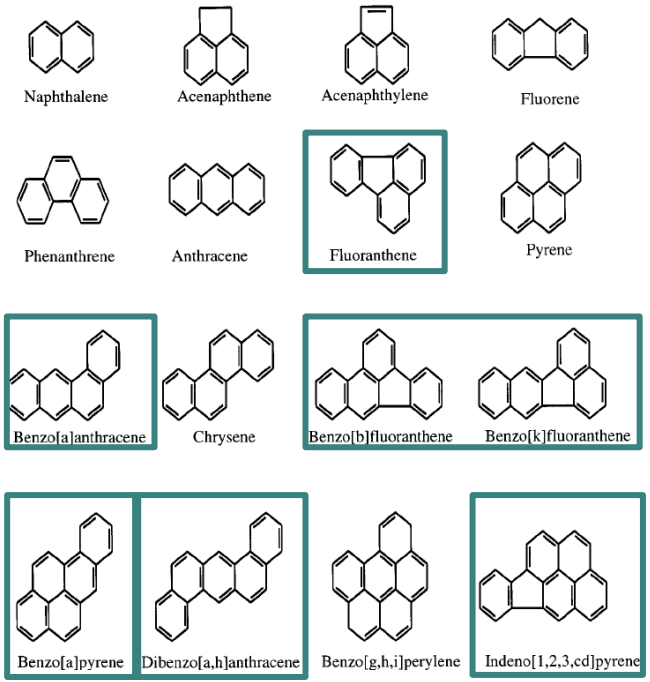


Figur 3.1: Opsummering af sagen, kromatogrammer vist for den mest forurenede dybde. Prøver hvor ingen af dybderne har påvist olieforurening er markeret med #. Kromatogram af referenceolie nederst til venstre.

Next steps

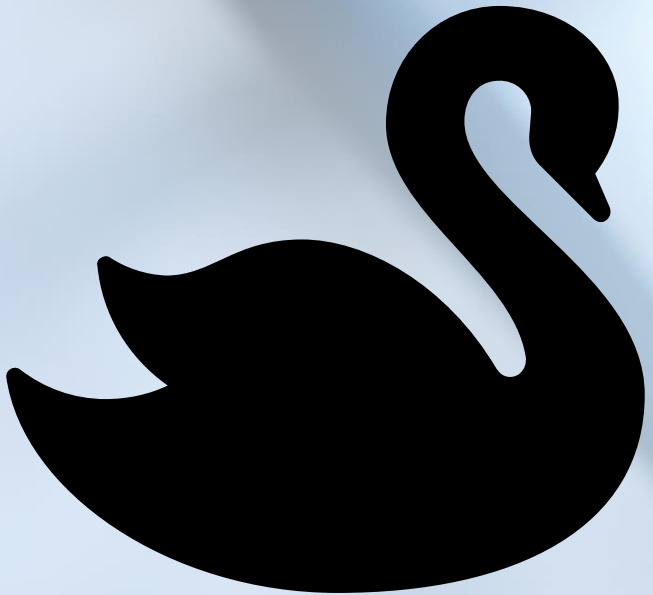
US EPA – 16
(all parent PAH, C0)



Next: PAH(16)

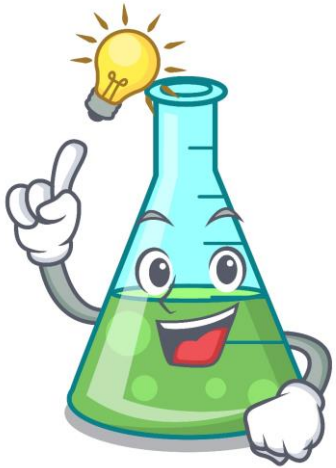
"Infinite" possibilities!
(so much scientific knowledge regarding the PAH(16) fingerprint)

⋆⋆⋆ Data quality



Easier to say that something is different than equal!

Line of evidence:
See the forest for the trees



Questions?