PERSAMPELAN DAN ANALISA

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21 March 2018

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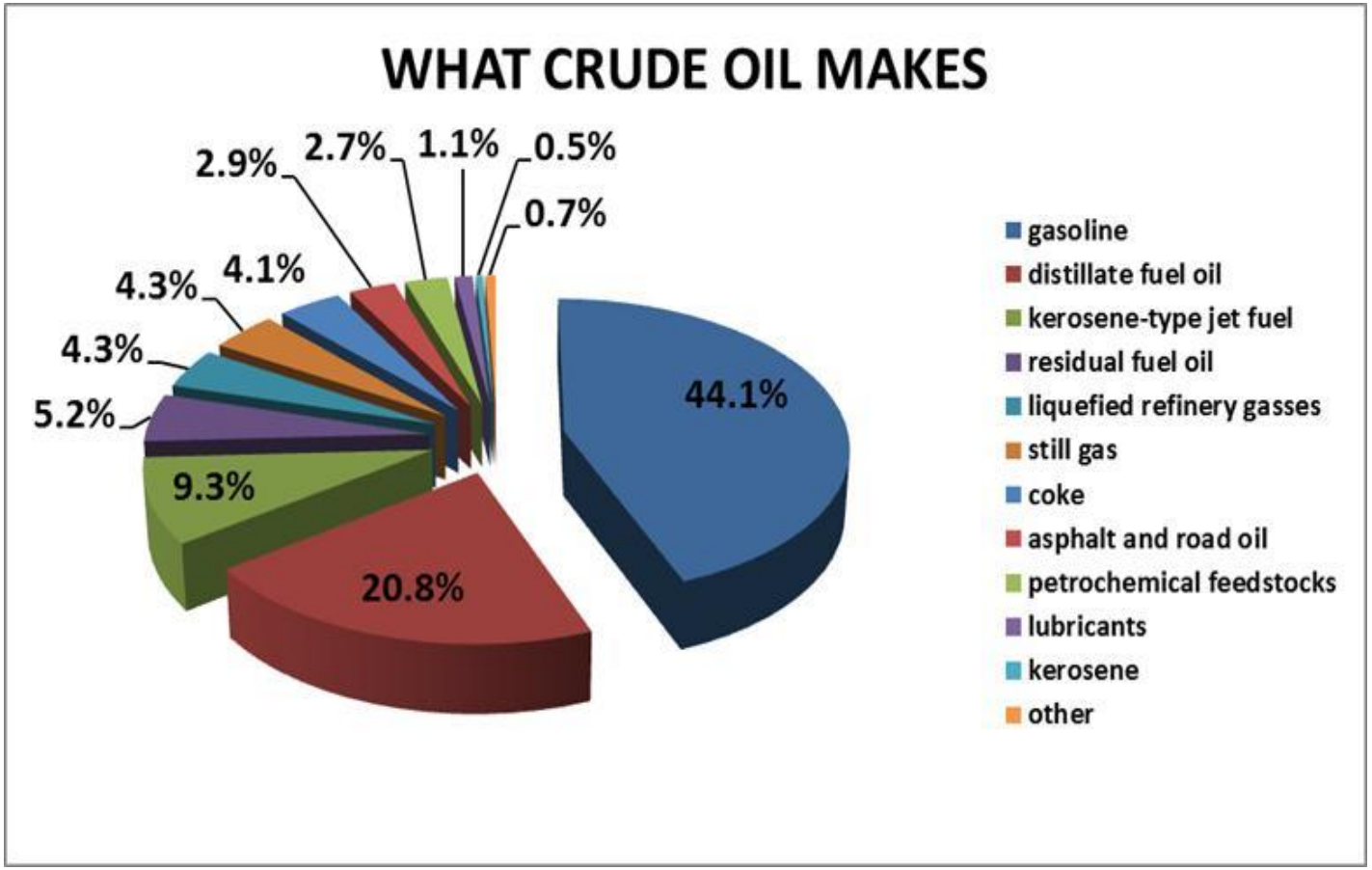
INTRODUCTION



INTRODUCTION

Oil spill:

- Release of liquid petroleum hydrocarbons into the environment
- Human activity
- A form of pollution
- Marine oil spills released into the ocean or coastal waters

INTRODUCTION

Oil spill can occur at any of these stages:

- Oil extracted from ground
- Oil is pumped to a pipeline
- Oil is transported to a refinery
- Oil is transported to final destination
- Illegal dumping

INTRODUCTION

- Environmental effects
  - Smothering impact on physiological functions
  - Chemical toxicity
    - lethal and sub-lethal
    - impairment of cellular functions

  - Ecological change
    - loss of key organisms
    - Invading of habitat by opportunistic species
  - Indirect effects
    - Loss of habitat
    - Elimination of ecologically important species

INTRODUCTION

- Economic effects
  - Tourism
    - short term – swimming, boating, angling, diving
    - long term – public perception (for prolonged, wide scale pollution)
  - Fisheries and mariculture
    - Fish stocks
    - Fouling gears, access to fishing sites
  - Shipyards, ports and harbours
    - Disrupted both spill and clean up
  - Heavy industry
    - Depends on seawater for operations

SAMPLING

SAMPLING FOR THE PURPOSE OF SOURCE IDENTIFICATION

- The most important stage of any chemical analysis is the sampling
- It does not matter how good your quality systems and test methods are, if you don't begin with a representative sample you cannot expect to produce accurate results
- Obtaining truly representative samples from oil spills can prove challenging:
  - because the composition of oil can vary widely before it is even removed from the ground.

Sampling methods/guideline

- ASTM 4489 standard practice for sampling of waterborne spills
- CEN/TR 1552-1:2006 oil spill identification. Waterborne petroleum and petroleum products. Sampling
- USCG marine safety lab: Oil spill handling and transmittal guide. 8th edition 2013
- Bonn agreement counter pollution manual: Volume 3, chapter 32, oil spill identification – Part 1
- IMO manual on oil pollution: Section VI, IMO guideline for sampling and identification of oil spills. IMO 1578E
- ITOPF TIP14 sampling and monitoring of marine oil spills

Practical sampling guidelines

- Samples taken must be representative of the spill and suspected source
- Care must be taken to avoid contamination of the samples from other hydrocarbon sources, including cross contamination between samples
- Samples must be stored safely (neat oil may be highly flammable) and in a manner that preserves the sample integrity
- Collected samples must be clearly and uniquely labelled with as much information about the sample as possible
- Samples should be securely sealed in a manner to prevent tampering and maintain a robust chain-of-custody, particularly when samples may be used as evidence in court action

General requirements

- **Safety - first priority, for the sampler**
  - Minimize risk of toxic exposure from oil spilled
  - Follow regulations
  - Guided/accompanied of knowledgeable people/crew

- **Training**
  - All personal involved in sampling need to be trained
  - Ensure correct sampling
  - Asked by lawyers in case legal proceedings
  - Sampling from ships (suspected polluters), the sampler must be working on board

General requirements

- **Sample planning**
  - Spilled sample, collect quickly - avoid evaporation
  - Source sample
  - Reference (blank) Samples
- **Sample Custody**
  - Sample handle as legal evidence and kept within "chain of custody”
  - Make notes, take photos and videos.

Oil spill Sampling rules

- All spills encountered and potential sources of spill should be sampled
- Samples should be taken even when it is clear where the spill originates
- Scattered and/or only thin sheen remains, every effort should be made to take a least a small sample
- If any part of oil spill differs from other part, take extra samples to check if more than one oil spill occurred in that area

Oil spill Sampling rules

- If spill response operation continues for more than one day, samples should be taken every day for determination of degree of weathering and possible contamination by other oils
- Blank samples – if an oil suspected of contamination
- Samples and sampling equipment – handled and stored properly
  - Reusable sampling equipment should be carefully cleaned and stored in plastic bags
  - NEVER reuse sample bottles – even after careful washing

Oil spill sampling rules

- Sample handle as legal evidence and kept within "chain of custody" until identification and possible legal procedures have been completed
- Make notes of all relevant information about sample and sample sites
- Quick handling of samples
  - Sent as soon as possible to laboratory
  - Delayed, keep at +4˚C (not frozen)

Amount of oil required

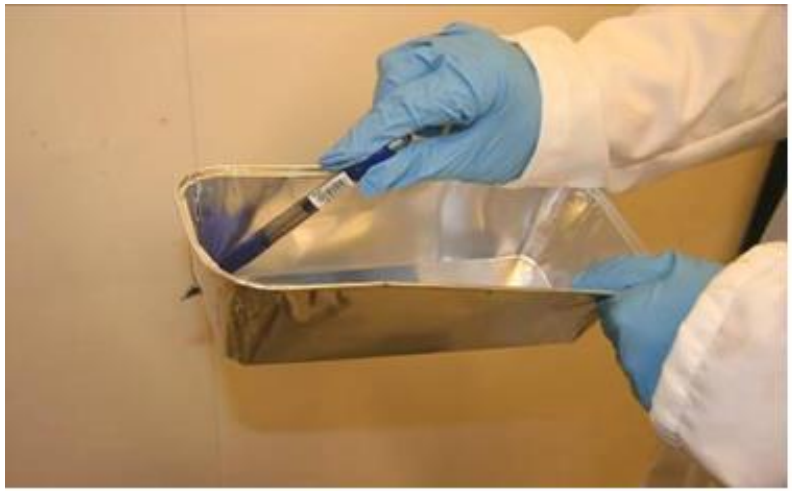
Description	Minimum required quantity (per sample)
Pure oil source sample	30-50 mL
Contaminated oil (eg. emulsified oil, oil from sea or shore, tarball, etc.)	10-20 g
Debries with oil, oil stranded sand	Sufficient quantity that oil content is approx. 10 g
Oiled feather	5-10 feathers depending on oil quantity present
Fish, shellfish	Multiple individuals of same species totaling 30 g
Water sample with visible oil	1 liter
Water sample with no visible oil	3-5 liters

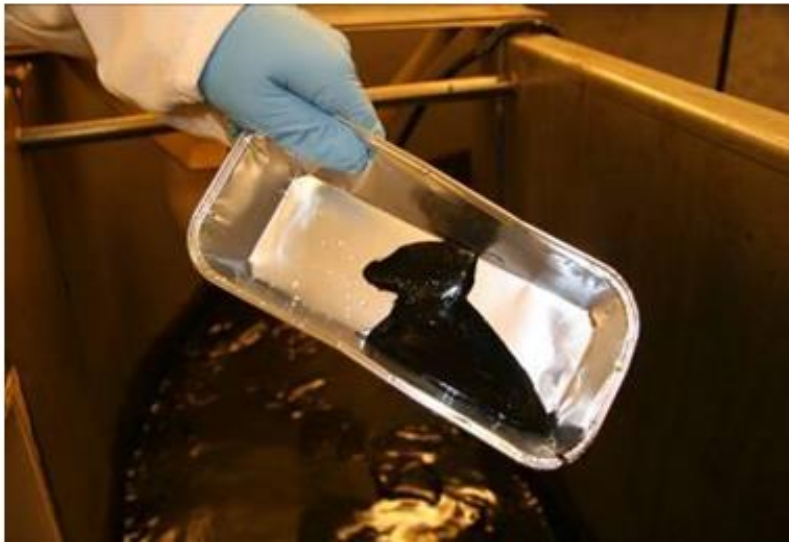
Source: ITOPF, 2011

Sampling techniques

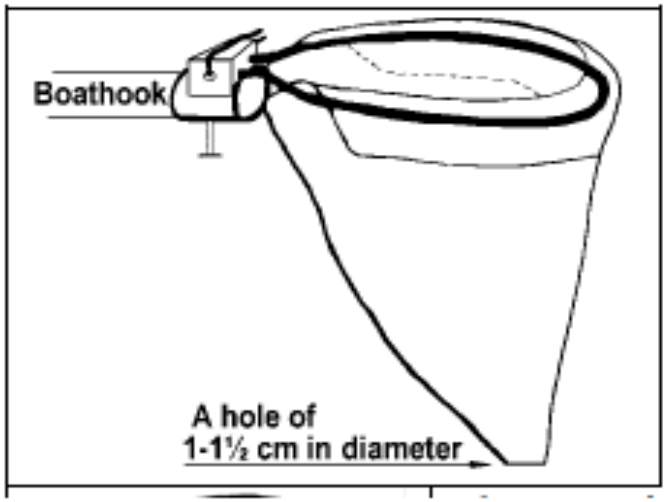
1) Thick waterborne layers, viscous oil, tarball

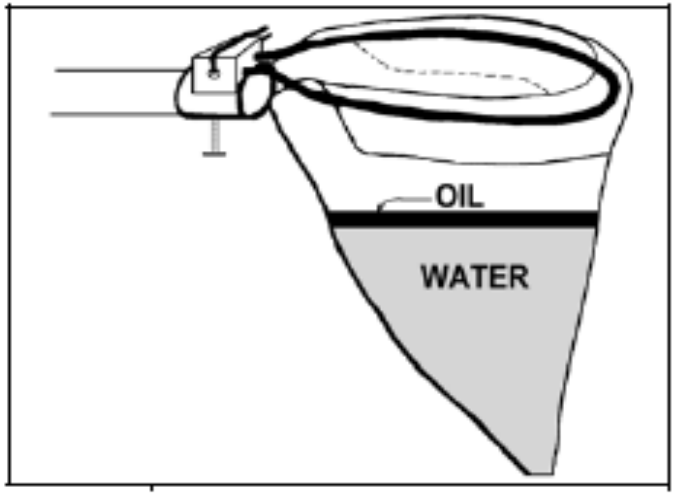
ALUMINIUM BEAKER

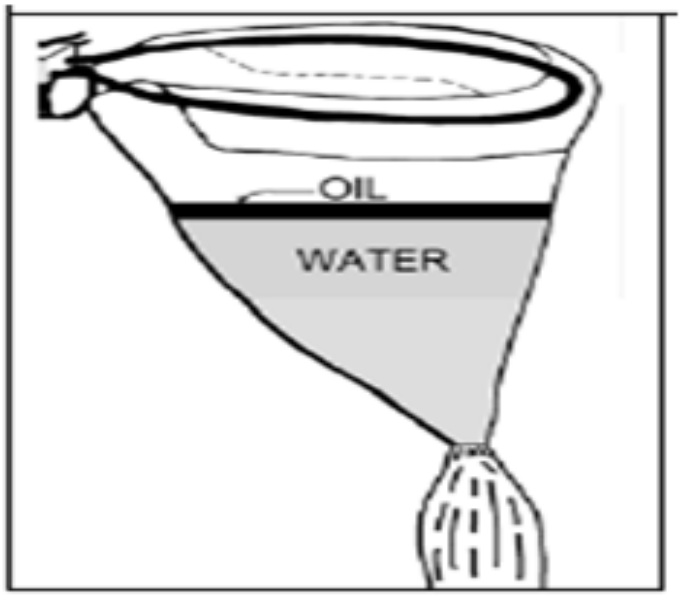




1) Thick waterborne layers, viscous oil, tarball







- Try to get 20-50 mL of oil, repeat the procedure to get the amount wanted
- Transfer the oil gather into 100 mL clean glass bottle, label. May use wooden spatula
- Place the bottle in the safety bag and seal the bag
- For large spill area take several positions within the spill

2) Thin oil layer on water (sheen)

2) Thin oil layer on water (sheen)

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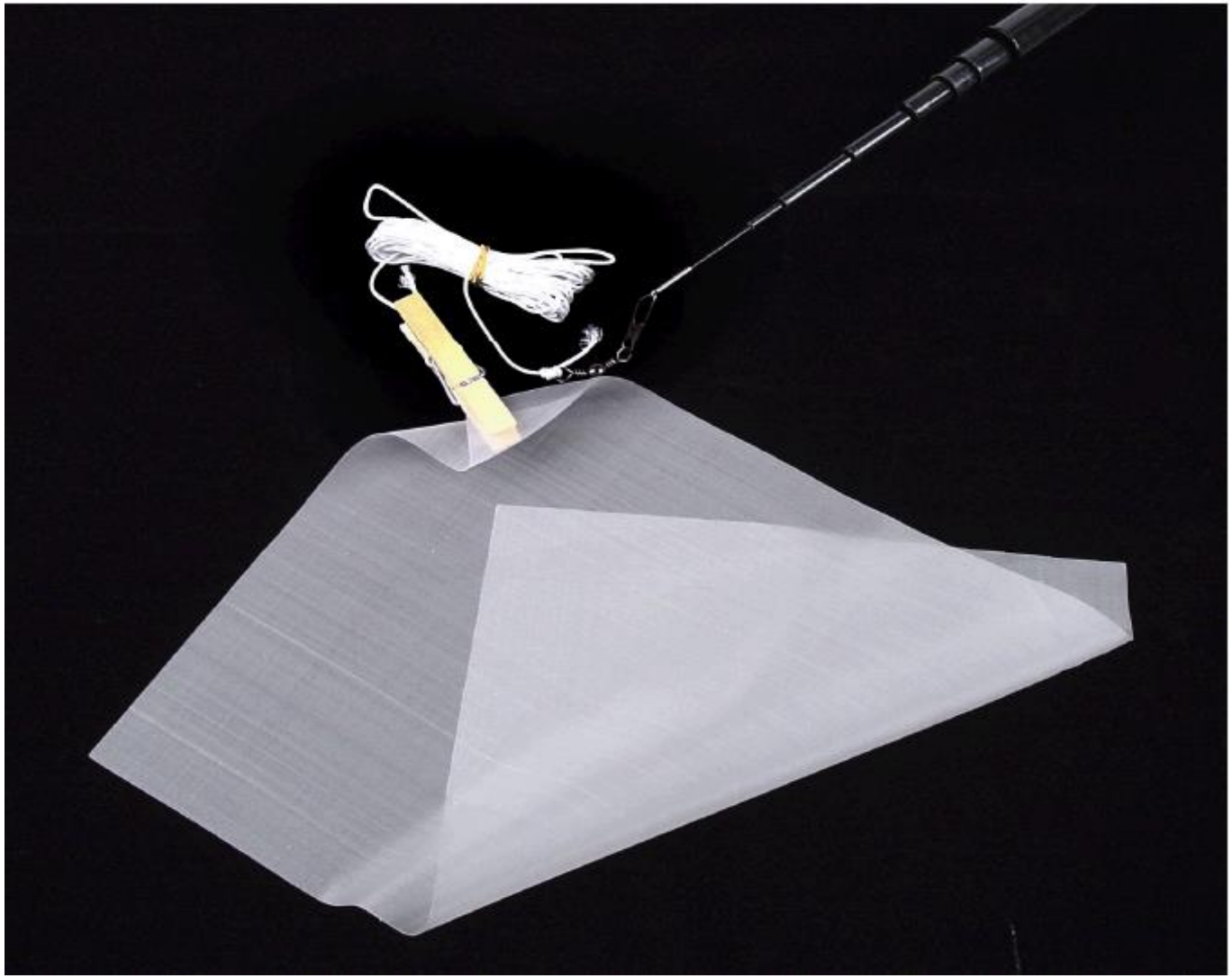
WATER

2) Thin oil layer on water (sheen)

WATER

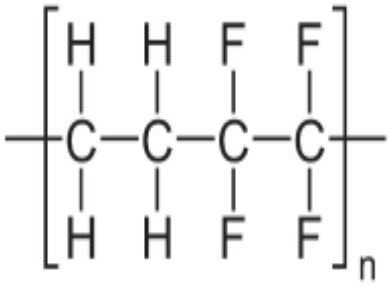
2) Thin oil layer on water (sheen)

ETFE NET

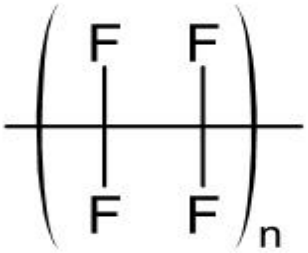


Sampling techniques

ETFE is **ethylene tetrafluoroethylene,**



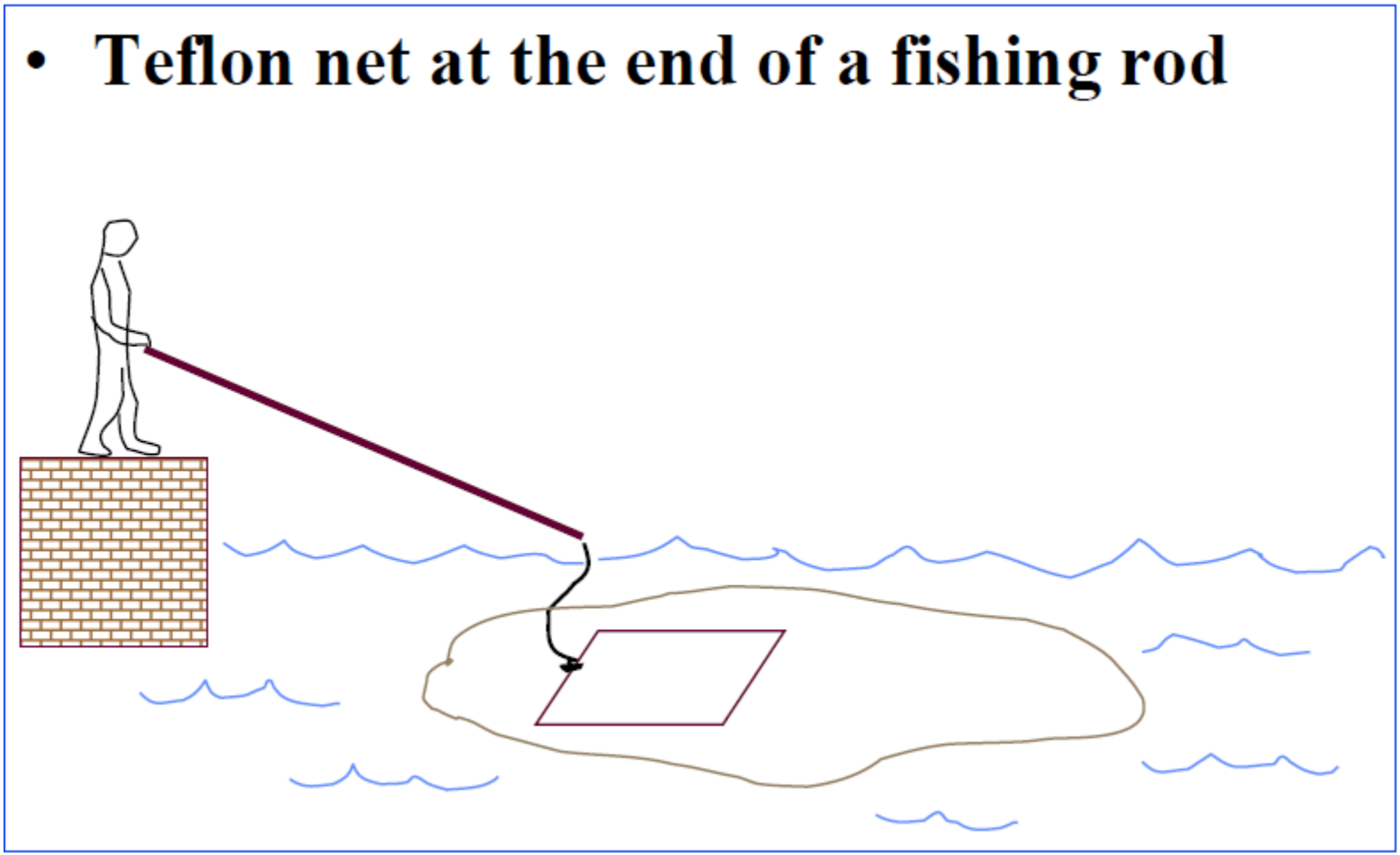
- not teflon (polytetrafluoroethylene)



- CEN/TF 120 N035 Oil spill identification, Technical Report 2006

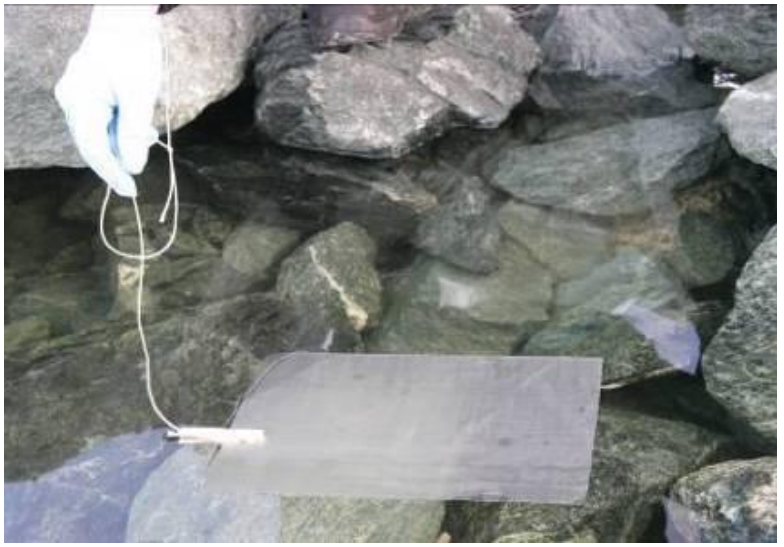
Very thin oil layers

- **Teflon net at the end of a fishing rod**



Very thin oil layers

Very thin oil layers



Oil on substrate

- rock/gravels/seaweeds/woodwork
  - Large amount of oil
    - Scrap the oil with spatula and transfer directly into 100 mL bottle
  - Lesser amount of oil
    - wipe the oil with the ETFE net and transfer the whole ETFE net to the glass bottle

Oil on substrate

- If none of the above works
  - transfer the contaminated object (gravel/rocks/seaweed etc.) directly in the glass bottle
- Reference samples
  - Non-polluted material (rock, gravel, sea-weed etc.)
  - As close to the "real" sampling area as possible.

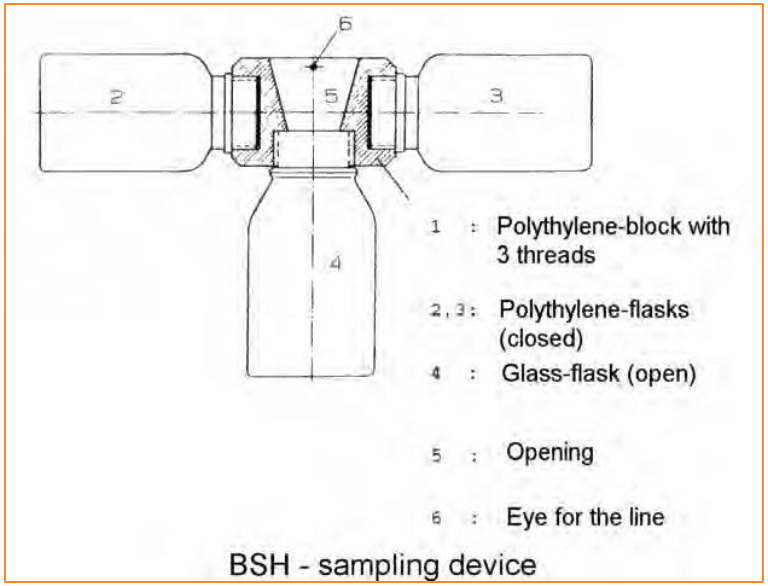
Oil on substrate

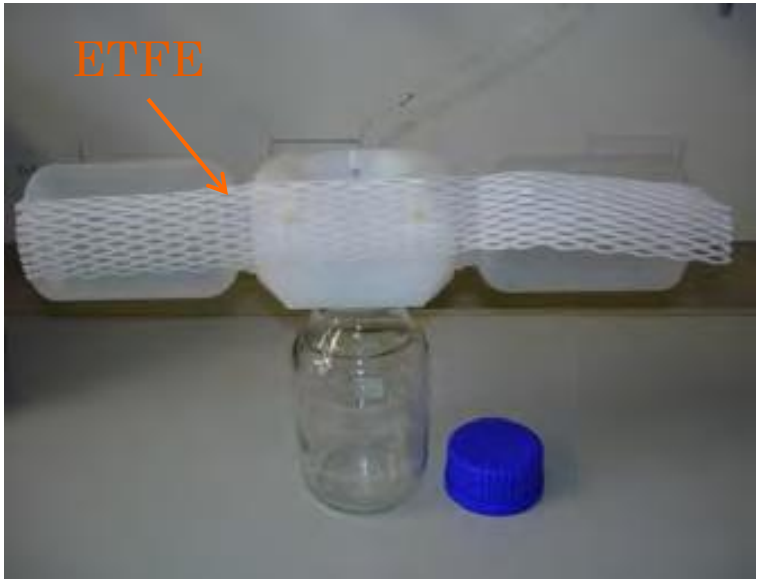
- Oil from sea birds and marine mammals
  - Heavy polluted animal
    - Wipe oil onto the Teflon net and transfer the net with oil to the 100 mL glass flask (glass).

Oil on substrate

- Less polluted animal
  - Contaminated feather is picked off or contaminated fur is cut of (with the knife) and transferred to the 100 mL glass flask
- Never take whole animal samples, body tissues, etc. which may become rotten during shipment.

Use of sampling buoy from airplane



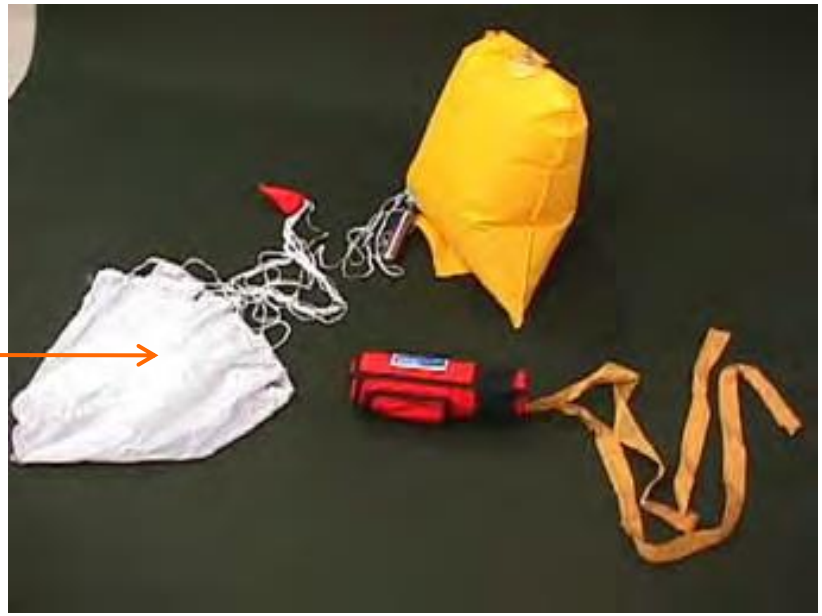


- Also can be used from bigger ships or from bridges in harbours

Use of sampling buoy from airplane

- Drop a sampling buoy into an oil spill from an air craft

ETFE net



- Record the position, wind and sea current
- Lift the buoy from the water without touching the sample net
- Drain the excess water, insert the ETFE into glass bottle

Source sample

- Investigations and oil sampling on board vessels
  - Cargo oil
  - Machinery spaces

    (bilge water, waste oil etc.)
- Follow safety regulations and protocols
- Get assistants from ship by crew under control
  - Tanks/ships hazardous are

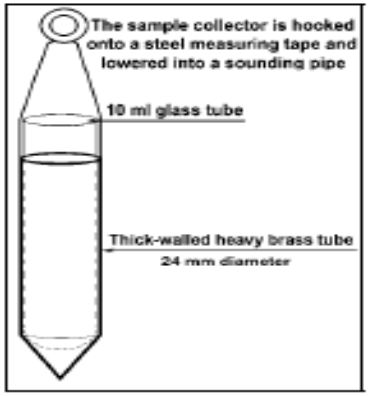
Source sample

- NEVER accept unknown samples handed over by ship representatives or shipping company
- Record observations using digital camera/video
- Use ships own sampling equipment if available
  - Get approval for external equipment usage

Source sample

- Sample collector – tanker or difficult access places

Sample collector with steel measuring tape.



- ETFE net – very small amount of oil

Oil sheen

Oil on ground/soil

Oil from ship

Oil from ship

Sample Handling, Packing and transportation

- Sample custody and documentation
  - Samples cannot be:
    - Manipulated
    - Mixed-up
    - Contamination
  - Chain of custody
  - How to maintain the ‘chain of custody’
    - Approved sealable and individually numbered safety bags with adhesive number labels

Sample Handling, Packing and transportation

- Filling and labeling of sample bottles
  - Sample bottles
    - Thick walled wide-mouth borosilicate glass bottles
    - 100 – 250 mL
    - Suitable Inner neck diameter 30mm
    - Lid tightening
    - New (unused) bottled for each sampling site
  - Avoid getting water into sample bottles
  - Do not fill to a higher level
  - Check the lid fits tightly
  - Wipe excess oil and water from the outside of the bottle

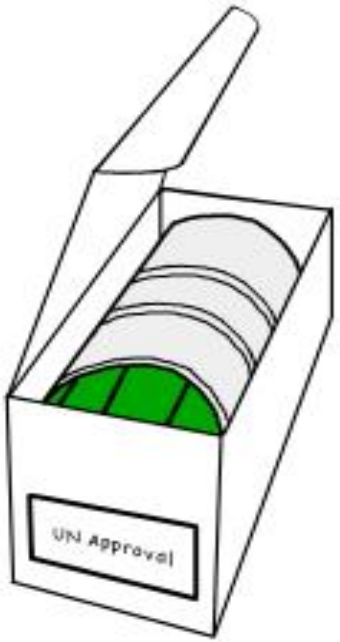
Sample Handling, Packing and transportation

- Packing of sample
  - 3 forms of oil:
    - Free oil
    - ETFE net containing oil
    - Oiled items (feathers, wood pieces, stone etc)
  - Affix label onto the sample bottle
  - Insert the bottle into safety bag and seal
  - Place the bottle package into a plastic jar
  - Ship the sample immediately or keep below +4˚C
  - Attach letter of request

Sample Handling, Packing and transportation

Approved sealable and individually numbered safety bag.

The safety bag containing the sample bottle is put into a 600 ml plastic jar.



The plastic jar (with its content) is placed in a shipping cardboard box.

Sample Handling, Packing and transportation

Sample Handling, Packing and transportation

COMMERCIAL SAMPLING KITS

- Case with equipment for sampling of oil spills

Case with equipment for sampling of oil spills	No.
Metal ring (for polyethylene cornet)	1
Holder for metal ring	1
Polyethylene cornet	20
Teflon® pad (20x30 cm) for thin oil films	15
Peg (for Teflon® pad)	20
Line (for rod and peg)	coil
Rod (for Teflon® pad) (perhaps not enough room in the case for this rod)	1
Sample bottle, 100 ml thick-walled borosilicate glass	10
Sample label	50
Safety bag (20x30 cm), approved, sealable, individually numbered	50
Wiping cloth (or paper)	package
Disposable gloves	package
Sampling peg (for scraping small samples of oil)	50
Plastic bag (for filled sample bottles, garbage etc.)	20
Laminated oil sampling flow diagram (cf. Annex3, Section 5)	1
Laminated instruction "Oil spill sampling" (cf. Appendix 1)	1
Laminated equipment list	1

COMMERCIAL SAMPLING KITS

- Case with equipment for sampling on board ships

Case with equipment for sampling on board ships	No.
Sample collector of brass for sounding pipes (to be hooked on the steel measuring tape)	1
Steel measuring tape	1
Brass weight (to be hooked on the steel measuring tape)	1
Ground wire (to be hooked on the steel measuring tape)	1
Water finding paste	tube
Blackboard chalks (for chalking steel measuring tapes)	package
Glass tube 10 ml (with lid) for sample collector	10
Teflon® pad (20x30 cm) for thin oil films	15
Line	coil
Sample bottle, 100 ml thick-walled borosilicate glass	20
Sample label	50
Safety bag (20x30 cm), approved, sealable, individually numbered	50
Writing-pad (with cover and pen)	1
Wiping cloth (or paper)	package
Disposable gloves	package
Sampling peg (for scraping small samples of oil)	50
Plastic bag (for filled sample bottles, garbage etc.)	20
Earplugs	30x2
Laminated oil sampling flow diagram (cf. Annex3, Section 5)	1
Laminated equipment list	1

DO AND DON'TS IN SAMPLING

- DO NOT composite any oil samples (oil spill, waste oil)
- DO NOT use plastic bottles/containers for samples
- DO Rinse all sampling equipments and bottles with solvents (dichloromethane) prior to use
- Use of EFTE net is HIGHLY RECOMMENDED for oil sheen instead of skimming technique

EXAMPLE OF REQUEST FOR ANALYSIS FORM

Request for analysis

Request analysis of the samples listed below

Sampling date:		**No. of samples:**		**No. of pages:**	

General information (Occurred incident, weather, spill size, suspected source, judged oil type, etc.)	Number label from safety bag	Information which is not given on the sample bottle *

*Information: Sampler: Name/field unit
Spill : Latitude & longitude, and sampling site's geographical name
Ship: Ship name and sample site on board the ship

Signature	Name in block letters	Rank

ANALYSIS

What happens in the laboratory?

Analysis

Evaluation

- Chromatograms;
- Distribution profiles;
- Weathering check (WR and distribution profiles);
- Diagnostic ratios (DR);

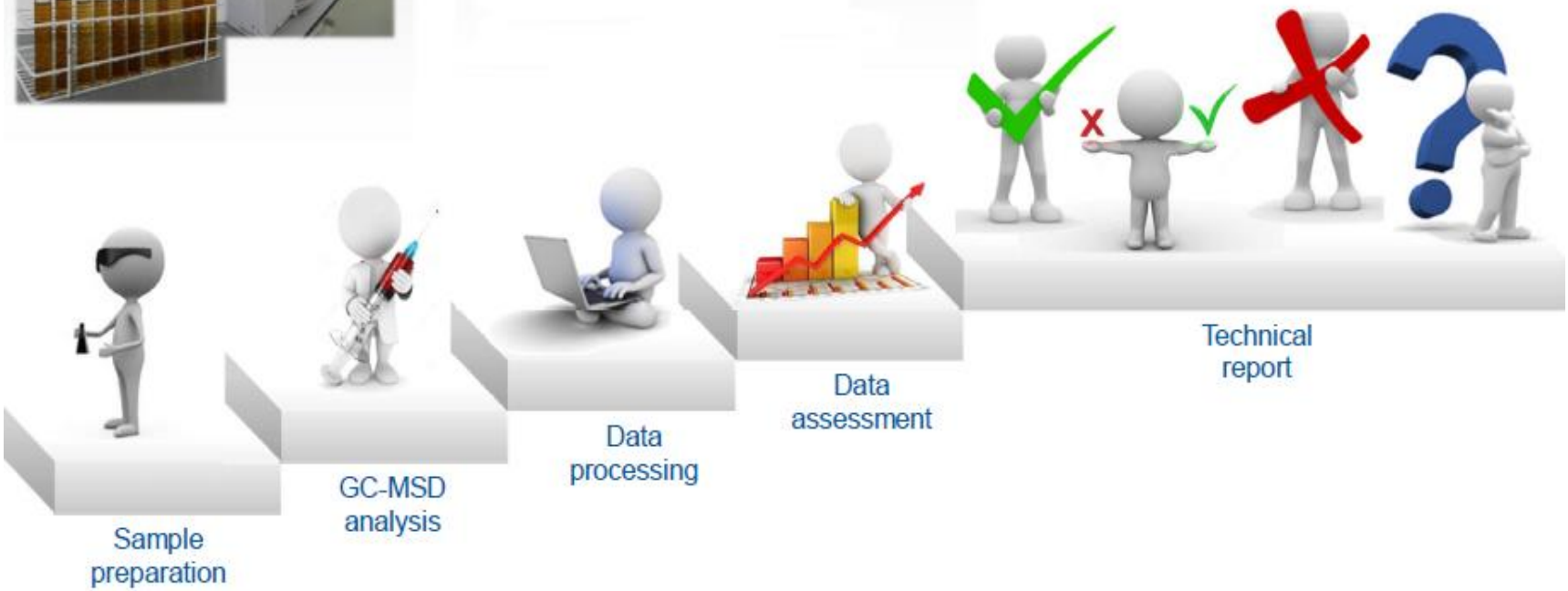
Conclusion

✓ - Positive match;

✓/× - Probable match

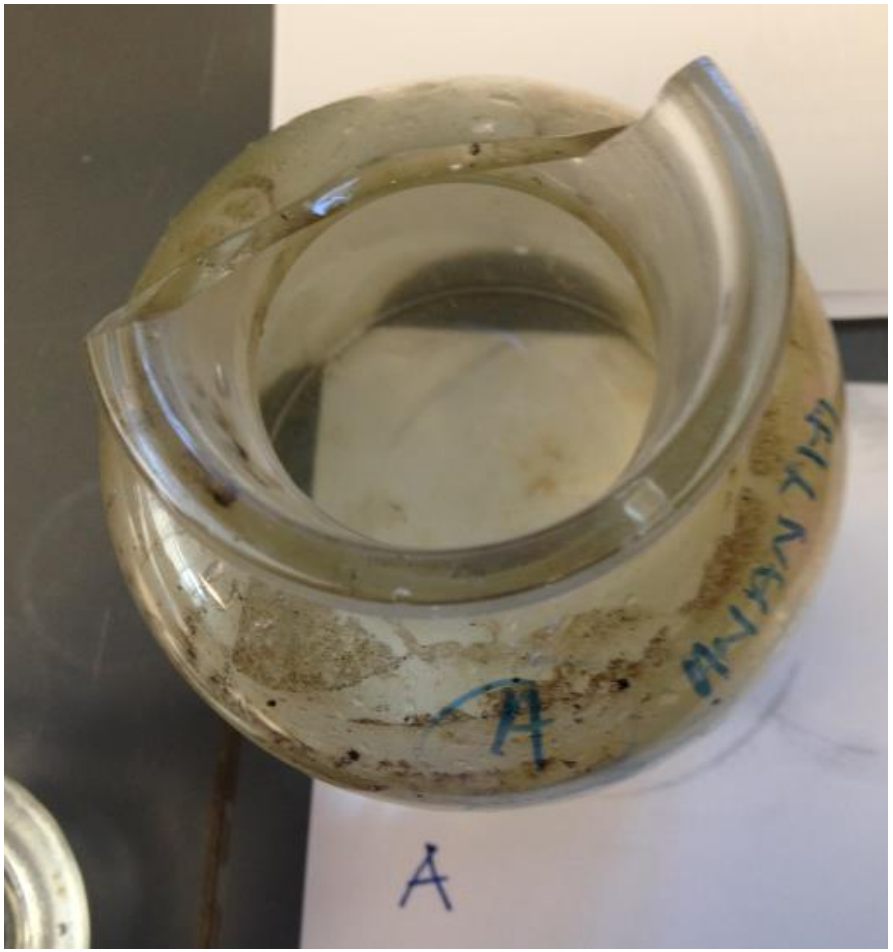
× - Negative match

? - Inconclusive



Samples sent to laboratory

Samples sent to laboratory



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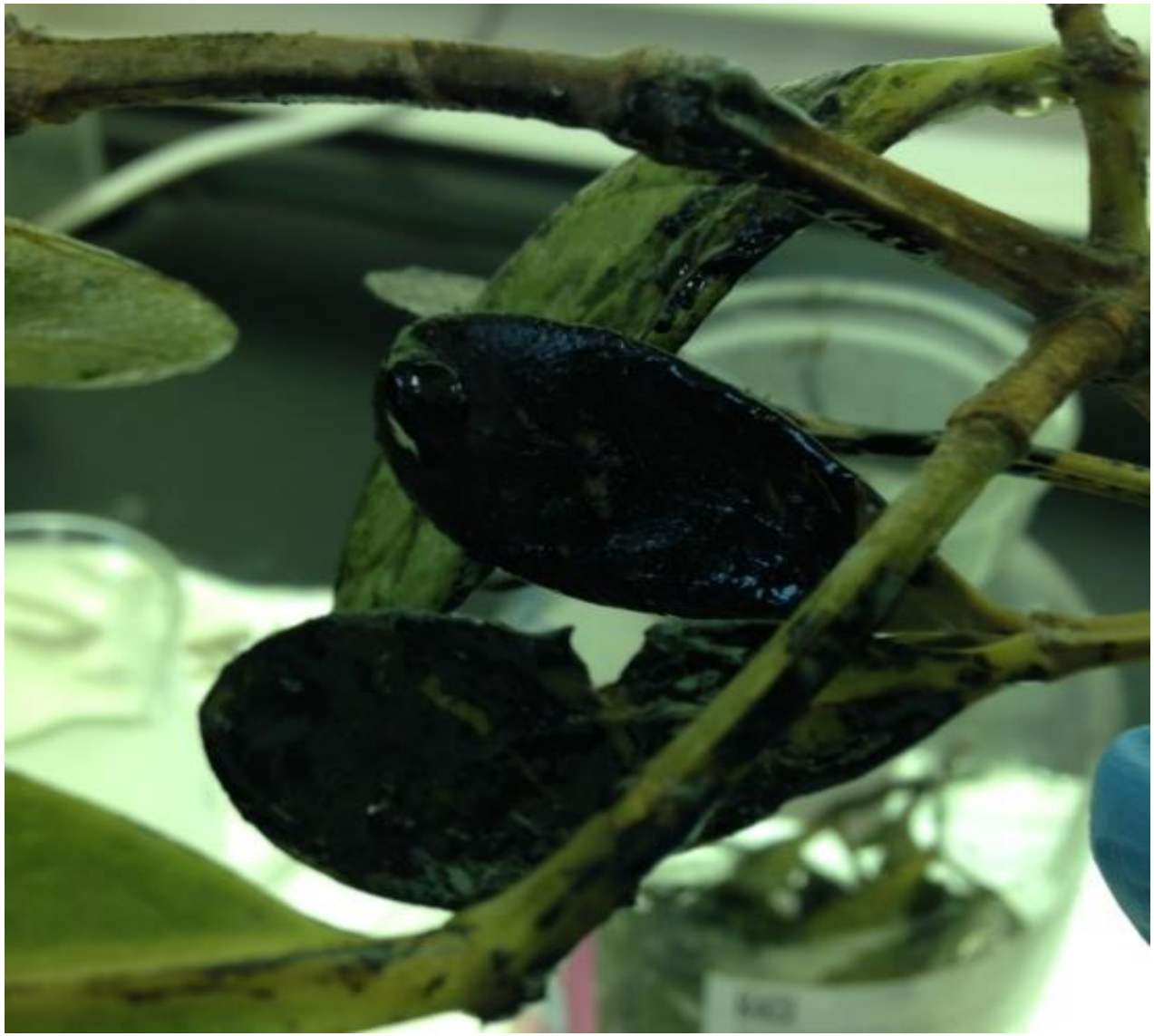


Sample preservation

- Water/emulsions
  - Sample should be stored in refrigerator at 4°C or less
  - Undisturbed storage of sample may allow oil to separate for water facilitating the oil collection for preparation
  - Sample preparation within a week

Sample preservation

- Sample containing primarily water
  - Add dichloromethane (DCM) added immediately

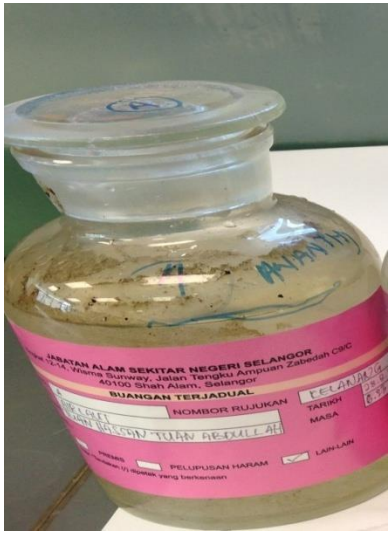
    example: 10ml to 1L water, shake
  - Store in refrigerator at 4°C or below
  - Sample preparation within a week
- Neat oil/oily sediment/oily soil/tarballs
  - Store in refrigerator at 4°C or below

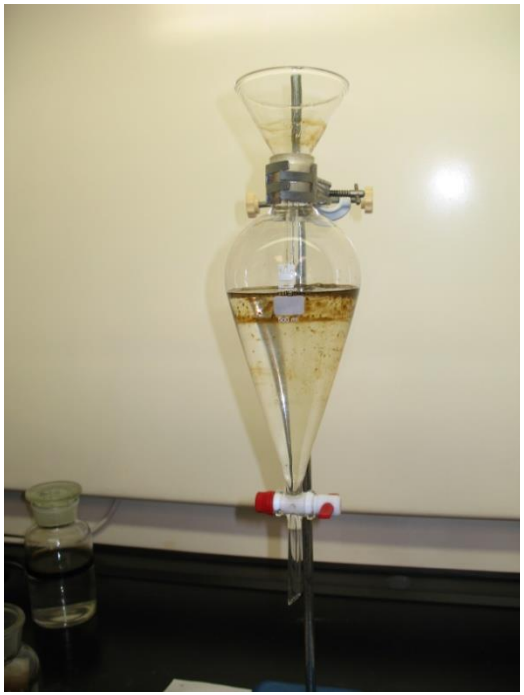
Sample preparation for analysis

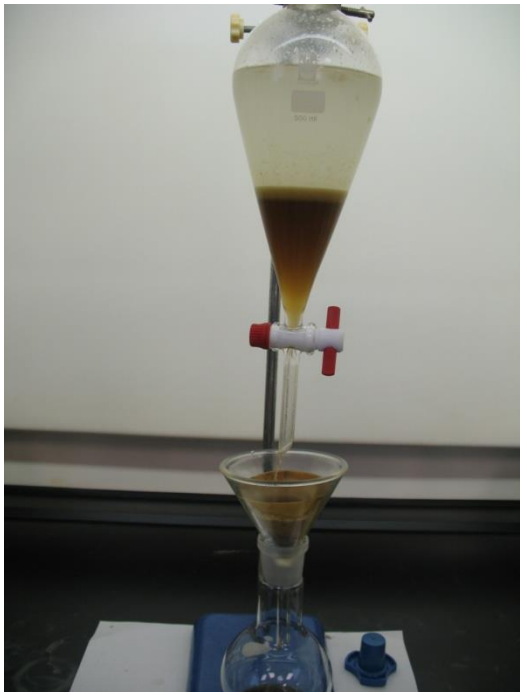
- Visual examination and description of samples
  - Note and record:
    - Colour
    - Odour
    - Viscosity
    - Free water
    - Debris
    - Photography ‘as-received’ condition

Sample preparation for analysis

- Water samples
  - Liquid-liquid extraction





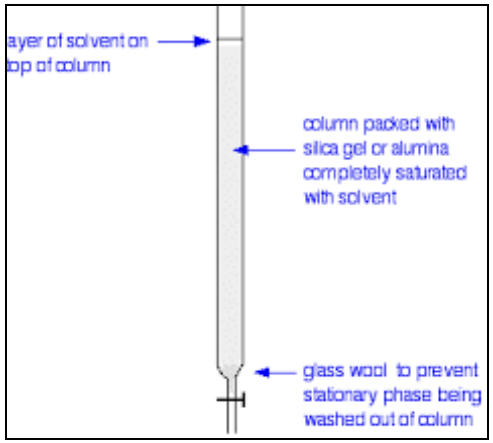


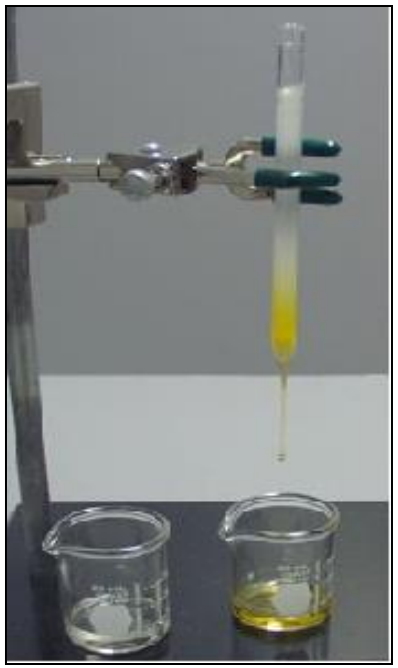
Sample preparation for analysis

- Water samples
  - ETFE net

Sample preparation for analysis

- Sample clean up
  - Minimize matrix interference
  - Remove asphaltenes
  - Soot particles
  - Silica or florisil column





CEN METHOD

- CEN Method: European Committee for Standardization
- Developed by Bonn-OSINET \
  - Group of experts collaborating on oil spill identification
- Improvement of 1991 Nordtest method
- Published in 2006 and 2012

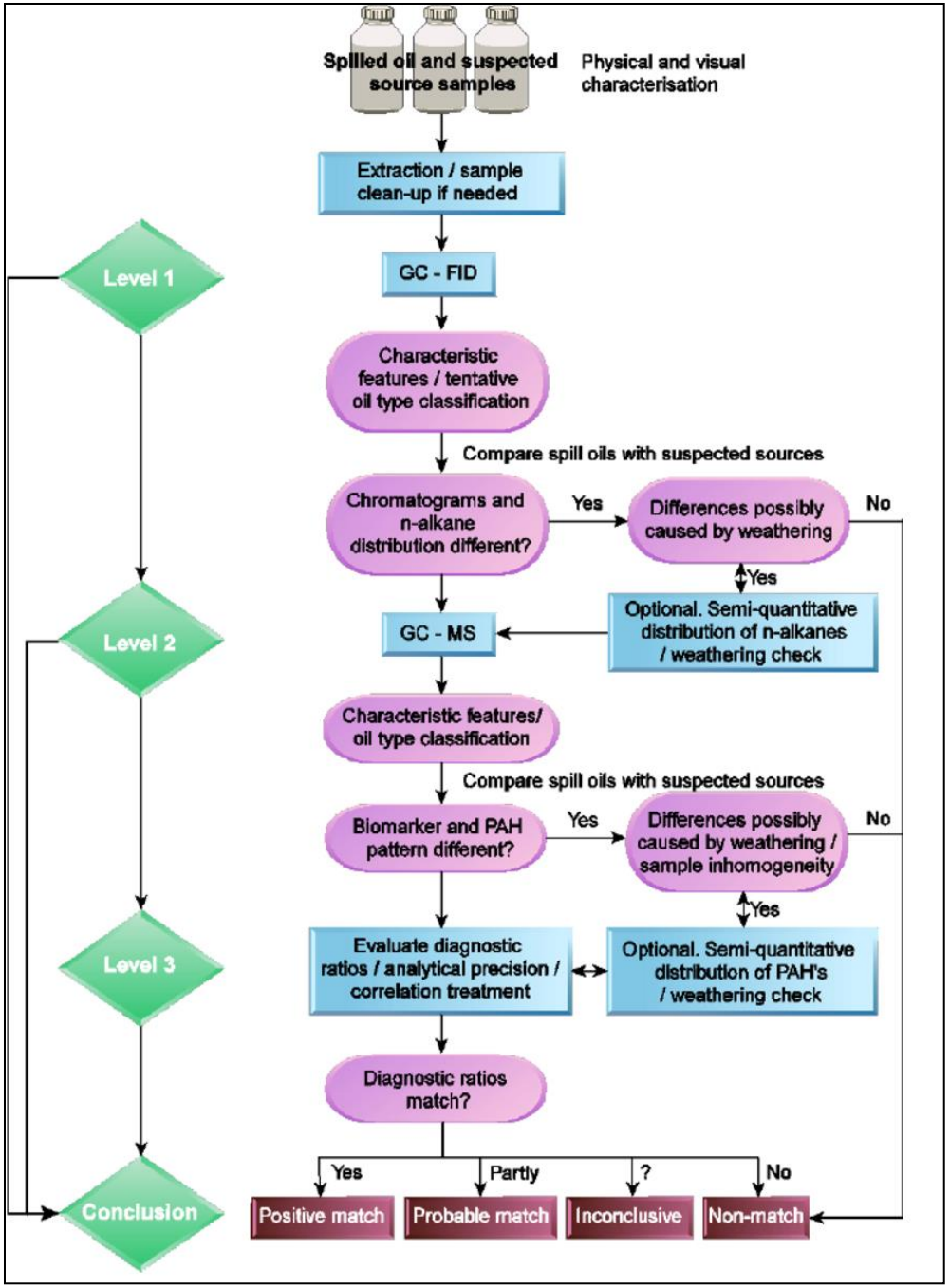
CEN METHOD

- Nordtest used visual comparison
- CEN introduced quantitative compound ratios
- Three level tiered approached
  - Level 1 :GC-FID
  - Level 2 : GCMS
  - Level 3 : Diagnostic ratios

CEN METHOD

Four technically defensible conclusion:

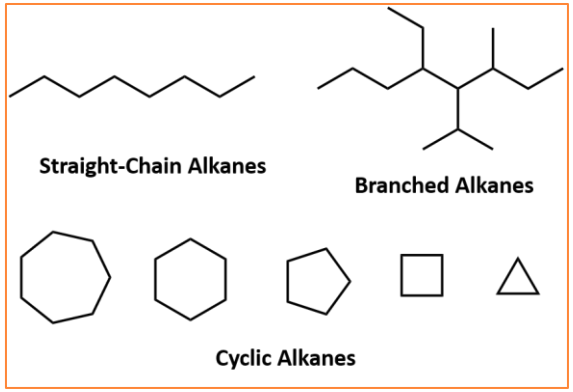
- Positive match
- Probable match
- Inconclusive
- Non-match

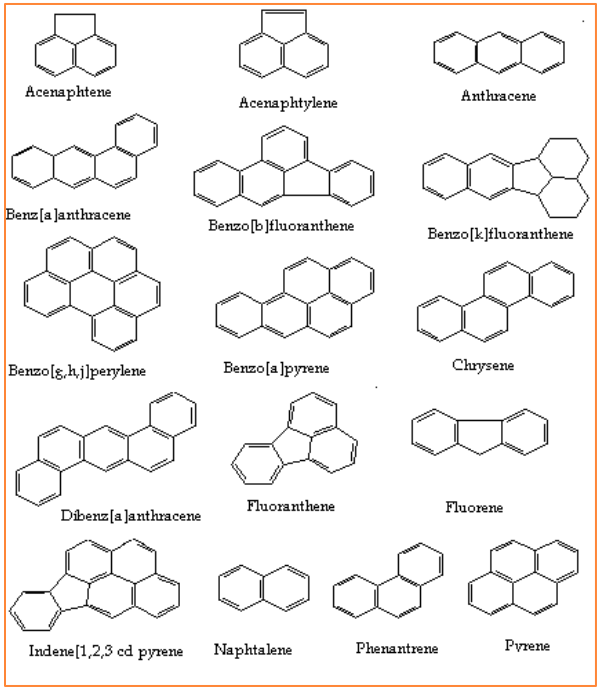


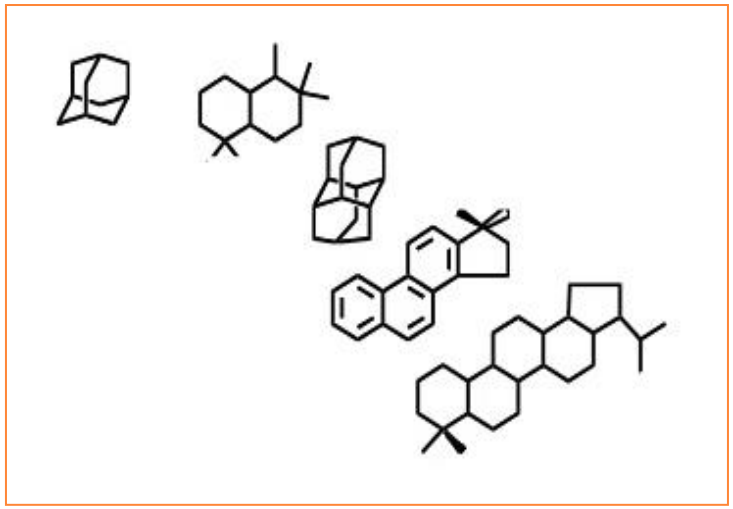
Source: SINTEF

COMPOUNDS OF INTEREST

- ALKANES
- PAHs
- BIOMARKERS







DIAGNOSTIC RATIO

- Diagnostic ratios

A suite of biomarkers (28) that are robust against weathering have been selected to cover genuine differences in oil samples and oil types

Diagnostic ratio		Light fuel oil	Lub oil	Bilge	HFO	Sludge	Crude oil
GC FID							
C17/pr		X		X		X	
C18/Ph		X		X		X	
Pr/ph		X		X		X	
GC MS							
m/z 85	C17/pr	X		X	X	X	X
	C18/ph	X		X	X	X	X
	Pr/ph	X		X	X	X	X
m/z 192	2MP/1MP	X		X	X	X	X
m/z 198	4MDBT/1MDBT	X		X	X	X	X
m/z 216	2MFL/4MPy	X		X	X	X	X
	B(a)F/4MPy	X		X	X	X	X
	B(b+c)F/4MPy	X		X	X	X	X
	2MPy/4MPy	X		X	X	X	X
	1MPy/4MPy	X		X	X	X	X
m/z 234	Retene/TMP	X		X	X	X	X
	BNT/TMP	X		X	X	X	X
m/z 191	27Ts/30ab		X	X	X	X	X
	27Tm/30ab		X	X	X	X	X
	28ab/30ab		X	X	X	X	X
	29ab/30ab		X	X	X	X	X
	30O/30ab		X	X	X	X	X
	31ab/30ab		X	X	X	X	X
	30G/30ab		X	X	X	X	X
m/z 217	27dbR/27dbS		X	X	X	X	X
m/z 218	27bb/29bb		X	X	X	X	X
m/z 231	SC26/RC26+SC27				X	X	X
	SC28/RC26+SC27				X	X	X
	RC27/RC26+SC27				X	X	X
	RC28/RC26+SC27				X	X	X

INSTRUMENT

- Flame ionization detection (GC-FID)
  - Gives indication of the sample type
  - Compares alkanes patterns

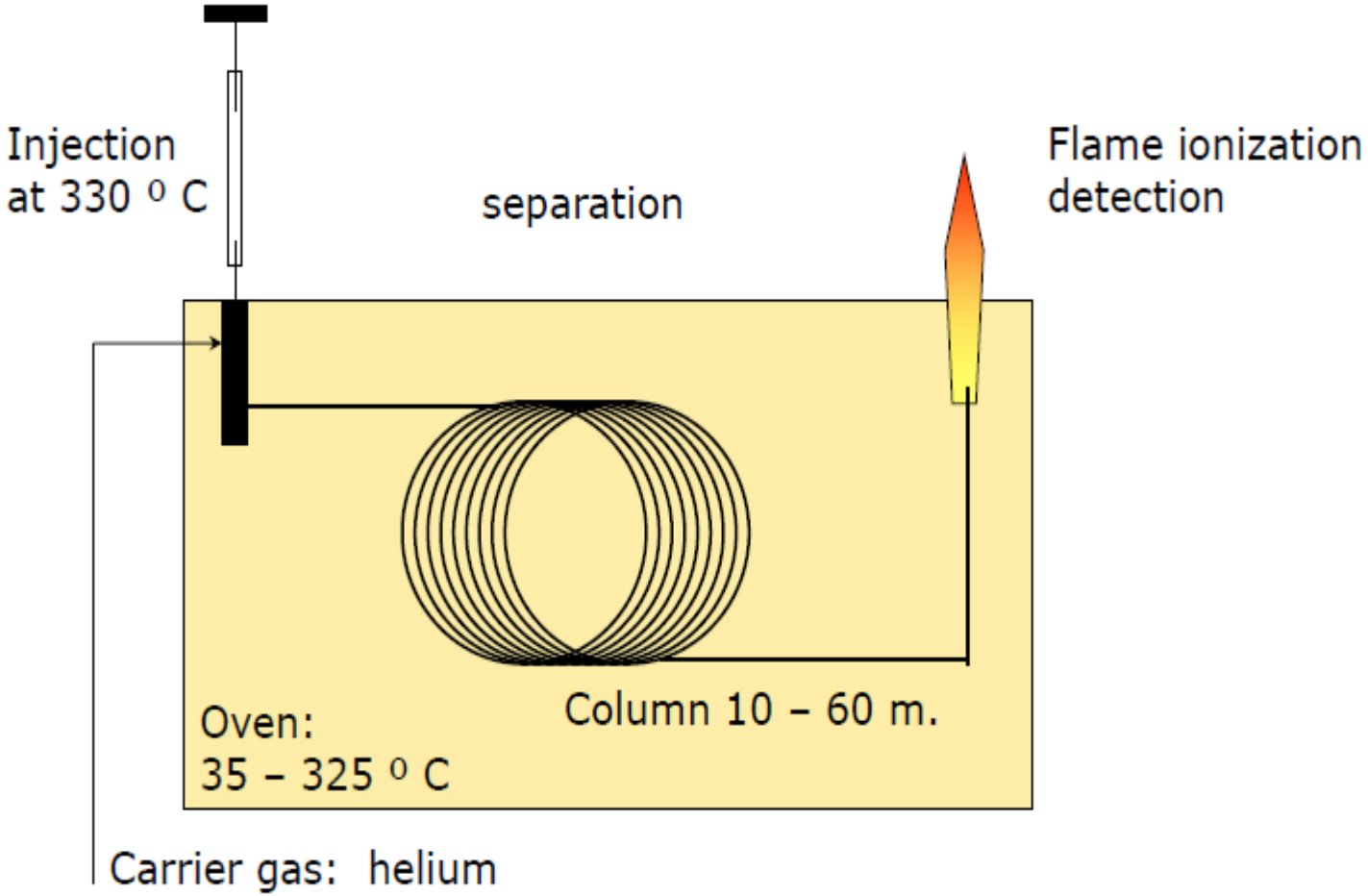
- Mass spectrometry (GC-MS)
  - Detailed information about compounds
  - Compares PAHs and biomarkers patterns

INSTRUMENTS

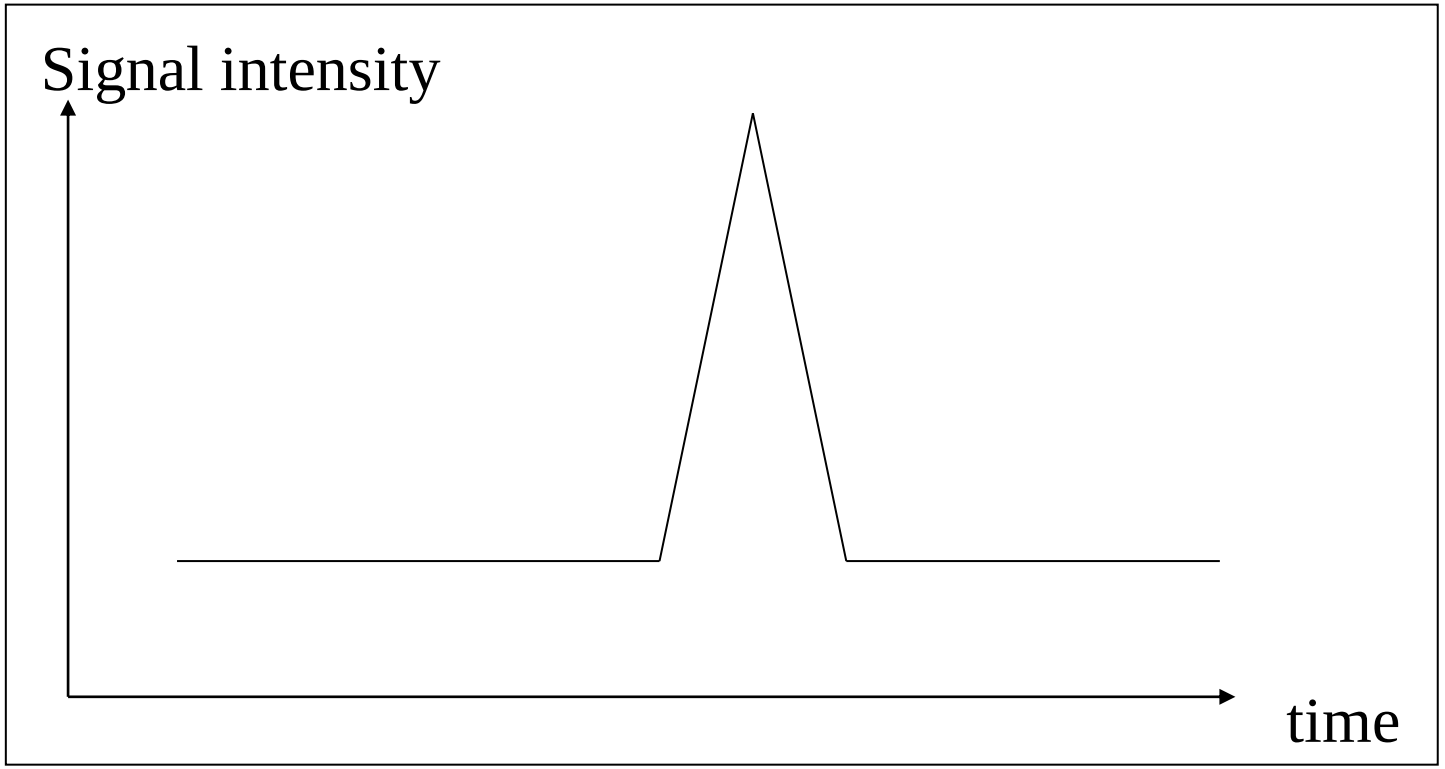
GC-MS

GC-FID

LEVEL 1 : GC-FID

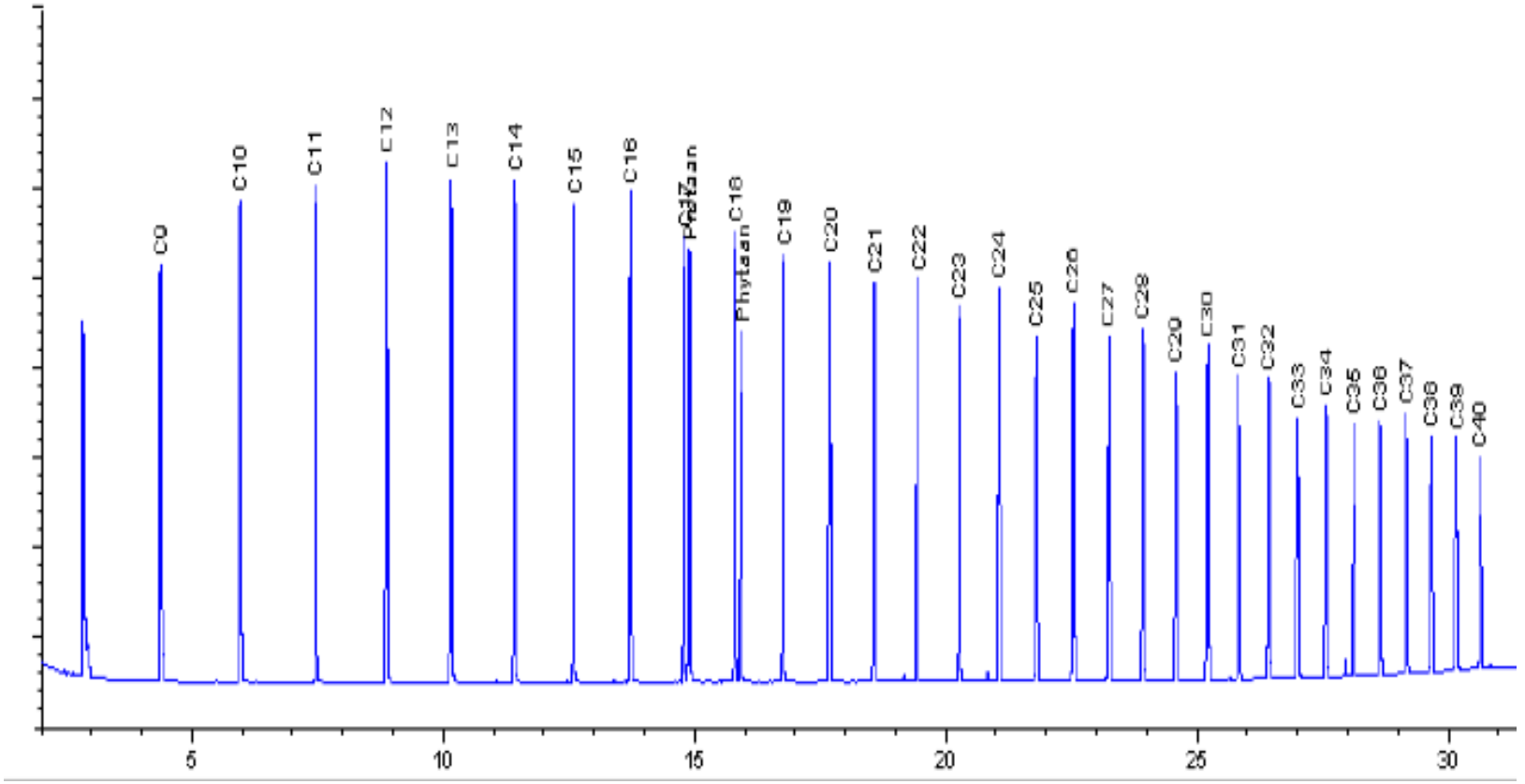


SYSTEM OUTPUT

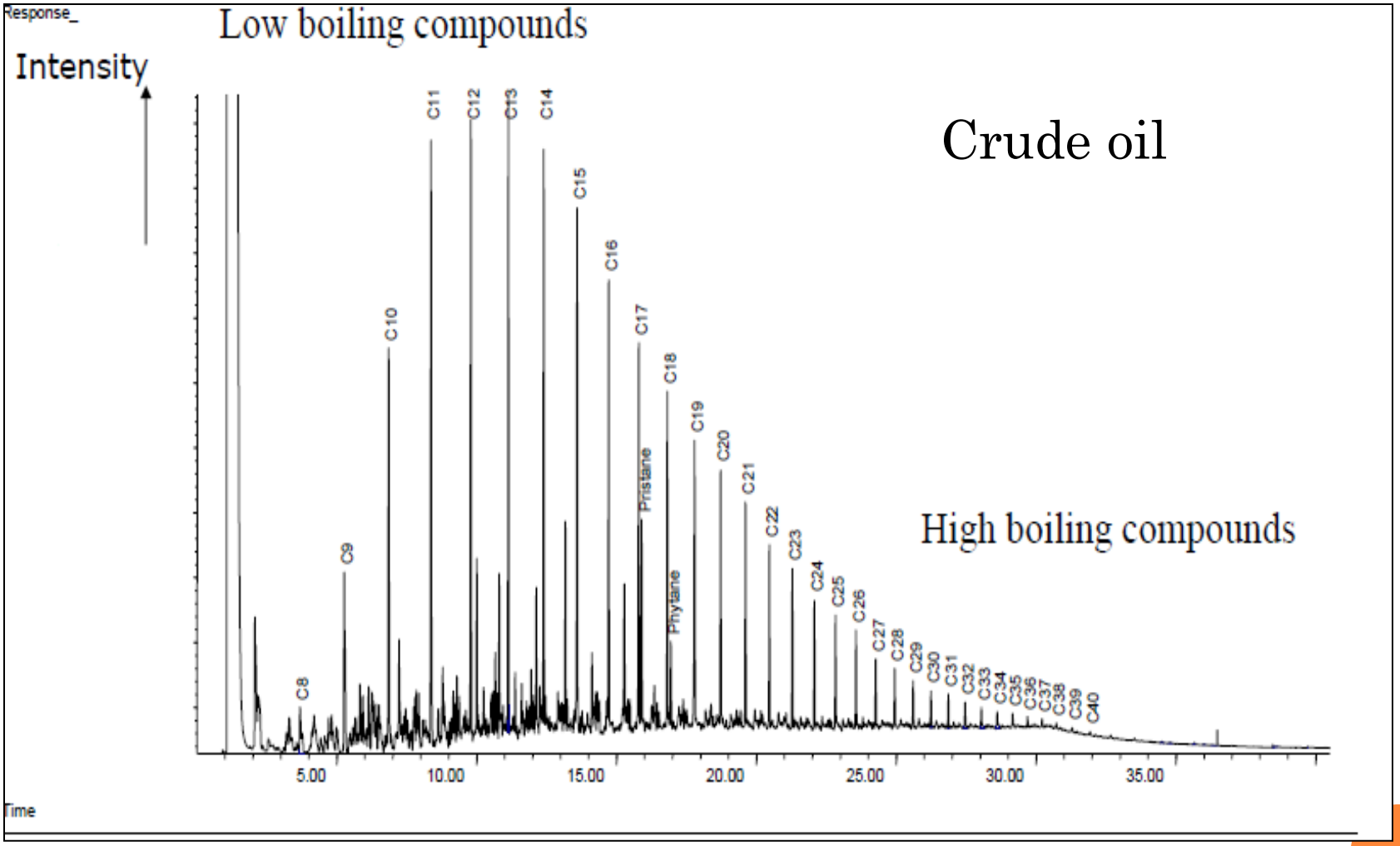


CHROMATHOGRAM

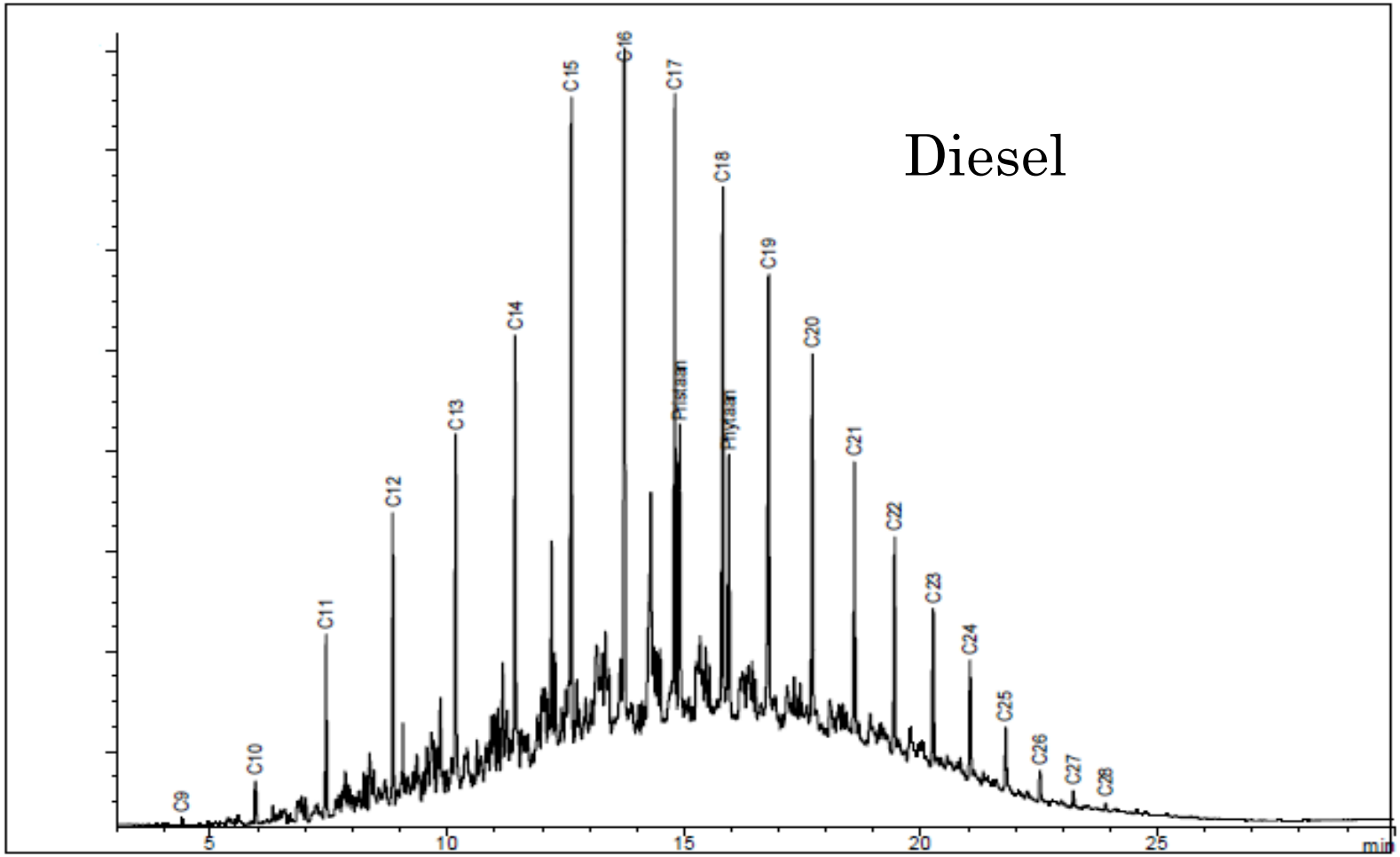
Standard alkane



TYPE OF OIL

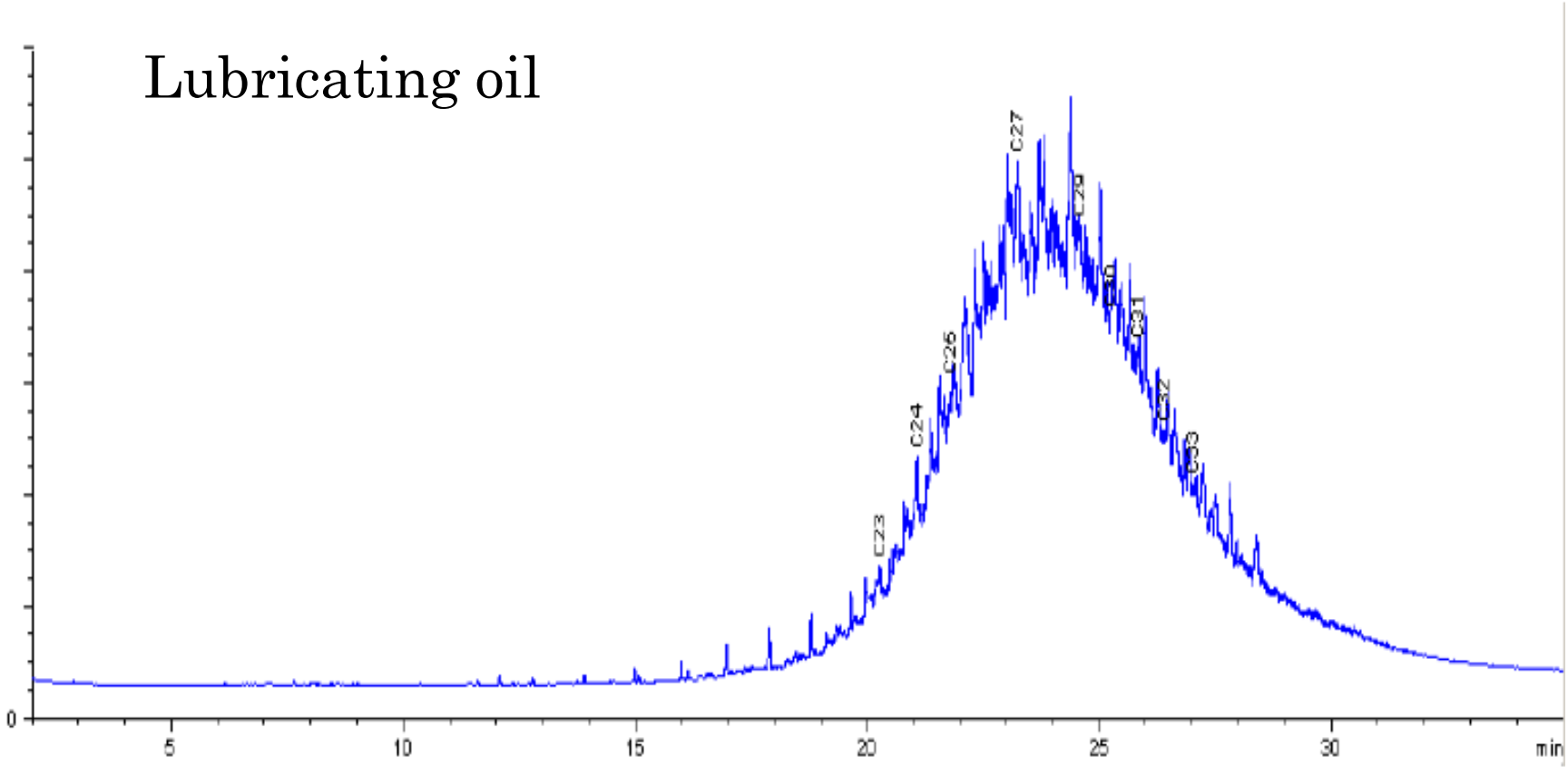

Response_
Intensity
Low boiling compounds
Crude oil
High boiling compounds
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
Pristane
C18
Phytane
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C31
C32
C33
C34
C35
C36
C37
C38
C39
C40
5.00
10.00
15.00
20.00
25.00
30.00
35.00
Time

TYPE OF OIL


Diesel
C9
C10
C11
C12
C13
C14
C15
C16
C17
Pristan
Phytan
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
5
10
15
20
25
min

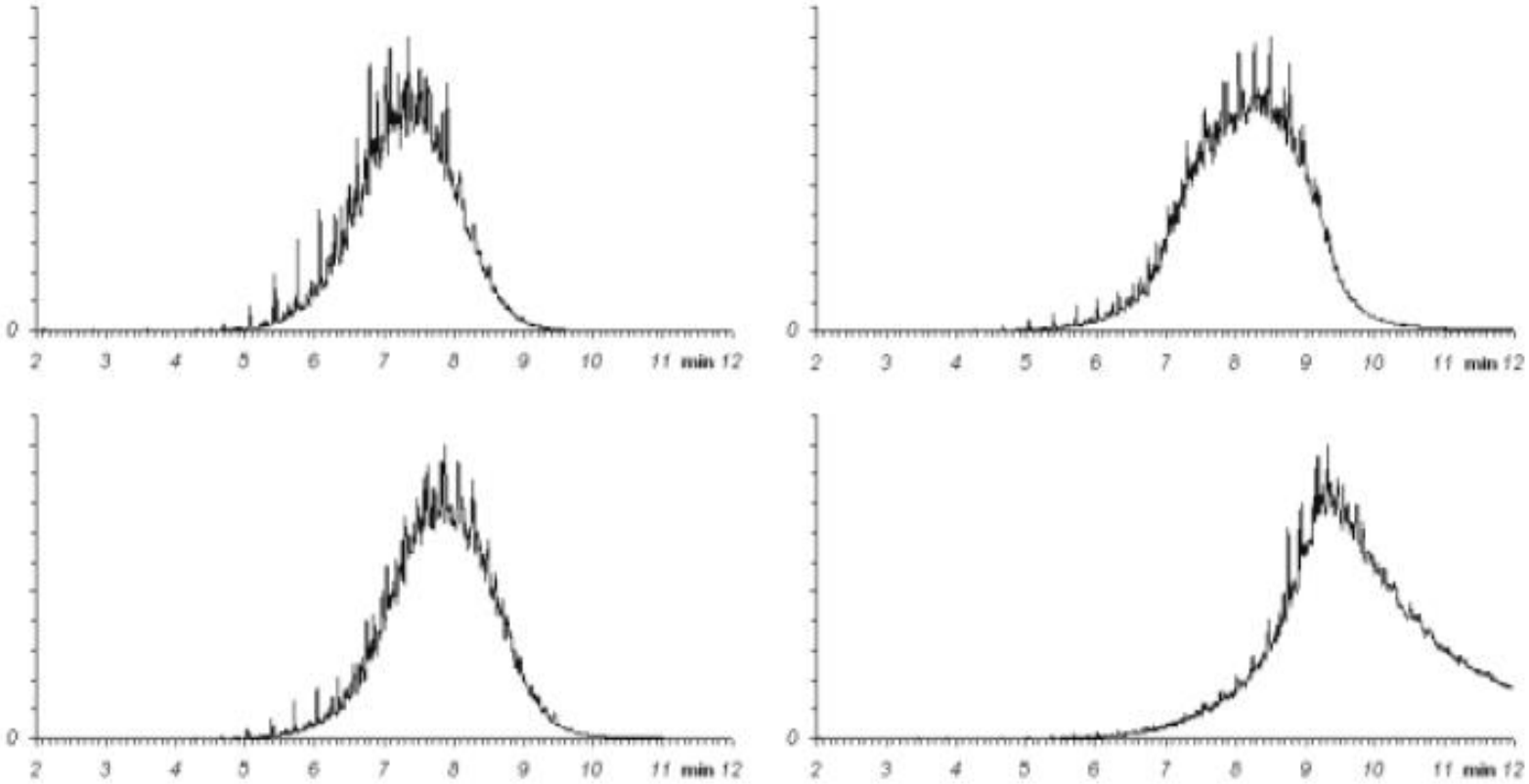
TYPE OF OIL

Lubricating oil

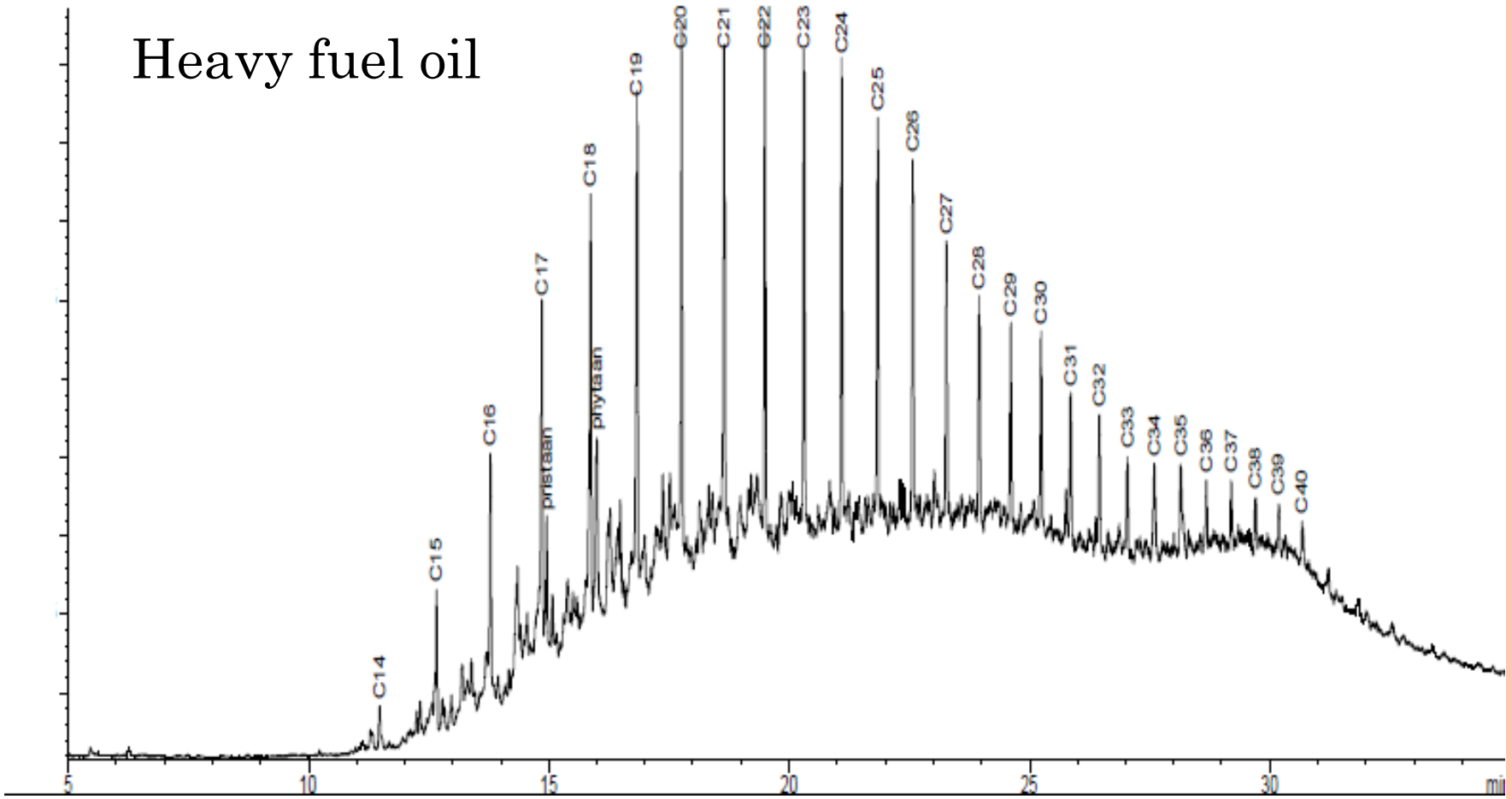


TYPE OF OIL

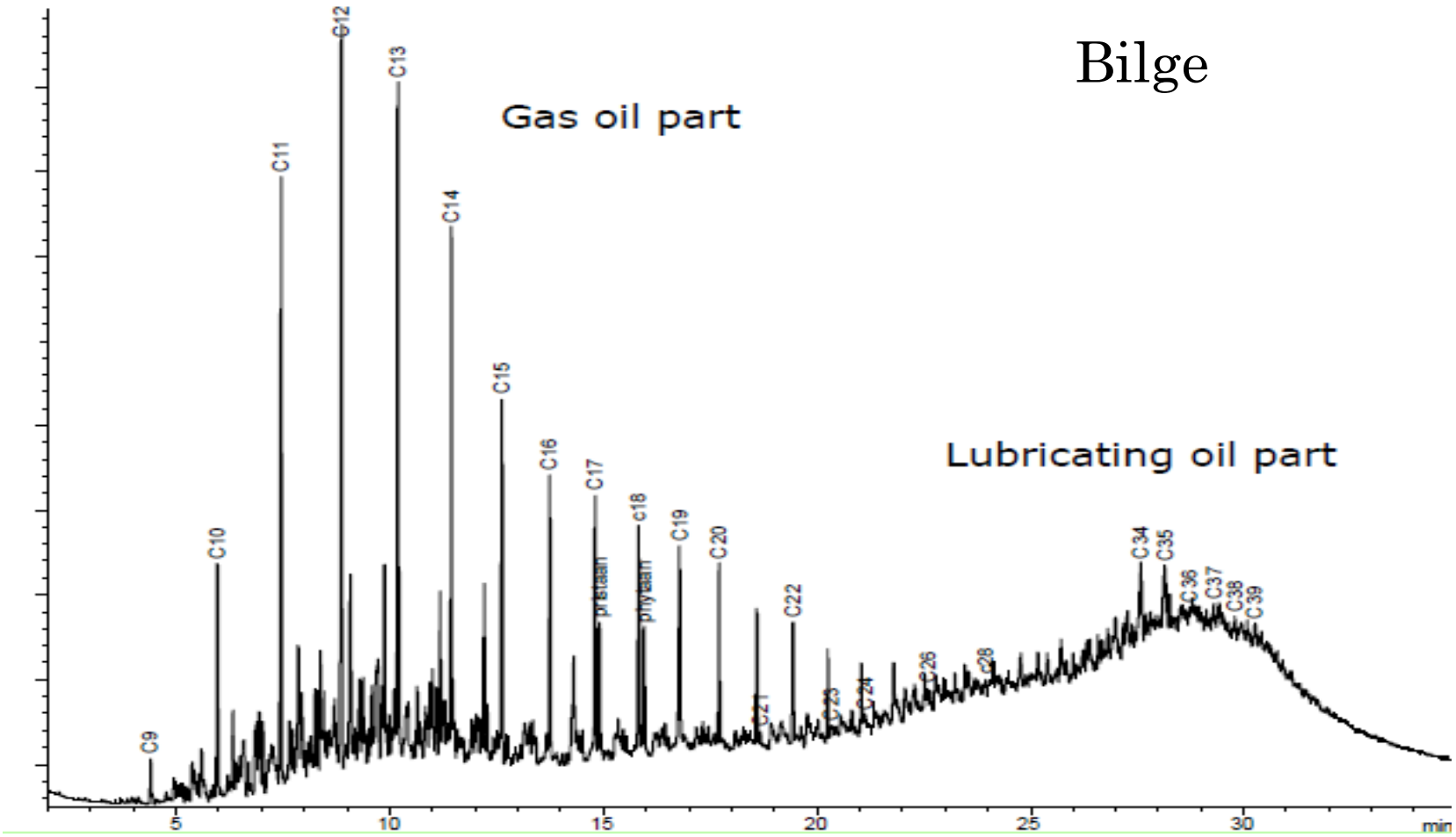
Different types of lubricating oil



TYPE OF OIL

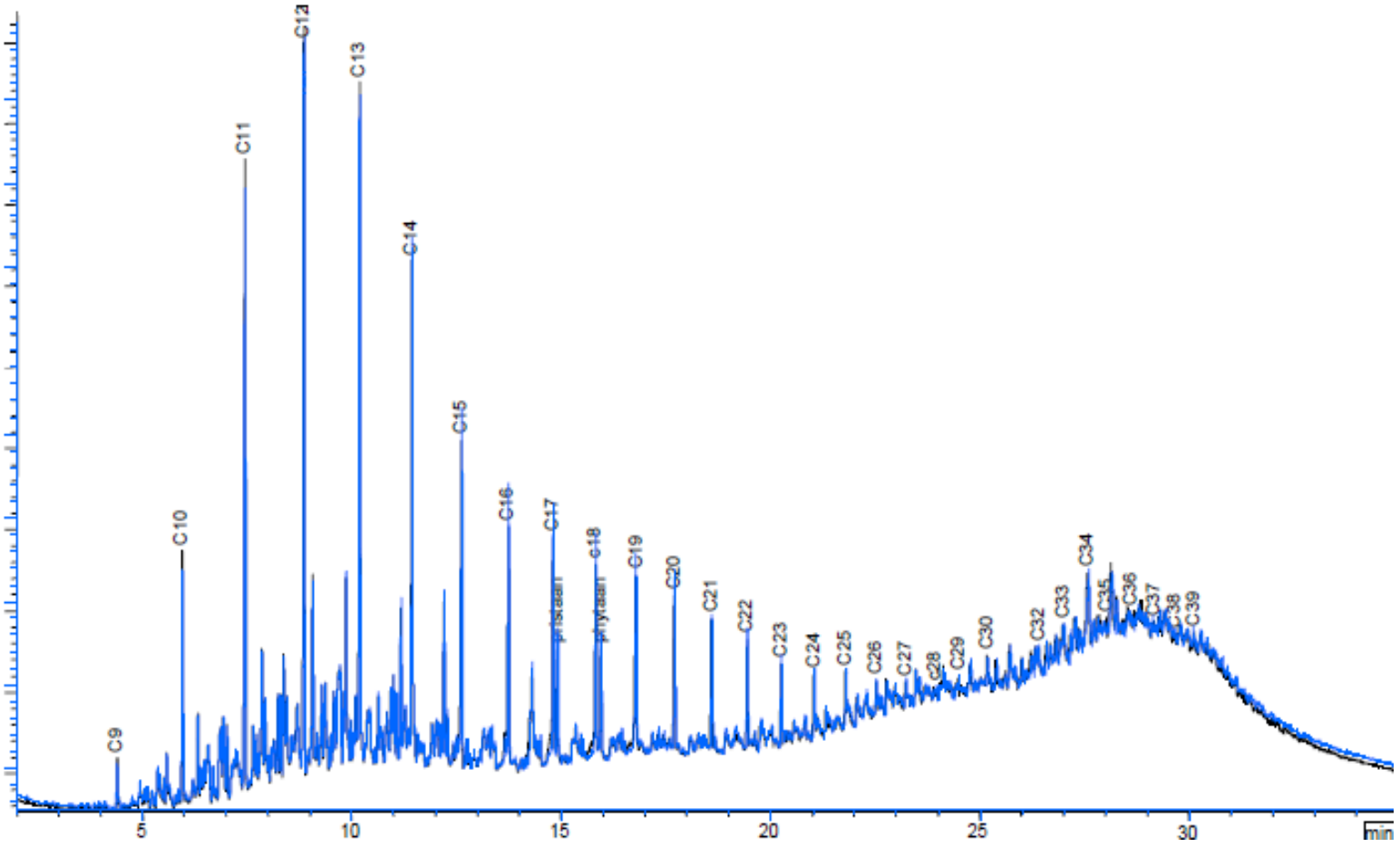

Heavy fuel oil
C14
C15
C16
C17
pristaan
C18
phytaan
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C31
C32
C33
C34
C35
C36
C37
C38
C39
C40
5
10
15
20
25
30
min

TYPE OF OIL

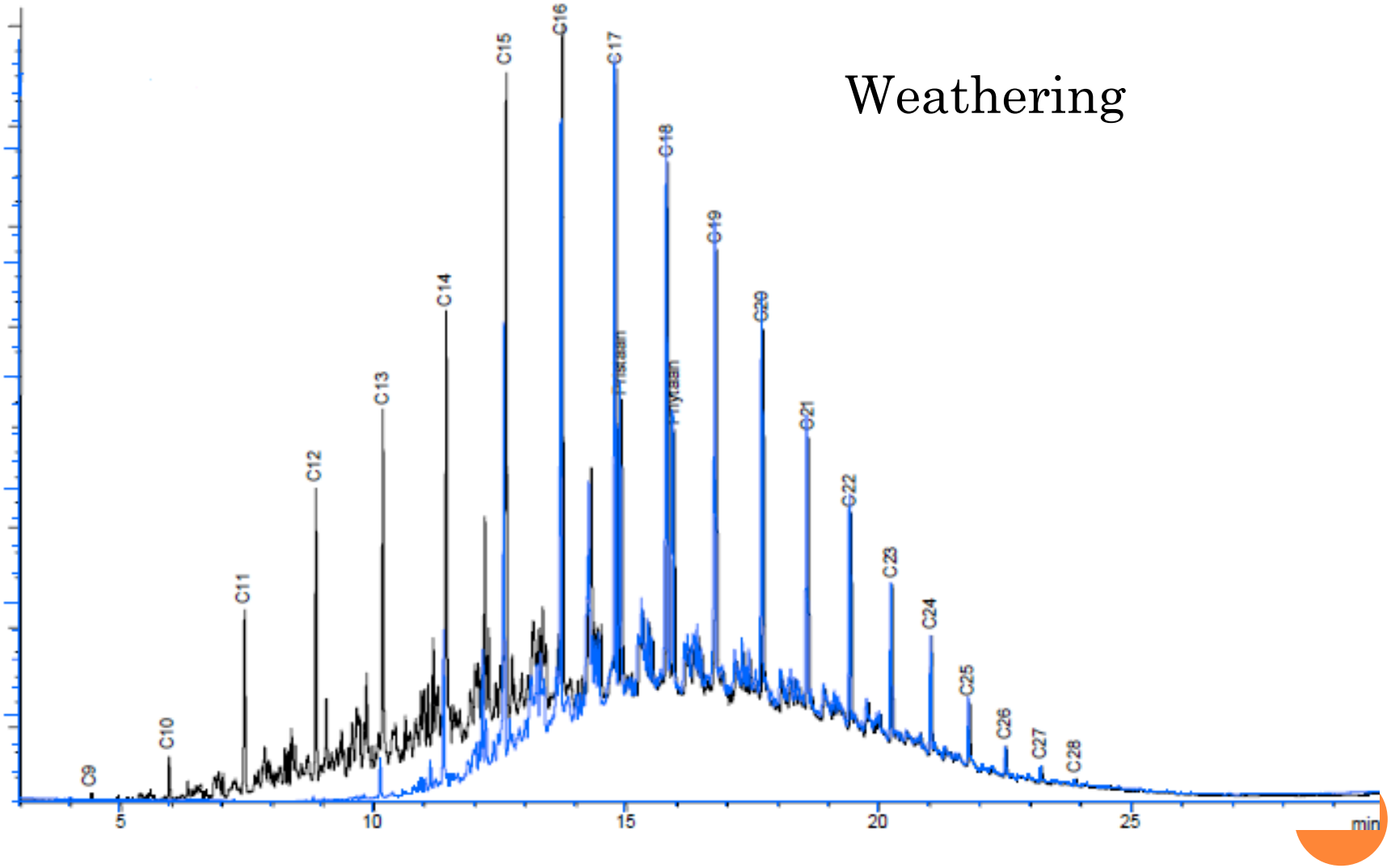

Bilge
Gas oil part
Lubricating oil part
C9
C10
C11
C12
C13
C14
C15
C16
C17
pristaan
c18
phytaan
C19
C20
C21
C22
C23
C24
C26
C28
C34
C35
C36
C37
C38
C39
5
10
15
20
25
30
min

COMPARISON OF OIL

Overlay of a source and spill samples

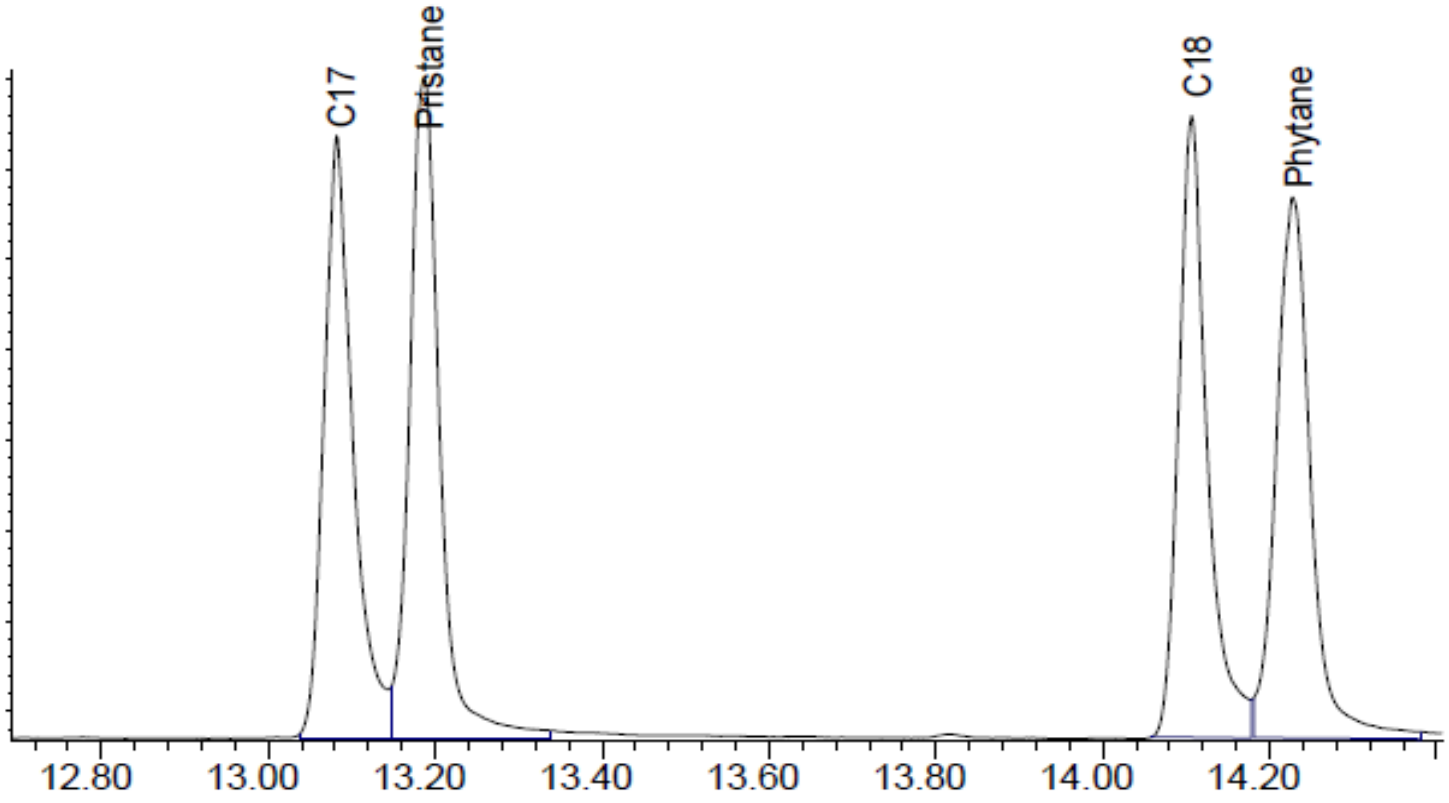


COMPARISON OF OIL



Weathering

INTEGRATION OF PEAKS

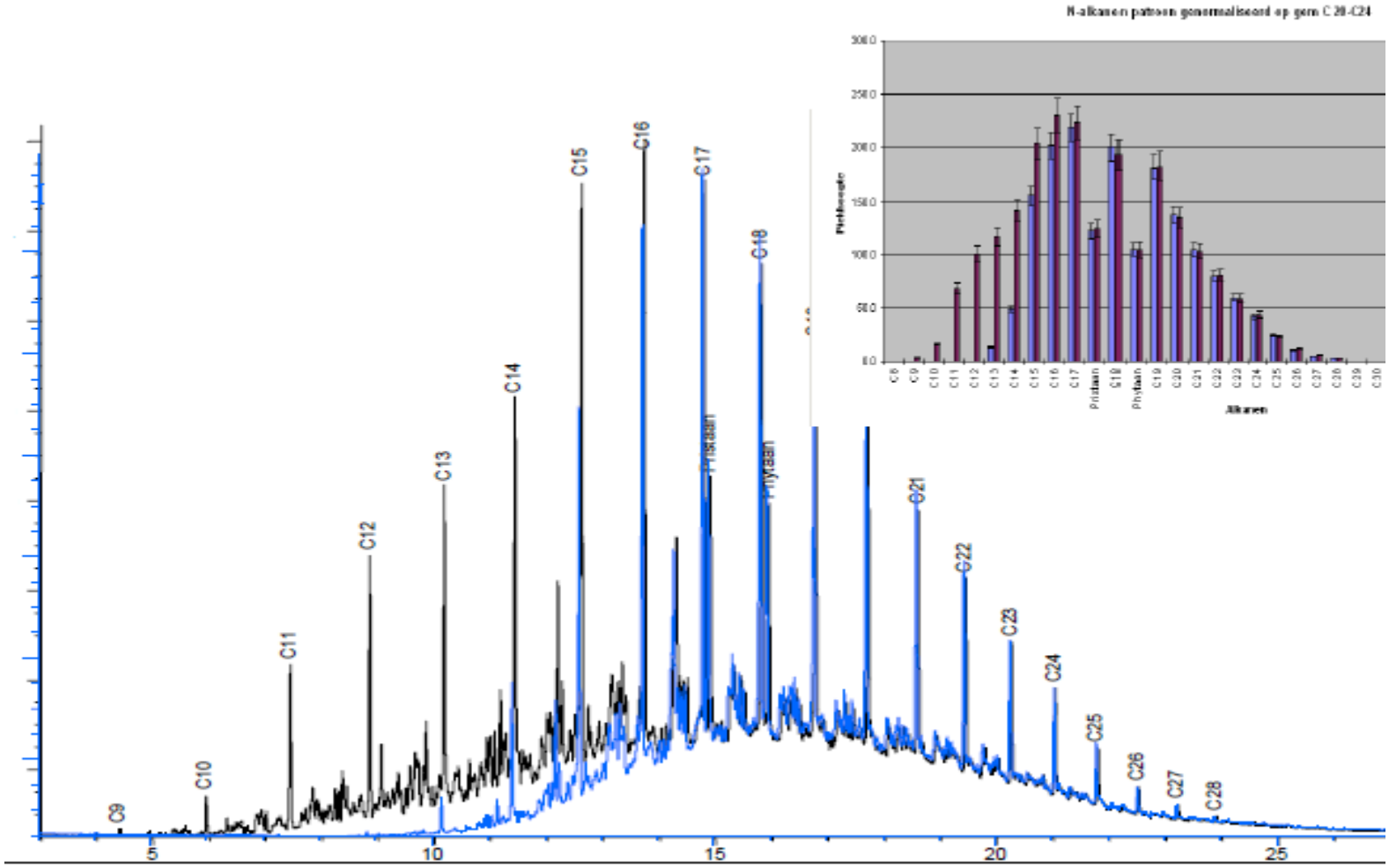


Calculation of peaks area or height

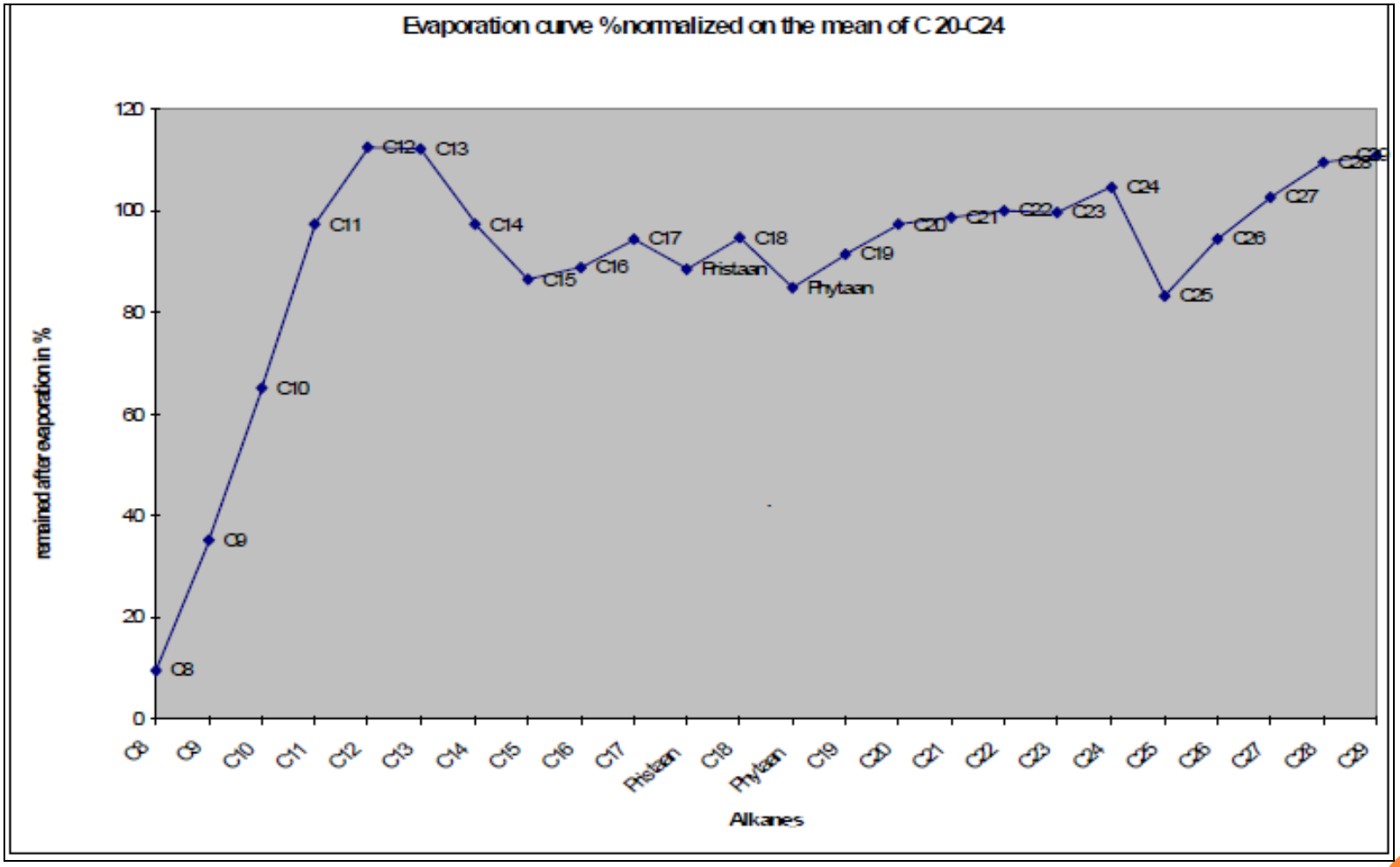
DATA

	Source 2	Source 2 dup		Spill	source		PW-plot calculati	% Spill/Source
	161121-rr16	161121-rr16			normalised		(source-	after normalisation
Alkane	Source 2	source 2	Alkane	Source 2	source 2	Alkane	spill)/source * 100 %	
C8	7389	7120	C8	7389.0	7587.2	C8	3	97
C9	108642	106326	C9	108642.0	113303.2		4	96
C10	234165	220631	C10	234165.0	235108.9	C10	0	100
C11	341101	321418	C11	341101.0	342509.6		0	100
C12	373511	349510	C12	373511.0	372445.1	C12	0	100
C13	426133	397692	C13	426133.0	423788.8		-1	101
C14	455020	433448	C14	455020.0	461891.1	C14	1	99
C15	454633	435124	C15	454633.0	463677.1		2	98
C16	421128	404862	C16	421128.0	431429.3	C16	2	98
norpristan	102210	91287	npri	102210.0	97277.3	npri	-5	105
C17	409233	379533	C17	409233.0	404438.2		-1	101
Pristane	164180	154218	Pristane	164180.0	164337.9	pri	0	100
C18	349341	334827	C18	349341.0	356798.5	C18	2	98
Phytane	150249	140302	Phytane	150249.0	149508.7	phy	0	100
C19	343076	322468	C19	343076.0	343628.5		0	100
C20	323455	303586	C20	323455.0	323507.5	C20	0	100
C21	320115	302709	C21	320115.0	322572.9		1	99
C22	296034	274002	C22	296034.0	291982.2	C22	-1	101
C23	290954	278508	C23	290954.0	296783.9		2	98
C24	273636	253353	C24	273636.0	269978.2	C24	-1	101
C25	267566	251728	C25	267566.0	268246.5		0	100
C26	269302	250768	C26	269302.0	267223.5	C26	-1	101
C27	286101	271009	C27	286101.0	288792.8		1	99
C28	270049	254192	C28	270049.0	270872.2	C28	0	100

WEATHERING


C9
C10
C11
C12
C13
C14
C15
C16
C17
Pristaan
Fytaan
C18
C21
C22
C23
C24
C25
C26
C27
C28
5
10
15
20
25

WEATHERING IN %



RATIOS

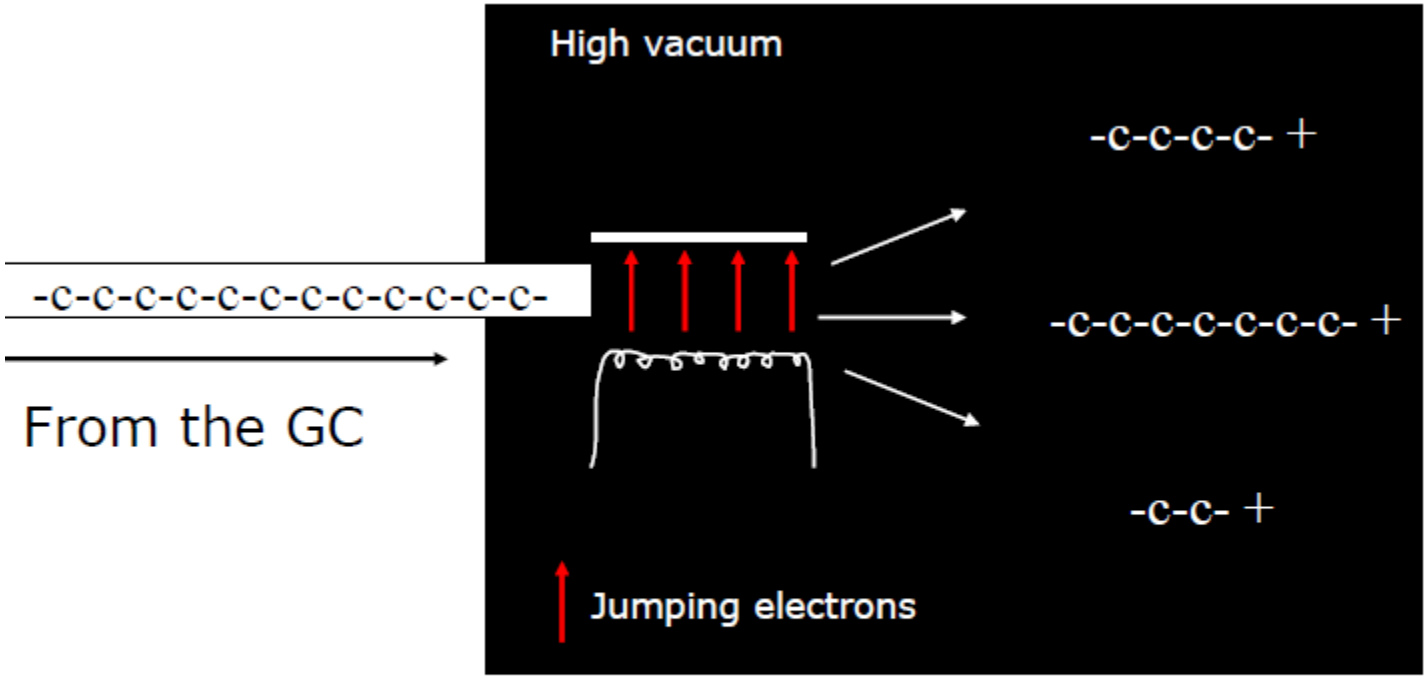
	absolute difference / mean difference*100			
sample comparison	C16/npri	C17/pri	C18/phy	pri/phy
Source 1 - Source 2	34.4	1.2	7.6	35.7
Source 1 - Source 3	18.1	44.5	28.3	61.4
Source 2 - Source 3	16.6	43.4	20.8	27.2
Source 1 - Spill	12.7	44.4	29.9	52.6
Source 2 - Spill	22.0	43.2	22.5	17.7
Source 3 - Spill	5.5	0.2	1.7	9.6

Assumption: Differences < 14% is caused by analysis
=> no significant difference

SUMMARY

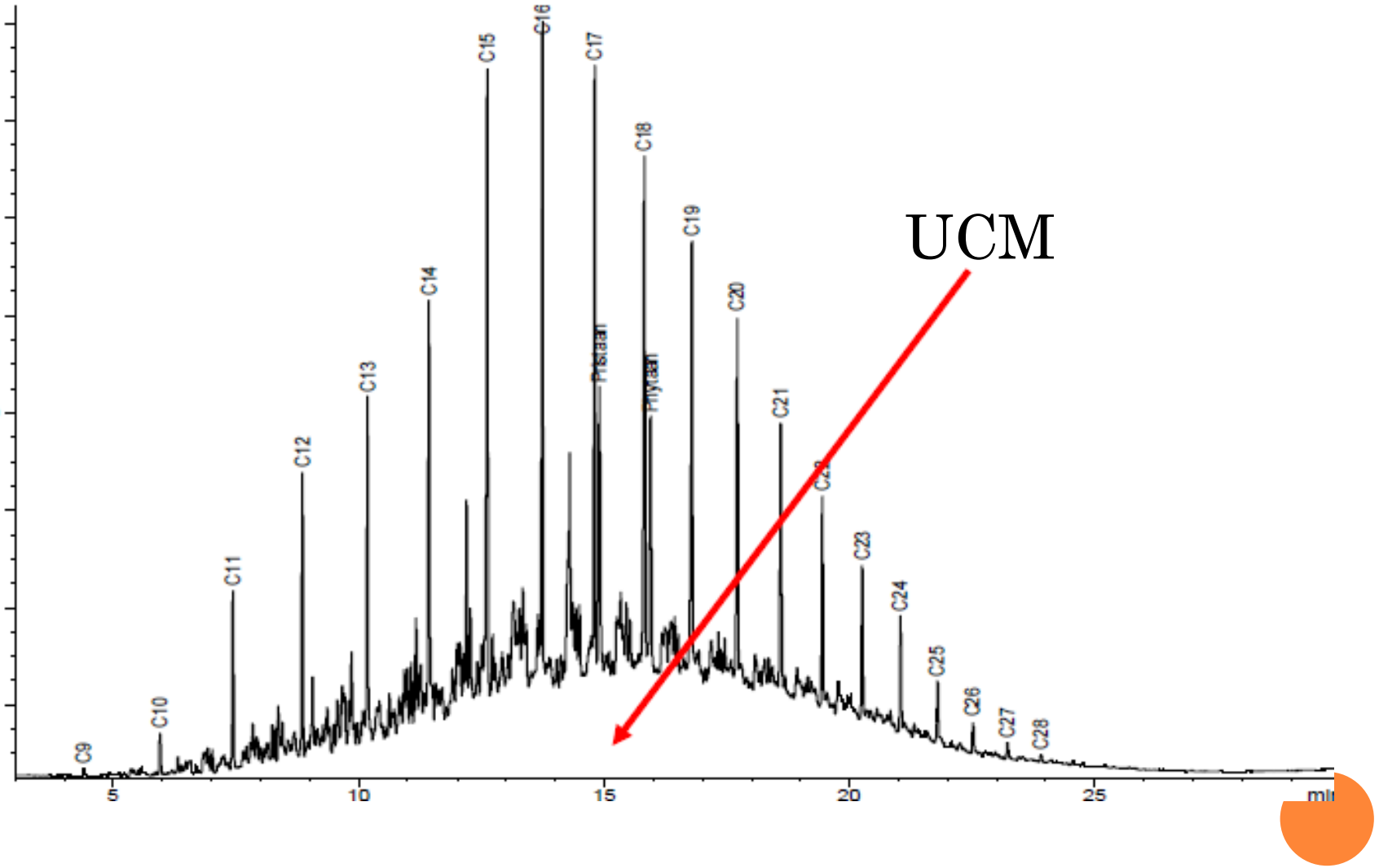
- Type of oil
- Comparison of chromatograms
- Weathering
- Comparison of ratios

LEVEL 2 : GC-MS

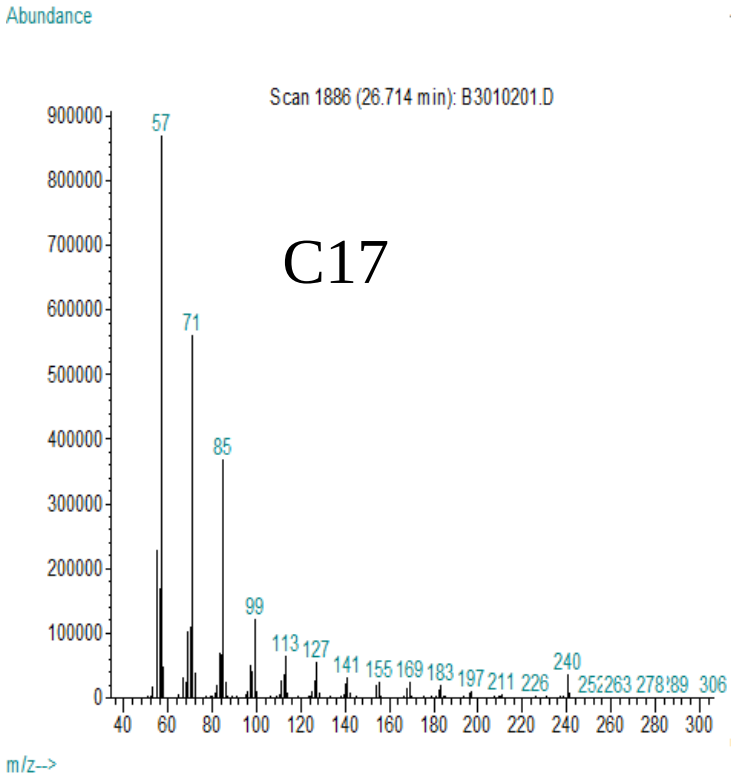


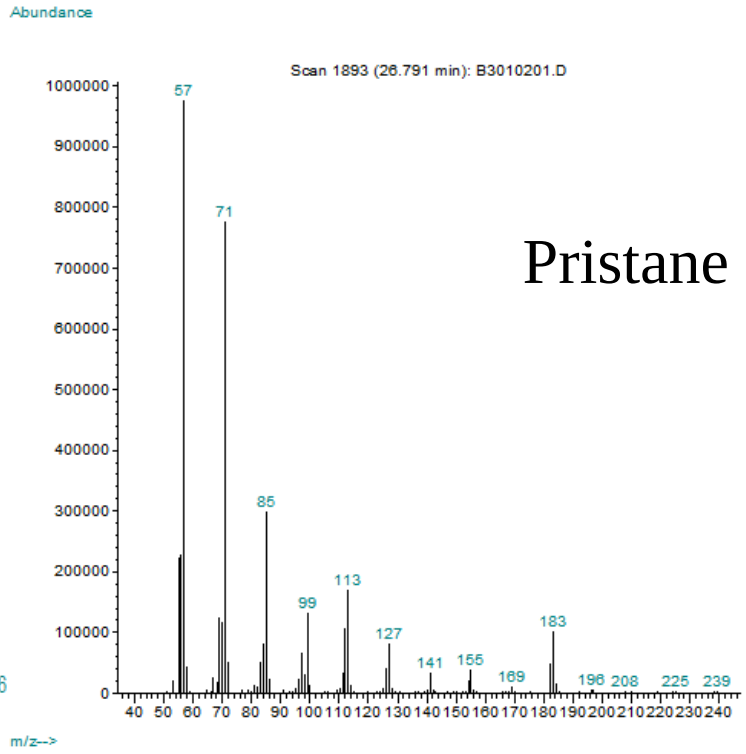
Analysis of charged fragments

DIESEL

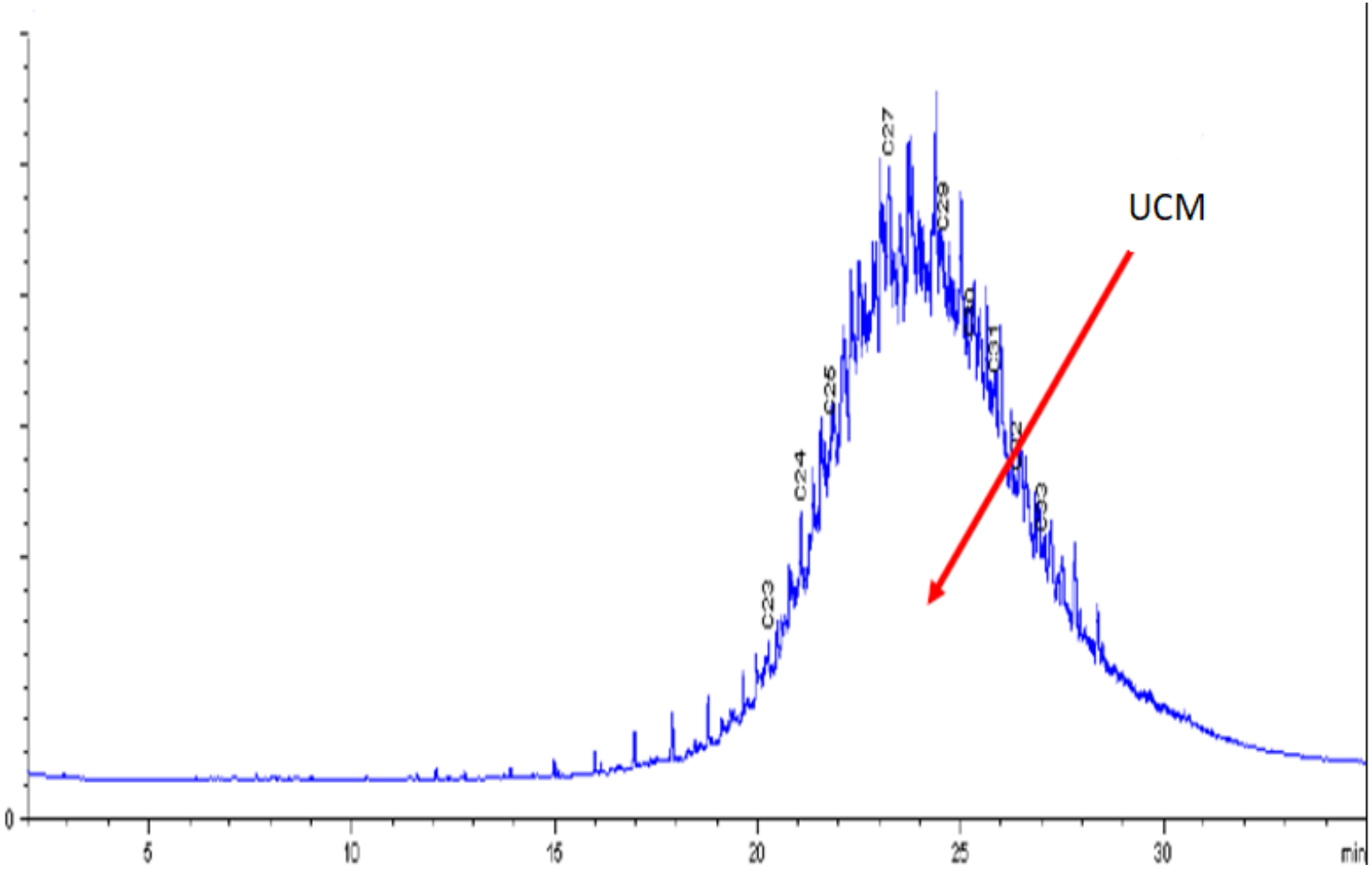

UCM
C9
C10
C11
C12
C13
C14
C15
C16
C17
Pristaan
Phytaan
C18
C19
C20
C21
C23
C24
C25
C26
C27
C28
5
10
15
20
25

Mass spectrum

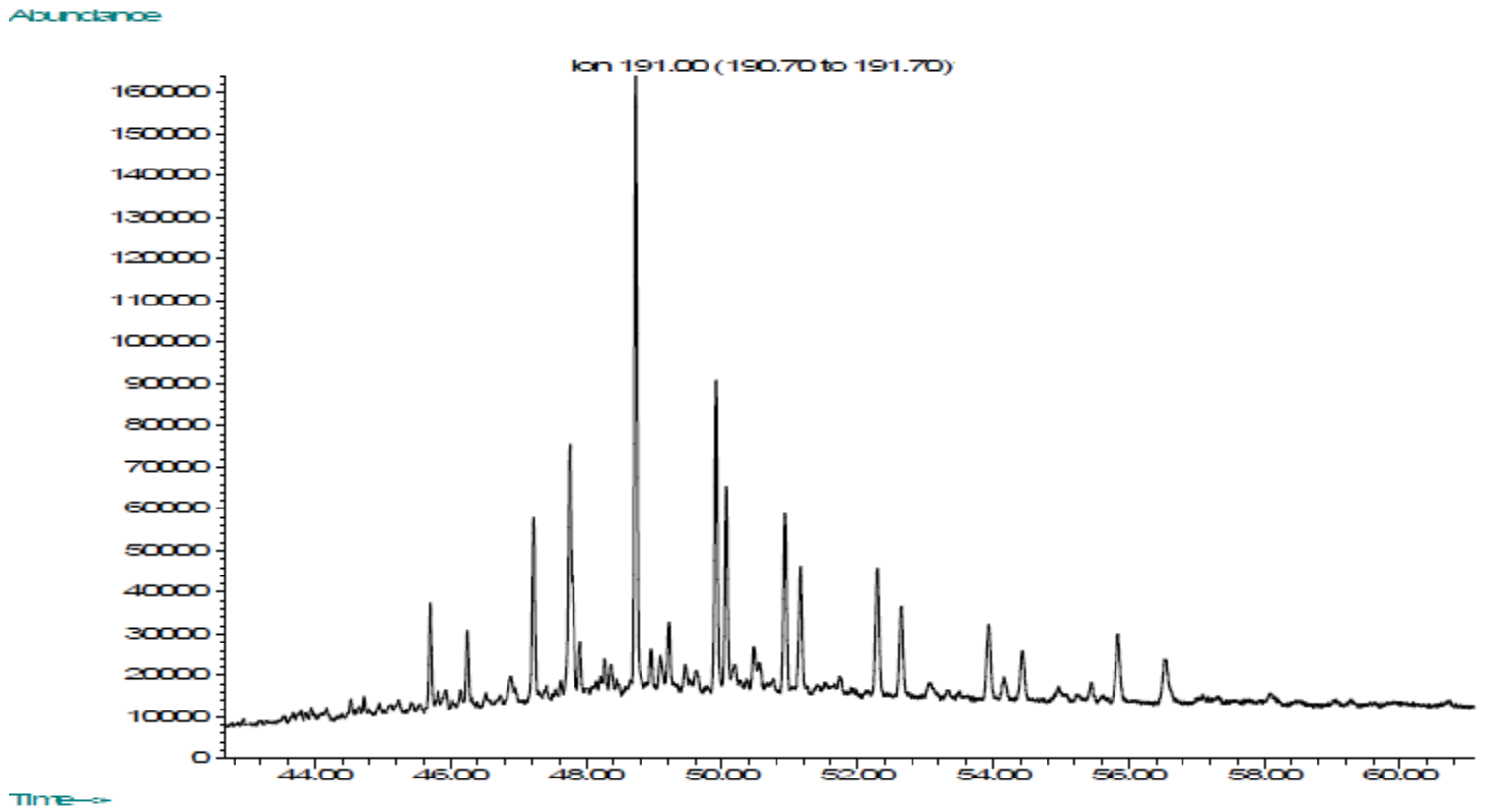




Lubricating oil

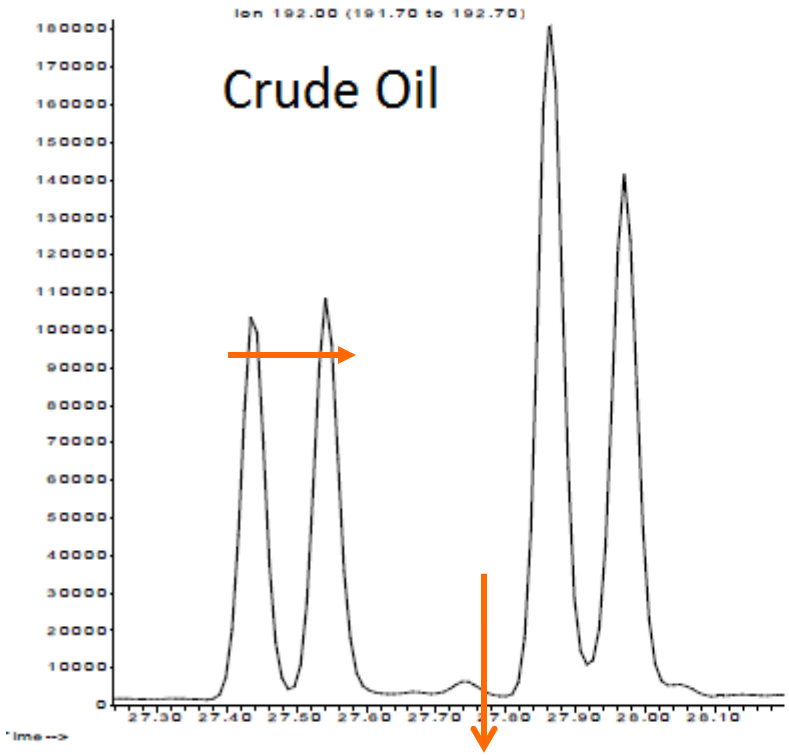


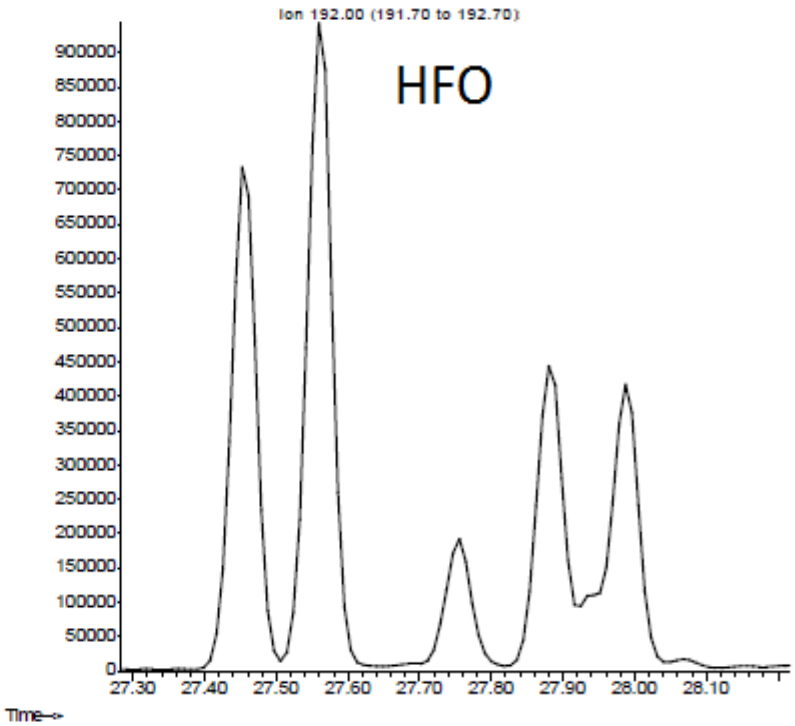
Biomarker ion m/z 191



Plot of mass over time => chromatogram

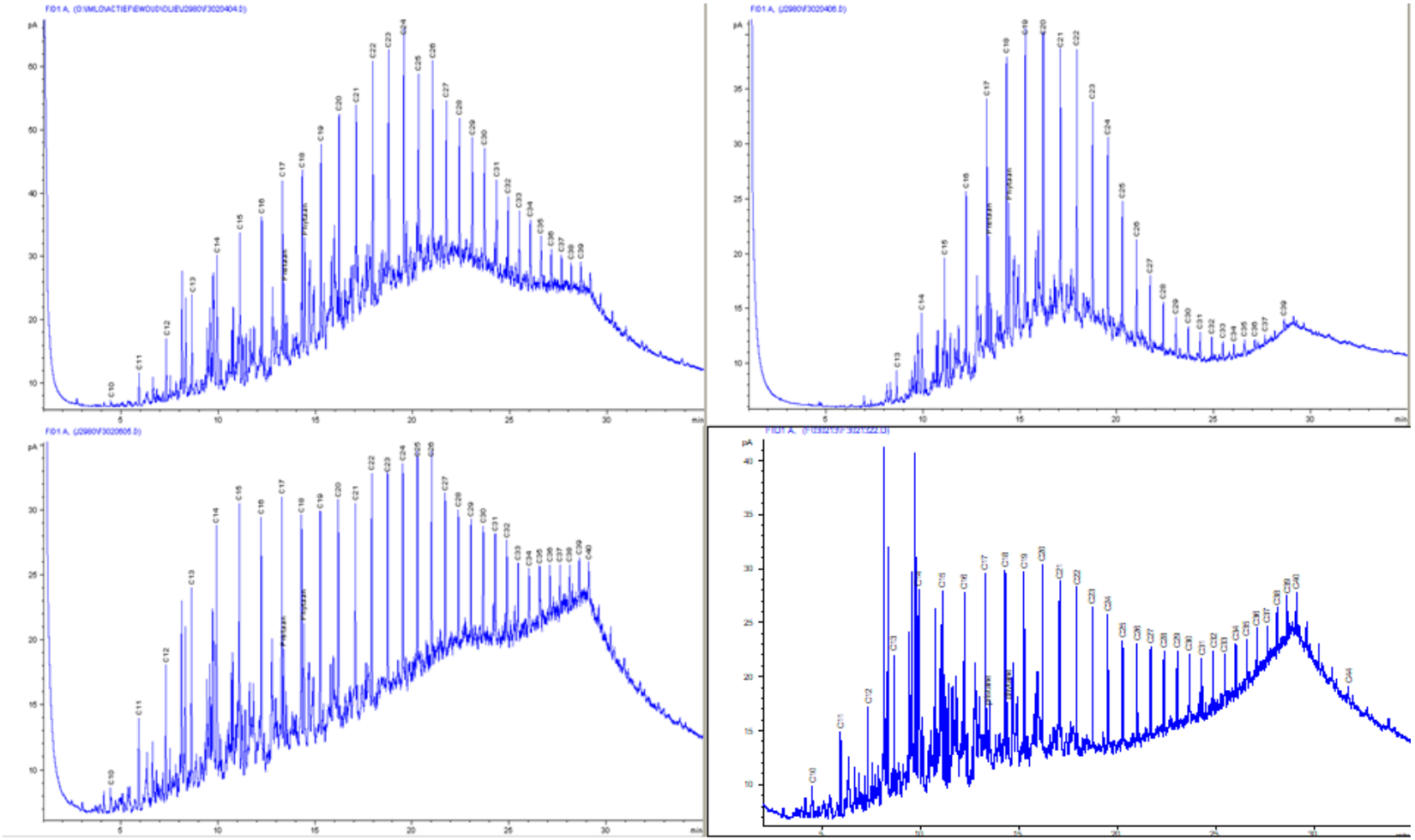
PAHS



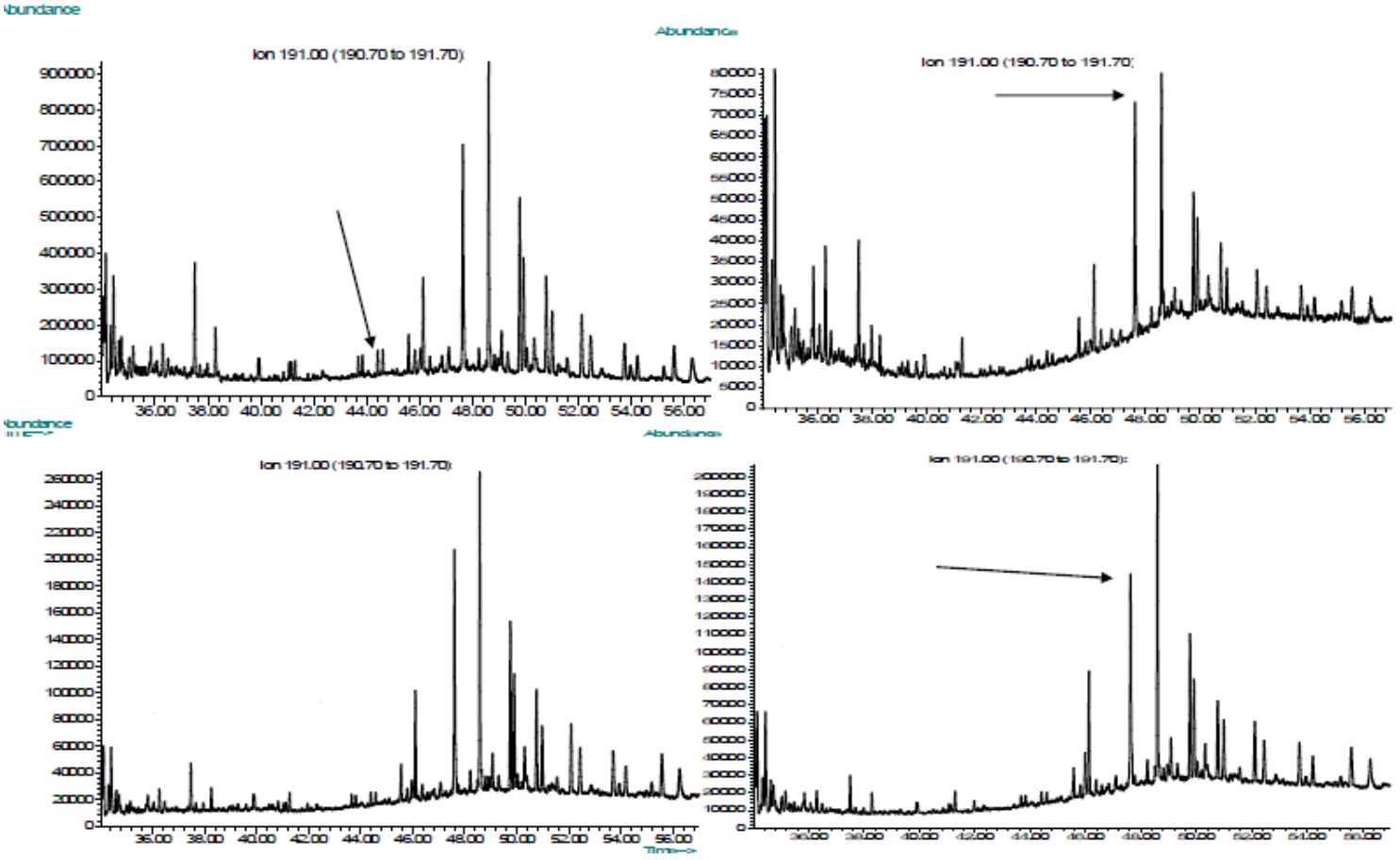


Methyl phenanthrene and methylantracene
One of the differences between crude oil and HFO

Crude oil



Biomarker ion m/z 191

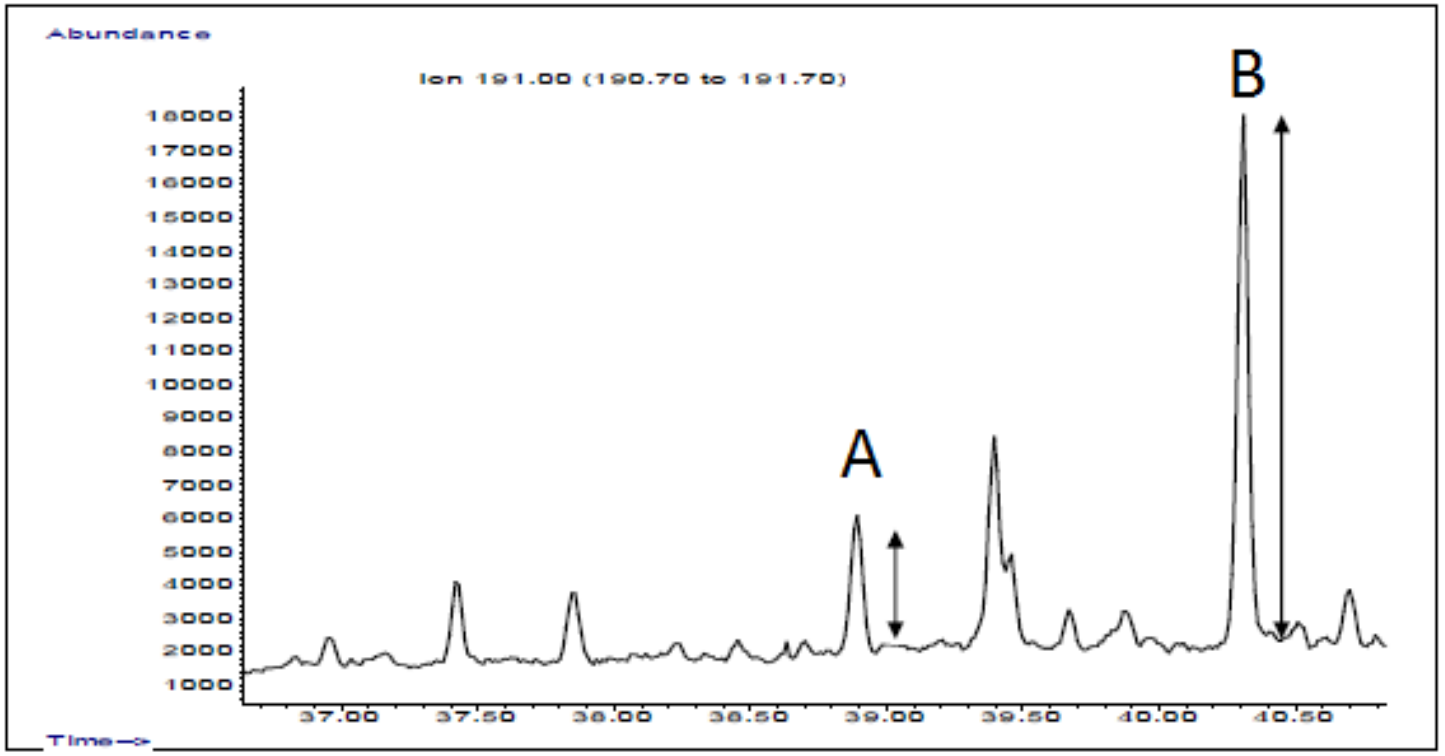


LEVEL 3: DIAGOSTIC RATIO

Minimum of 36 compounds are integrated

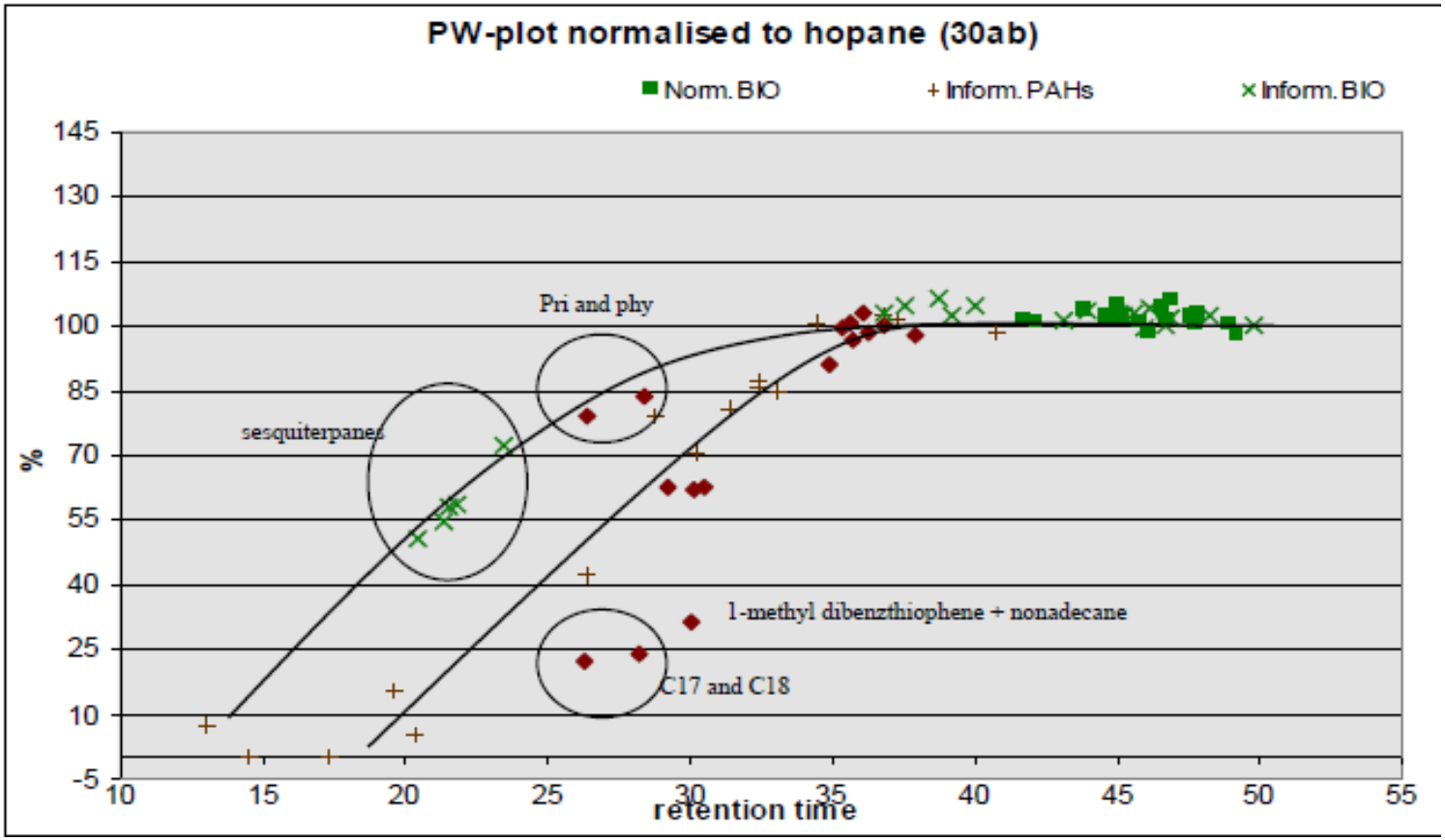
Ratio calculated:

A/B * 100%



WEATHERING PLOT

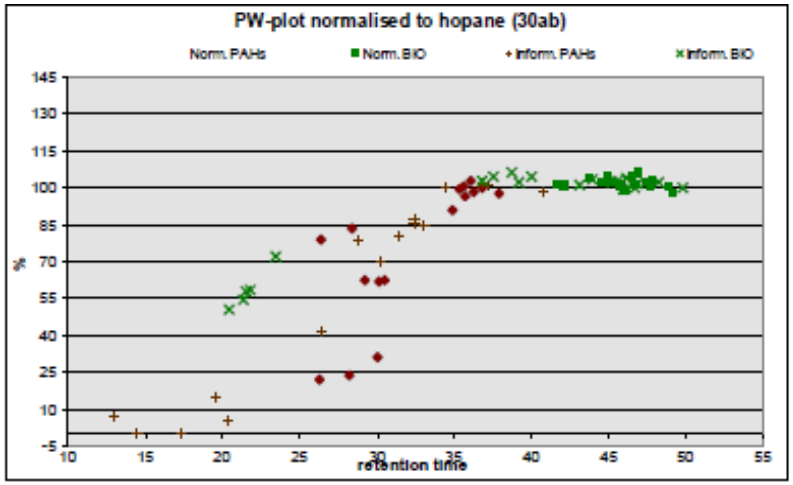
- Evaporation, dissolution and biodegradation have different effect
- No weathering effect after 35 min

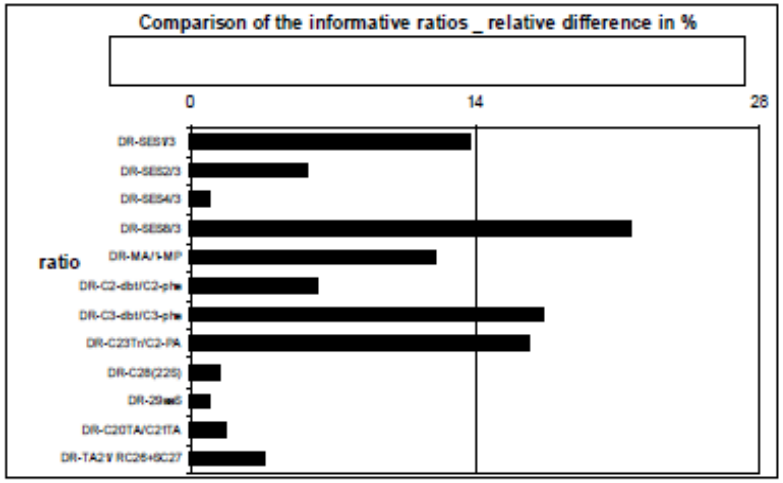


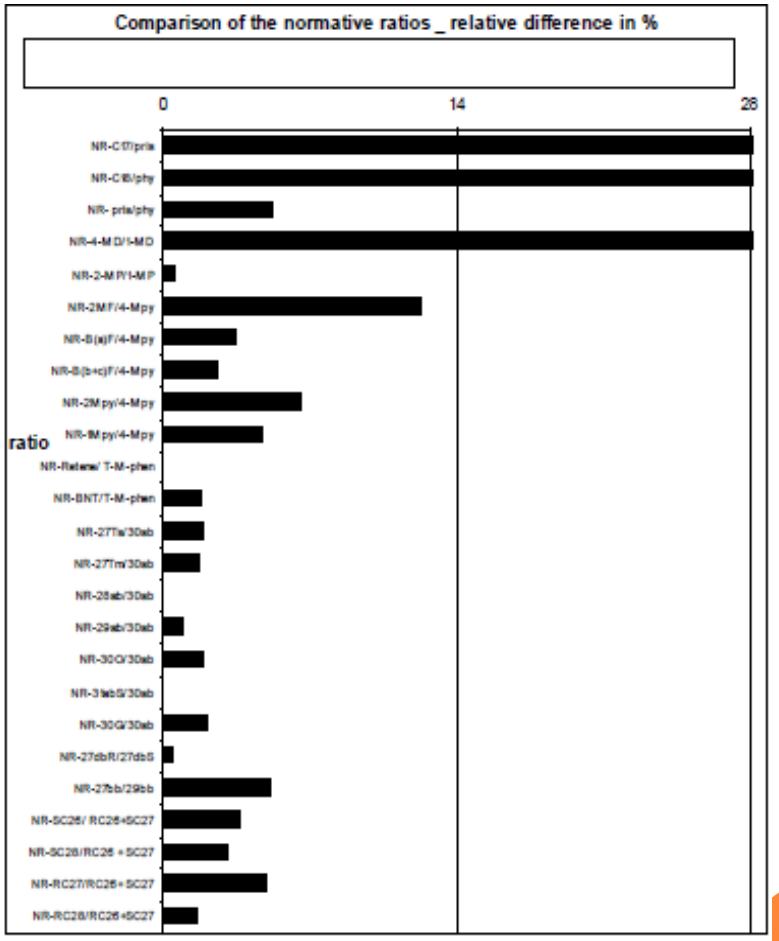
PEAK RATIOS

Diagnostic ratios	mean sample 1	mean sample 3	mean	absolute difference	repeatability based on RSD 5%	flag
					14	0
BaF-4MP%	45.75	45.96	45.86	0.21	6.42	
BbF-4MP%	34.56	37.33	35.94	2.77	5.03	
Retene/C4-phe%	0.00	0.00	0.00	0.00	0.00	
2-MP/1-MP%	66.91	65.48	66.19	1.43	9.27	
C2-dbt/C2-phe%	36.12	32.93	34.52	3.20	4.83	
C3-dbt/C3-phe%	41.42	39.49	40.45	1.93	5.66	
4-MD/1-MD%	80.20	77.83	79.02	2.38	11.06	
C3-dbt/C3-chr%	83.71	84.79	84.25	1.08	11.80	
C23tri-30ab%	46.02	45.18	45.60	0.84	6.38	
C24tri-30ab%	29.00	27.71	28.36	1.28	3.97	
C25tri-30ab%	25.34	24.04	24.69	1.30	3.46	
C24tetra-30ab%	0.00	0.00	0.00	0.00	0.00	
C28+C29 tri-30ab%	29.07	29.69	29.38	0.62	4.11	
C28tri-30ab%	18.40	18.55	18.47	0.16	2.59	
C29tri-30ab%	15.56	16.28	15.92	0.71	2.23	
27Ts/27Tm%	43.75	45.24	44.49	1.49	6.23	
28ab/30ab%	0.00	0.00	0.00	0.00	0.00	
25nor30ab/30ab%	0.00	0.00	0.00	0.00	0.00	
29ab/30ab%	43.78	44.44	44.11	0.67	6.18	
29Ts/30ab%	14.53	15.11	14.82	0.58	2.08	
30d/30ab%	6.77	6.00	6.38	0.77	0.89	
30O/30ab%	0.00	0.00	0.00	0.00	0.00	
30g/30ab%	13.32	12.51	12.91	0.81	1.81	

COMBINATION OF INFORMATION - WEATHERING AND RATIO







SUMMARY

- Separate compounds that not separated by GC-FID
  - Visual comparison of ion patterns
  - Identification of oil type
  - Comparison of peak patterns
  - Weathering effects
    - Spill and source sample

SUMMARY

- Oil spill identification is a ‘fingerprinting’ technique
- Samples are exactly compared
- Comparison based on stable compounds
- Weathering can be estimated

PT OIL SPILL IDENTIFICATION

BONN AGREEMENT
Oil Spill Identification
Network of Experts

- JKM participated in Round Robin 2015, 2016 and 2017
- 31 laboratories form 22 countries participated.

THANK YOU

QUESTIONS ?