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Source Differentiation of Hydrocarbons in Soil

Report no.:	AR-15-CA-00298939-01
Batch no.:	EUDKVE-00298939
Customer:	Eurofins Environment
Customer no.:	CA0000146
Project name/no.:	PIPE Houston, 0072016
Date:	2016.02.26

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Hydrocarbon Sources

Matrix: Soil
Sampler: Customer
Date of sampling: 2016.02.21 – 2016.02.24
Date of analysis: 2016.02.26 – 2016.02.28

The hydrocarbons identified in soil samples ”Sample_1A”, ”Sample_2A” and ”Sample_4A” stem primarily from Diesel/Heating Oil (between 54% and 88% of the hydrocarbons). The hydrocarbons in ”Sample_4A”, however, stem primarily from Motor/Lubricating Oil and Pyrogenic Hydrocarbons (48% and 30%, respectively) while ”Sample_5A” contains a mixture of Gasoline (36%) and Pyrogenic Hydrocarbons (38%). ”Sample_3A” has a relatively large share of unexplained hydrocarbons in the hydrocarbon fraction >C15-C35, which indicates the presence of hydrocarbon sources in the sample other than those explained by the archetype model.

Sample name:		Sample_1A	Sample_2A	Sample_3A	Sample_4A	Sample_5A
Lab sample name :		V1529893801	V1529893801	V1529893803	V1529893804	V1529893805
Hydrocarbon source	Unit					
Biogenic C5 Hydrocarbons	%	2 ±1	<DL	<DL	3 ±1	<DL
Gasoline	%	<DL	3 ±1	8 ±4	<DL	36 ±6
Turpentine/Petroleum	%	7 ±4	<DL	<DL	<DL	11 ±2
Diesel/Heating Oil	%	54 ±5	55 ±3	9±2	88 ±7	6 ±4
Motor/Lubricating Oil	%	27 ±4	24 ±6	48±7	4 ±1	4 ±1
Pyrogenic Hydrocarbons	%	<DL	5 ±2	30±5	<DL	38 ±6
Part of the hydrocarbons not explained by the archetypal model	Unit					
Benzene-C10	%	2	3	5	1	0
>C10-C15	%	1	3	7	0	0
>C15-C20	%	4	5	10	2	1
>C20-C35	%	3	2	13	2	1
Sum	%	100	100	100	100	100

Characters:
± : 95 % confidence interval
< DL: Below detection limit

The results from the analysis only apply for the studied sample(s).

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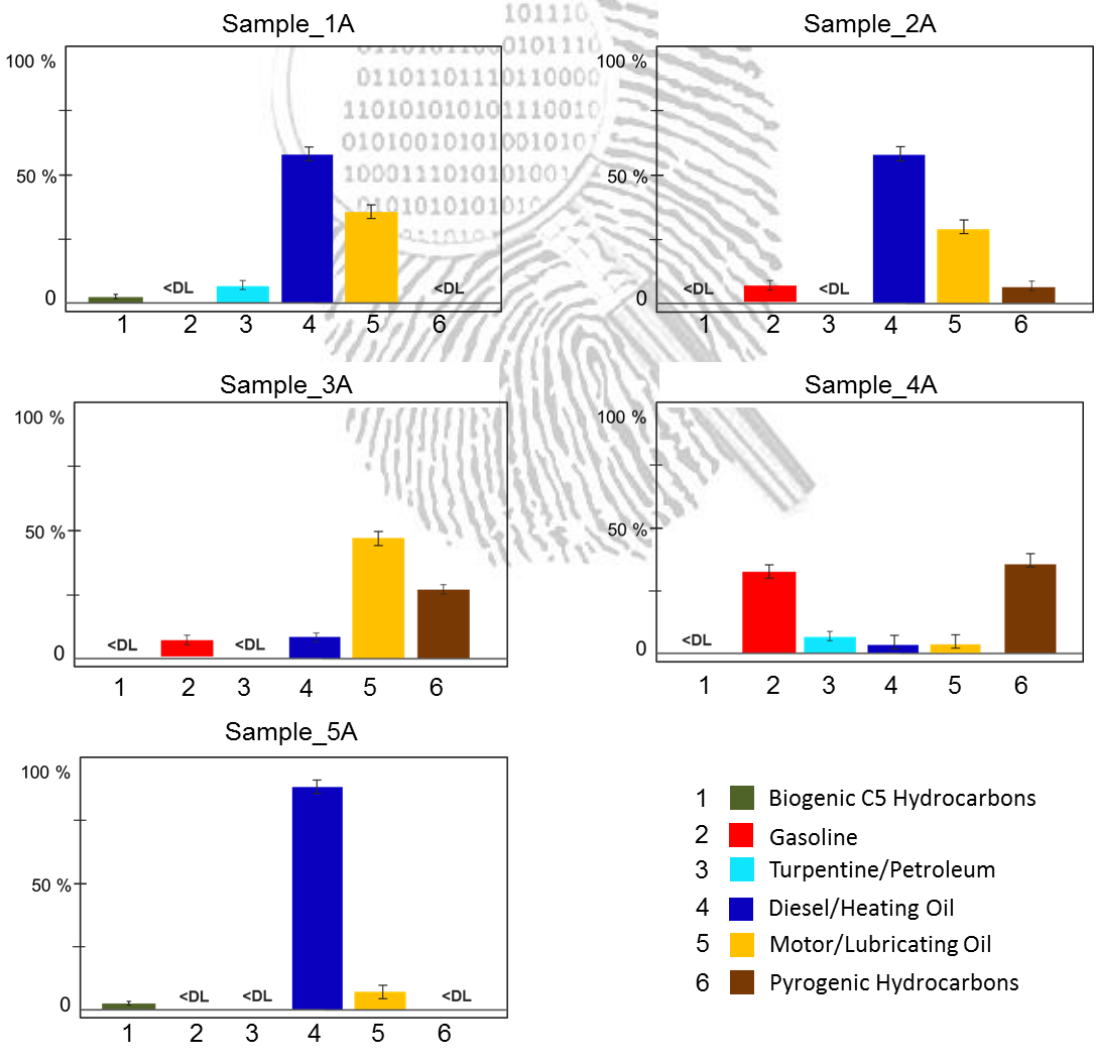

Characters:

I : Standard deviation
< DL: Below detection limit

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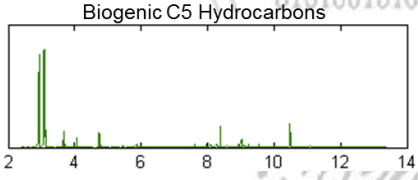
Hydrocarbon Sources in the Archetypal Model

Matrix: Soil
Sampler: Customer
Date of sampling: 2016.02.21 – 2016.02.24
Date of analysis: 2016.02.26 – 2016.02.28

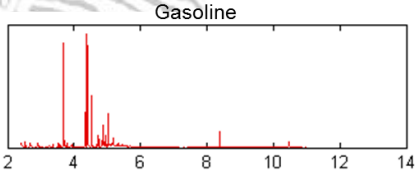
Multivariate statistical analysis has been used to describe the archetypes of hydrocarbon sources in soil. The data processing method has been patented. Six archetypes have been validated and may thus be described by the model. The archetypes are ”Biogenic C5 Hydrocarbons”, ”Gasoline”, ”Turpentine/Petroleum” ”Diesel/Heating Oil”, ”Motor/Lubricating Oil” and ”Pyrogenic Hydrocarbons”. The model is built on the chemical fingerprint of hydrocarbons in soil derived from the retention time of GC-FID chromatograms.

Biogenic C5 Hydrocarbons



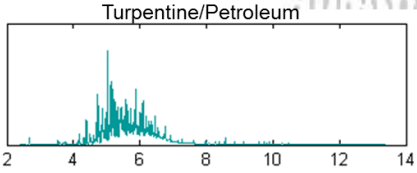
Biogenic volatile C5 hydrocarbons are characterized by few, distinctive peaks in the boiling point range of 70-100°C. Most likely the peaks are pantanone and pentanal.

Gasoline



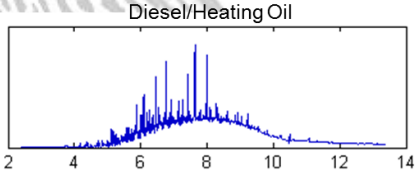
The gasoline fraction is primarily in the boilling point range of 70-200 °C corresponding to hydrocarbons from C6 to C12. The gasoline fraction is characterized by volatile hydrocarbons, primarily benzene, toluene, ethylbenzene, *m*-xylene, *p*-xylene and *o*-xylene and C9 og C10 aromates.

Turpentine/Petroleum



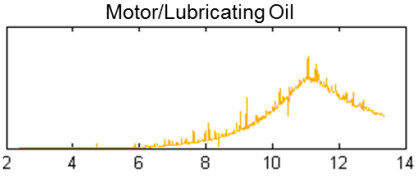
Turpentine/Petroleum is primarily located in the boiling point range of 100-250°C corresponding to hydrocarbons from C7-C14. The chemical fingerprint of Turpentine/Petroleum is comparable with that of Diesel/Lubricating oil, only with lower boiling point range and without the characteristic *n*-alkane pattern.

Diesel/Heating Oil



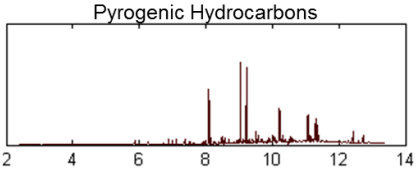
Diesel/Heating oil is located primarily in the boiling point range of 215-450°C corresponding to hydrocarbons from C12-C30. A non-weathered Diesel/Heating oil is recognized by high intensity *n*-alkane peaks. The chemical fingerprint of the *n*-alkane peaks can be used to evaluate the degree of weathering– the lower *n*-alkane peaks, the more weathered.

Motor/Lubricating Oil



Motor/Lubricating oil is characterized by high boling hydrocarbons typical in the boiling point range of 340-520°C. This corresponds to hydrocarbons from C20 to C40.

Pyrogenic Hydrocarbons



Pyrogenic hydrocarbons are primarily represented by polycyclic aromatic hydrocarbons (PAHs) and are characterized by distinctive peaks within the entire boiling point range. Often the chemical fingerprint is dominated by PAHs with more than four rings. The pyrogenic hydrocarbons most likely originate from diffusive, airborn contamination, i.e. from incomplete combustion of organic material.