

NATURE, ORIGIN AND EVOLUTION OF ORGANIC POLLUTANTS FROM TRANSPORTS IN AN URBAN SEDIMENTARY ARCHIVE

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INTRODUCTION

It is now admitted that Humans have emerged as the predominant force on geological and geochemical cycles (Zalasiewicz et al., 2015). The Anthropocene Working Group of the International Commission on Stratigraphy aims at defining the beginning and the stratotype of this new geological era. Within the Golden Spike project (BIOHEFFECT/INSU-CNRS) we hypothesize that urban areas are potential targets for defining such a stratotype due to (1) the high diversity and concentration of anthropic tracers/pollutants; (2) sediments archiving those tracers potentially accumulate in specific areas. This would constitute a sedimentological record of the evolution of a large array of societal concerns (food, health, energy, transport...) in urban socio-ecosystems over the Anthropocene.

OBJECTIVES

- 1) Identify potential hydrocarbons tracers of transport activities;
- 2) Determine their sources (fuels, oils and bitumen);
- 3) Constrain factors that control their presence and abundance in sediments.

PREVIOUS WORK

1.5m long CSA-03/2016-5 core was drilled in a decantation tank that collects the unitary (wastewater – WW / stormwater - SW) sewer network of Orléans (see posters P3 and P7).

- 1) 10 months of sedimentation are recorded;
- 2) Organic and mineral facies originate from WW and SW inputs, respectively, under the control of precipitation (P3);
- 3) Drugs and illicit drugs concentrations depend on facies (grainsize, organic matter content) and speciation in addition to consumption rates (P7).

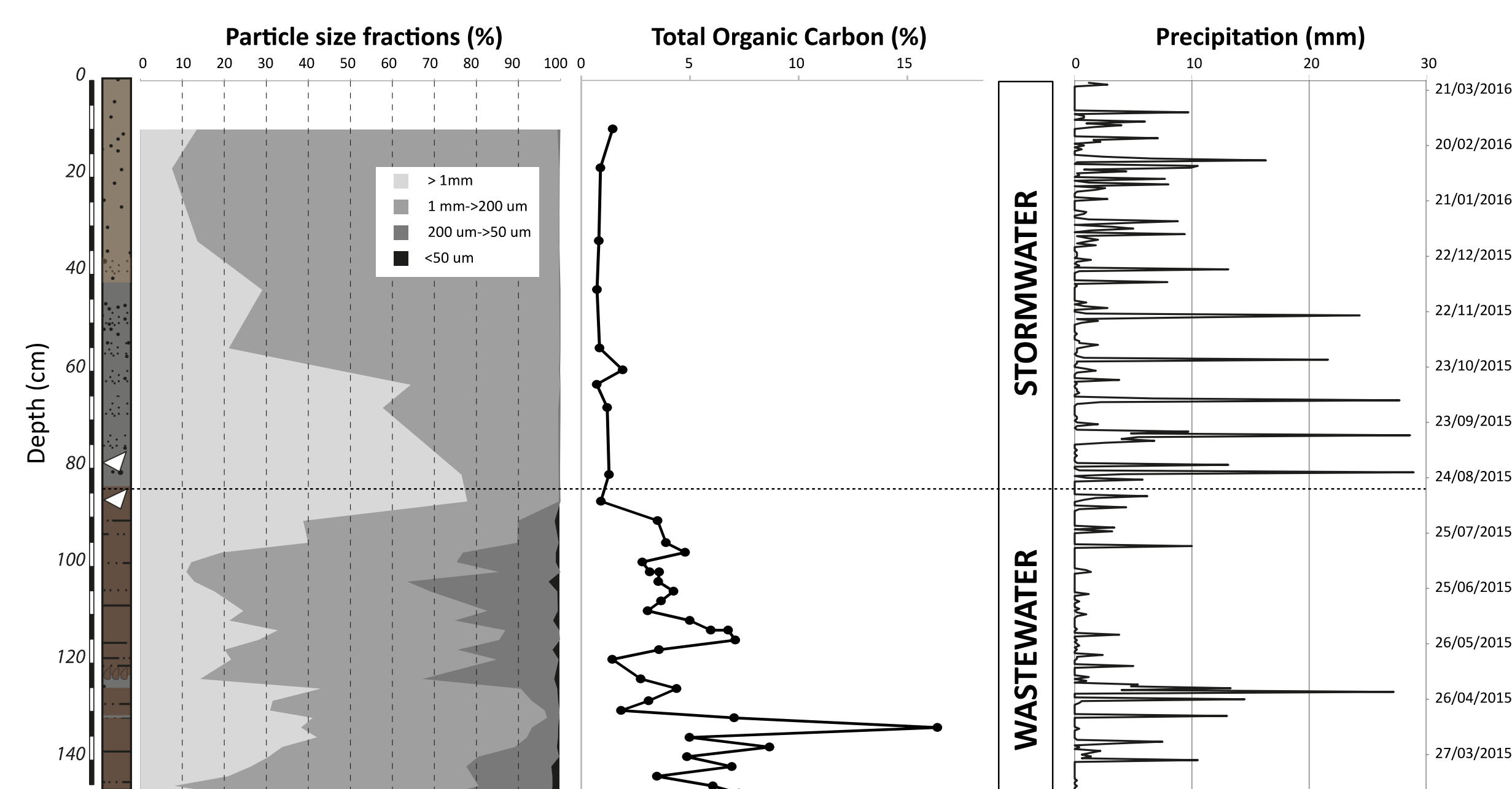


Figure 1: Evolution of grainsize and TOC in core CSA-03/2016-5 and comparison with precipitation over the period.

MATERIALS & METHODS

Sediments were extracted with H₂O:MeOH (1:1) for Drug Target Residues and then extracted with DCM:MeOH (1:1) for lipids. The total lipid extract was first separated into neutral/acidic and polar compounds on aminopropyl-bonded silica. The neutral fraction was further separated into aliphatics, aromatics, ethers, ketones and alcohols. Hydrocarbons were identified and quantified in the aliphatic and aromatic fractions by GC-MS after addition of 5^α-cholestane as a quantitation standard.

Asphalt from a recently installed sidewalk was submitted to the same treatment

RESULTS

n-Alkanes

n-Alkanes exhibit either high or low CPI, reflecting two main sources.

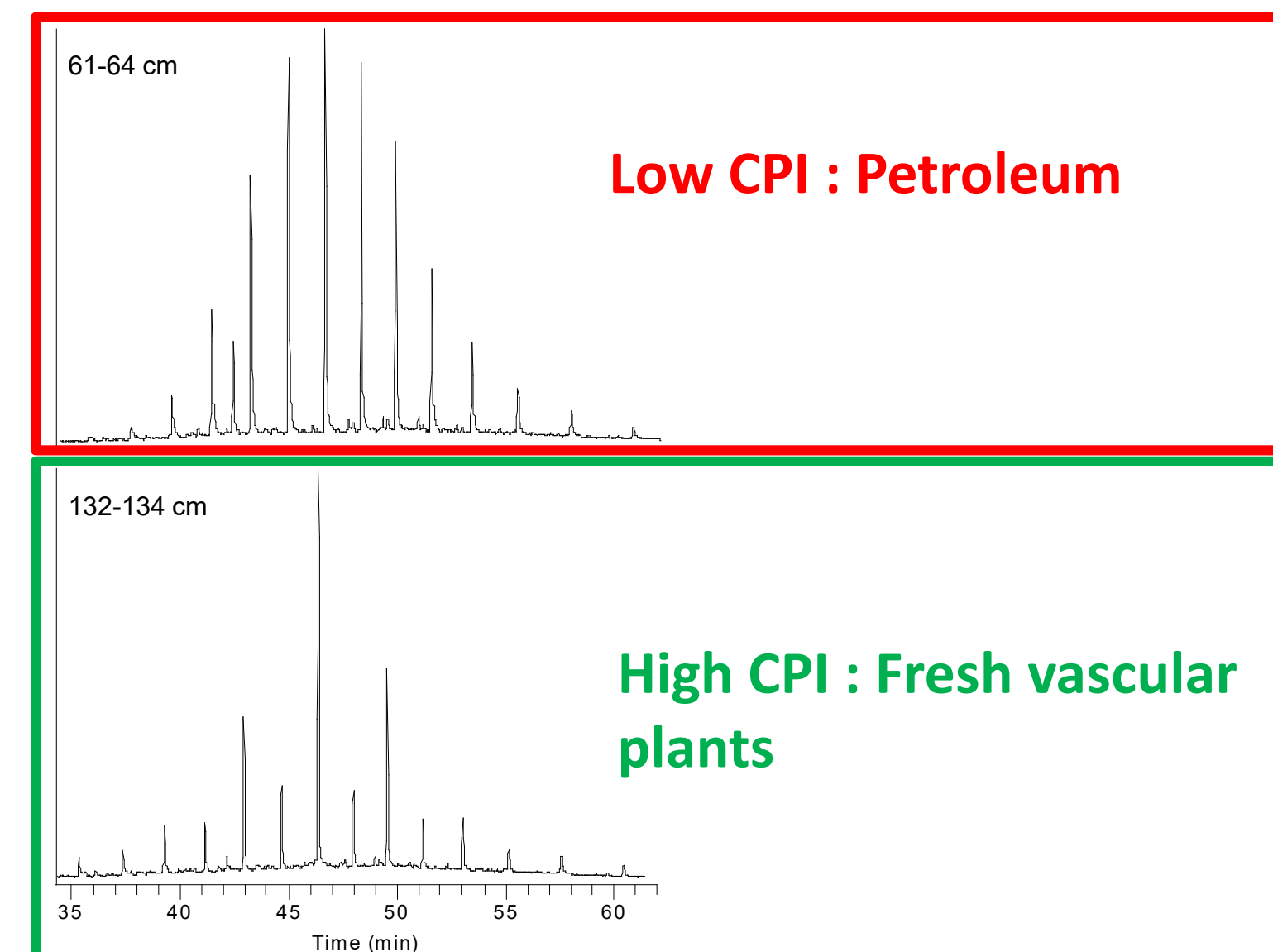


Figure 2: n-Alkanes distribution in two selected sediment extracts.

Aromatics

Tetra- and pentacyclic PAH are detected. Yunker et al. (2002) ratio allow determining two sources.

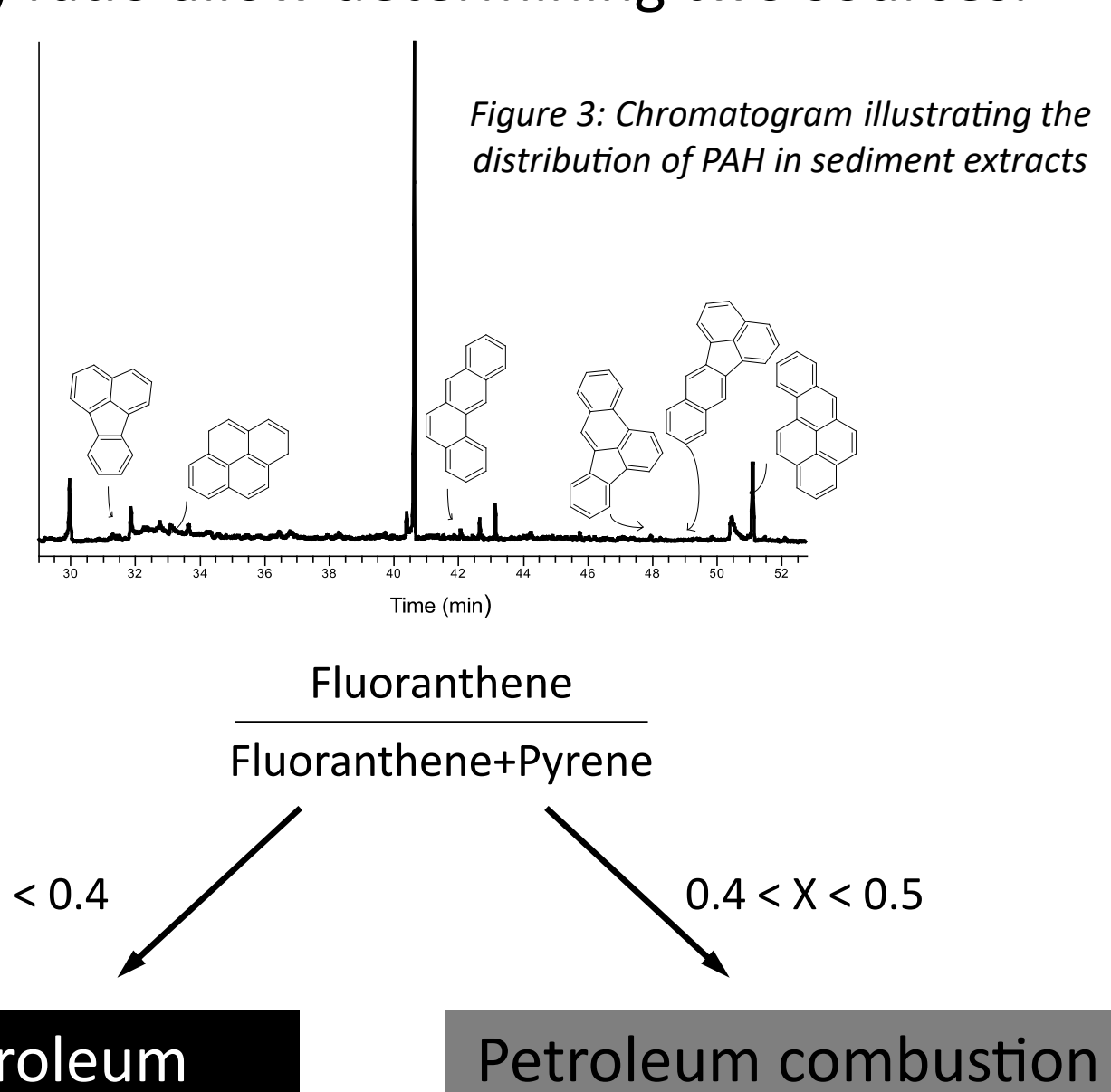


Figure 3: Chromatogram illustrating the distribution of PAH in sediment extracts

Sources and evolution with depth

Two mains sources of biomarker:

- Onocerane I, nor-onocerane, hopanes and PAH derive from petroleum products from roads (gasoline, asphalt...), sidewalks (asphalt), and combustion.
- n-alkanes with high CPI derive from fresh plants.

Hydrocarbon distribution primarily denotes **source** contribution :

- PAHs and n-alkanes display distinct distributions depending on WW or SW input.

Facies play an important role on biomarker archivability, whatever a WW or SW input:

- Hopanes and onocerane I are found in all facies.

Pentacyclic triterpenes

17 α ,21 β and 17 β , α 21, C27 to C36 hopanes (R and S) are identified in both sediments and asphalt extracts.

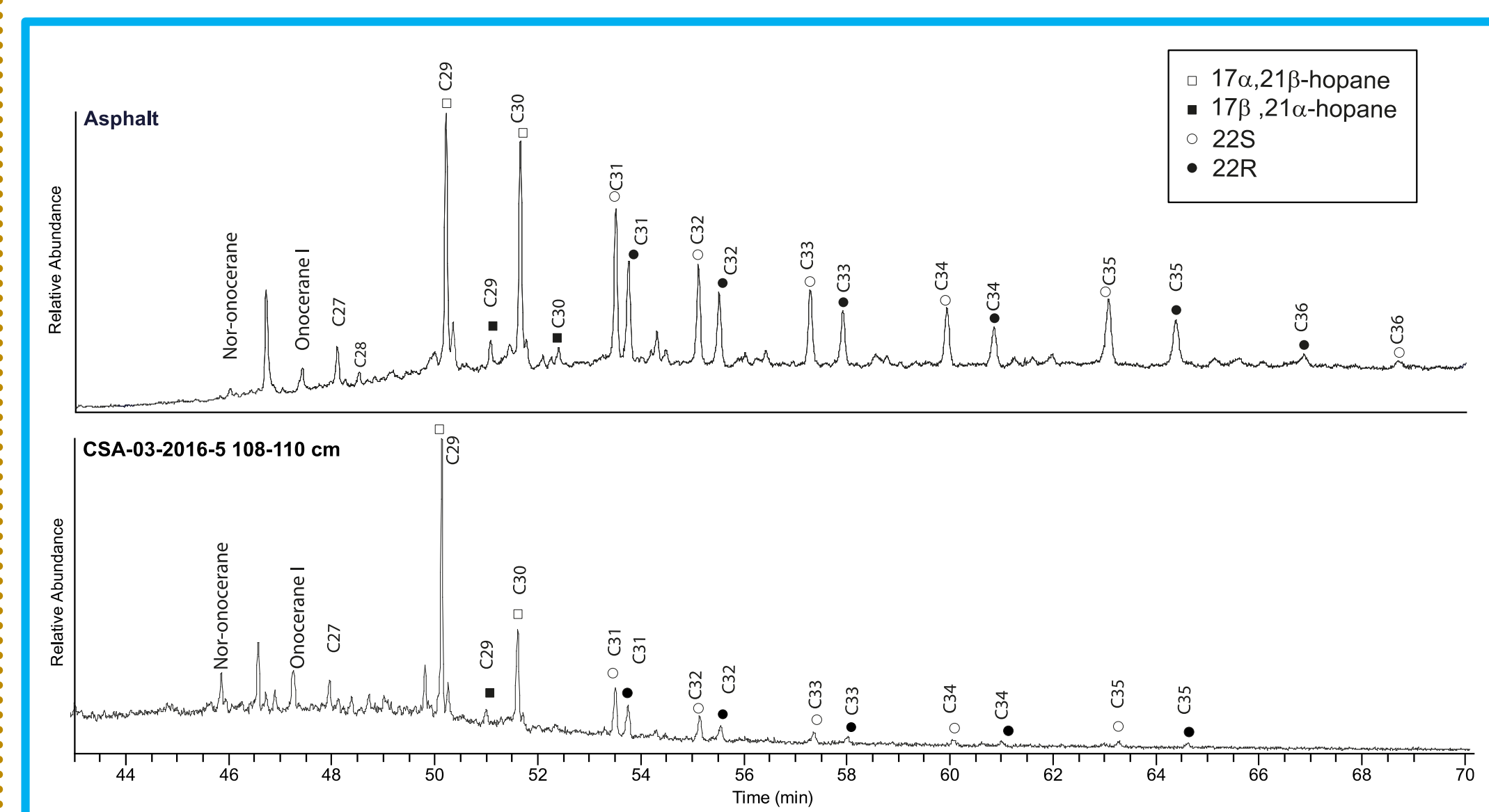


Figure 4: m/z 123+177+191 chromatogram of the aliphatic hydrocarbon fraction of lipid extracted from sidewalk asphalt (A) and CSA-03/2016-5 sediments (B).

Onocerane I and potentially nor-onocerane are also detected

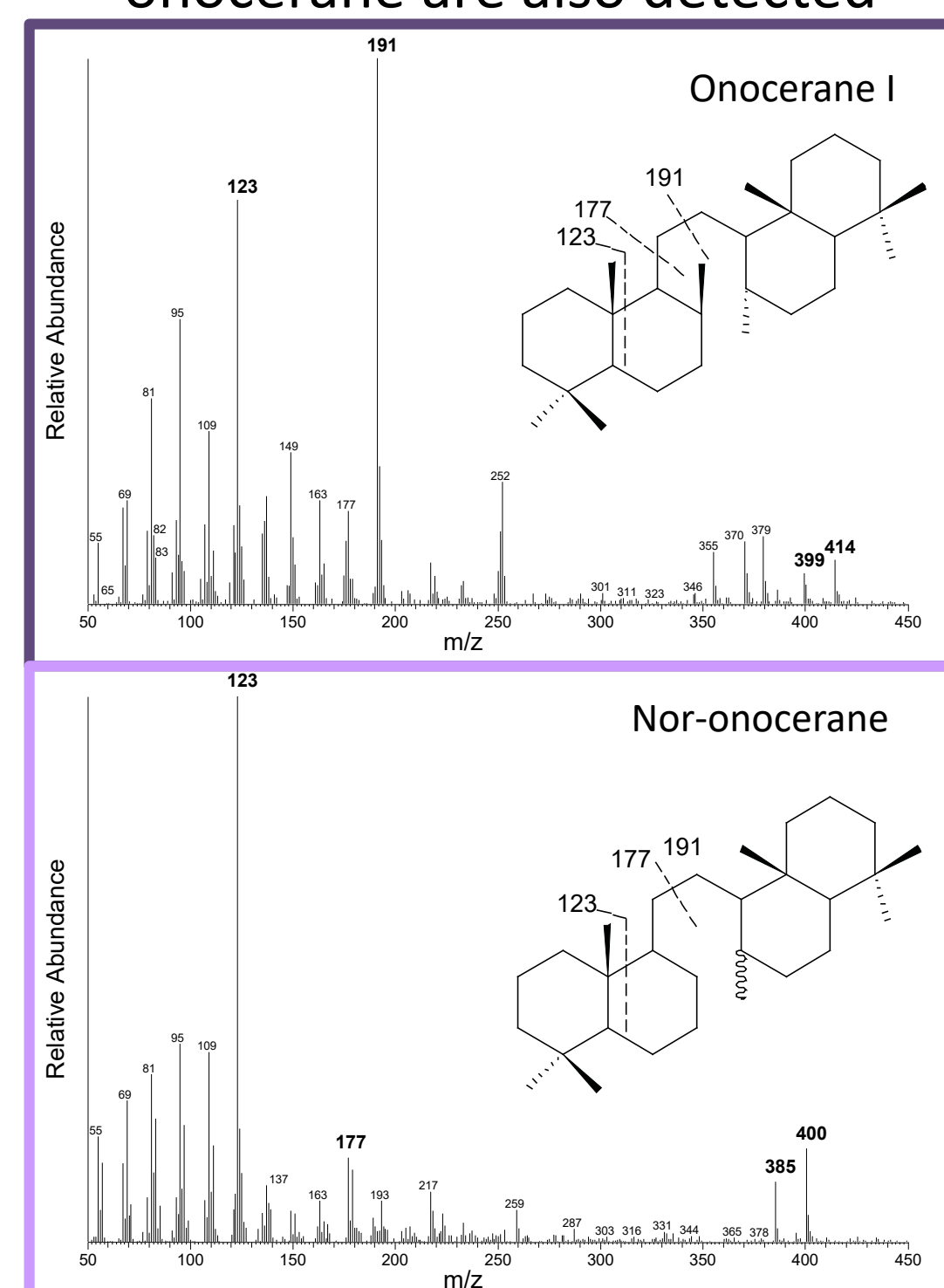


Figure 5: Mass spectra of onocerane I and of a compound tentatively identified as nor-onocerane.

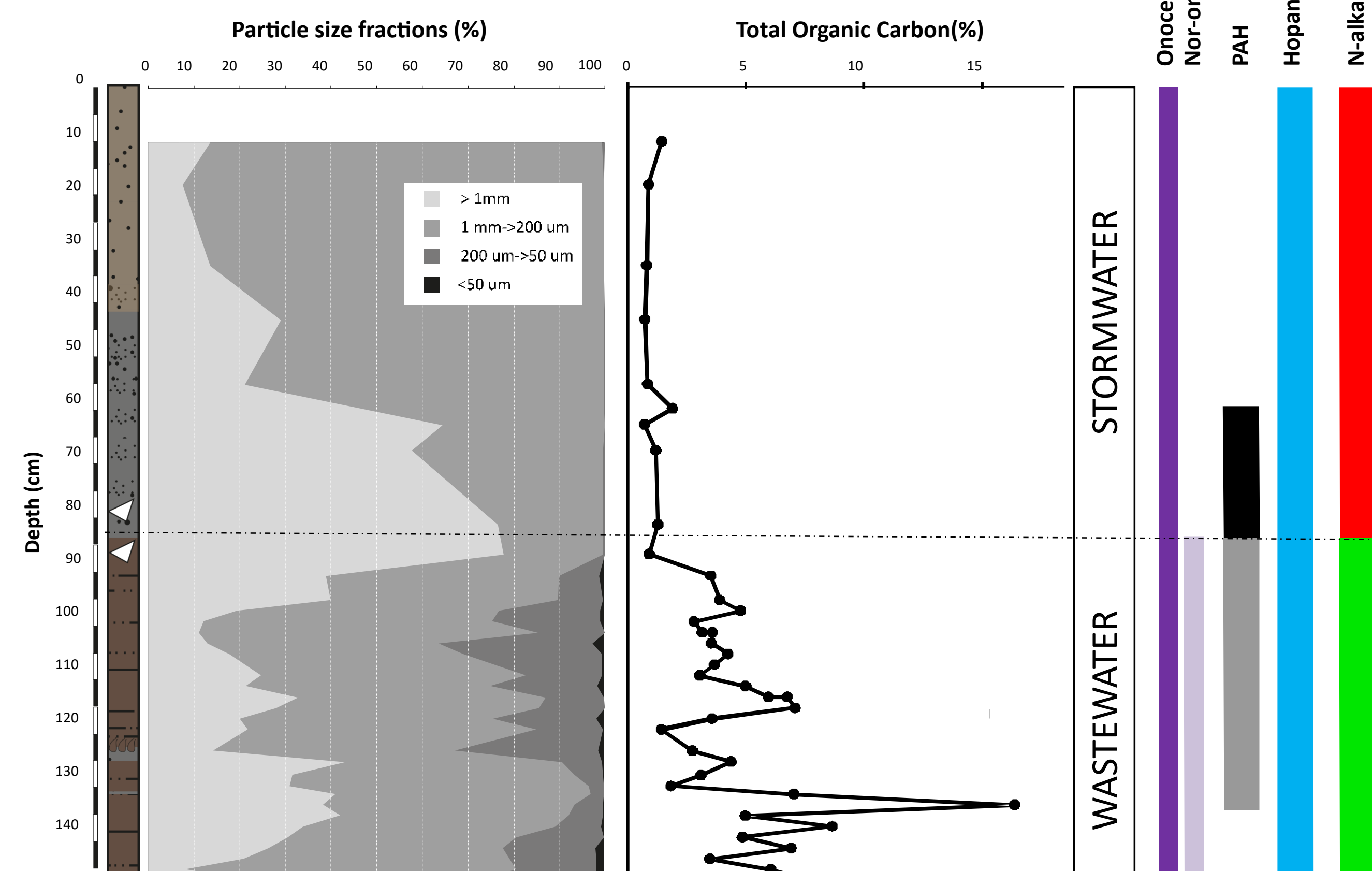


Figure 6: Evolution of grainsize, TOC, onocerane I and nor-onocerane, PAH, hopanes and n-alkanes in core CSA-03/2016-5

CONCLUSIONS

This study reveals the presence of **diversified hydrocarbons** in anthropic sediments with different sources:

- Asphalt for onocerane I and nor-onocerane, a compound here **tentatively identified for the first time**,
- Petroleum products for some PAHs, some n-alkanes and hopanes,
- Fresh vascular plants for n-alkanes with high CPI.

In addition to the respective inputs of wastewater and stormwater, facies (mineralogy, OM content) play a key role on biomarker occurrence.

ACKNOWLEDGEMENTS

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REFERENCES

- Pearson and Obaje, 1999. Organic Geochemistry 30, 583-592
Tissot and Welte, 1984. 2nd ed, Springer-Verlag, Heidelberg.
Yunker et al., 2002. Organic Geochemistry 33, 489-515.
Zalasiewicz et al., 2016. Anthropocene 19, 55-60.