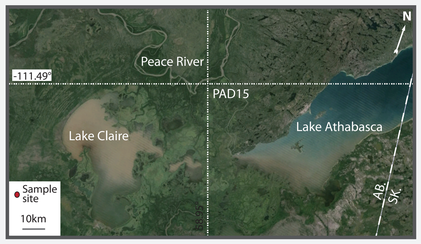
Compound-specific Radiocarbon Analysis to Evaluate the Contribution of Peace River Floodings to the PAH Background in the Peace-Athabasca Delta.

JOSUÉ JAUTZY,*[1] JASON M. E. AHAD,[2] ROLAND I. HALL,[3] JOHAN A. WIKLUND,[3] CHARLES GOBEIL,[1] AND MARTINE M. SAVARD[2]

[1] Université du Québec, Institut national de la recherche scientifique, Eau, Terre et Environnement
[2] Geological Survey of Canada
[3] University of Waterloo

Introduction

WHERE?



No large-scale bitumen surface mining in the Peace River watershed.

Natural bitumen outcrops on river banks.

WHY?

Oil sands located in a sensitive & complex environmental system.
Rapid growth of oil sands industry:
--> questionning the environmental impacts.

Focus on: Polycyclic Aromatic Hydrocarbons (PAHs).
--> hazardous and carcinogenic organic compounds.
--> produced by: - incomplete combustion of biomass (modern or fossil).
- maturation of kerogene towards fossil fuel.
- early stage diagenesis.

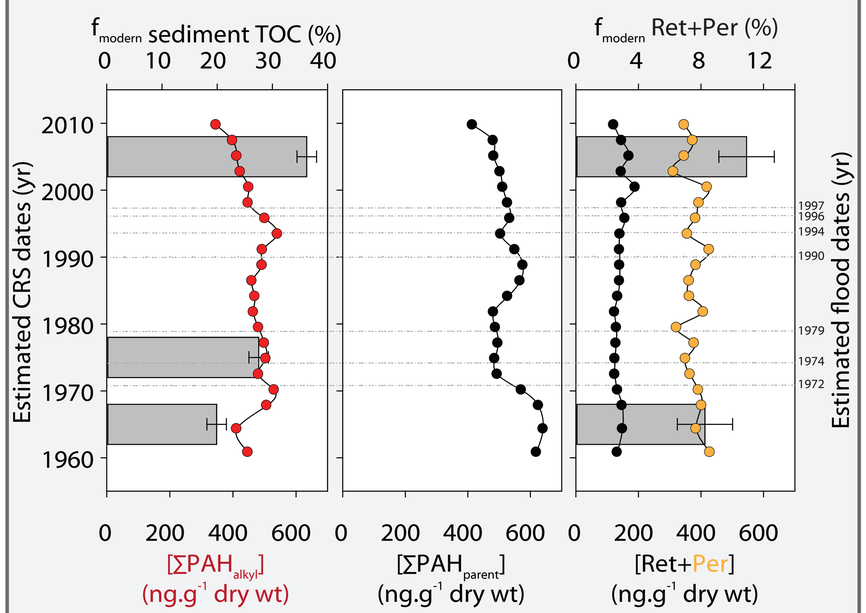
Establishing PAH background crucial in this region for source apportionment.

HOW?

Natural chronological record used:
--> ^{137}Cs & ^{210}Pb dated lake sediment core.

--> novel appproach based on ^{14}C content of specific PAH_{alkyl} source discrimination.
--> able to estimate the relative contribution of fossil vs modern PAH.
fraction modern (f_{modern})

Results & Discussion



[PAH] :

> ISQGs for phenanthrene, benz[a]anthracene, dibenz[a, h]anthracene.

Alkylated PAH peak correlated with ice jam floods reported for this lake (C/N ratio & magnetic suceptibility profile).[(1)]

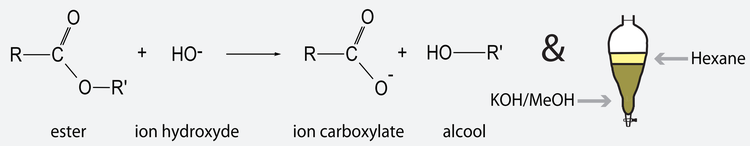
PAH_{alkyl} often related to fossil fuel, but can be produced by forest fire or during diagenesis.[(2, 3)]

No correlation between [Ret] and $[PAH_{alkyl}]$ profile.
--> $[PAH_{alkyl}]$ unlikely related to forest fire events.

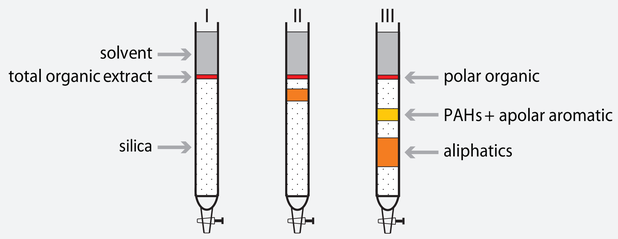
Methods

MARS & Soxlhet Extraction

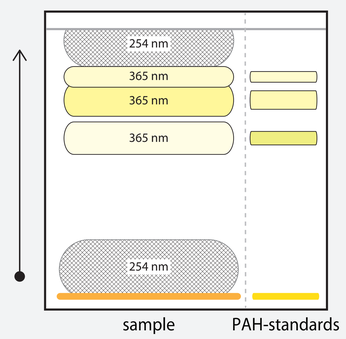
Saponification & Liquid/Liquid Extraction



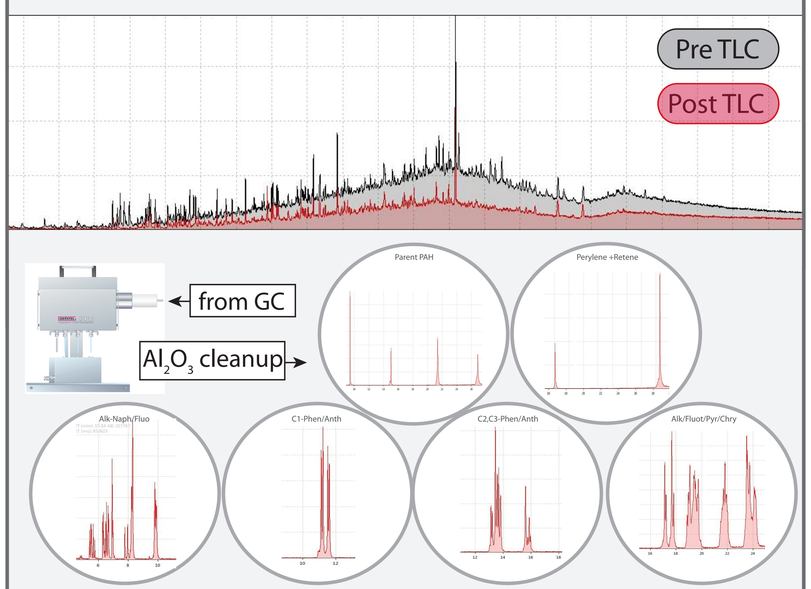
Silica-gel Cleanup



TLC



PAH Harvest (using PcGC)



AMS measurements

mass balance calculation:

$$\Delta^{14}C_{sample} = \Delta^{14}C_{modern} f_{modern} + \Delta^{14}C_{fossil} f_{fossil}$$

Radiocarbon dead = $\Delta^{14}C$ = -1000 ‰

Results & Discussion

PAH diagnostic ratios shows only a fossil fuel source in the entire sedimentary sequence --> not sensitive enough for this type of environment.

need to refine fingerprinting...

$\Delta^{14}C$ of specific PAHs:

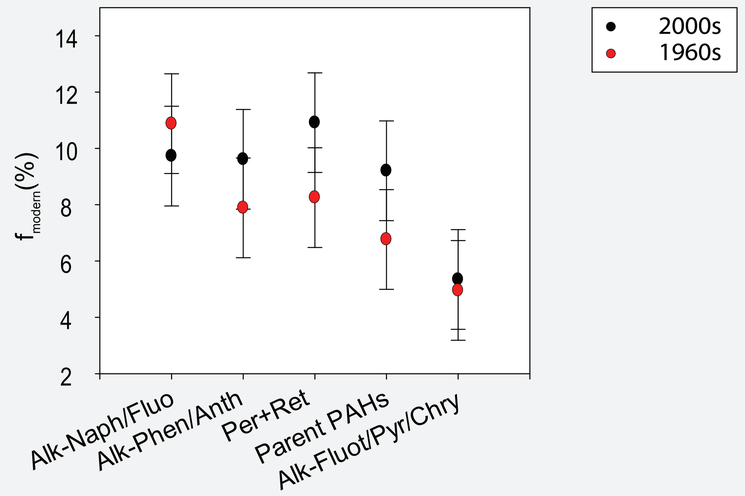
Sediment TOC : increasing trend for f_{modern} (from 20 to 36%)
--> flood frequency decrease associated with climate change.[(1)]

All PAH groups are < 12% modern, even though perylene and retene believed to be related to modern biomass diagenesis or combustion.[(3, 4)]
Bacterial community selection --> metabolize fossil organic compound

Variation between top and bottom layer of the core within the error bars

However...

All PAHs except Alk-Naph/Fluo groups show an increasing trend for the modern fraction.
Mining related PAHs in this region -->particulate transport[(5)] *--> unlikely to reach this remote area.*
Light PAHs more volatile--> could be transported further.



Take Home Conclusions

(1) PAH_{alkyl} naturally occuring in this lake from outcrops erosion/river transport/ lake deposition during major flood events.

(2) More than 85% of the PAH_{alkyl} are bitumen related.

(3) Less frequent flooding events in the last 10 years resulted in slightly less input of bitumen related PAHs.

To be continued...

(1) Compound specific $\Delta^{14}C$ on specific PAHs group from the 1970s layer.

(2) Assess and model the input of bitumen derived PAHs into Athabasca Lake.

(3) Use of dual compound specific $\delta^{13}C$ & $\delta^{2}H$ on light M.W. PAHs for further source characterization.

References

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Contact Information

*Tel: 418-654-4677 #4480; e-mail: josue.jautzy@ete.inrs.ca