FAPESP Week 2024 Illinois, USA April, 9th to 10th

FRAMING PANEL: WATER - Session 1

Disentangling the 'Anthropocene' using organic geochemical markers: findings and challenges on the South Atlantic coast and Antarctica

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FAPESP

USP 90 ANOS 1934 2024

César de Castro Martins (MARTINS, C.C)

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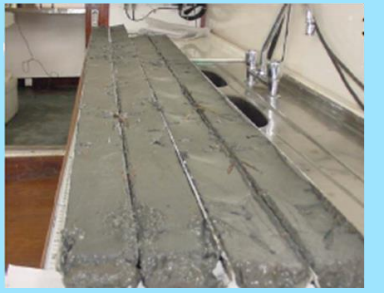
Research Fields (since 1999) :

- sources, production and transport of organic matter in marine ecosystems;
- environmental contaminants (PAHs, PCBs, DDTs and pesticides);
- organic geochemistry of recent and ancient sediments;
- biomarkers and climatic change;



➢ Oceanography Institute (Instituto Oceanográfico)

- ➢ 2 main Departments
- ➢ ~ 50 Professors / Researchers / Lectures

Laboratório de Química Orgânica Marinha
Instituto Oceanográfico - USP

Laboratory of Marine Organic Chemistry

- **Good infrastructure to support organic compounds analyses.**



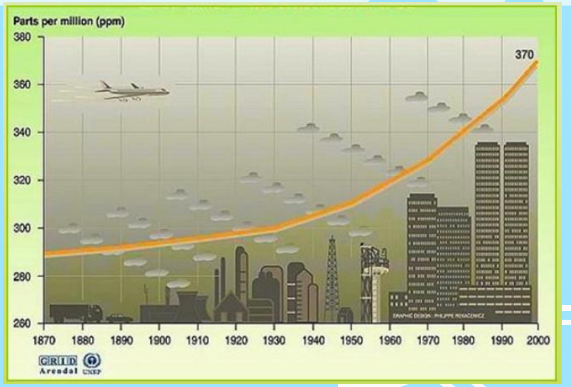




Gas and liquid chromatography systems

Anthropocene

➢ *an 'unofficial' unit of geologic time, used to describe the most recent period in Earth's history, when human activity started to have a significant impact on the planet's climate and ecosystems.*



* Google images

March, 2024

nature

NEWS | 06 March 2024 | Correction 06 March 2024

Geologists reject the Anthropocene as Earth's new epoch — after 15 years of debate

But some are now challenging the vote, saying there were 'procedural irregularities'.

By Alexandra Witze

nature

NEWS | 14 March 2024

Ditching 'Anthropocene': why ecologists say the term still matters

Beyond stratigraphic definitions, the name has broader significance for understanding humans' place on Earth.

By David Adam

nature

NEWS | 20 March 2024

It's final: the Anthropocene is not an epoch, despite protest over vote

Governing body upholds earlier decision by geoscientists amid drama.

By Alexandra Witze

nature

CORRESPONDENCE | 26 March 2024

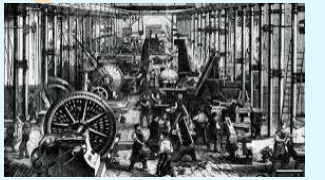
The 'Anthropocene' is here to stay — and it's better not as a geological epoch

By Thomas P. Roland, Graeme T. Swindles & Alastair Ruffell

Discussion is far to finish...

The beginning of Anthropocene continue to be widely debated

Did it begin at the start of the *'Industrial Revolution'* of the 1800s ?



Should be 1945, when humans tested the '*First Atomic Bomb'*, and then dropped on Japan ?

Did it begin in the year 1950 with the *'Great Acceleration'*, a dramatic increase in human activity affecting the planet ?

Should be 1963–1965, the period of maximum global radioactivity particles '*fallout*' due to atmospheric nuclear weapons testing ?

Plastics ? Pesticides (as DDTs) ? Other pollutants ?

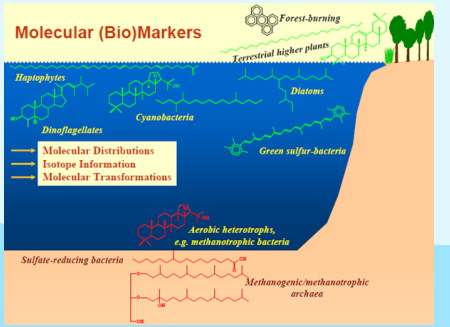
A great environmental challenge: When, Where, How !

*** Google images**

Geochemical organic biomarkers

⇒ **What is it ?**

- **organic compounds (C, H) from biogenic and anthropogenic sources.**



⇒ **Specific features**

- **chemical stability;**
- **specificity in relation to a specific source;**
- **high potential to preserve under bacteria/chemical degradation conditions;**
- **low structural alteration in different time scales**

⇒ **Applications**

- ***indicators of (recent and geological) events and enviromental processes***

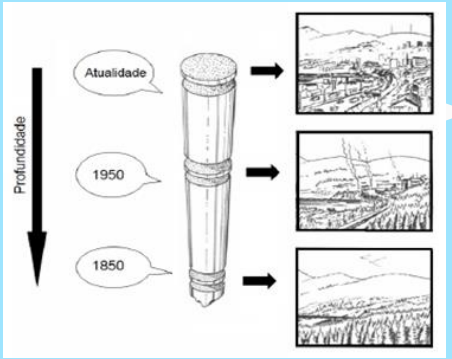
(Colombo et al. 1989, ES&T *23*, 888).

"Basic" questions in organic geochemistry

Organic Matter Origin

"Anthropocene"

- **anthropogenic**
  - oil spills
  - sewage
  - fossil fuel combustion
  - erosive process
  - biomass burning
- **biogenic**
  - aquatic
    - organisms
      - plankton
      - bacteria
      - algae
      - diatoms
    - climatic change
    - paleoproductivity
  - terrestrial
    - C3 plants
    - C4 plants
    - paleovegetation
    - paleopluviosity



ORGANIC MARKERS OF ANTHROPIC ACTIVITIES

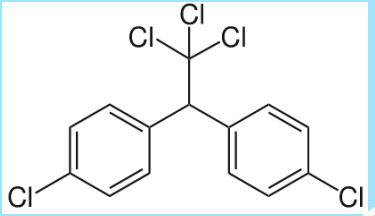
Environmental contaminants as potential indicators

⇒ Aliphatic Hydrocarbons (AHs)

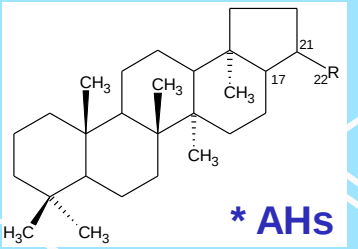
⇒ Polycyclic Aromatic Hydrocarbons (PAHs)

⇒ Organochlorine compounds (DDTs e PCBs)

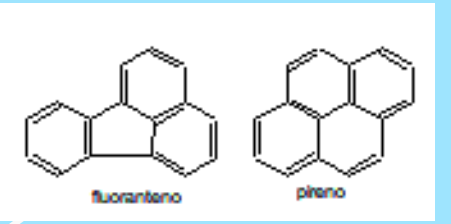
⇒ Faecal sterols (coprostanol)



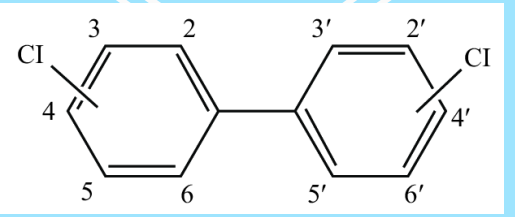
DDT



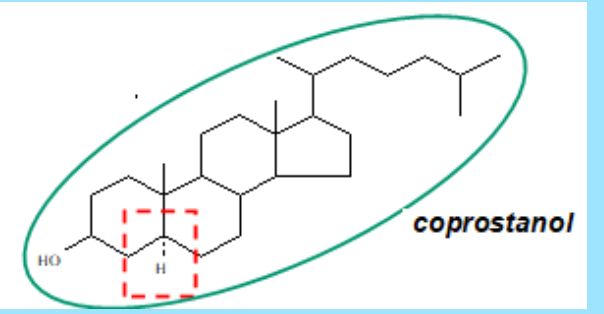
* AHs



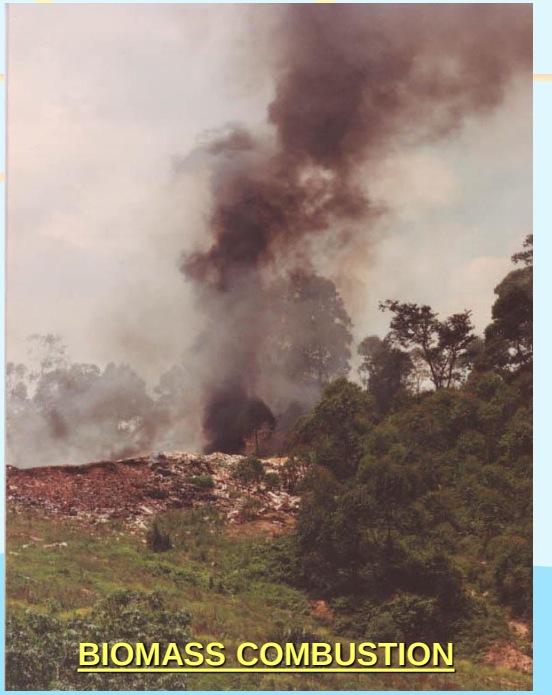
PAHs



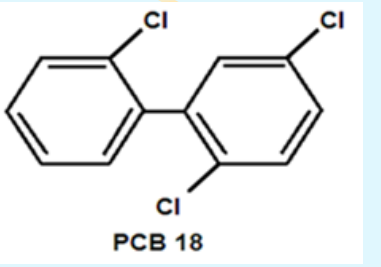
PCBs



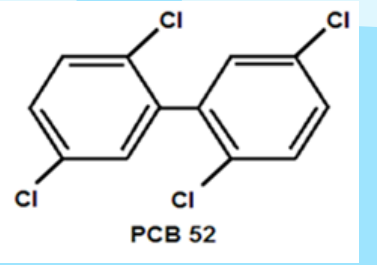
PAHs sources



Polychlorinated Biphenyls (PCBs) sources

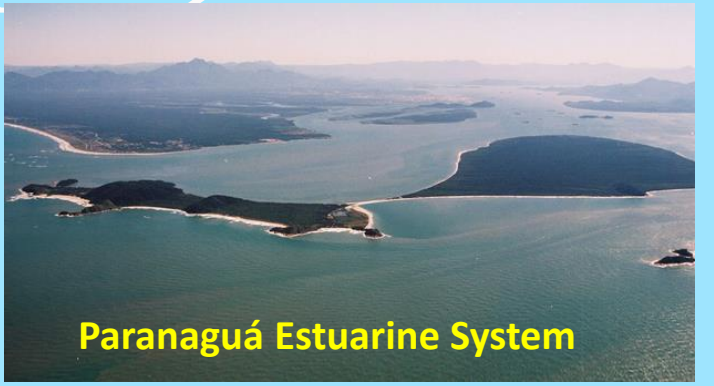


- Used in the past: electrical capacitors and transformers, flame retardants, paints and varnishes
- Restrictions and Prohibitions defined by the Stockholm Convention (2001)



Study areas

South Atlantic coastal and marine ecosystems



Are PAHs and PCBs efficient geochemical markers of the Anthropocene?

Organic geochemistry & Geochronology

Marine Pollution Bulletin 63 (2011) 452–458

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Polycyclic aromatic hydrocarbons (PAHs) in a large South American industrial coastal area (Santos Estuary, Southeastern Brazil): Sources and depositional history

César C. Martins [a,b,*], Márcia C. Bícego [b], Michel M. Mahiques [b], Rubens C.L. Figueira [b], Moyses G. Tessler [b], Rosalinda C. Montone [b]

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[b] Instituto Oceanográfico da Universidade de São Paulo, Praça do Oceanográfico, 191, 05508-900 São Paulo – SP, Brazil

Journal of Hazardous Materials 360 (2018) 428–435

Contents lists available at ScienceDirect

Journal of Hazardous Materials

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Historical records and spatial distribution of high hazard PCBs levels in sediments around a large South American industrial coastal area (Santos Estuary, Brazil)

Amanda Câmara de Souza [a,*], Satie Taniguchi [b], Rubens Cesar Lopes Figueira [b], Rosalinda Carmela Montone [b], Márcia Caruso Bícego [b], César C. Martins [b,c,**]

[a] Programa de Pós-Graduação em Sistemas Costeiros e Oceânicos (PGSISCO), Universidade Federal do Paraná, Caixa Postal 61, 83255-976, Pontal do Paraná, PR, Brazil
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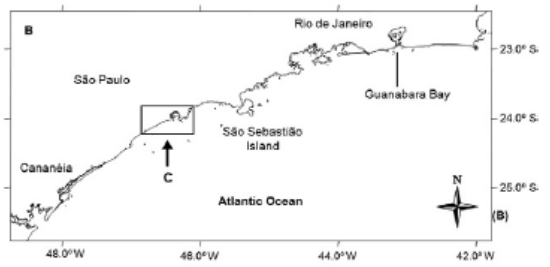
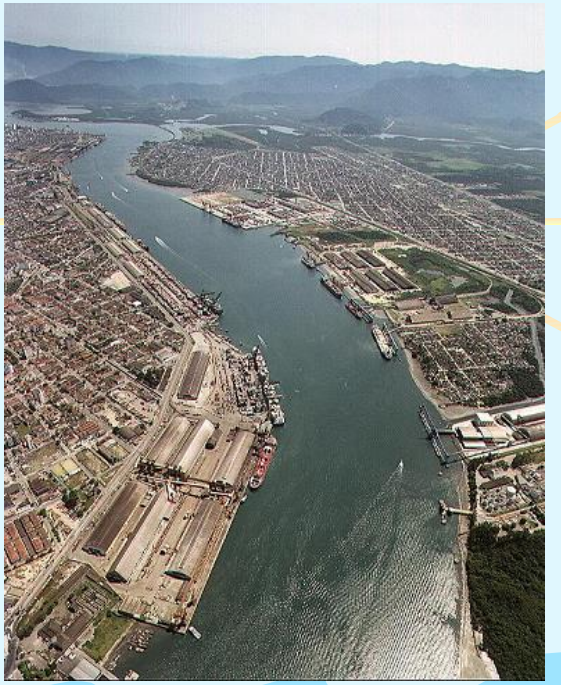
[c] Centro de Estudos do Mar, Universidade Federal do Paraná, Caixa Postal 61, 83255-976, Pontal do Paraná, PR, Brazil



Santos and São Vicente Estuarine System, South Atlantic



Santos and São Vicente Estuarine System, South Atlantic

- More than 1200 industries established since 1950s;
- 1,2 million inhabitants;
- The largest harbour of South America;

Santos estuary: the most important industrial, urban and economic centre in South America

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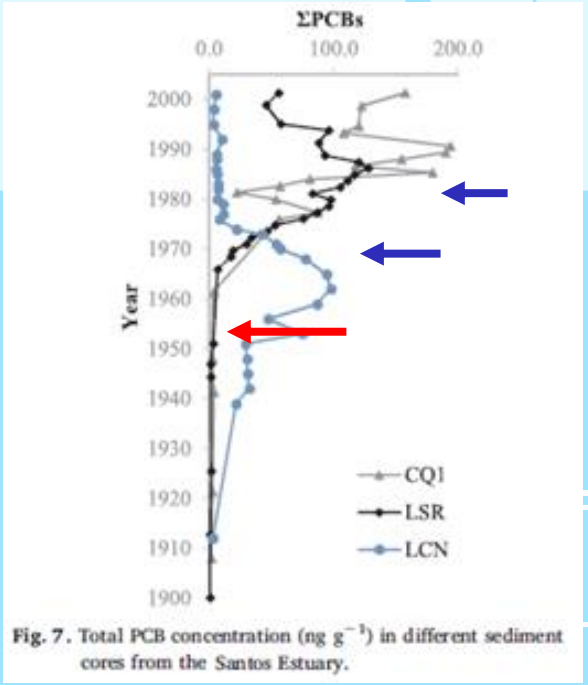

Fig. 7. Total PCB concentration (ng g^{-1}) in different sediment cores from the Santos Estuary.

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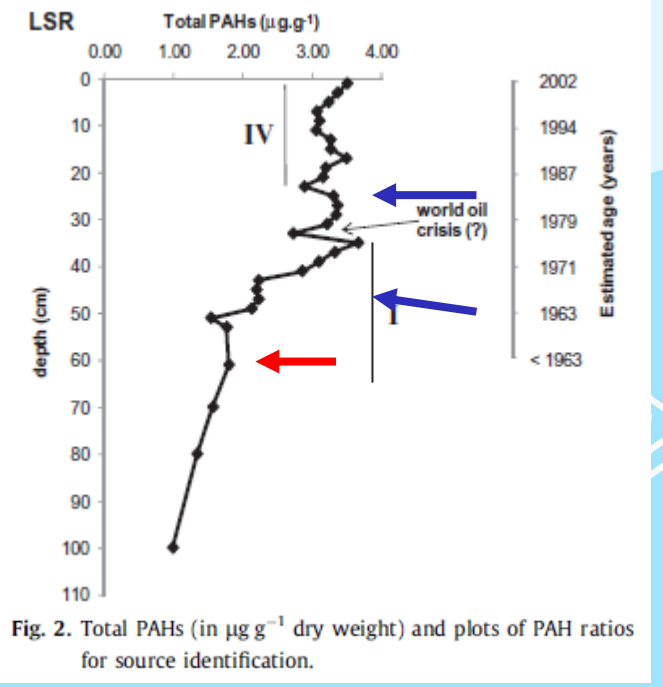
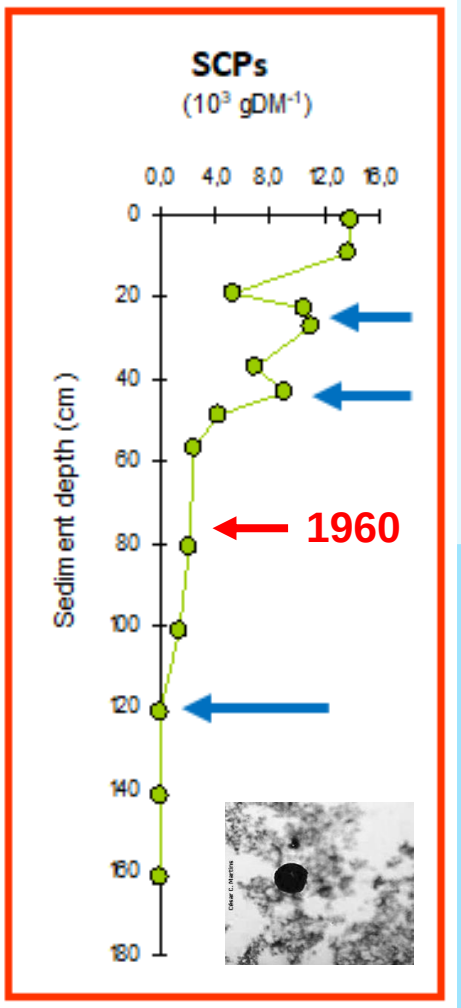


Fig. 2. Total PAHs (in μg g^{-1} dry weight) and plots of PAH ratios for source identification.

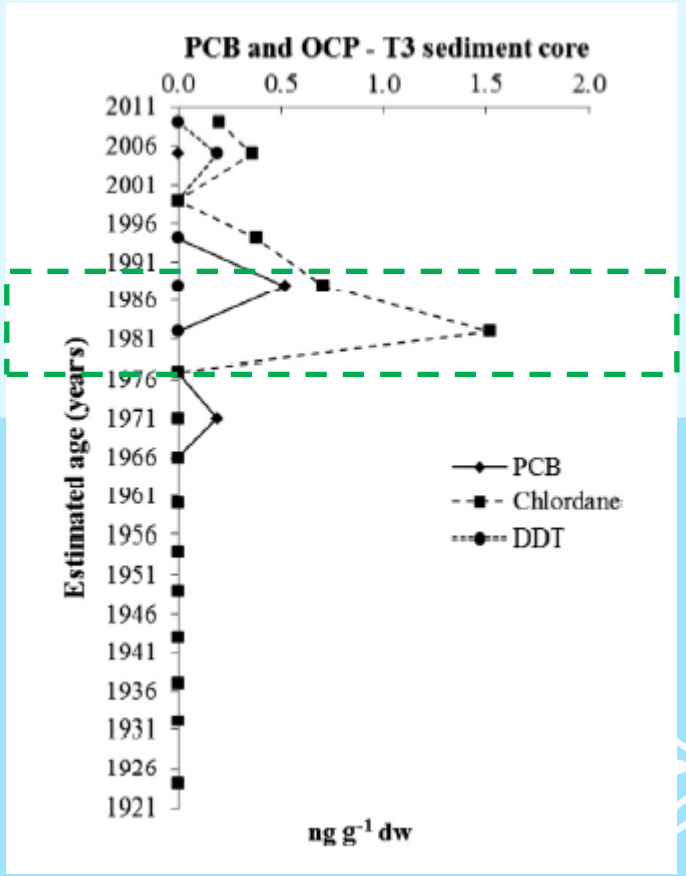


Anthropocene 'started' in the 1960s !

SCPs as time-marker of beginning of the Anthropocene in Santos Estuary, Brazil

Guaratuba Bay, South Atlantic

PCBs and DDT: organochlorine compounds



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Marine Pollution Bulletin 70 (2013) 247–252

Contents lists available at SciVerse ScienceDirect

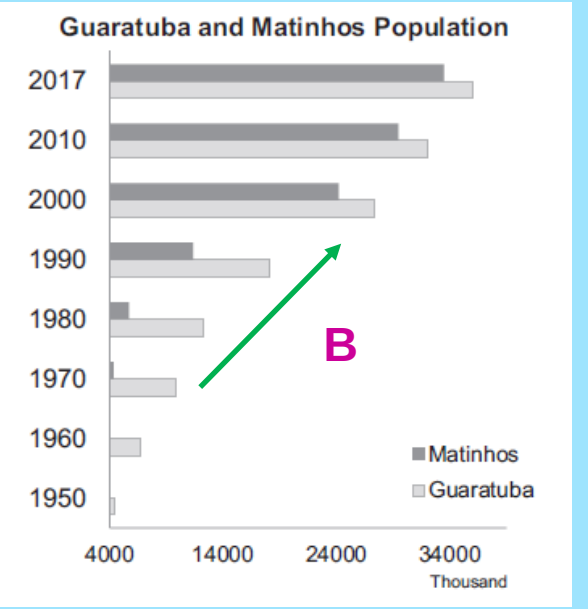
Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Spatial distribution and historical input of polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) in sediments from a subtropical estuary (Guaratuba Bay, SW Atlantic)

Tatiane Combi [a,b,*], Satie Taniguchi [c], Rubens Cesar Lopes Figueira [c], Michel Michaelovitch de Mahiques [c], César C. Martins [a,*]

[a] Centro de Estudos do Mar da Universidade Federal do Paraná, Caixa Postal 61, 83255-976 Pontal do Paraná, PR, Brazil
[b] Programa de Pós-Graduação em Sistemas Costeiros e Oceânicos (PGSISCO) da Universidade Federal do Paraná, Caixa Postal 61, 83255-976 Pontal do Paraná, PR, Brazil
[c] Instituto Oceanográfico da Universidade de São Paulo, Praça do Oceanográfico, 191, 05508-900 São Paulo, SP, Brazil



Anthropocene 'started' in the end of 1970s !

Siberia, Russia

Environmental Pollution 242 (2018) 528–538

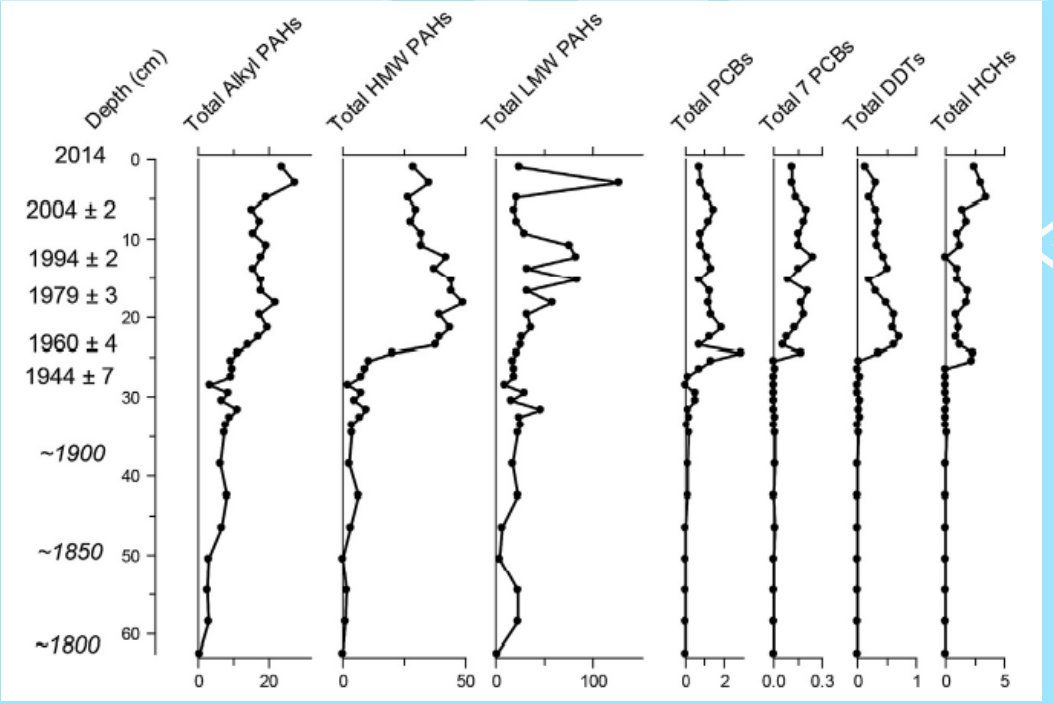
Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

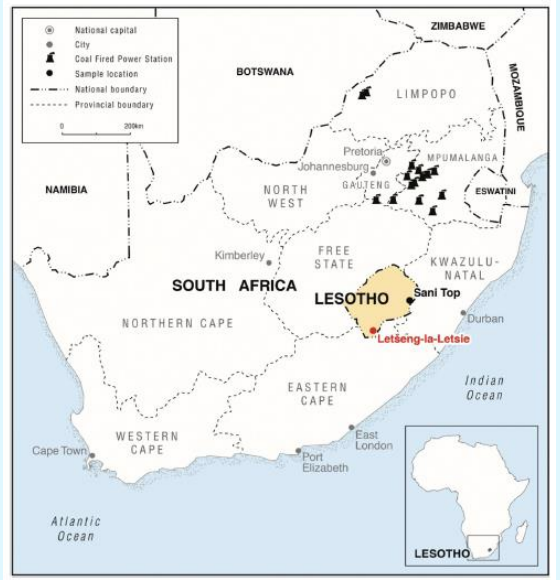
Lake sediment records of persistent organic pollutants and polycyclic aromatic hydrocarbons in southern Siberia mirror the changing fortunes of the Russian economy over the past 70 years☆

Jennifer K. Adams [a, *, 1], César C. Martins [b], Neil L. Rose [a], Alexander A. Shchetnikov [c, d, e], Anson W. Mackay [a]



Temporal variations in organic contaminants and molecular markers are reflective of economic development in Russia with earliest records of contamination occur pre-WWII.

Lesotho, Africa



Science of the Total Environment 737 (2020) 139642

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Natural archives of long-range transported contamination at the remote lake Letšeng-la Letsie, Maloti Mountains, Lesotho

Neil L. Rose [a,*], Alice M. Milner [b], Jennifer M. Fitchett [c], Kristy E. Langerman [d], Handong Yang [a], Simon D. Turner [a], Anne-Lise Jourdan [e], James Shilland [a], César C. Martins [f], Amanda Câmara de Souza [f], Christopher J. Curtis [c,d]

[a] Environmental Change Research Centre, Department of Geography, University College London, Gower Street, London WC1E 6BT, UK
[b] Department of Geography, Royal Holloway University of London, Egham, Surrey TW20 0EX, UK
[c] School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, 1 Jan Smuts Avenue, Braamfontein, 2050, South Africa
[d] Department of Geography, Environmental Management and Energy Studies, University of Johannesburg, Corner Ditton and University Avenue, Auckland Park, Johannesburg, South Africa
[e] Bloomsbury Environmental Isotope Facility, Department of Earth Sciences, University College London, Gower Street, London WC1E 6BS, UK
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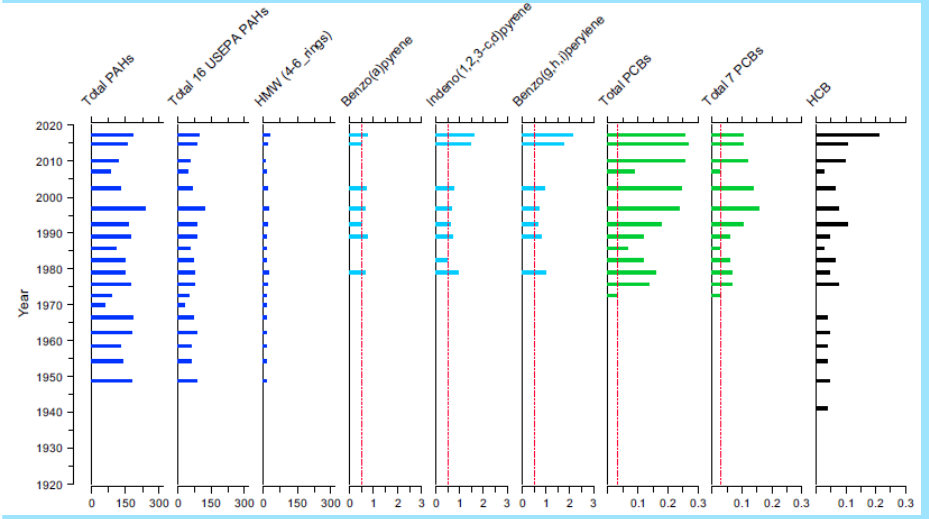

PAHs and PCBs showed low but increasing levels of contamination since *ca.* 1970.

One of the first multi-pollutant historical records for southern Africa.

The multiple faces of CARbon and METals in the Antarctic ecosystem: elementary, isotopic, and molecular tools applied to geochemistry and marine pollution of Antarctica

Gabrielle Viera Lube – MS
Amanda Camara de Souza - PhD

FUTURE CHALLENGES

✓ To develop more organic geochemical markers to detect the human activities, specially to track environmental change since the beginning of First Industrial Revolution in the South Hemisphere.

✓ To define more region-specific (sentinel) sites and provide more information about organic geomarkers that can be use in a worldwide perspective.

✓ To include multiple parameters (social, economics, geomorphological, etc.) of each region of the globe and to integrate to the organic geochemical markers data.

THANK YOU FOR YOUR ATTENTION !

Senior Visiting Professor

(Grant nº 88887.477472/2020-00)

Geochemical organic markers in sediment cores of the Santos-São Vicente Estuary, SP: a historical register of the introduction of hydrocarbons in the marine environment

(Grant nº 01/10704-8)

Reconstruction of historical input of sewage and organic matter deposition in the Paraná coast, Brazil

(Grant nº 448945/2014-2)

SCAN ME

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