

## Long-term accumulation of metals and persistent pollutants (PAHs, PCBs, organochlorine pesticides) from Eure river watershed (France) in sediments: possible consequences of a dam removal

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- **Context of the European Water Framework Directive (2000/60/CE)**

- Allow free Suspended Particulates Matter transfers in rivers
- French authorities decided to remove dam of Martot
  - Consequences for sediments blocked upstream the dam ?

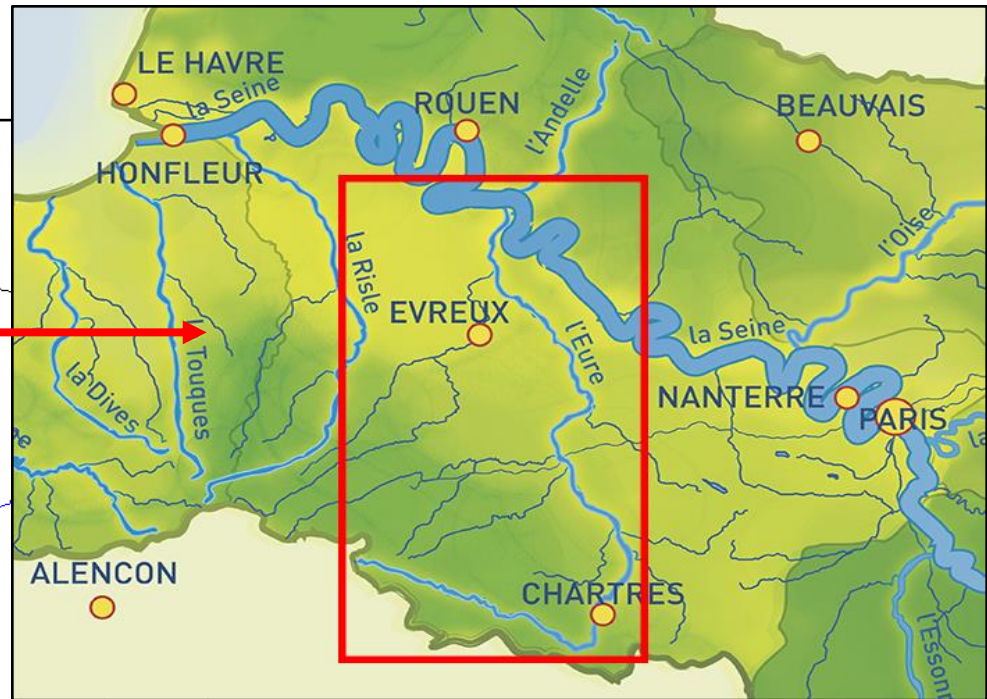
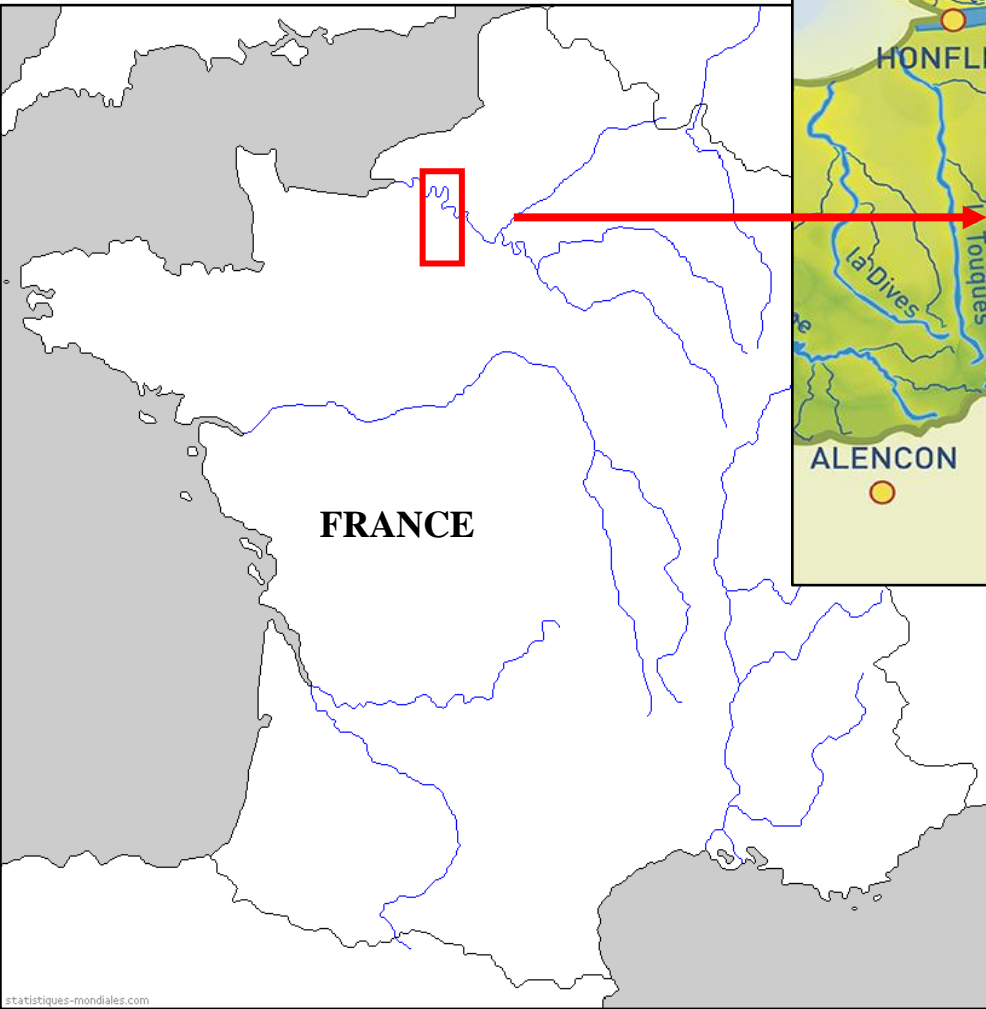


- **Observatory of the Seine Sediments in the Eure River (Eure county: 27) and the Seine River (Seine-Maritime county: 76)**
- **Aim:** Study dam removal impacts (dam located on the Eure River (Normandy, France))
  - Qualities and quantities of sedimentary transfers
  - **Accumulation of polluted sediments in Eure Watershed since the last century**
  - Fate of organic (PAHs, PCBs, organochlorine Pesticides) and metallic pollutants after dam removal
  - Assessing the bio-accessibility

THE EURE WATERSHED

CORE SAMPLING

CORE DATING



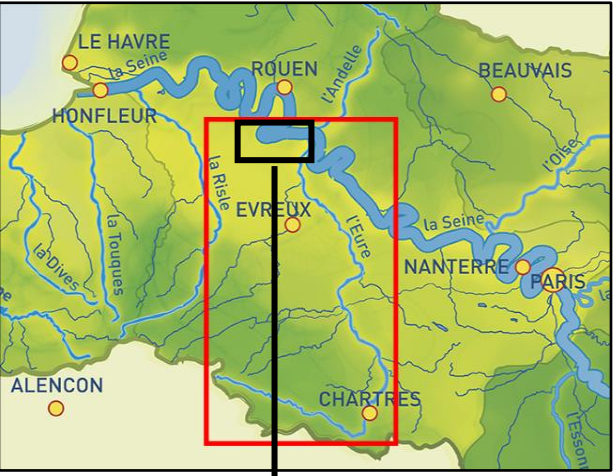
The Eure River Watershed ([www.rivierevivante.fr](http://www.rivierevivante.fr))

- **Eure River:**
  - 228.7 km long
  - One of the main tributaries of the Seine River downstream
  - Two main tributaries:
    - Iton (131.8 km long)
    - Avre (80.4 km long)
  
- **Eure Watershed:**
  - 6,017 km<sup>2</sup>
  - Land use:
    - Agricultural land: 71.2 %
    - Forest: 22.3 %
    - Artificial lands: 6 %
    - Water and humid surfaces: 0.5 %

THE EURE WATERSHED

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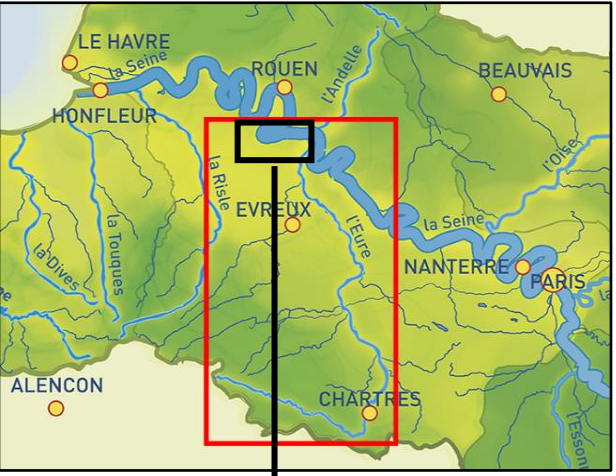
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- The Eure River and the Seine River are « side by side » until the confluence



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- **Eure River downstream (~ 10 km long)**
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- Dam of Martot: 300 m upstream the Eure River/Seine River confluence



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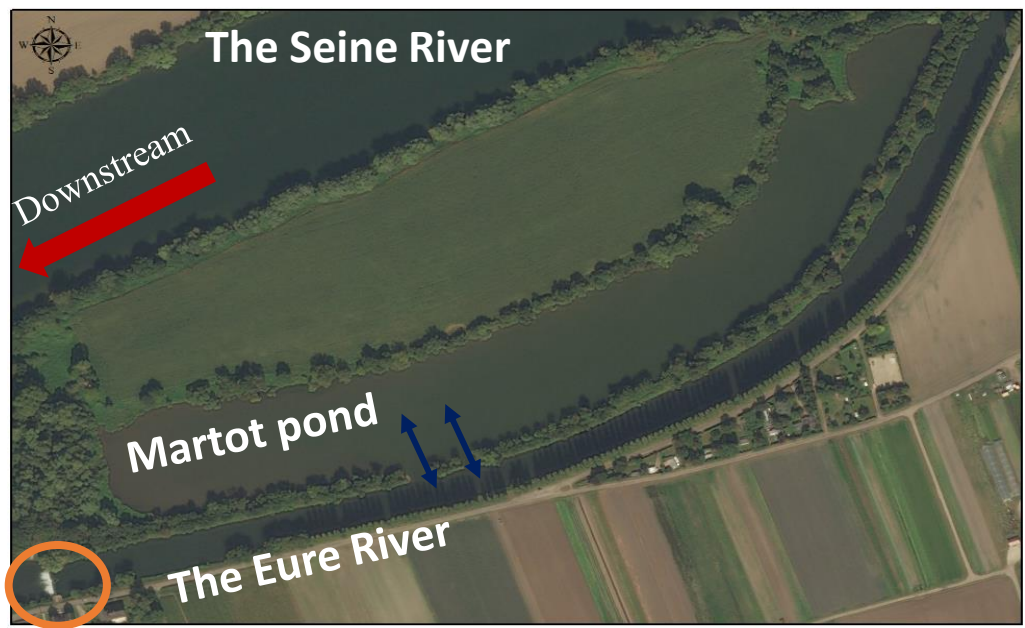
CORE SAMPLING

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- **Eure River downstream (~ 10 km long)**
  - The Eure River and the Seine River are « side by side » until the confluence
  - Dam of Martot: 300 m upstream the Eure River/Seine River confluence
  - Two ponds: Martot pond & Les Damps pond



Dam of Martot



- **Martot pond:**
  - Formerly connected to the Seine River
  - Since 1942: connected to the Eure River
  - Filled by Seine then Eure sediments inputs



- THE EURE WATERSHED

- MARTOT POND*

- Core sampling in 2015:

- **MAR15-01**; MAR15-02; MAR15-03; MAR15-04

- Core sampling in 2016:

- EUR16-01; EUR16-02; EUR16-03

- **MAR16-02**; MAR16-03

- Core sampling in 2017:

- EUR17-01; EUR17-02; EUR17-03; EUR17-04

- MAR17-01; MAR17-02

- CORE SAMPLING**

- CORE DATING



THE EURE WATERSHED

CORE SAMPLING

CORE DATING

LES DAMPS POND

- (10 km upstream Martot pond)
- Core sampling in 2017:
  - DAM17-01; **DAM17-02**



- THE EURE WATERSHED

- CORE SAMPLING

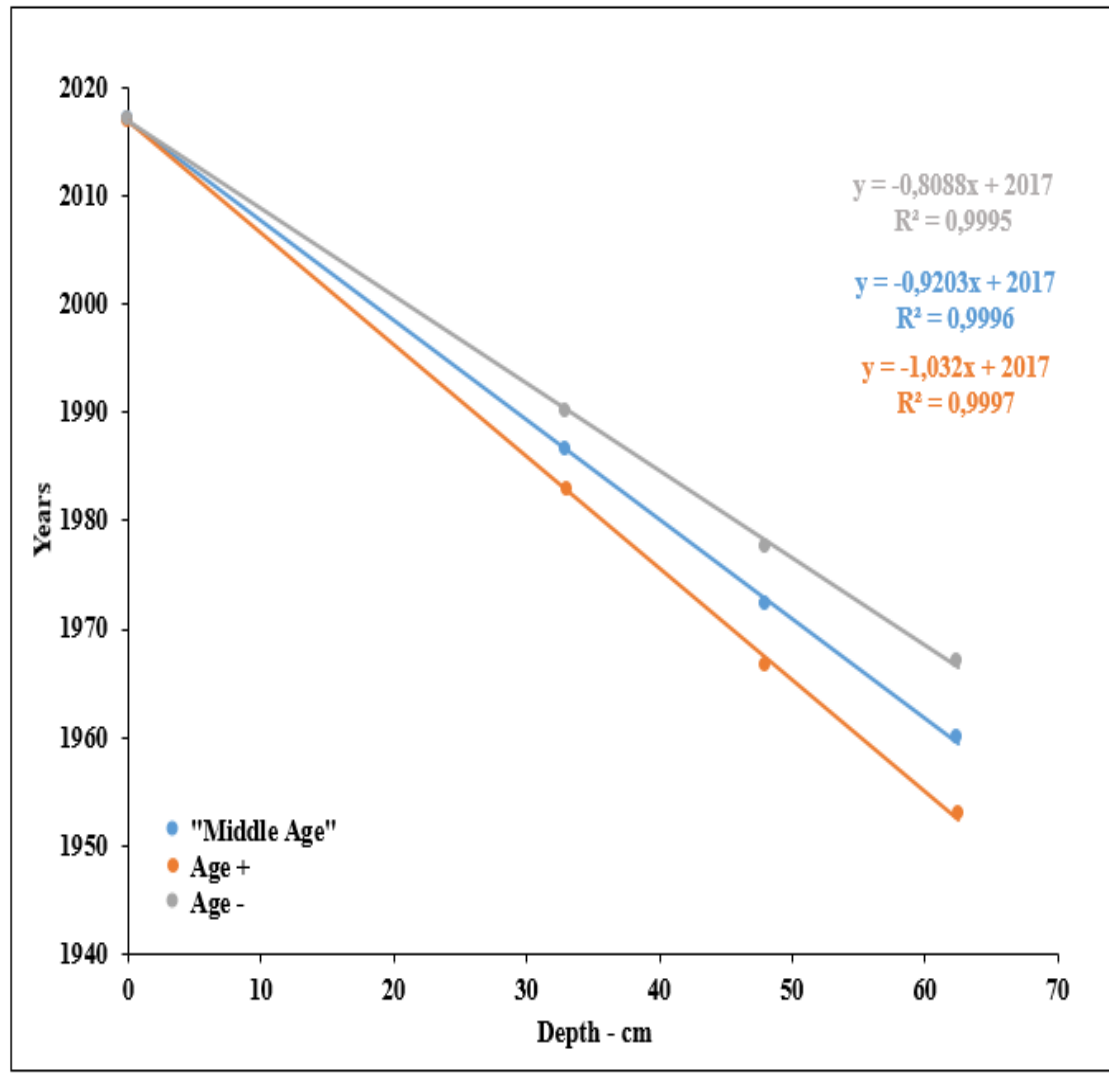
- **CORE DATING**

- **Dating of DAM17-02 core** (sampling in Les Damps pond):
  - Dating of MAR15-01 by absolute dating using  $^7\text{Be}$ ,  $^{137}\text{Cs}$ ,  $^{210}\text{Pb}$  (in 2015)
  - Dating of DAM17-02 by correlation with MAR15-01: correlation with XRF Core Scanner data
    - Correlation with  $\text{Pb}/\text{Ti} = f(z)$  and  $\text{Mn}/\text{Ti} = f(z)$
    - Find several references points

THE EURE WATERSHED

CORE SAMPLING

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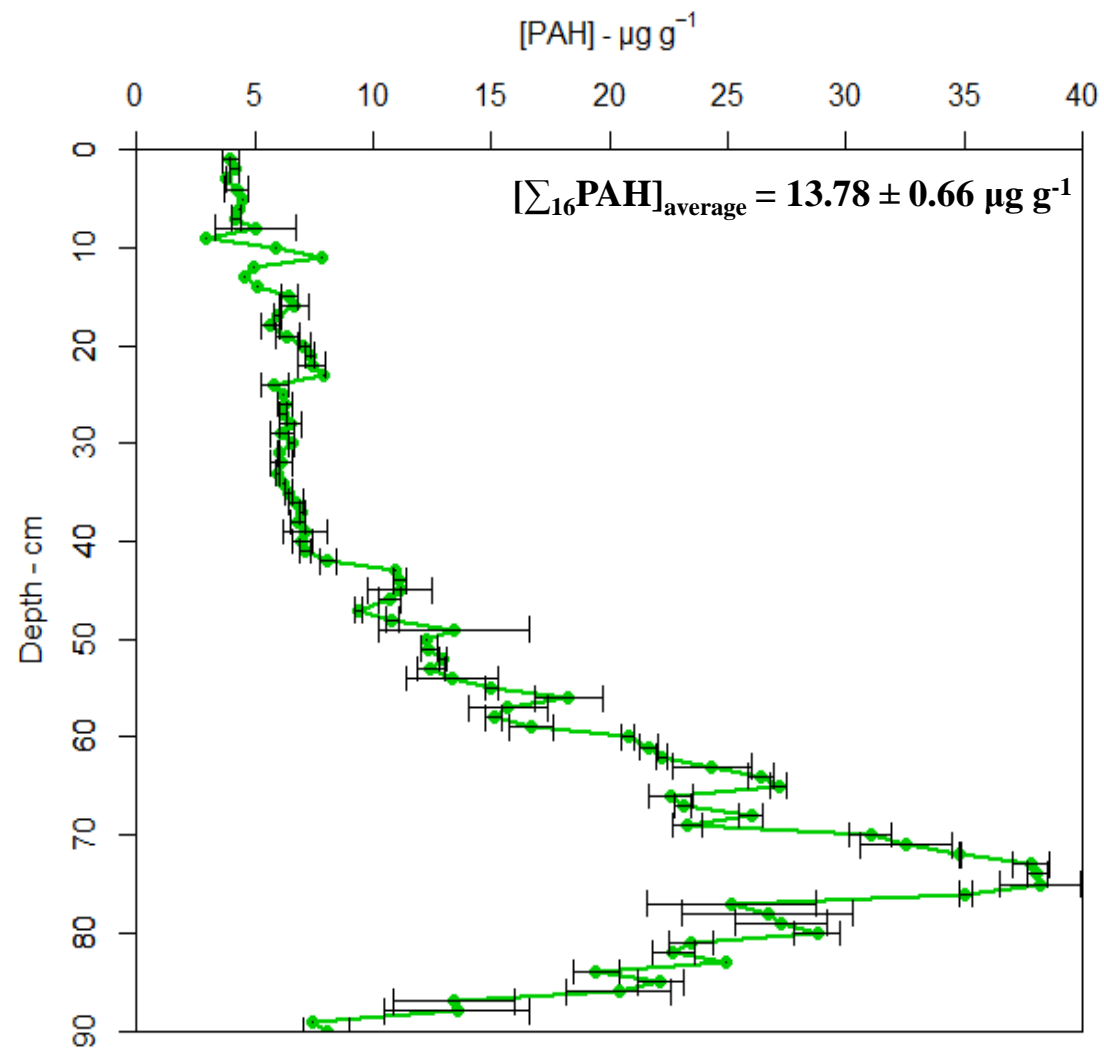


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  - Find several references points
- Plotting DAM17-02 Age Model
  - Obtaining a sedimentation rate for Les Damps pond
- ☐ **Sedimentation rate :  $0.92 \text{ cm an}^{-1}$**
- Comparable to the sedimentation rate of Martot pond:  $1.08 \text{ cm an}^{-1}$

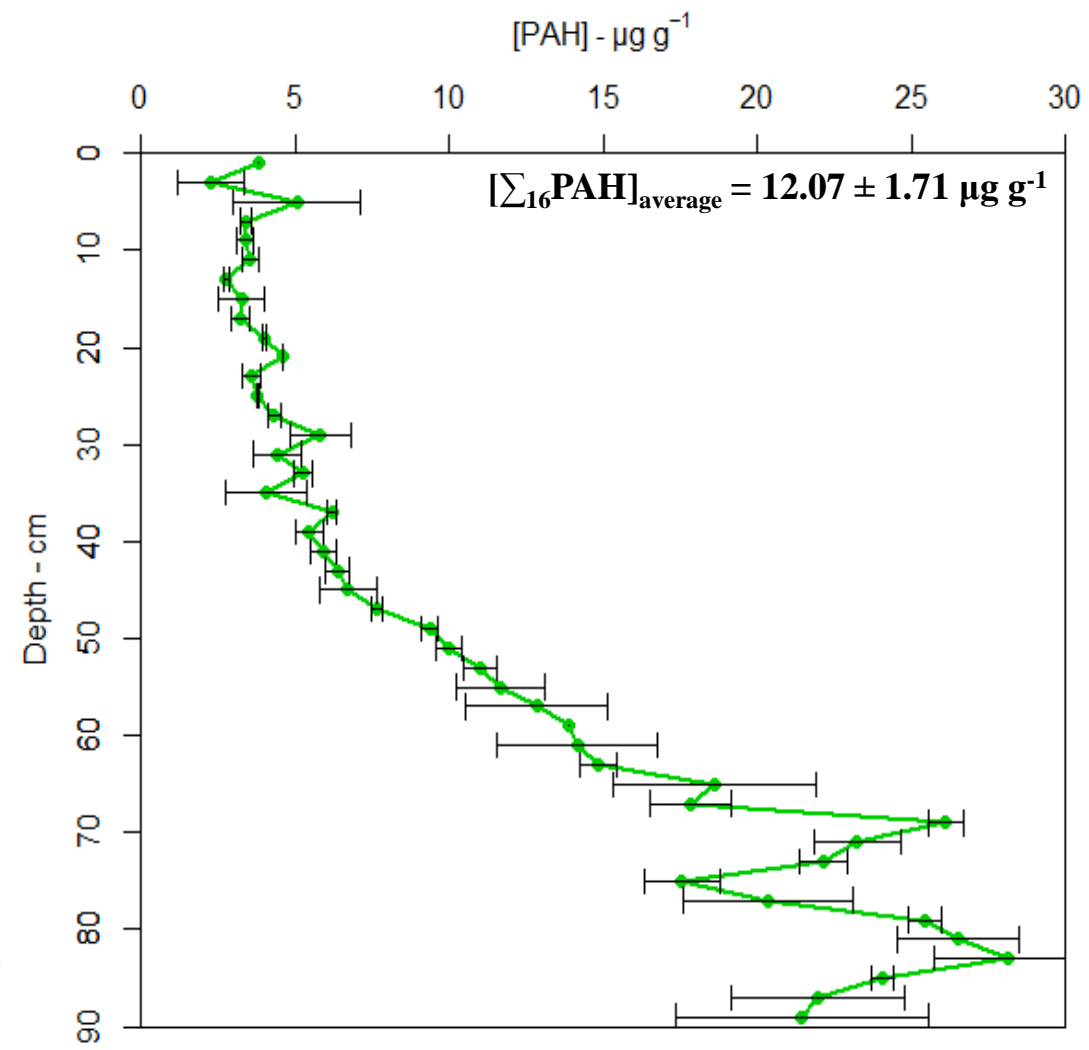
- $\sum_{16}\text{PAHs}$
- $\sum_7\text{PCBs}$
- TRACE-METAL ELEMENTS: example of Pb

- *MARTOT POND: MAR16-02*



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- *LES DAMPS POND: DAM17-02*



16<sup>th</sup> ICCE 2017 - Oslo, Norway

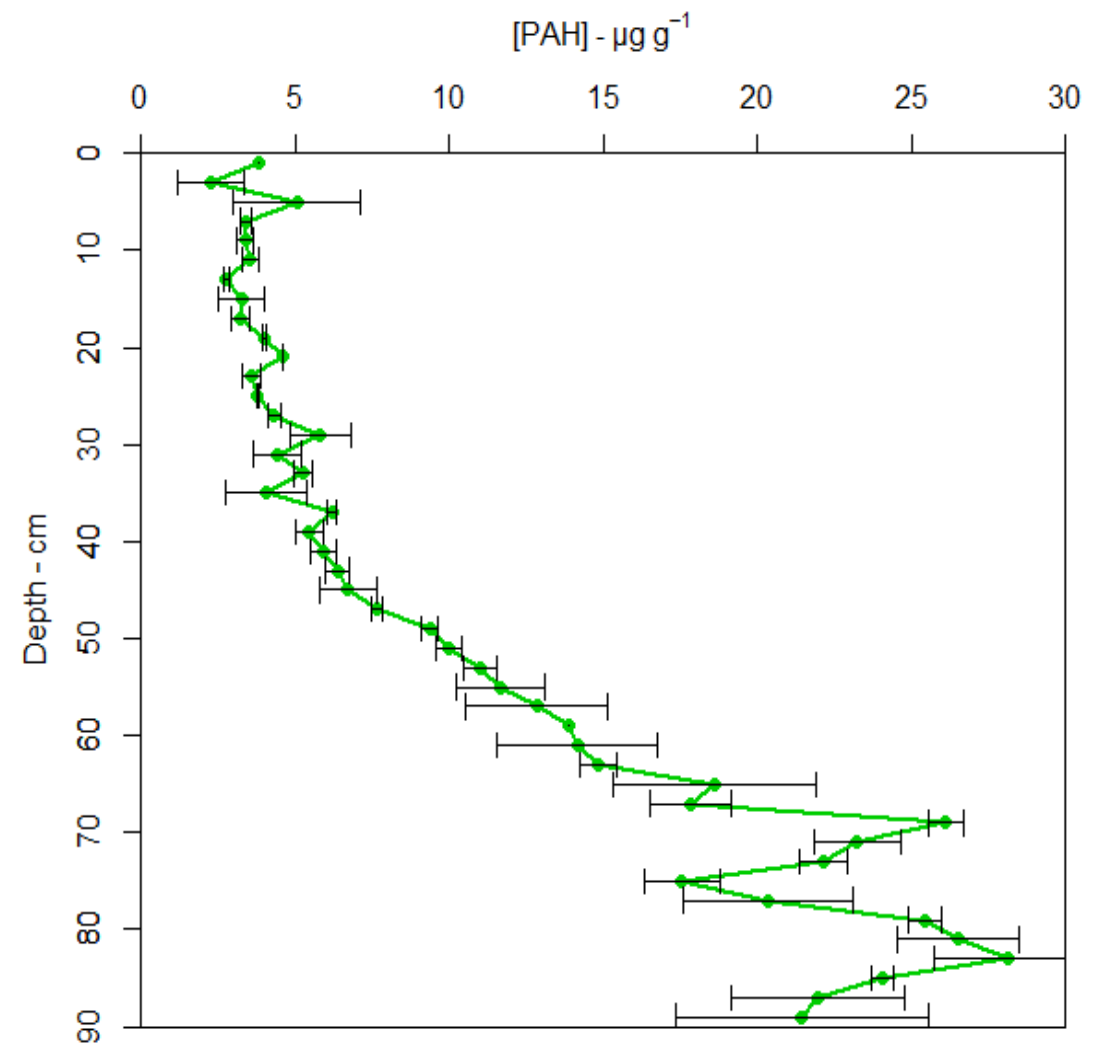
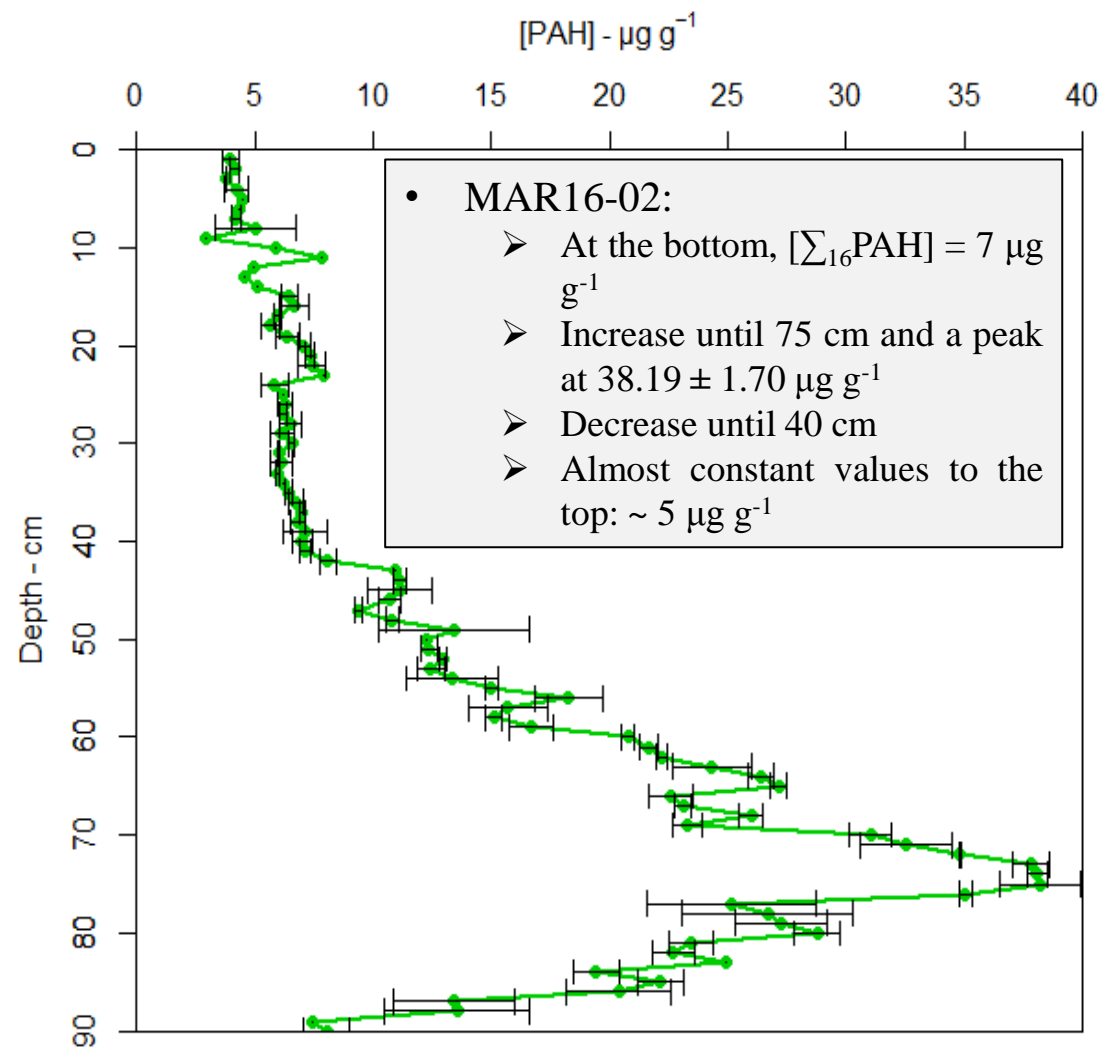
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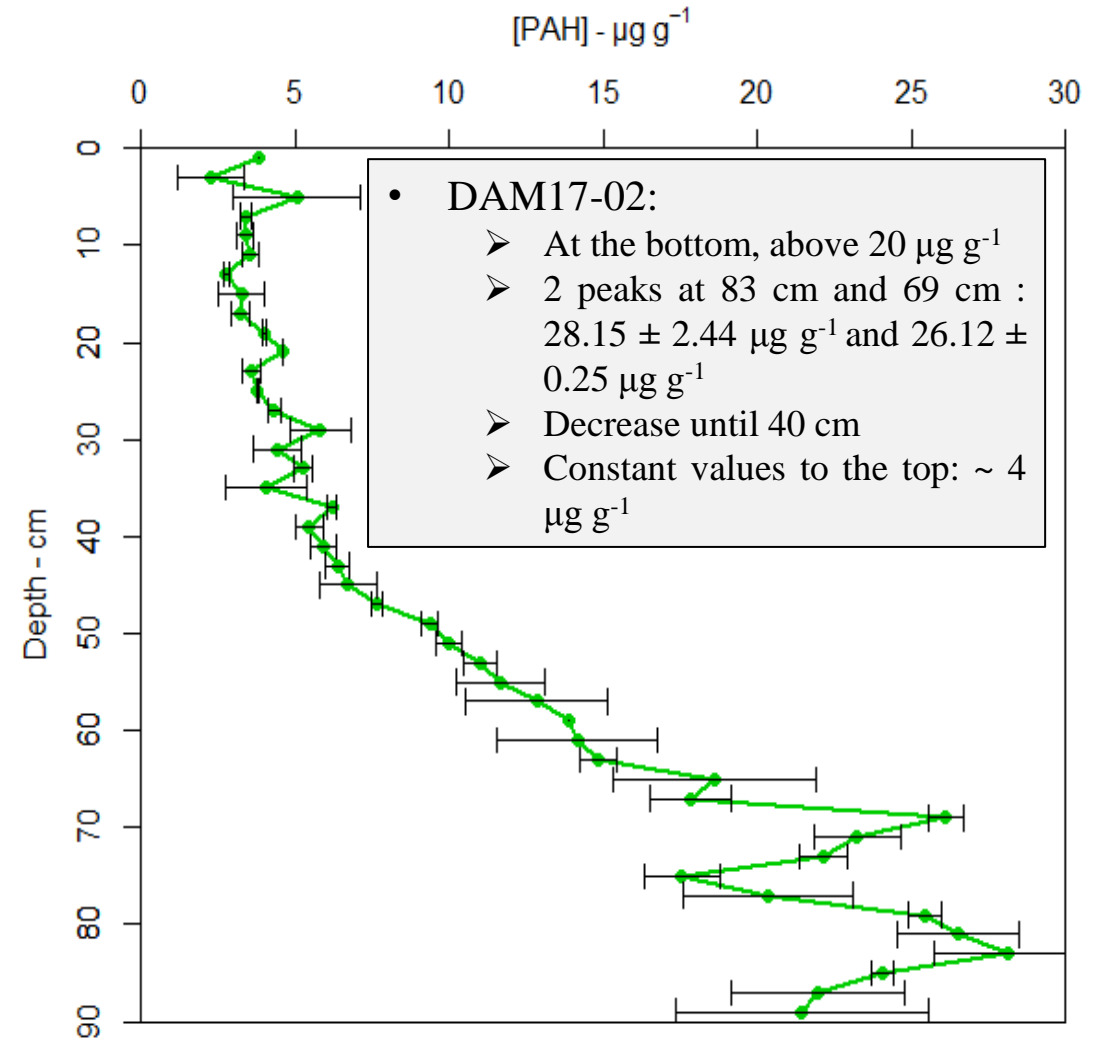
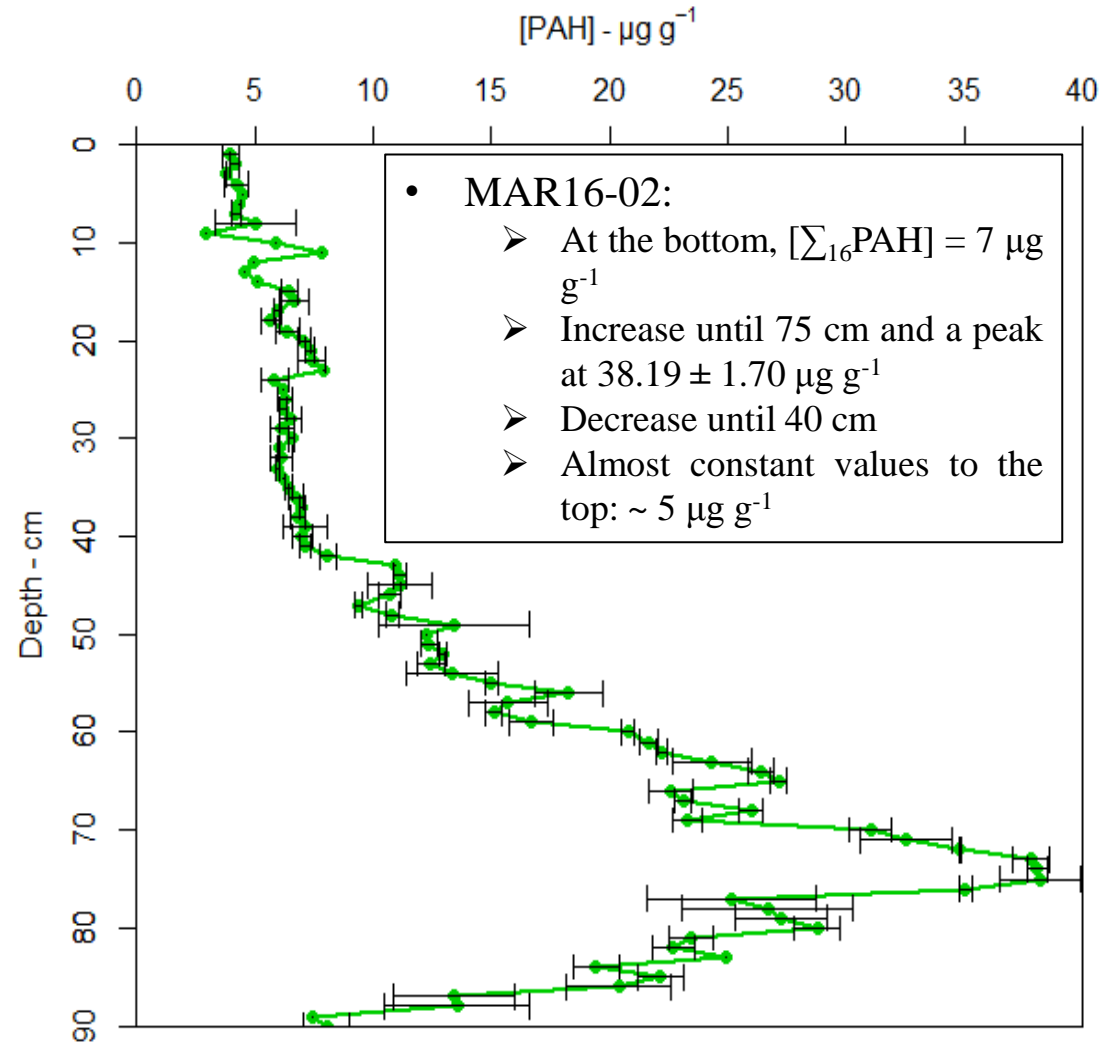
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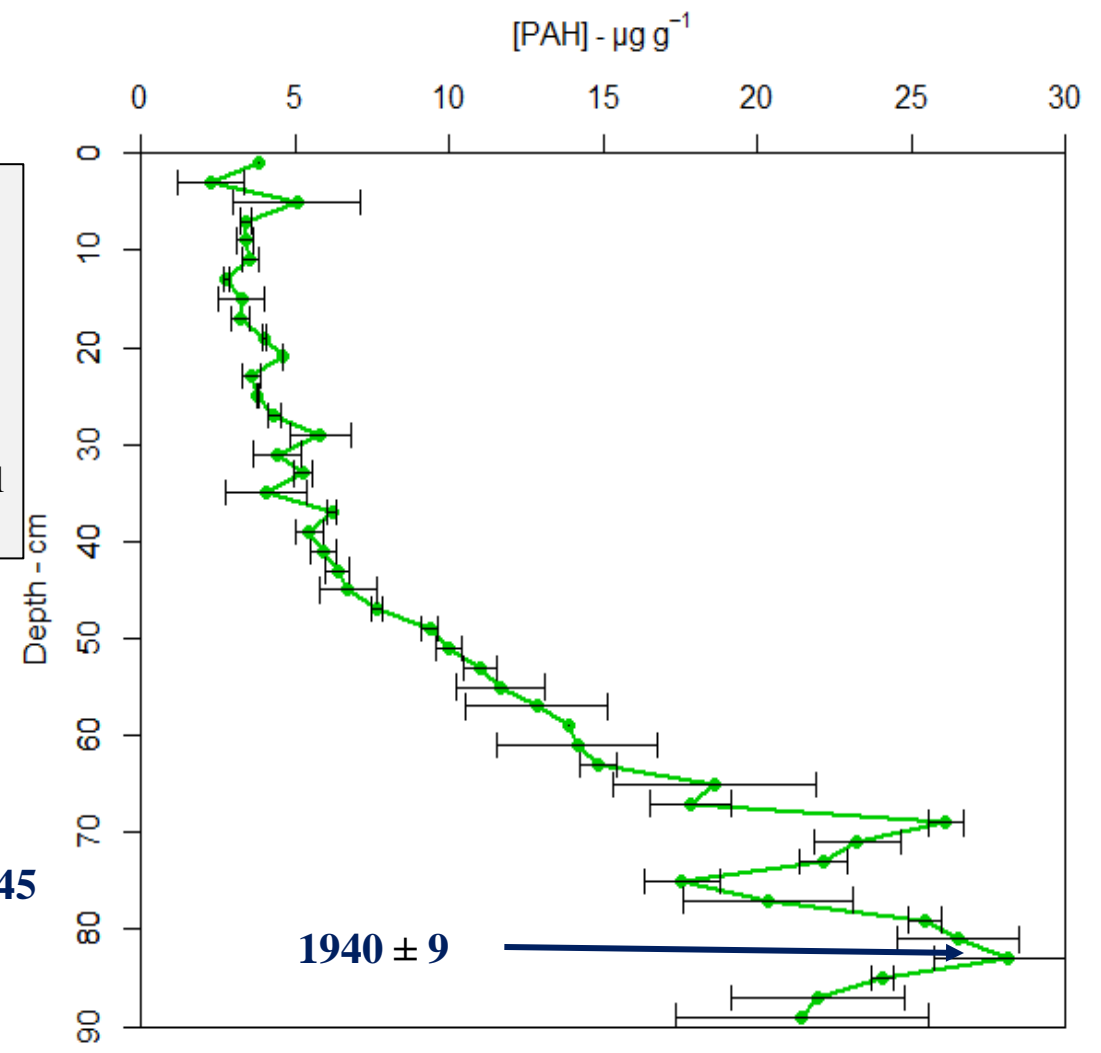
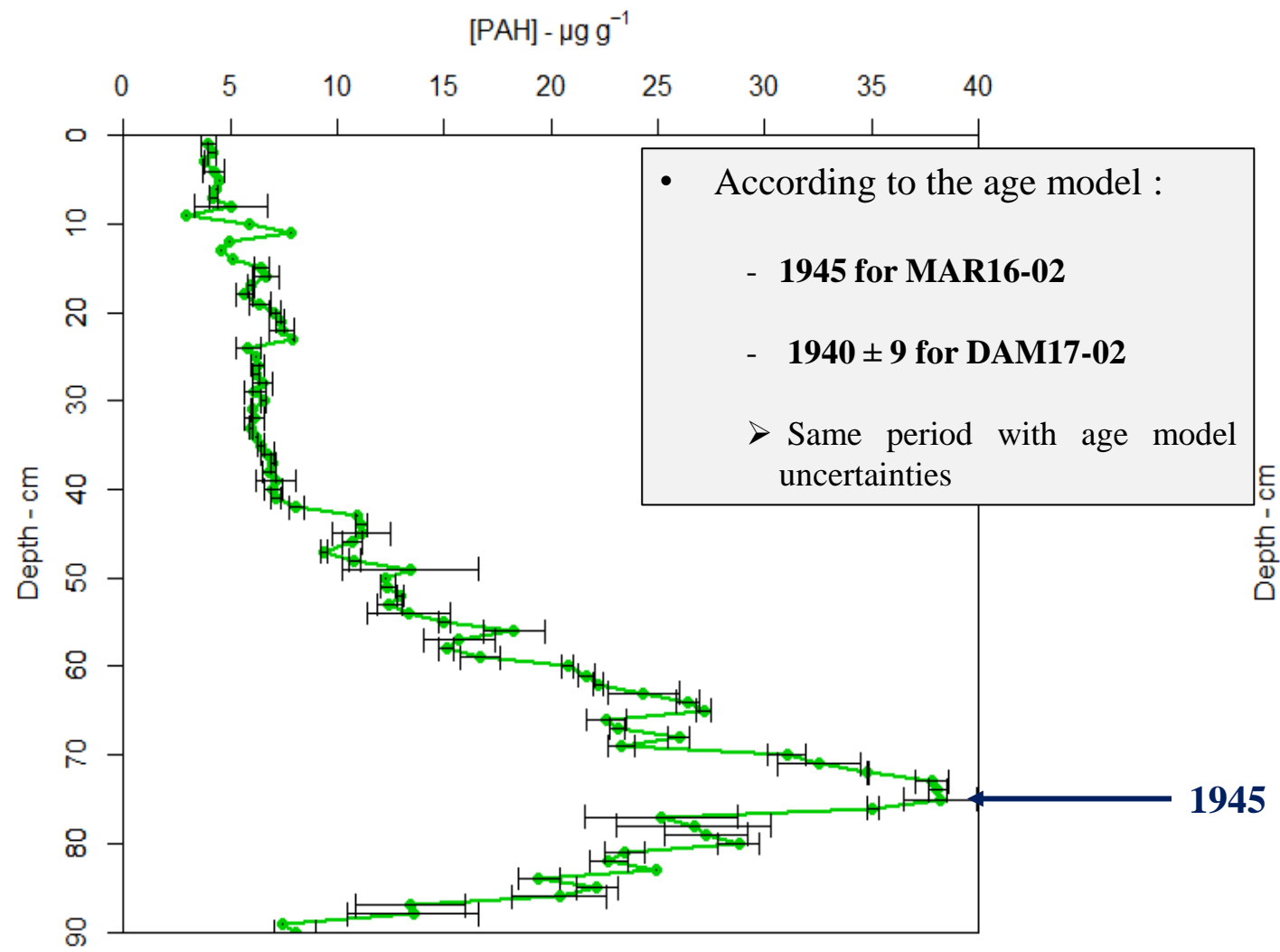
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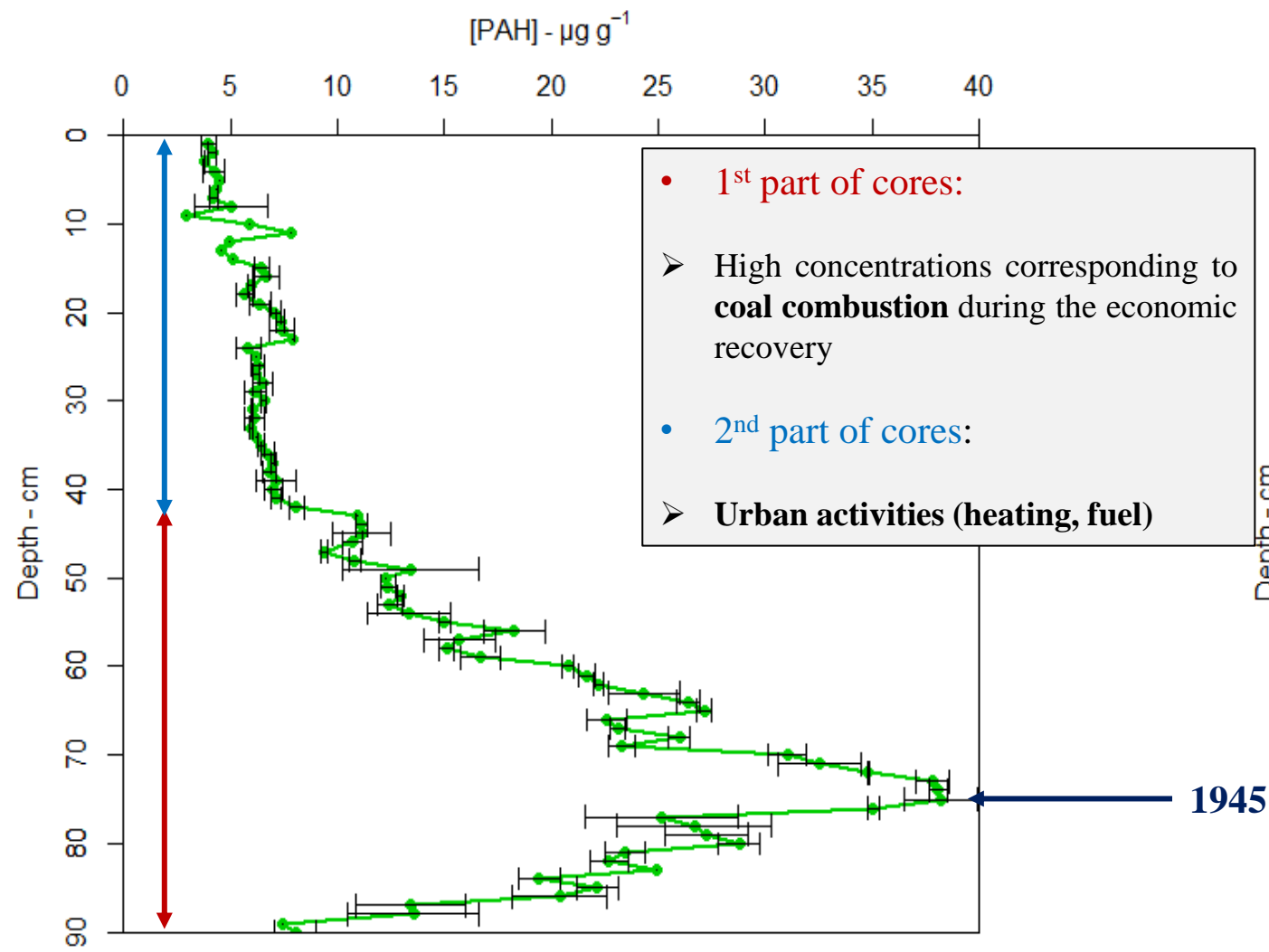
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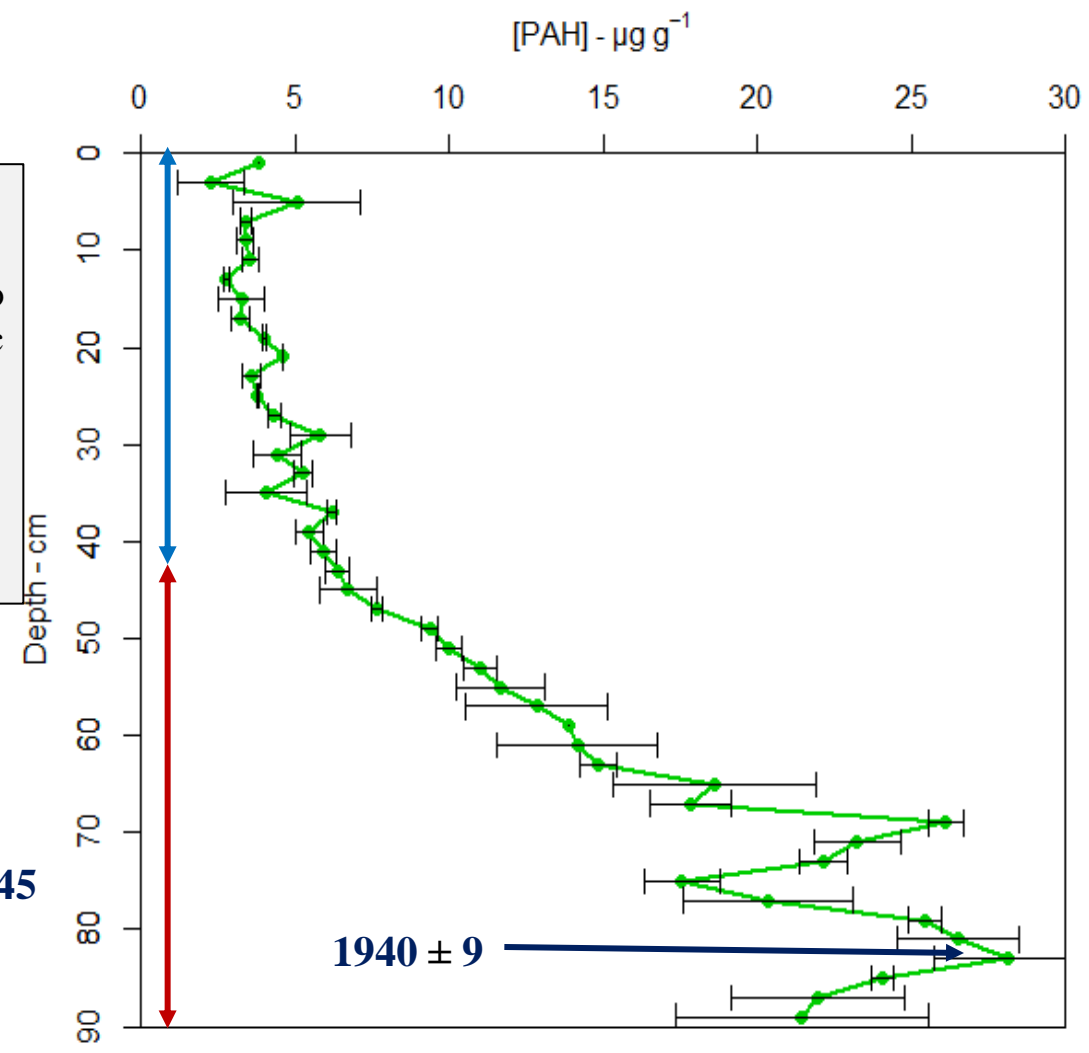
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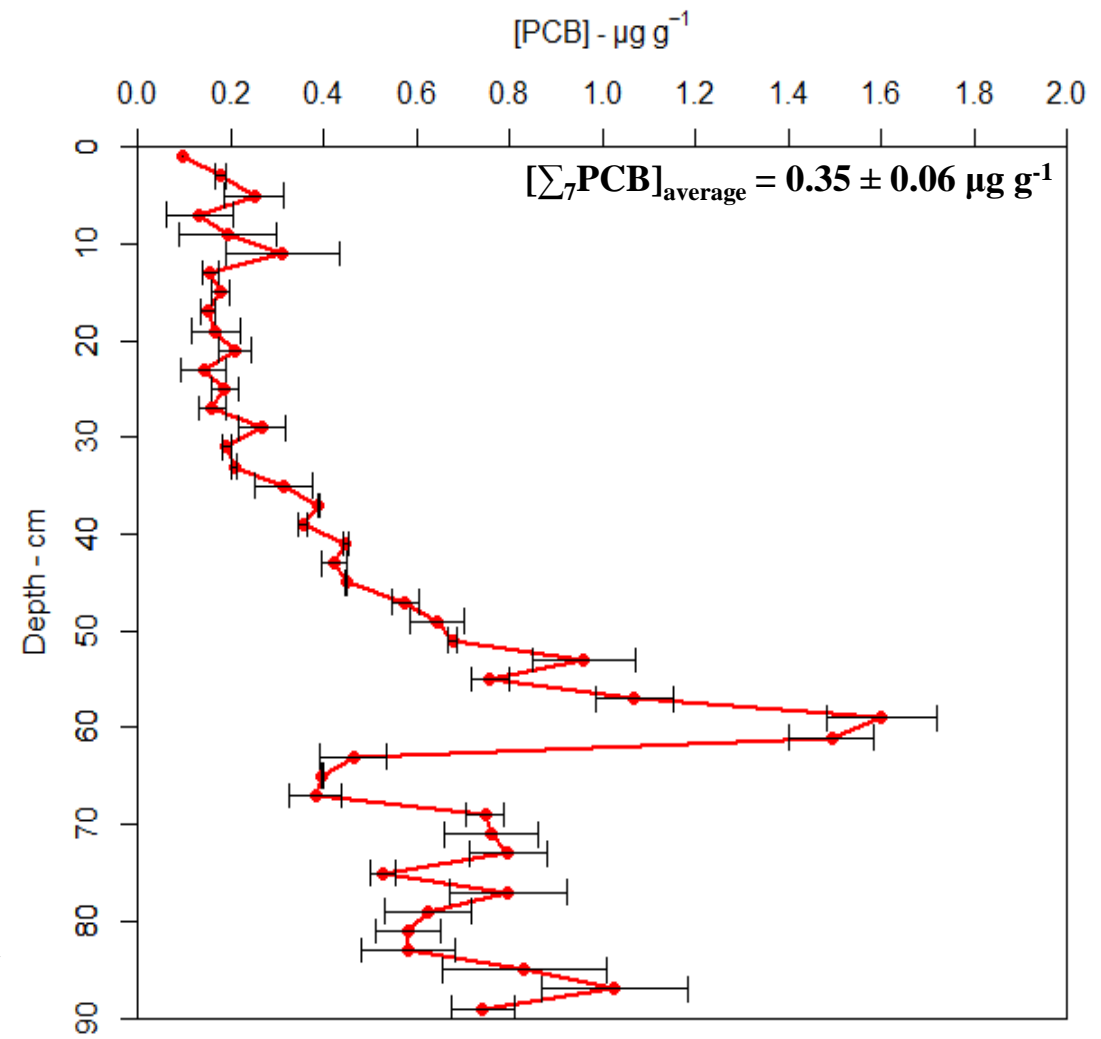
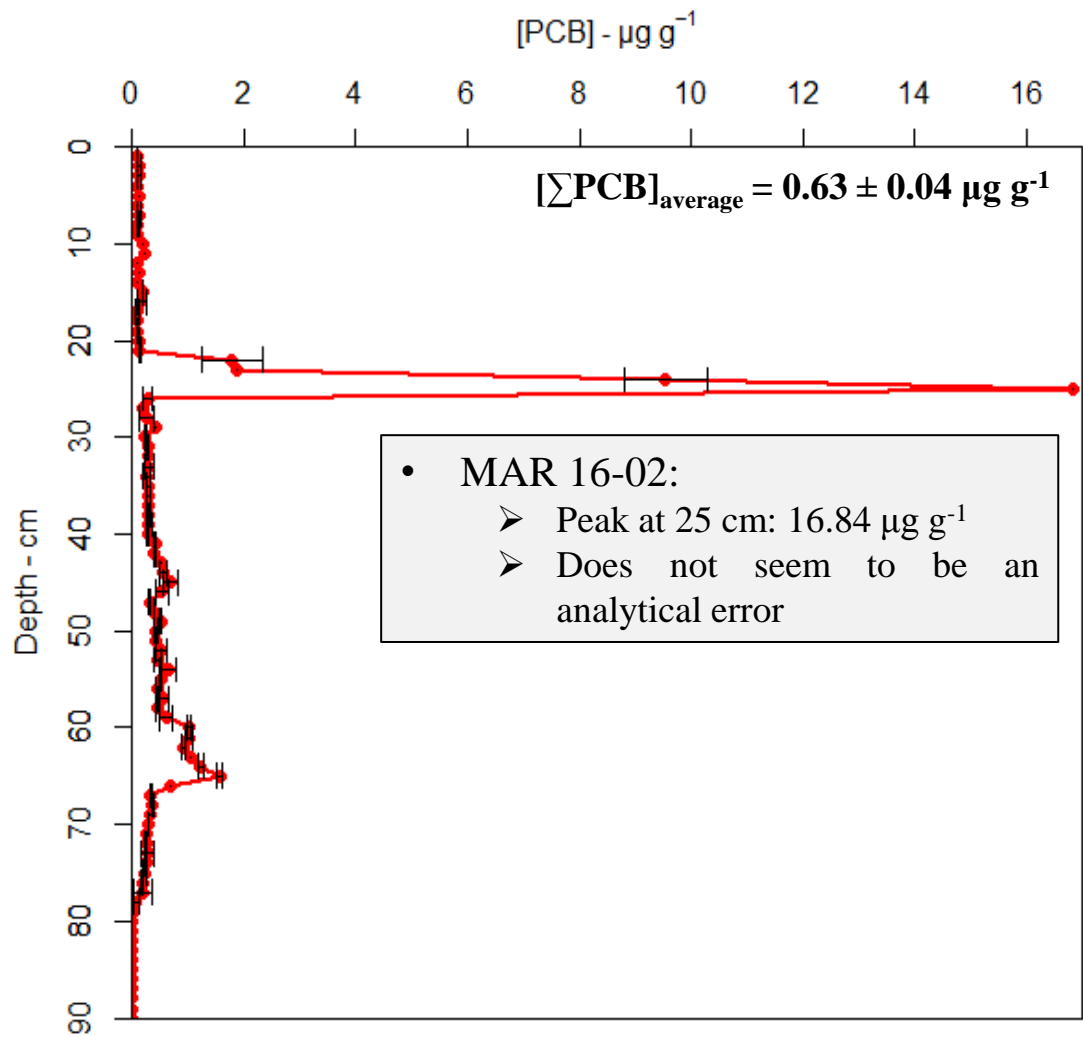
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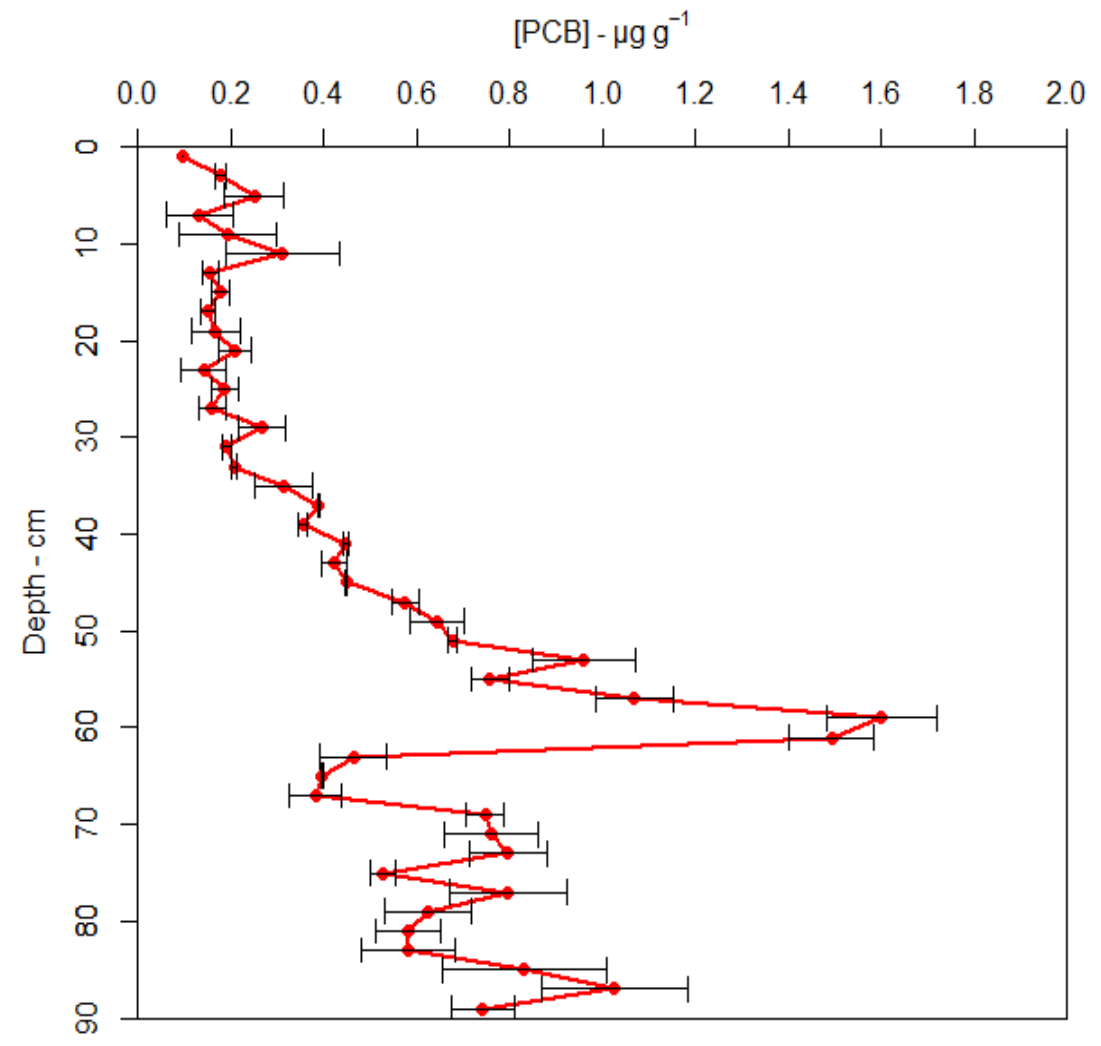
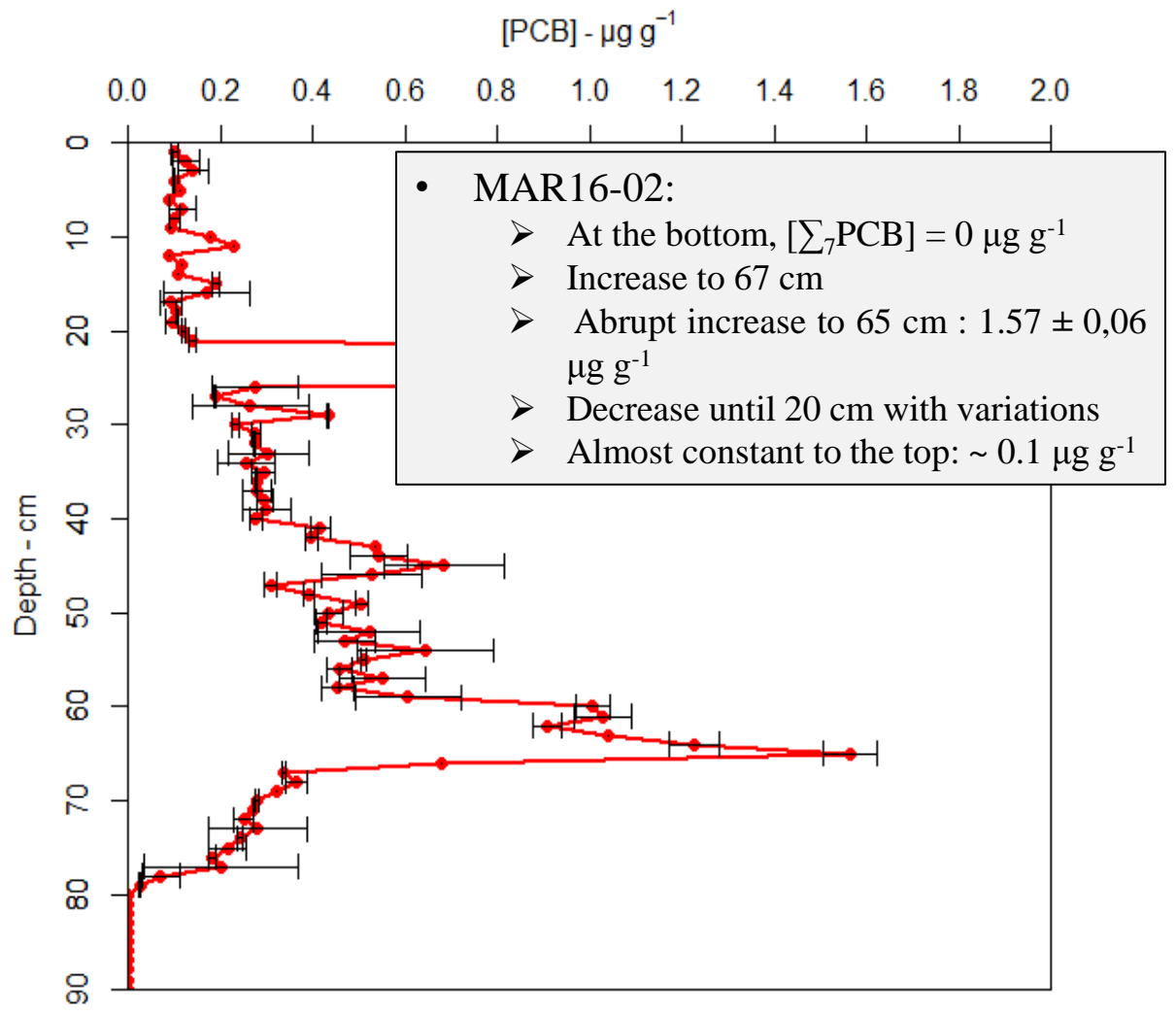
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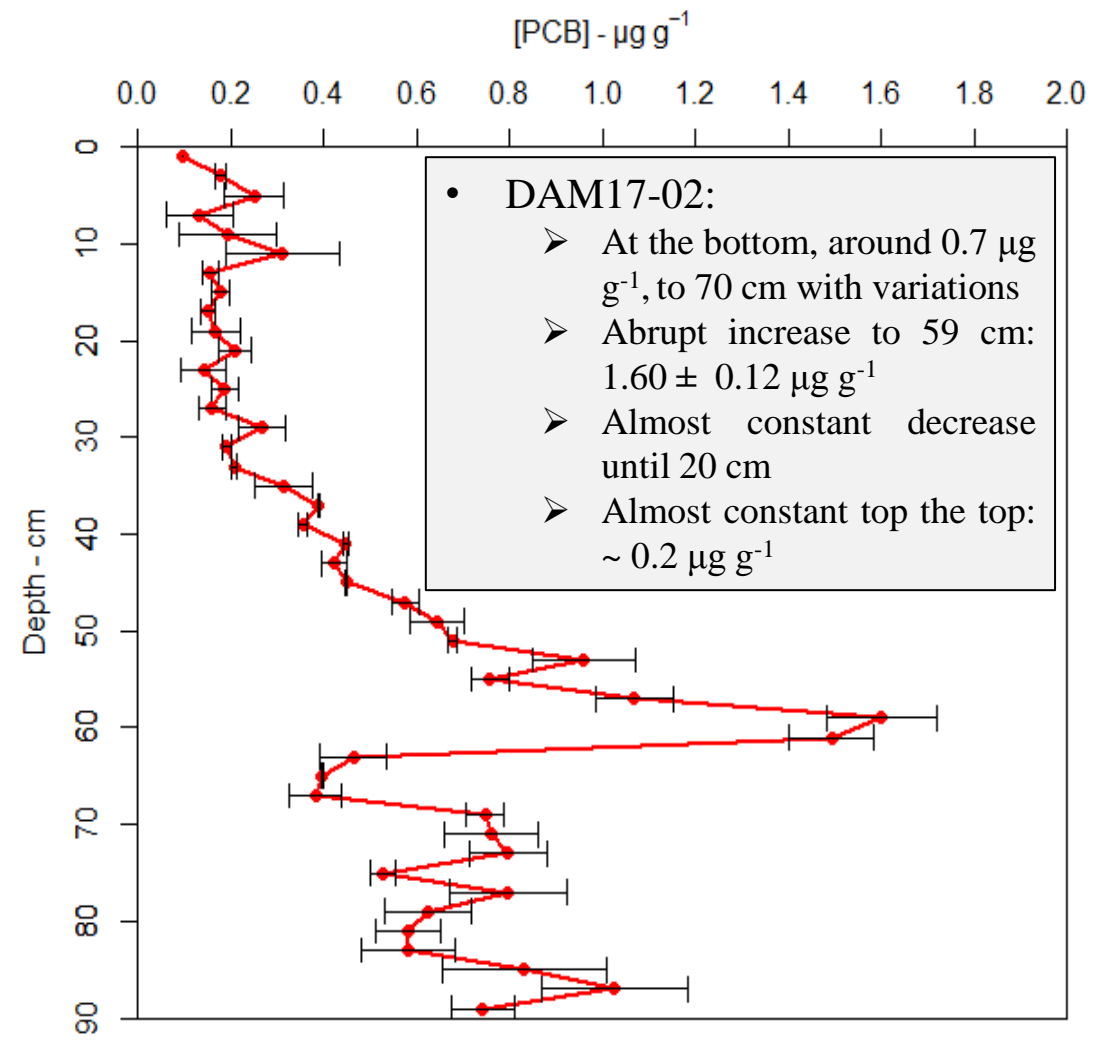
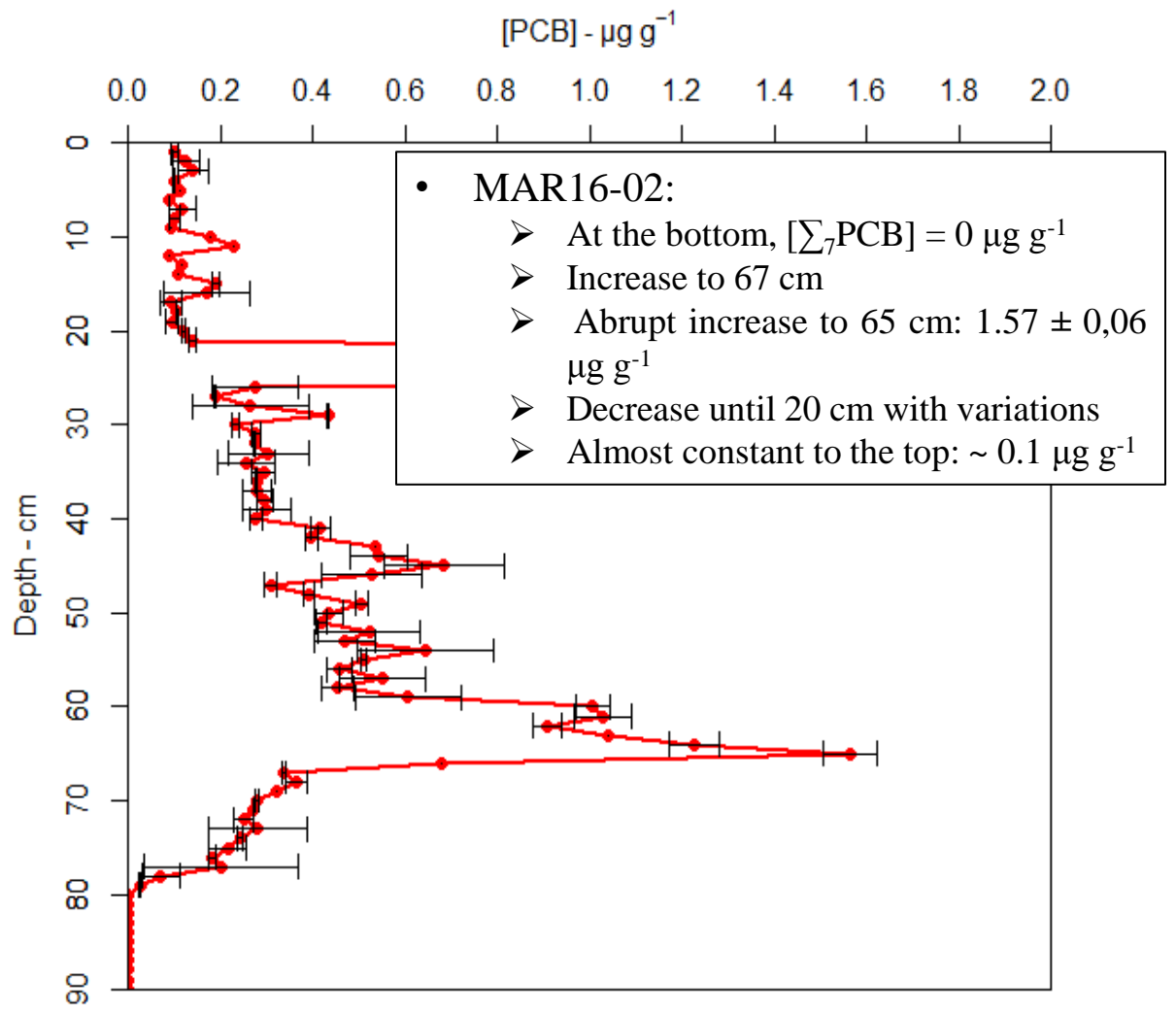
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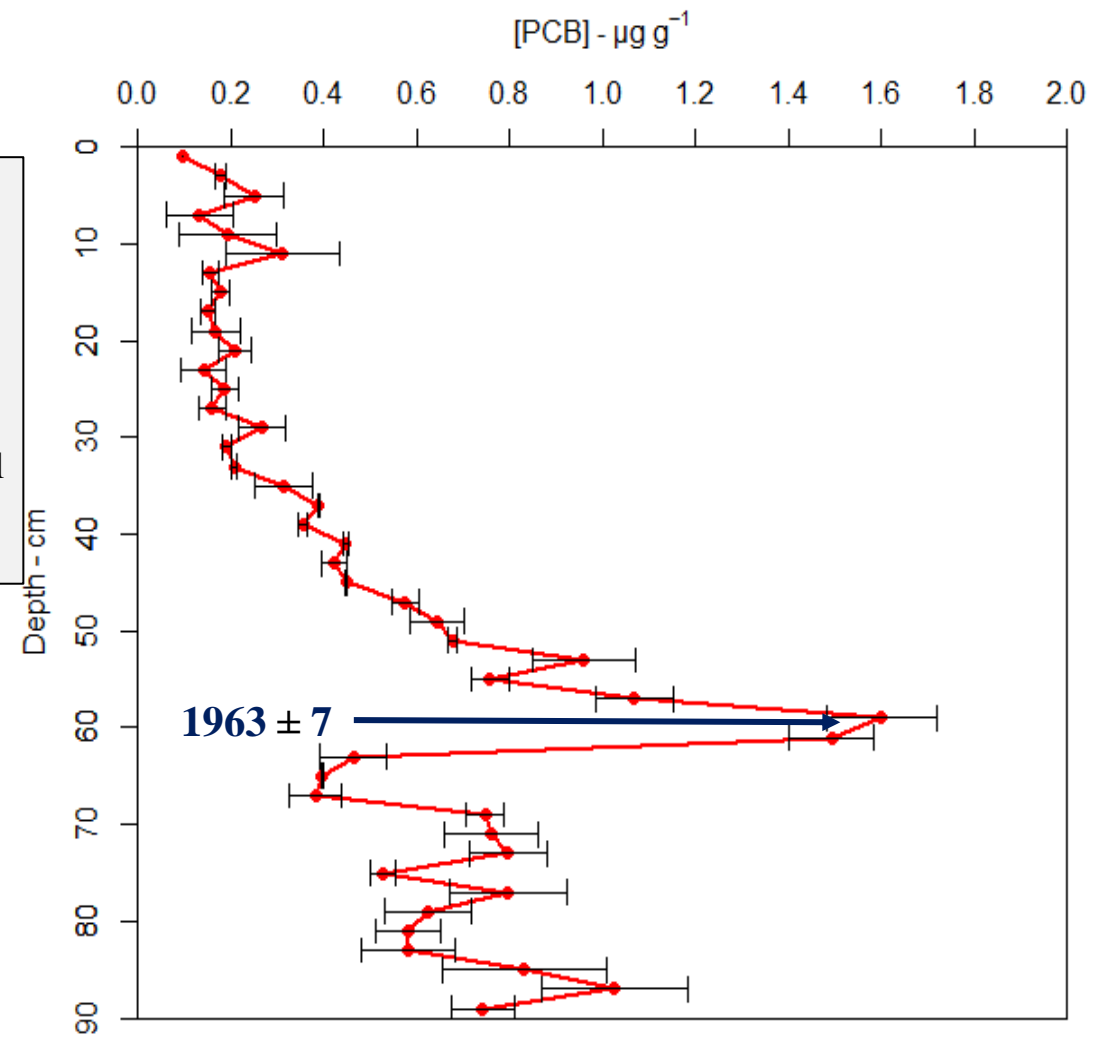
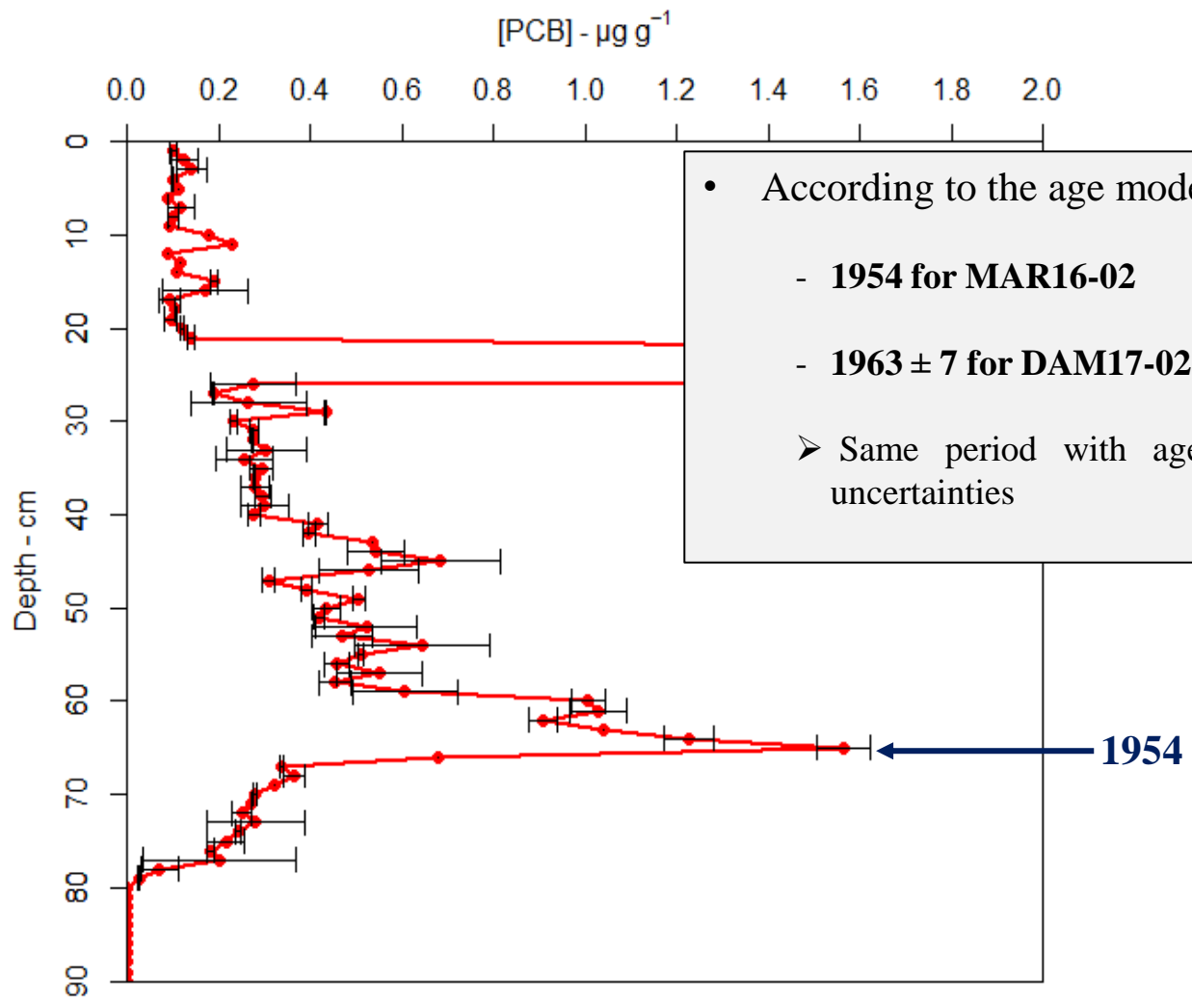
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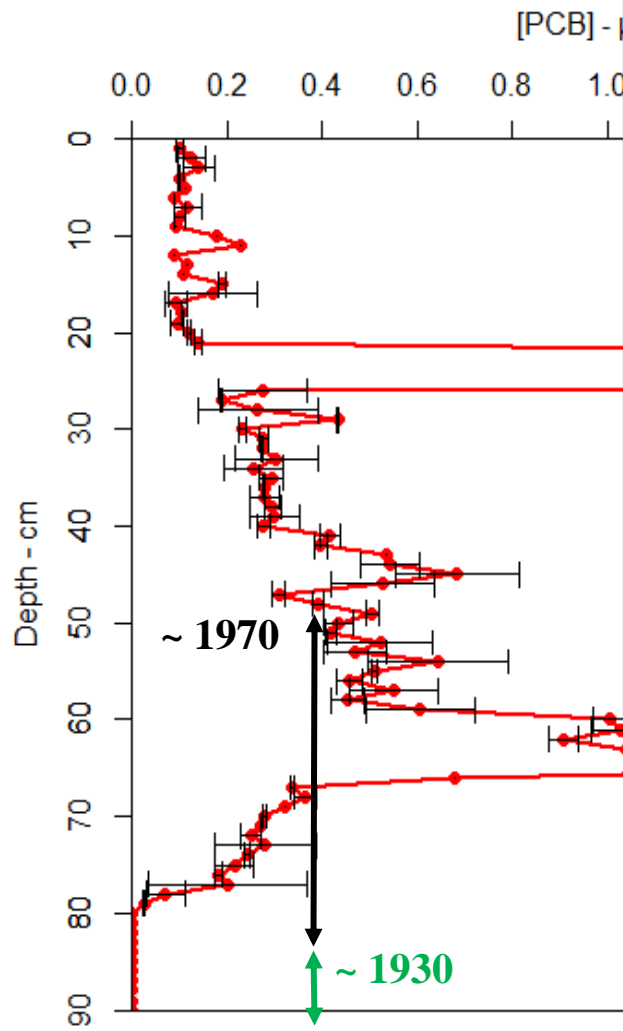


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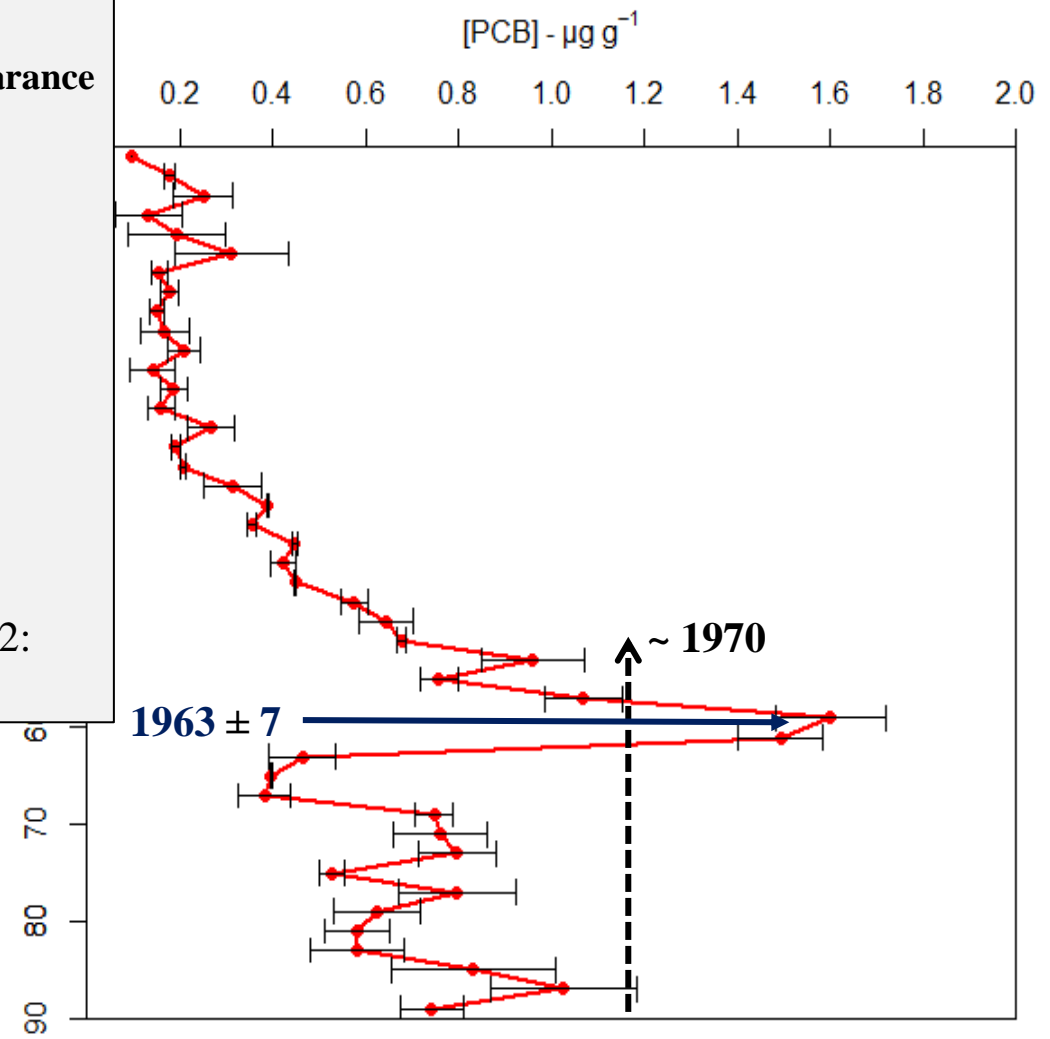
• **MARTOT POND: MAR16-02**



• **Bottom of cores:**

- MAR16-02: nothing before **~1930: appearance of PCBs in environment**
- 1930-1970:
  - **Interval during which PCBs were used**
  - **1950-1960: Economic recovery ?**
- 1970-now:
  - **Progressive decrease after prohibition**
- High concentration at 25 cm for MAR16-02:
  - **Local pollution ?**

• **LES DAMPS POND: DAM17-02**



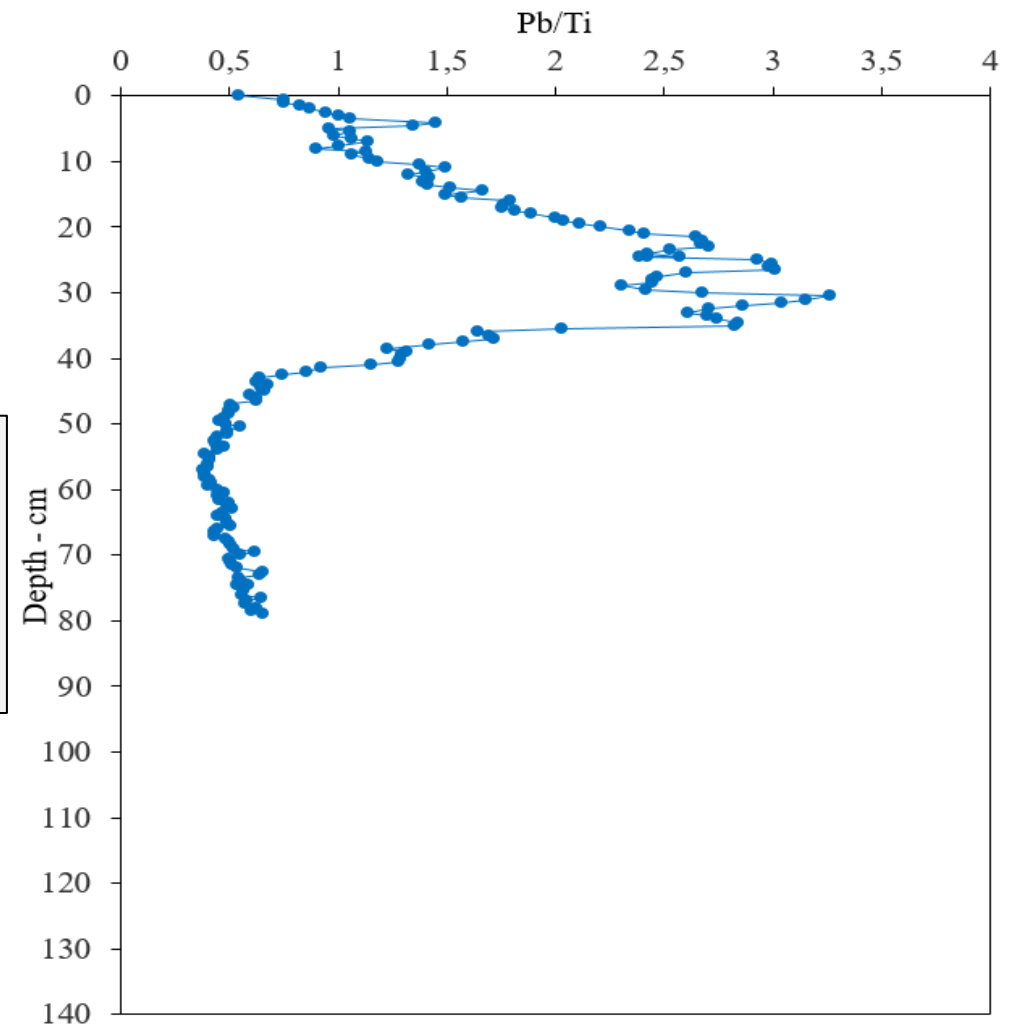
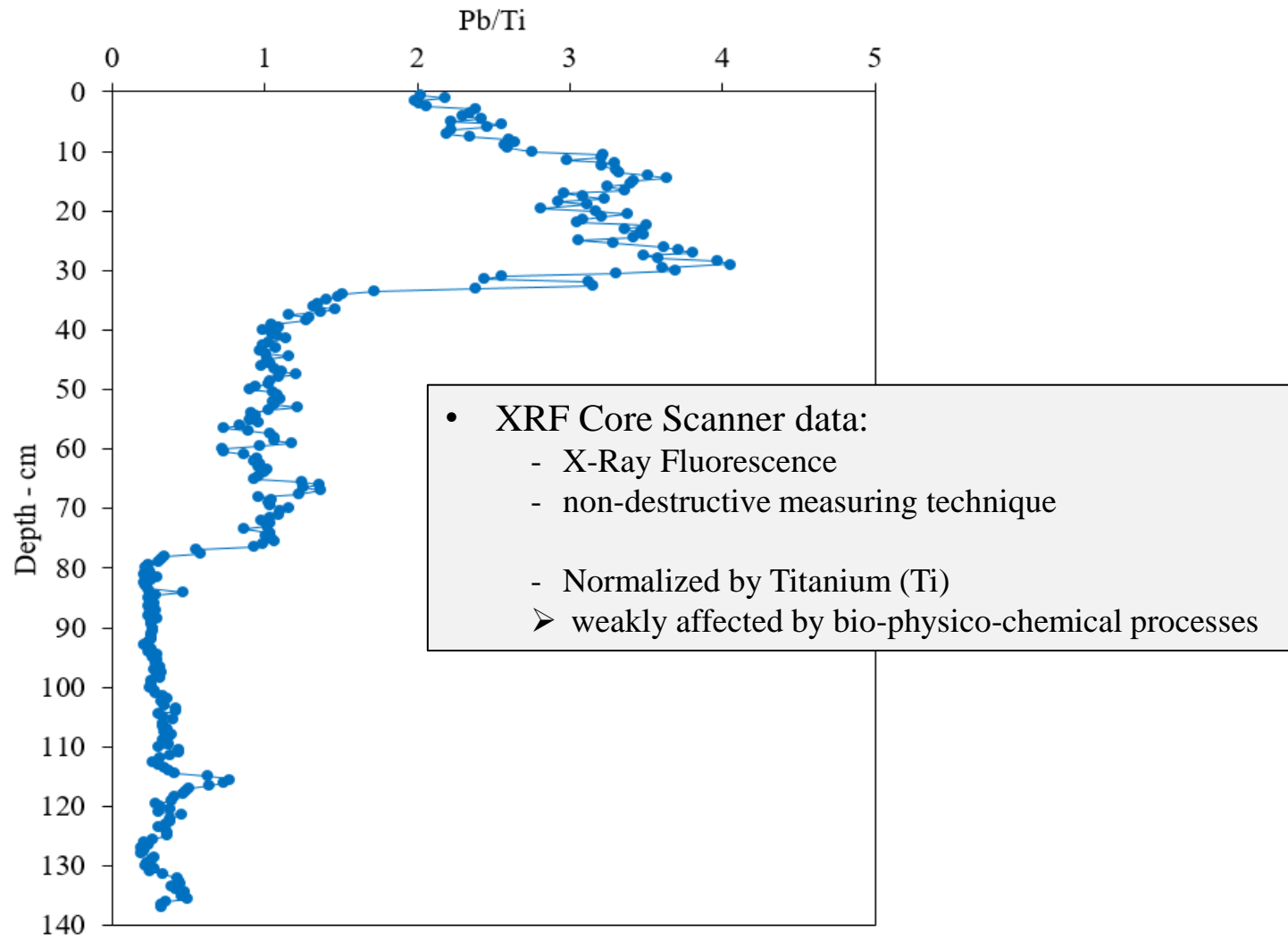
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• *MARTOT POND: MAR15-01*

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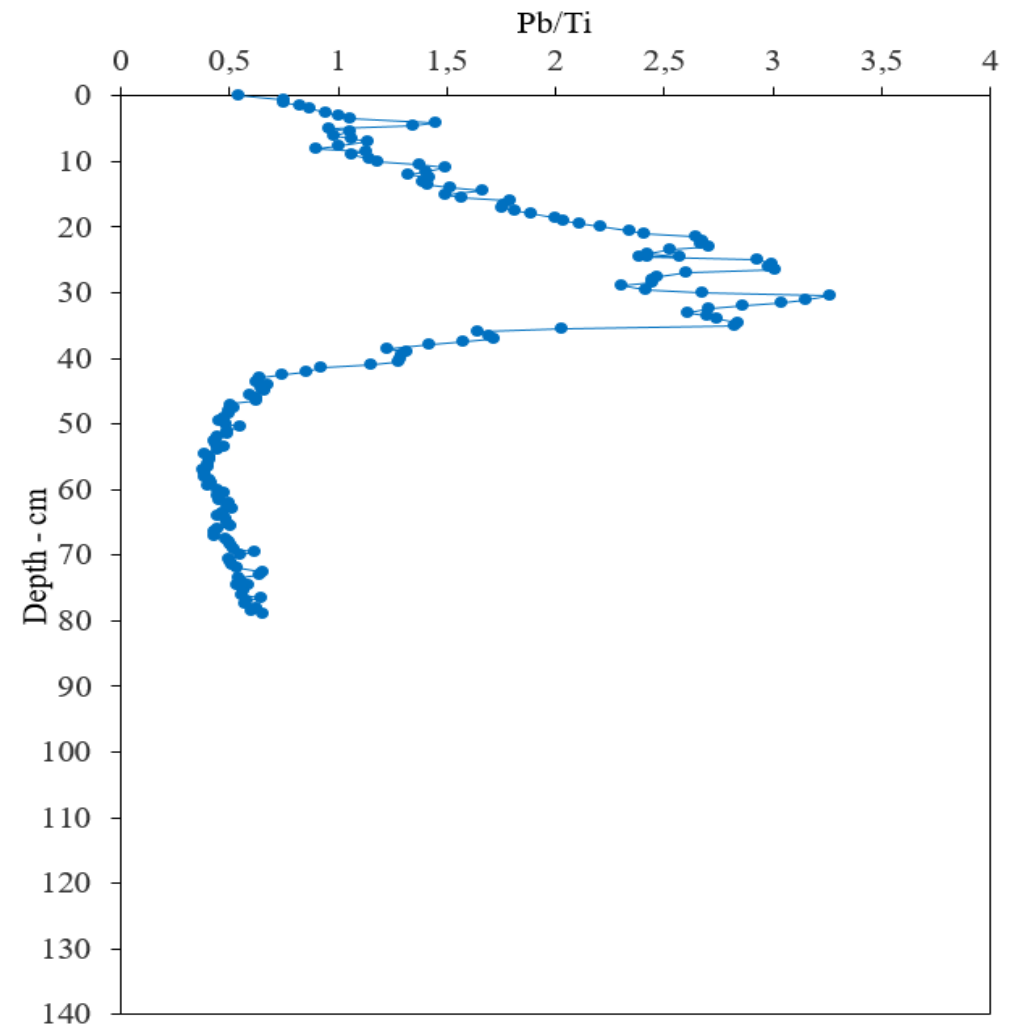
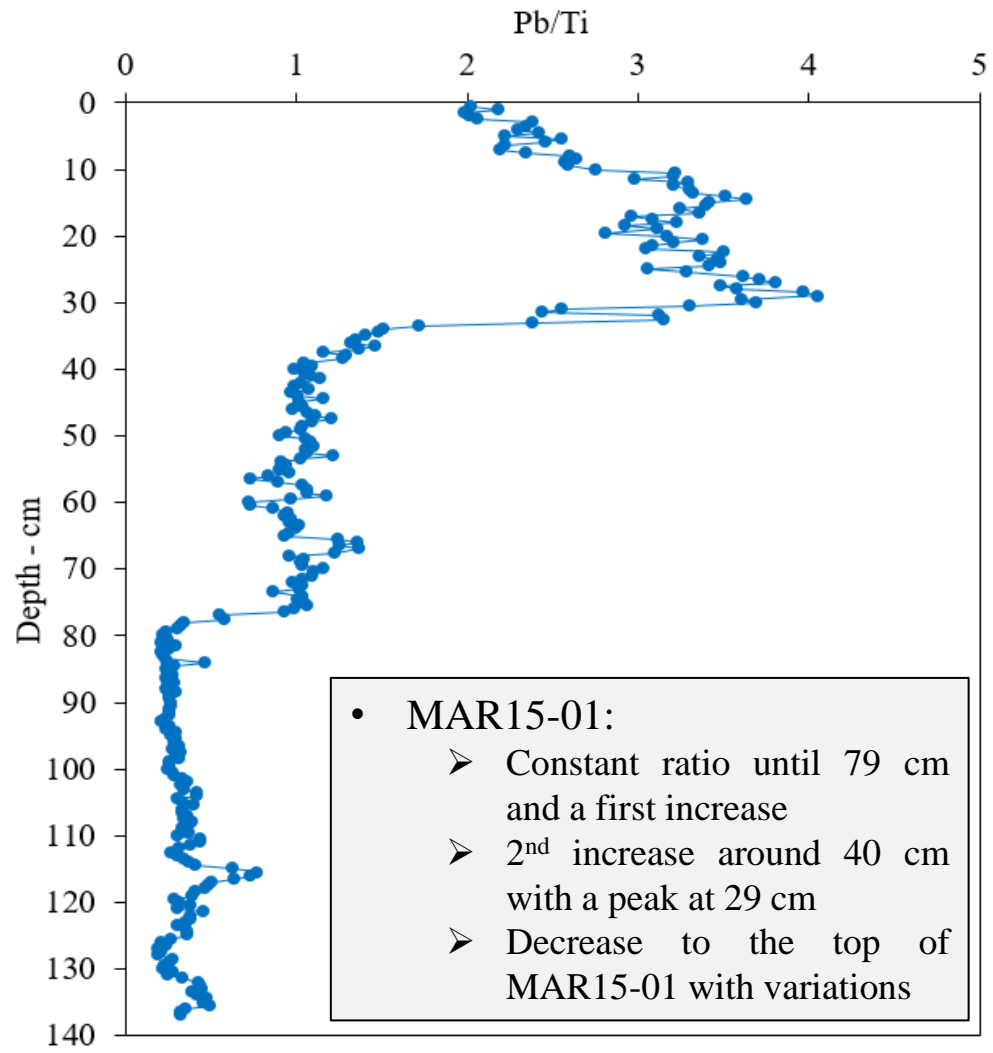
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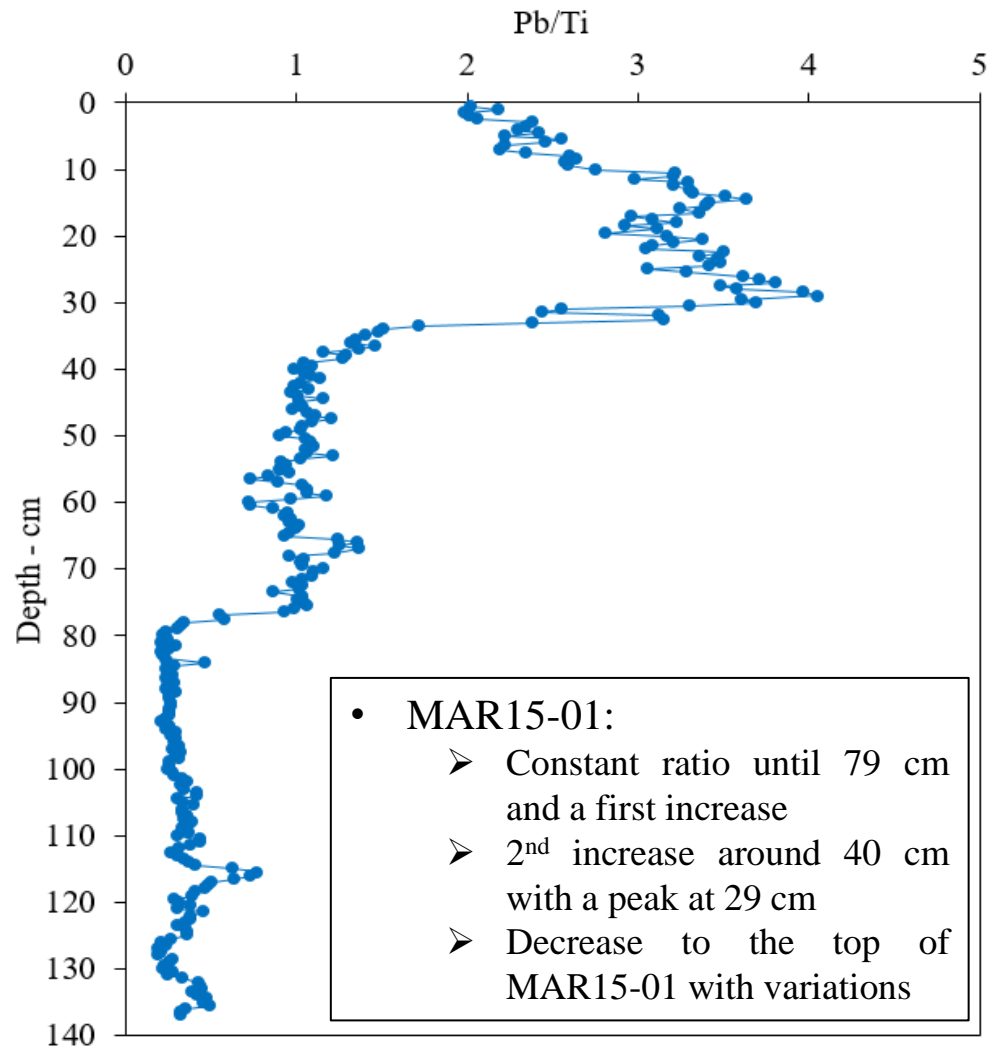


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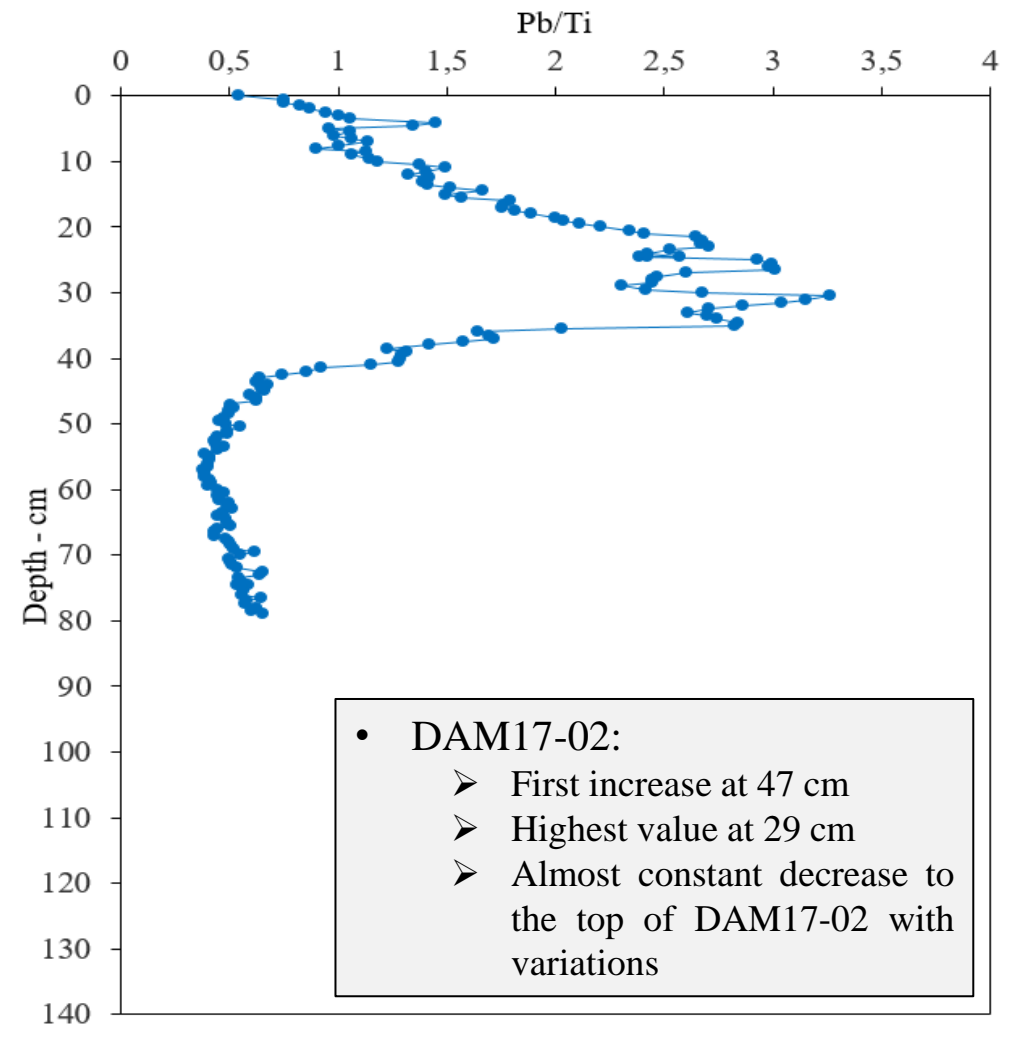
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• **LES DAMPS POND: DAM17-02**

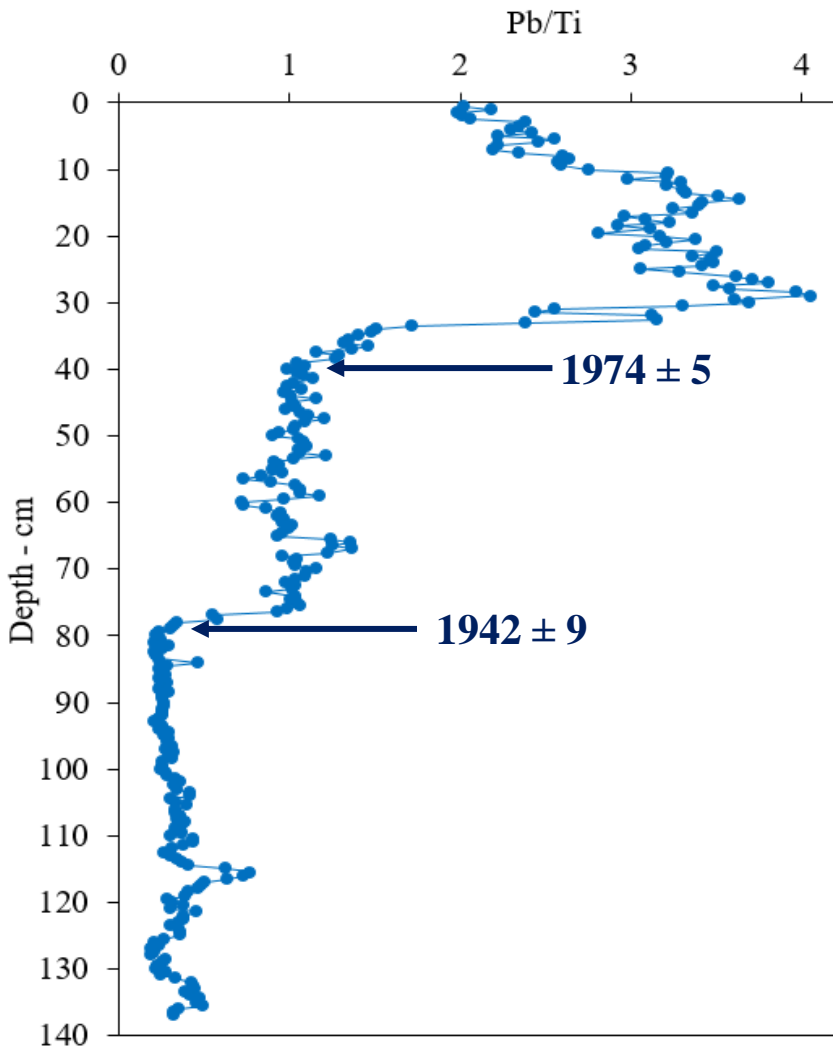


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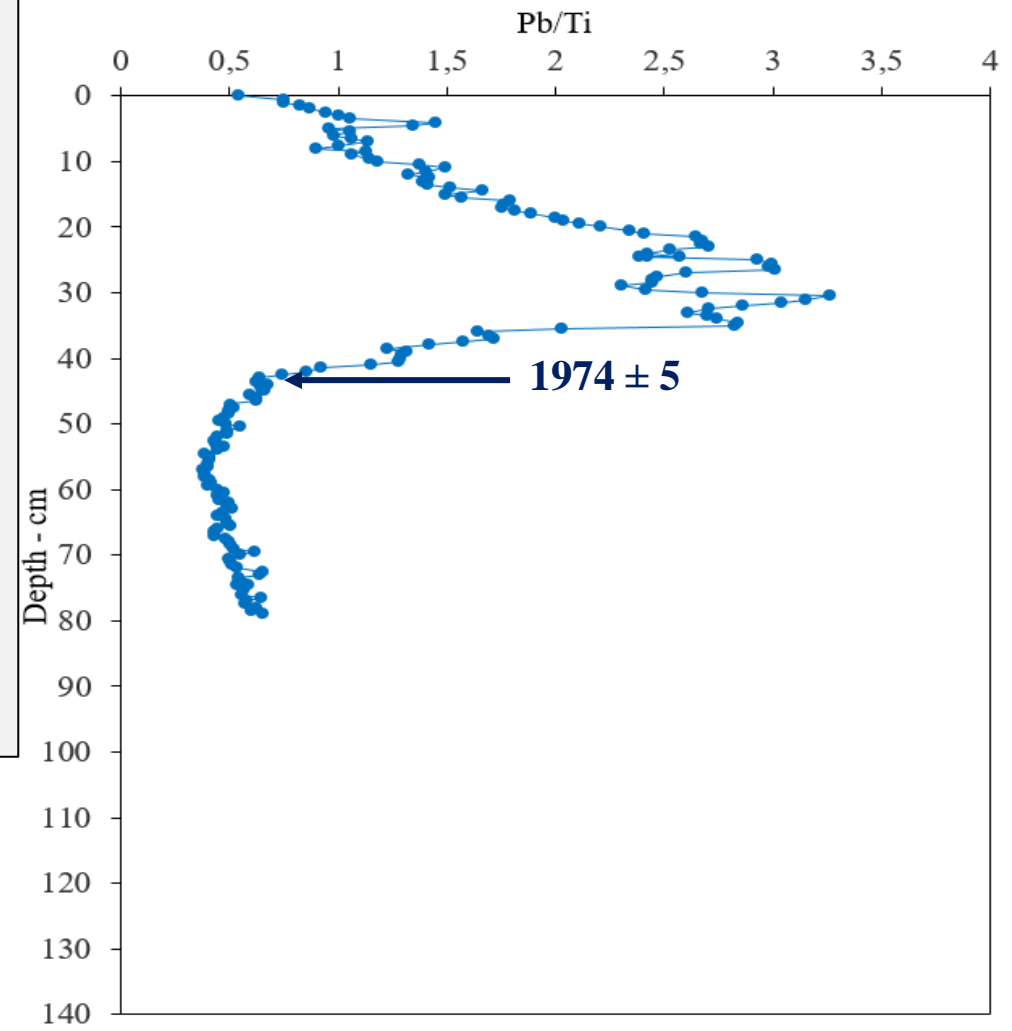
• **MARTOT POND: MAR15-01**



• According to the age model:

- MAR15-01: First increase: 1942
- **Changes in sediments inputs**
- Opening of a cathode-ray tubes factory in the Eure watershed in 1956: not visible
- 2<sup>nd</sup> increase on MAR15-01 and 1<sup>st</sup> increase on DAM17-02: 1974
- **Opening of a 2<sup>nd</sup> factory in 1974**

• **LES DAMPS POND: DAM17-02**

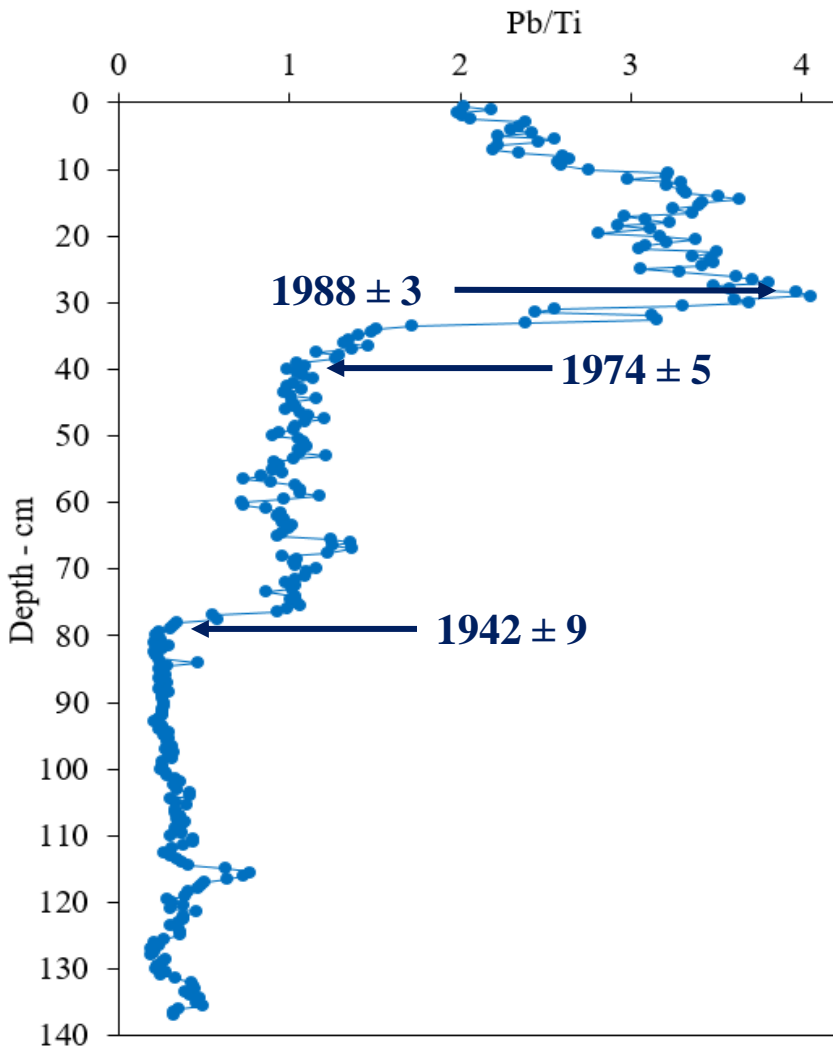


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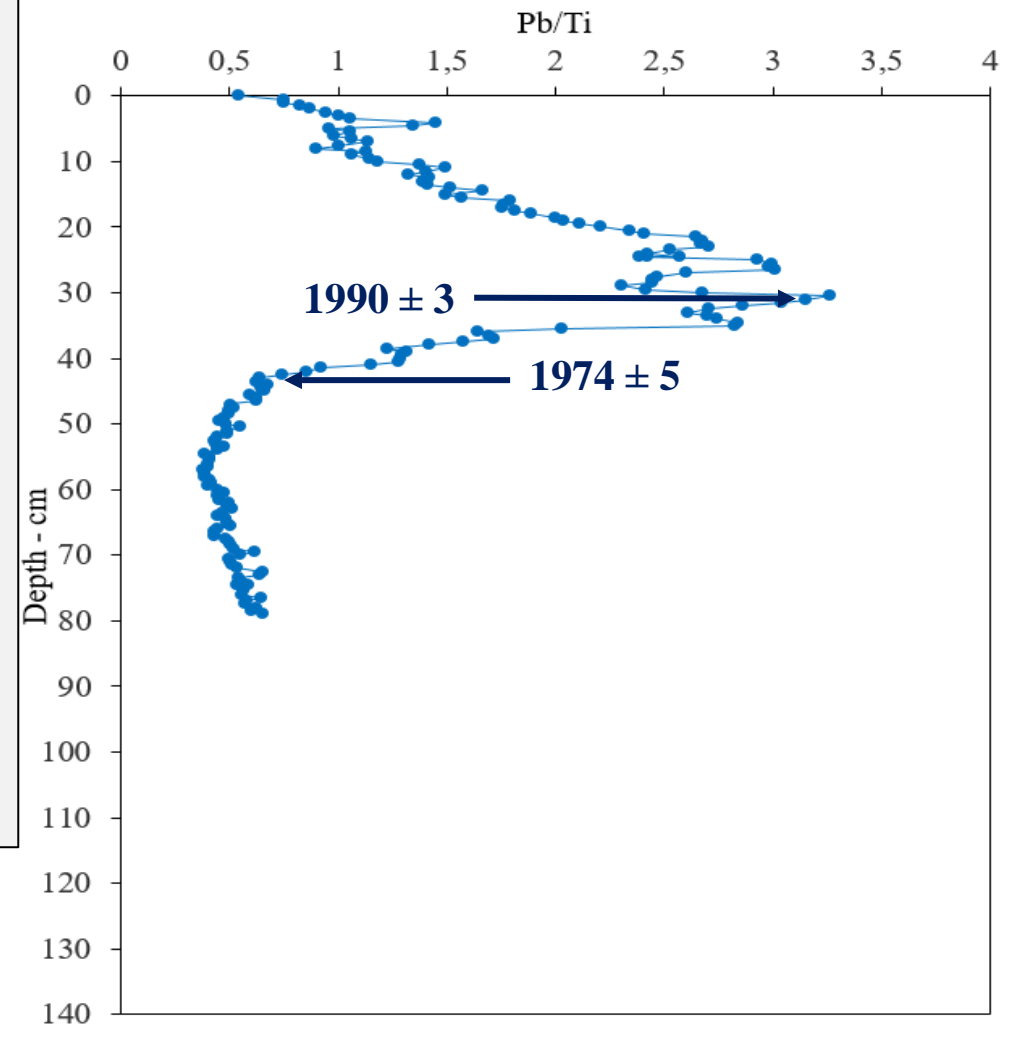
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- **Opening of a 2<sup>nd</sup> factory in 1974**
- **1990: pic of activities**

• **LES DAMPS POND: DAM17-02**

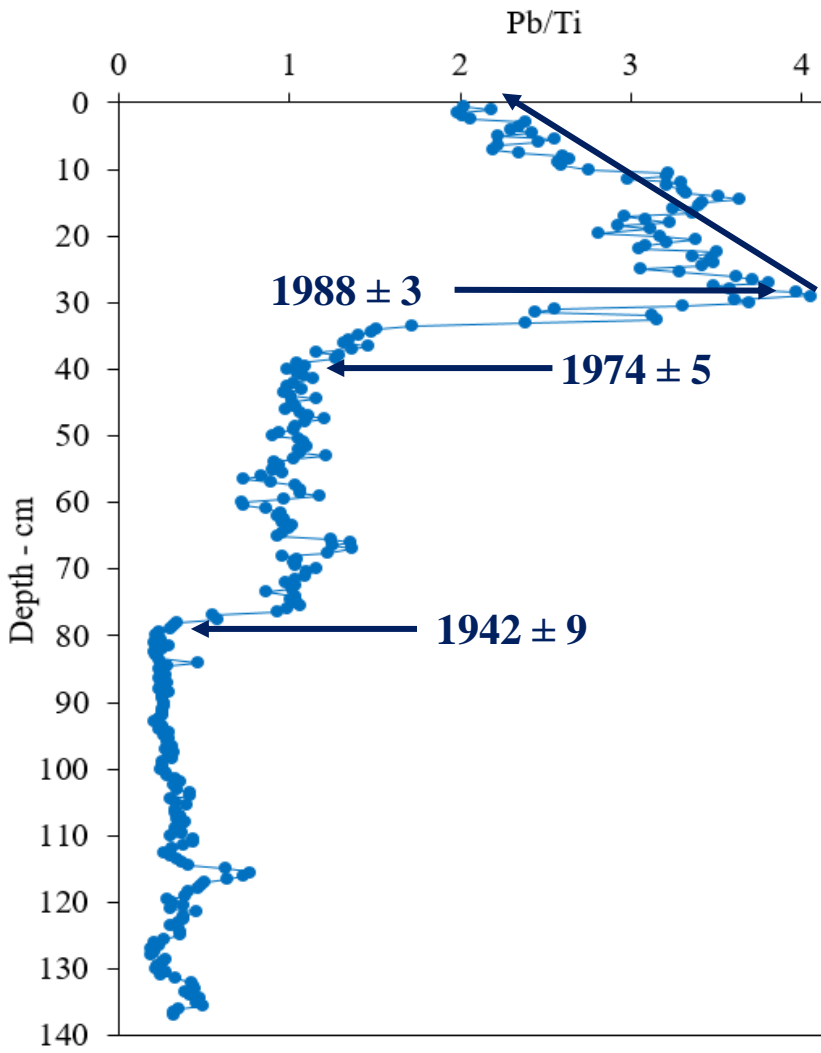


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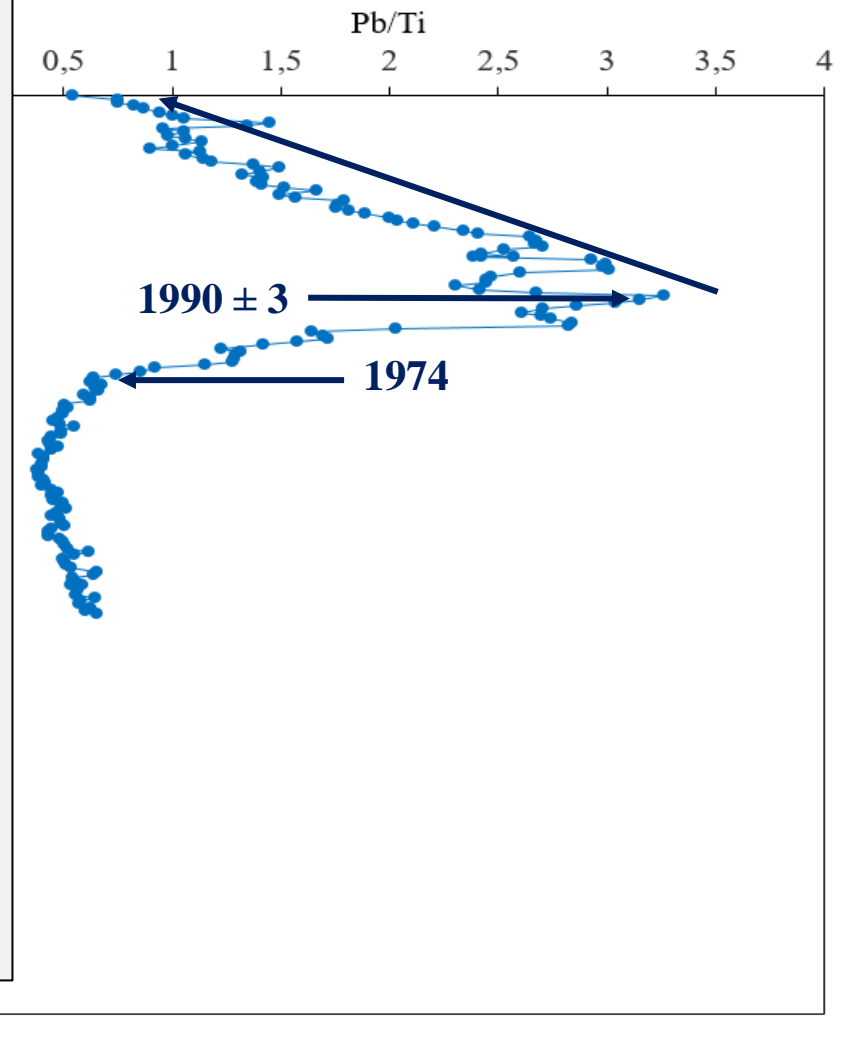
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▪ **TRACE-METAL ELEMENTS: exemple of Pb**

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• **LES DAMPS POND: DAM17-02**



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  - **Opening of a 2<sup>nd</sup> factory in 1974**
  - **1990: pic of activities**
  - Decrease to the top of the core:
    - **Emerging of flat-screen television**
    - **Purchasing of the factory**
  - ☐ Pb/Ti at the top > Pb/Ti at the bottom of MAR15-01:
    - Other sources ?



- **Eure River Watershed:**

- Historical pollution linked to anthropogenic impacts
- Accumulation of pollutants throughout the last century
- Potential re-suspension and re-mobilisation after dam removal

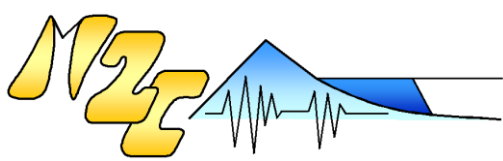


- **Eure River Watershed:**

- Historical pollution linked to anthropogenic impacts
- Accumulation of pollutants throughout the last century
- Potential re-suspension and re-mobilisation after dam removal

- **Impact of the dam removal ?**

- Hydro-sedimentary transfers
- Pollutants transfers



**THANK YOU FOR YOUR ATTENTION**



*Martot pond frozen in January 2017, Normandy, France*