Changes of chromium and lead concentration, and possibility of its application to estimate relative age of alluvial deposits – laboratory and field experiments.

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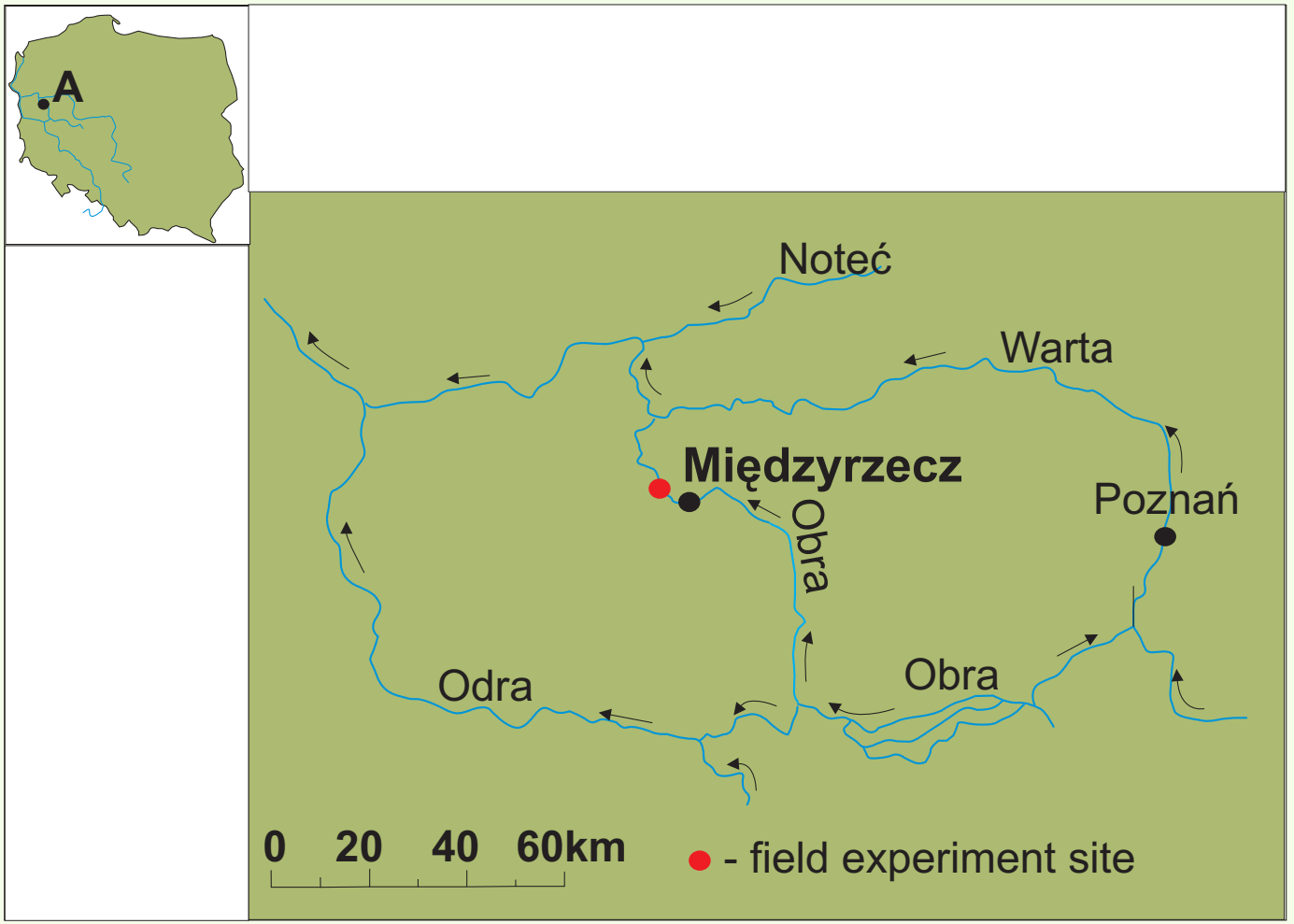
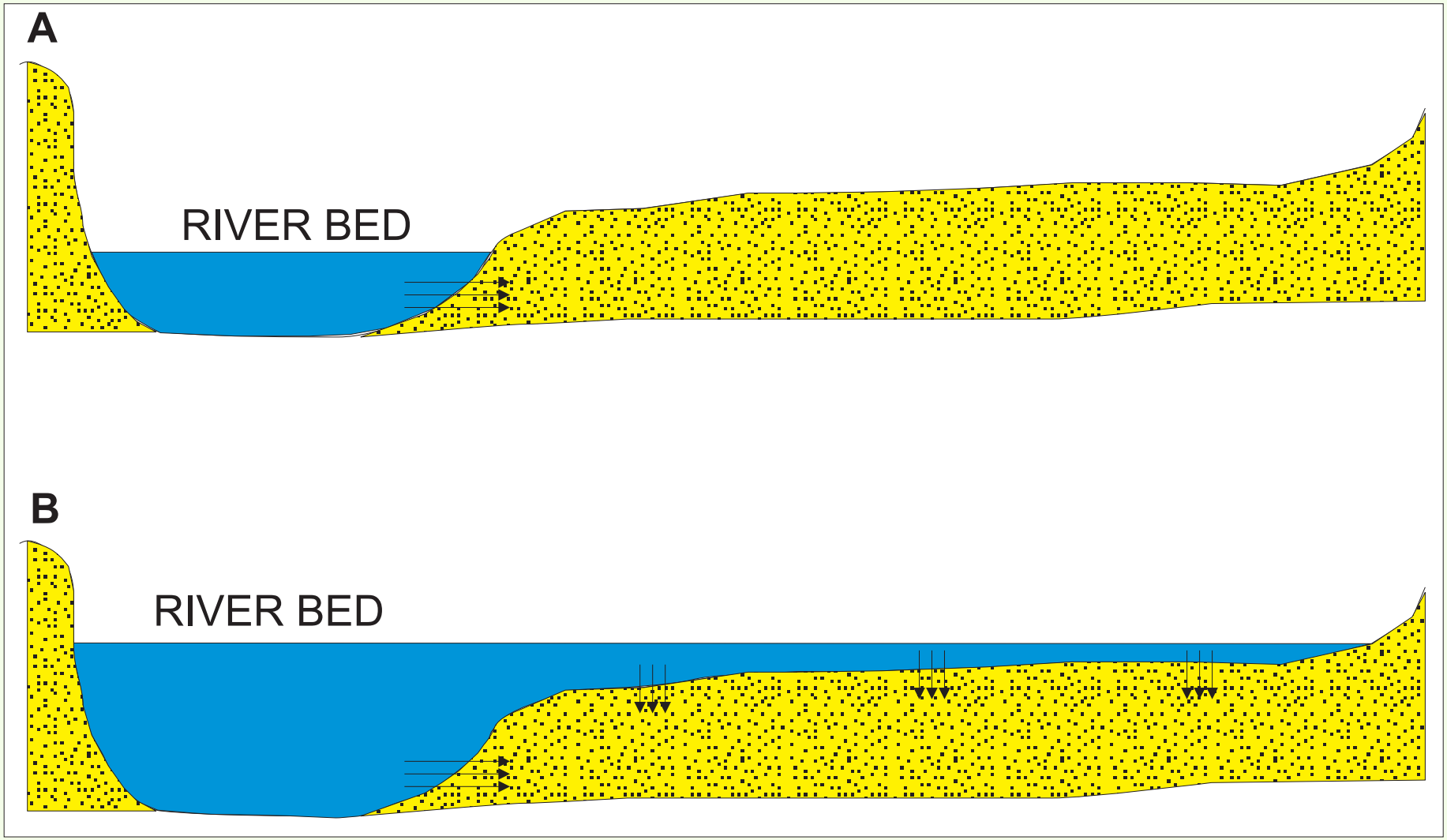
Introduction



- Weaving industry centers in the lower course of the Obra river (16th – 19th century)
- Cr (alum: KCr (SO_4)2 12H_2O) and Pb (lead acetate: $Pb(C_2H_3O_2)_4$) compounds in paints used at that time (Mączak, 1955)



Schema of supplying alluvial deposits with Cr and Pb compounds during low (A) and high (B) water stages during period of textures production.

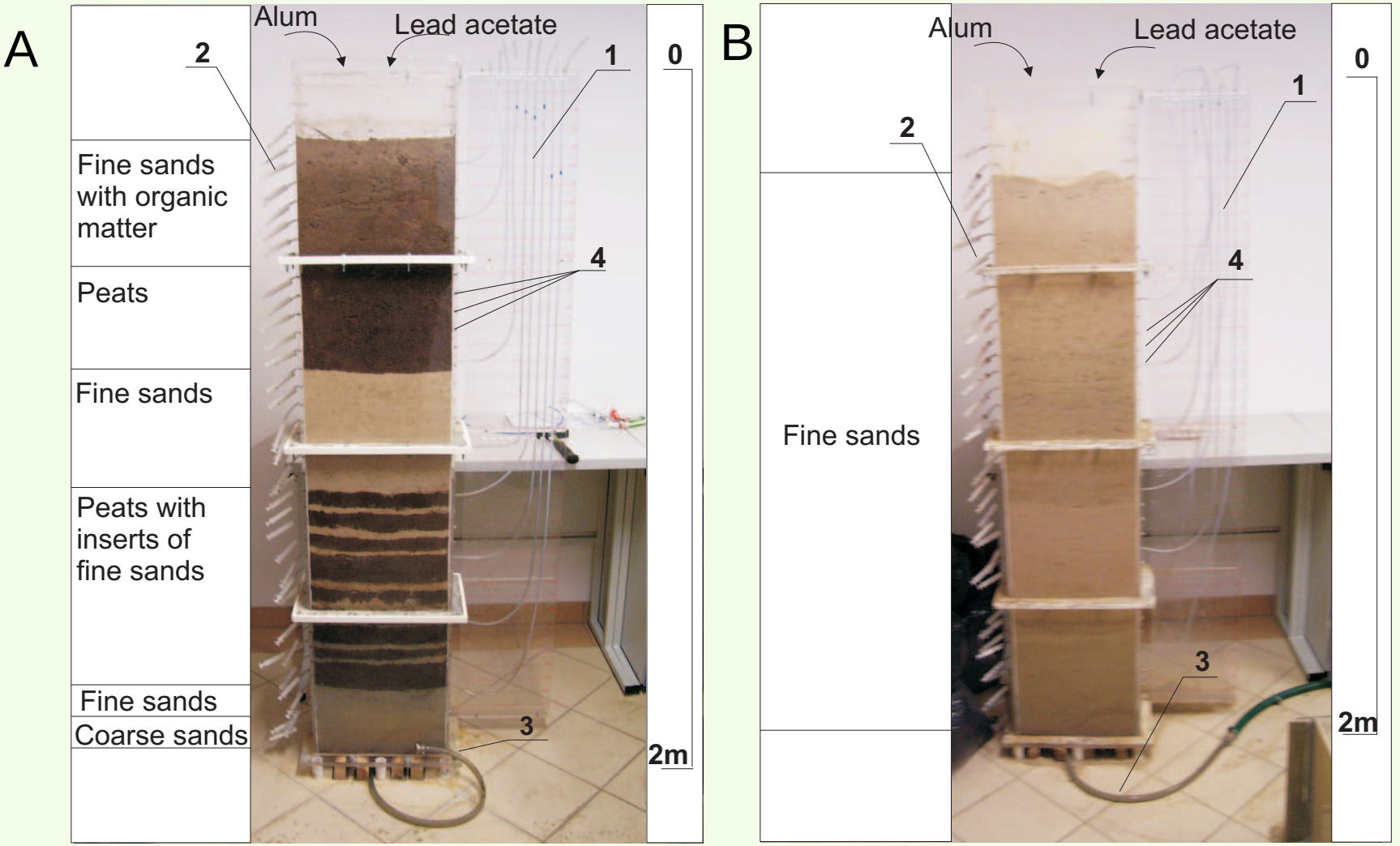
Main research problem:

Is it possible to use changes of chromium and lead concentration to estimate relative age of alluvial deposits?

Research tasks:

1. Determination of vertical and horizontal migration abilities of Cr and Pb through laboratory and field experiments.
2. Analysis of Cr and Pb concentration in vertical profiles unaffected by field experiment.
3. Verification if observed concentration changes can be applied to relative dating (radiocarbon analyses).

Research methods: Laboratory experiments of vertical Cr and Pb migration



Column filled with alluvial deposits (A) and alluvial fine sands (B): 1- piezometers, 2 – syringes for water samples, 3- a tap for letting water out, 4 – holes for sediment samples

Vertical migration experiments:

- **Stage I:** Soaking the deposits in the column with distilled water. Next, collecting water samples.

- **Stage II:** Refilling the lower half of the column with water and filling the upper part with the compounds of chromium (54 mg Cr dm^{-3}) and lead (130 mg Pb dm^{-3}). Water samples collection.

- **Stage III:** Letting out about 20 dm^3 of the solution to initiate vertical migration of the compounds inside the column. Sediment and water samples collection.

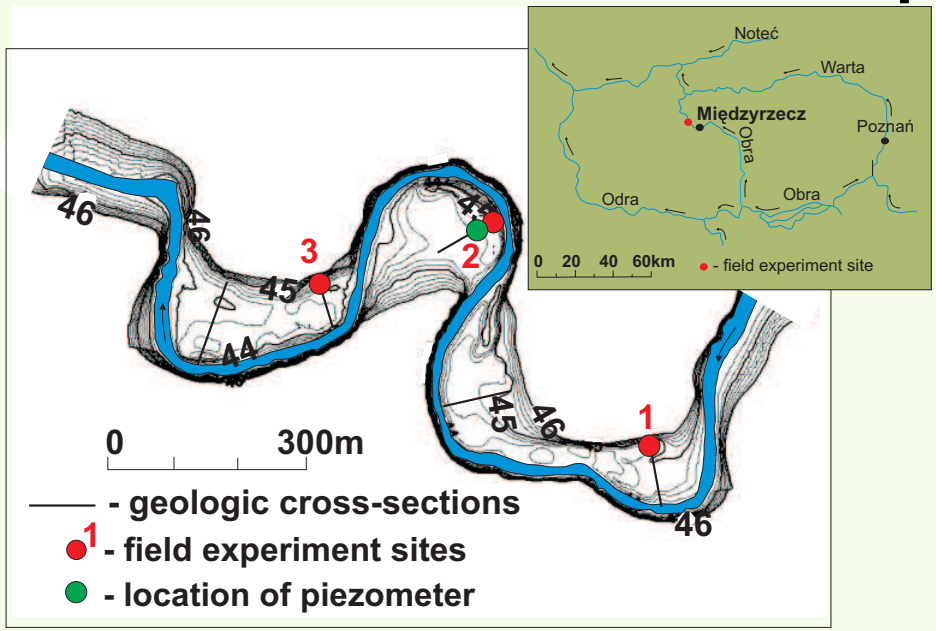
- **Stage IV:** Letting about 60 dm^3 of distilled water through the deposits placed in the column. Sediment samples collection.

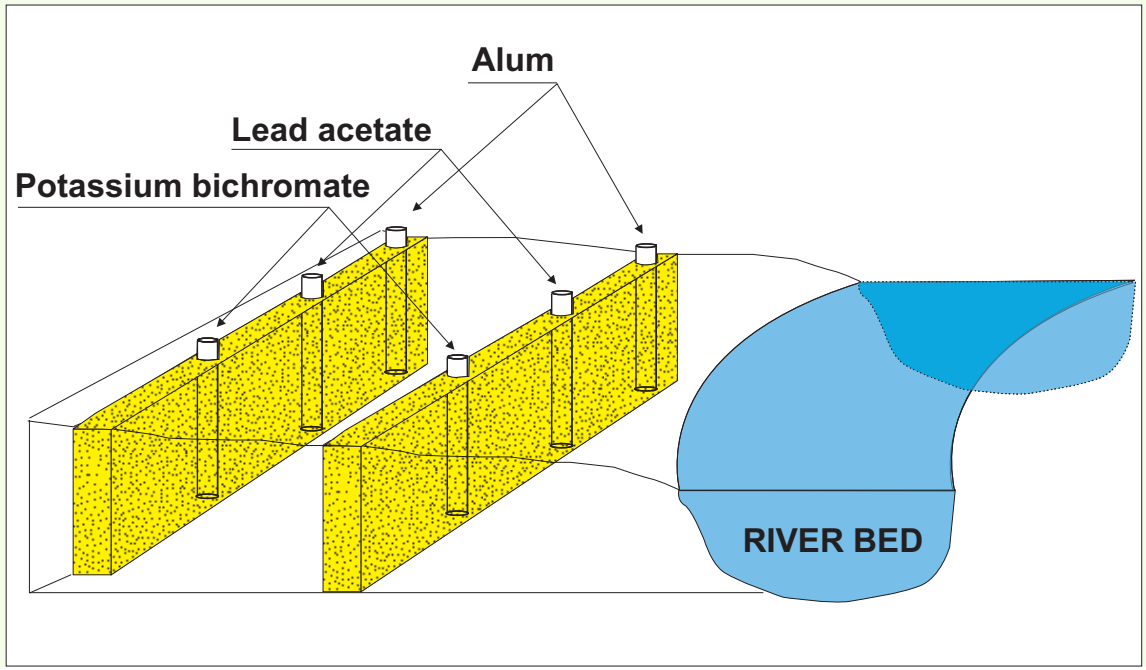
- Concentrations of chromium and lead were calculated on the basis of weight proportions of the compounds taken from paint recipes, annual production of textures in the 16^{th} century (Mączak, 1955) and mean annual discharge in the Obra river bed (4 m^3 s^{-1}).

Experiment of horizontal Cr and Pb migration

Horizontal column filled with alluvial deposits. 1 – separated part of the device supplied with Cr and Pb compounds, 2 – artificial slope simulating floodplain slope, 3 – peats, 4 – fine sands.

Field experiment





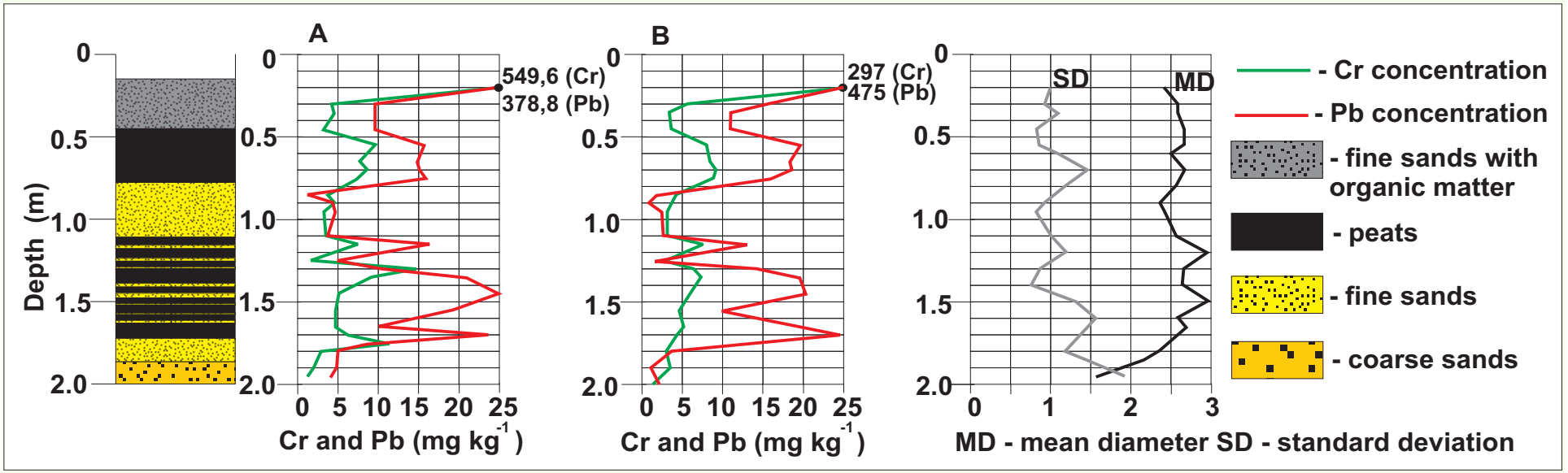
3 sites with different geologic structure.

6 pipes placed in floodplain deposits on each site.

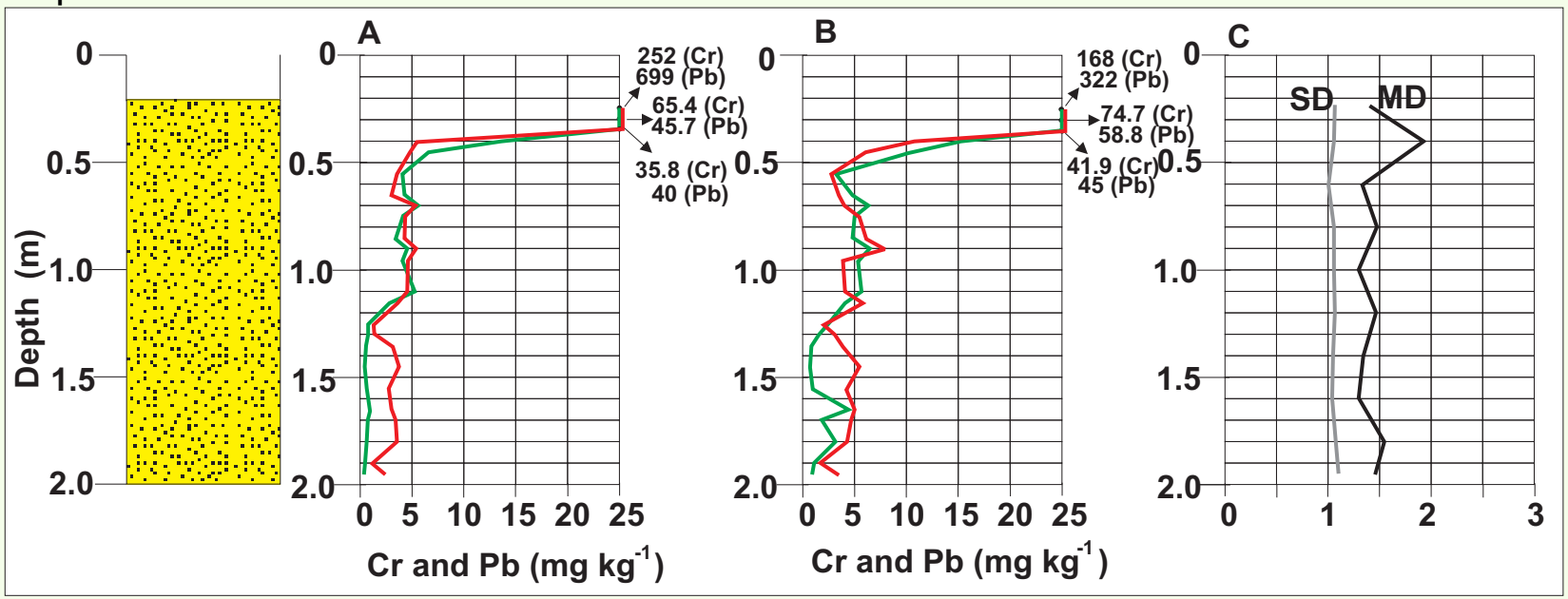
18.10.2007 – 4.09.2008:
Refilling the pipes once a month with the compounds.

Groundwater level - piezometer

Results: vertical migration experiments

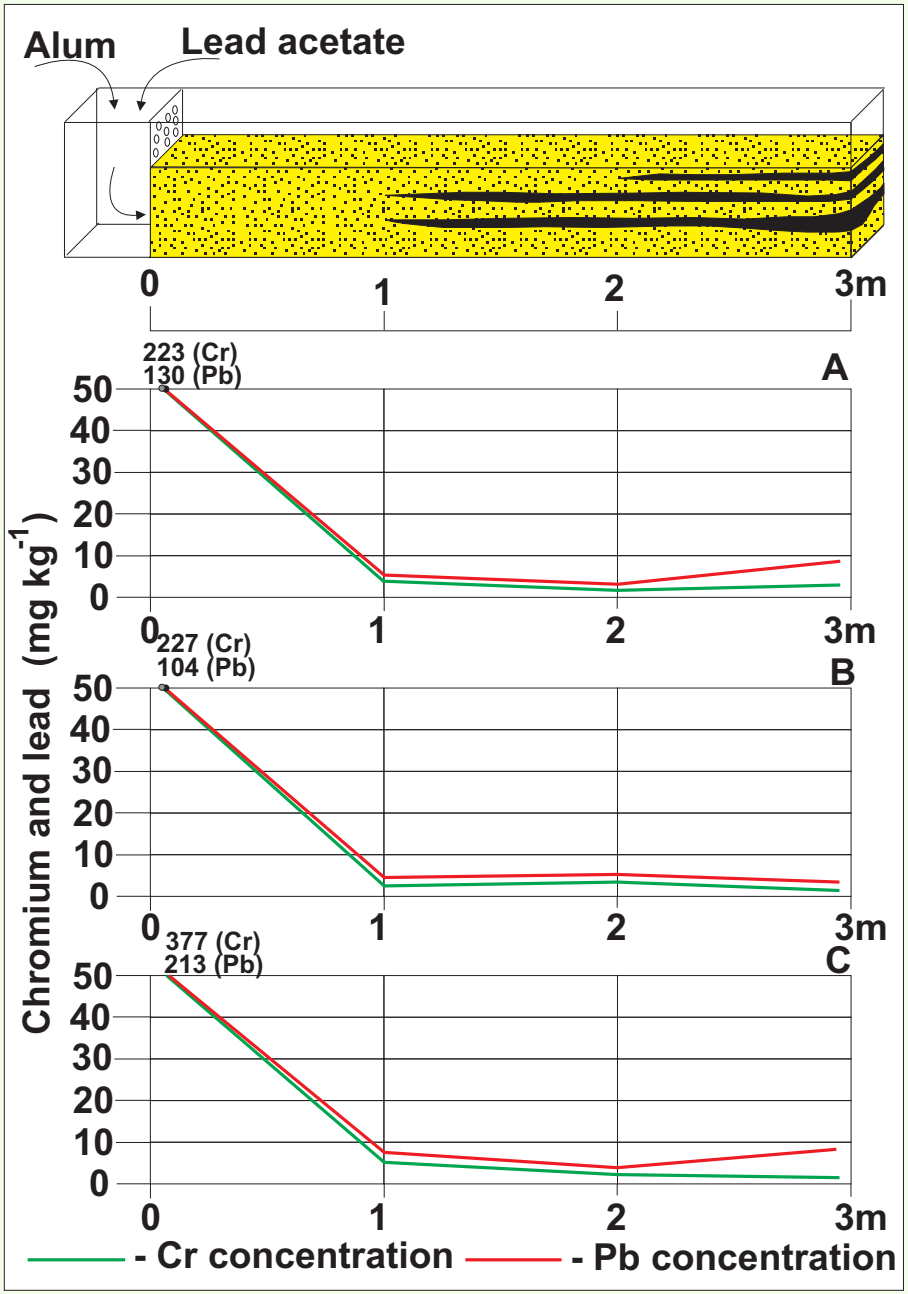


Cr and Pb concentrations in the deposits placed in the column after stage III (A) and stage IV (B) of the experiment



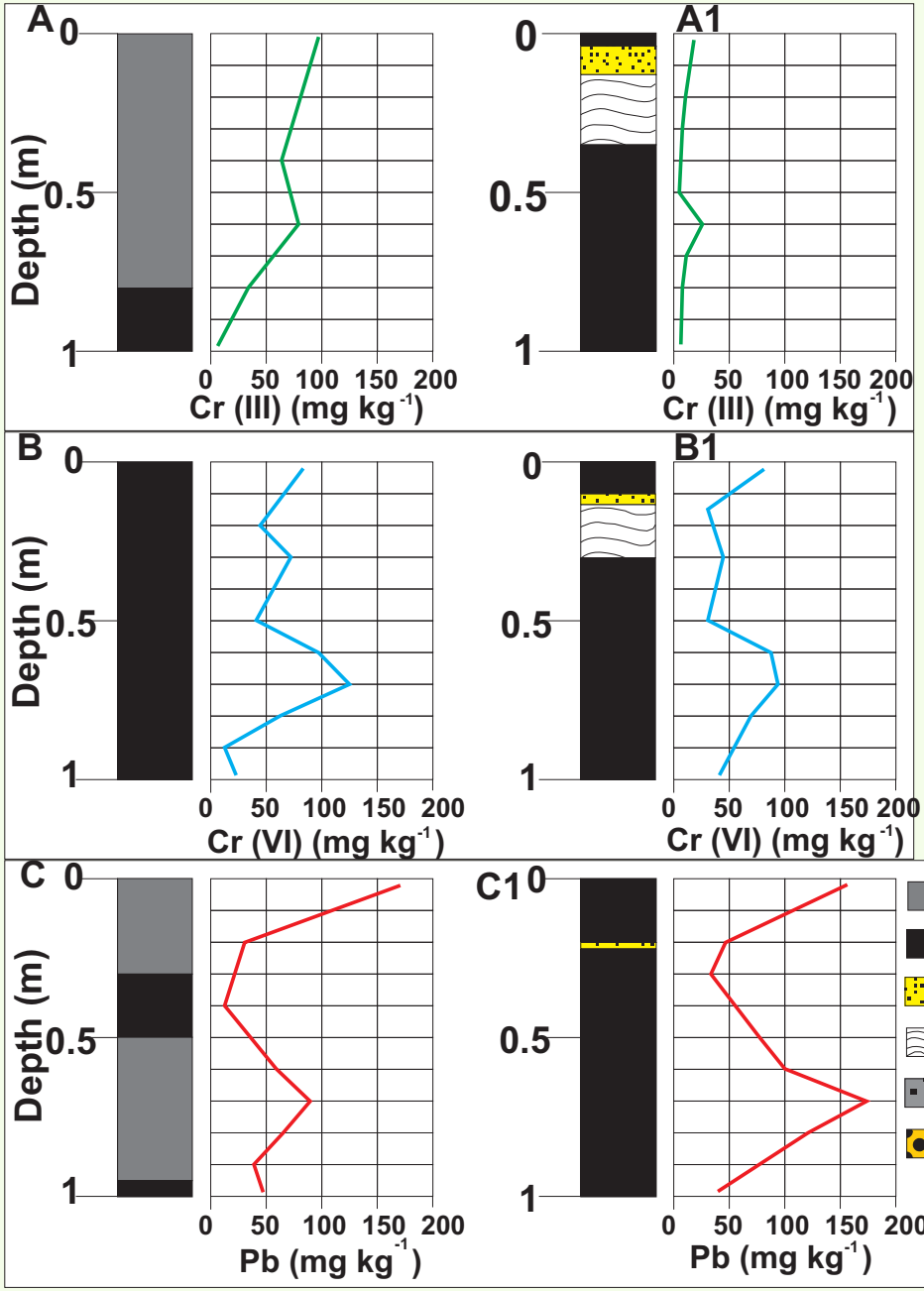
Cr and Pb concentrations in alluvial fine sands after stage III (A) and stage IV (B) of the experiment

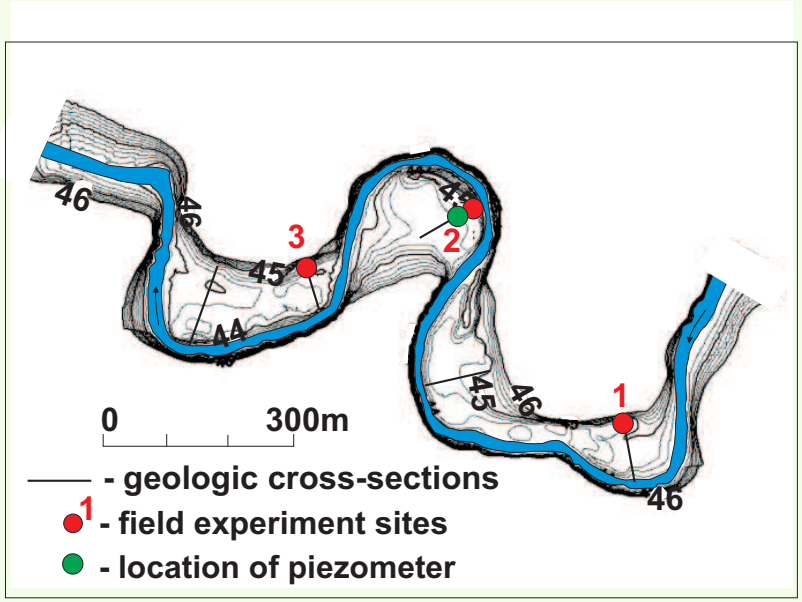
Results: horizontal migration experiment



Cr and Pb concentration after the first stage of the experiment:
A – surface layer
B – 15 cm depth
C – bottom layer

Results: field experiment

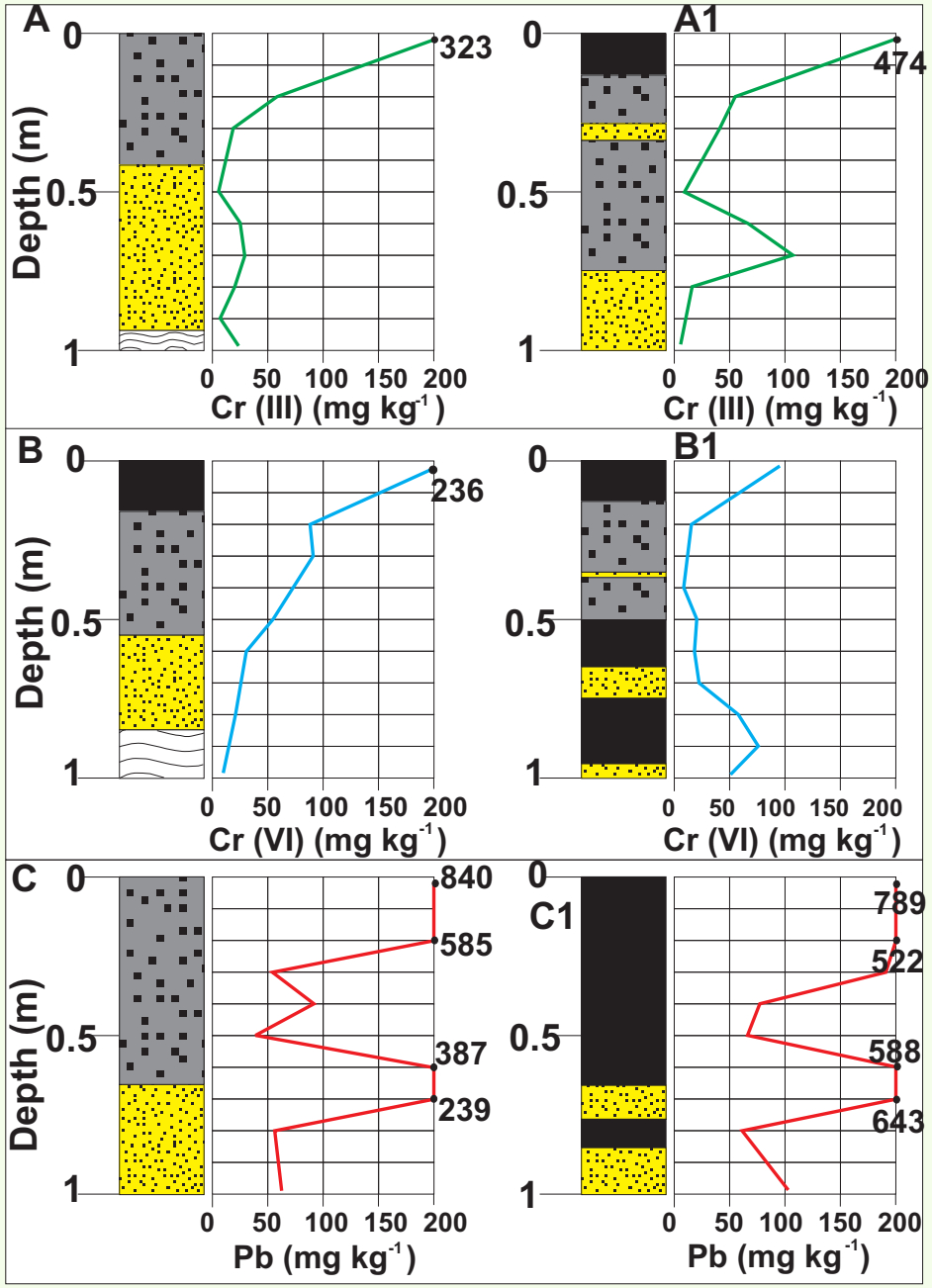


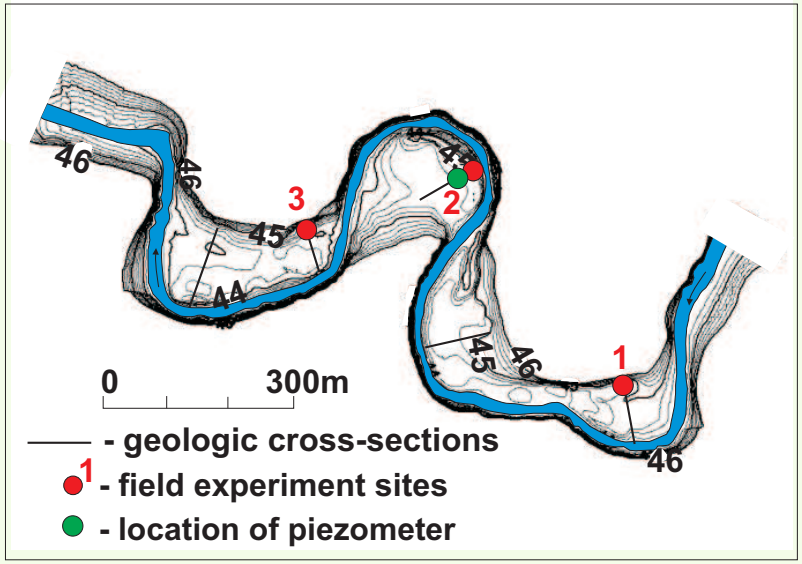


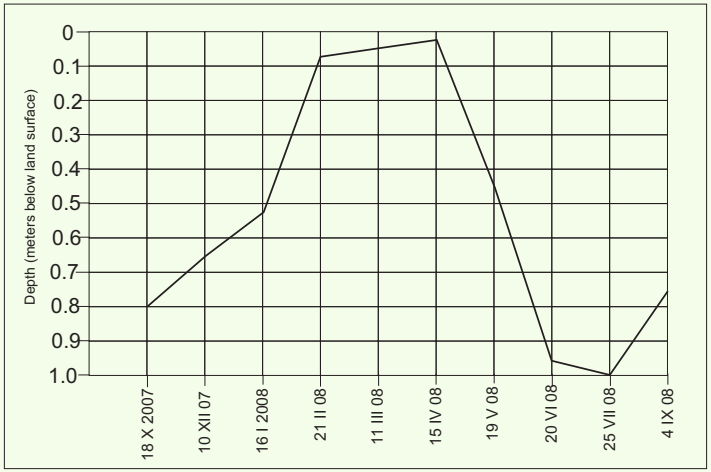
Cr (III), Cr (VI) and Pb contents in vertical profiles on site 1:

1 – gyttjas
2 – peats
3 – fine sands
4 – sandy silts
5 – fine sands with organic matter
6 – coarse sands

Results: field experiment



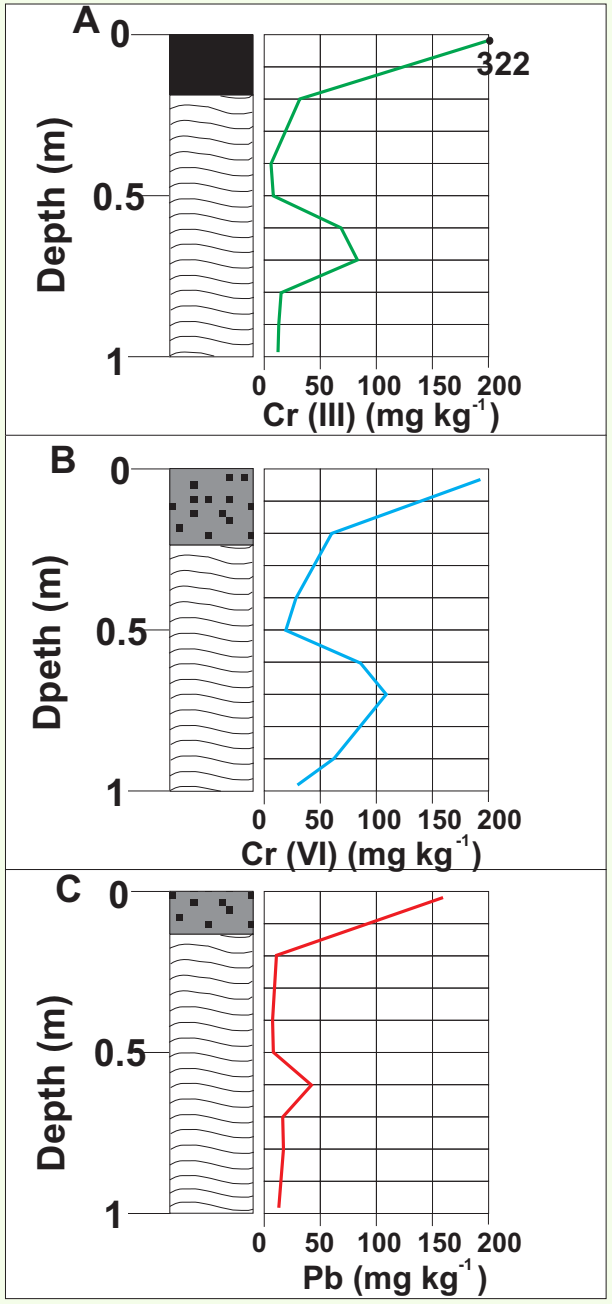


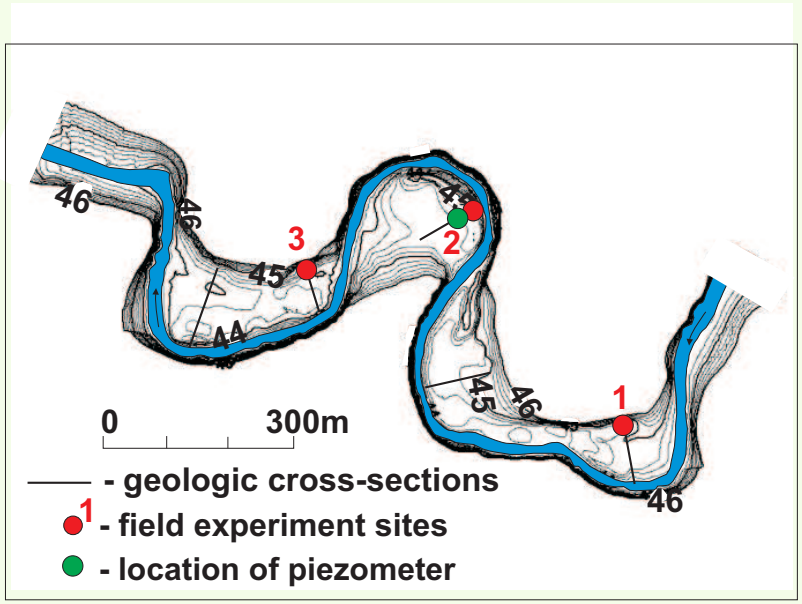


Groundwater level changes on site 2

Cr (III), Cr (VI) and Pb contents in vertical profiles on site 2.

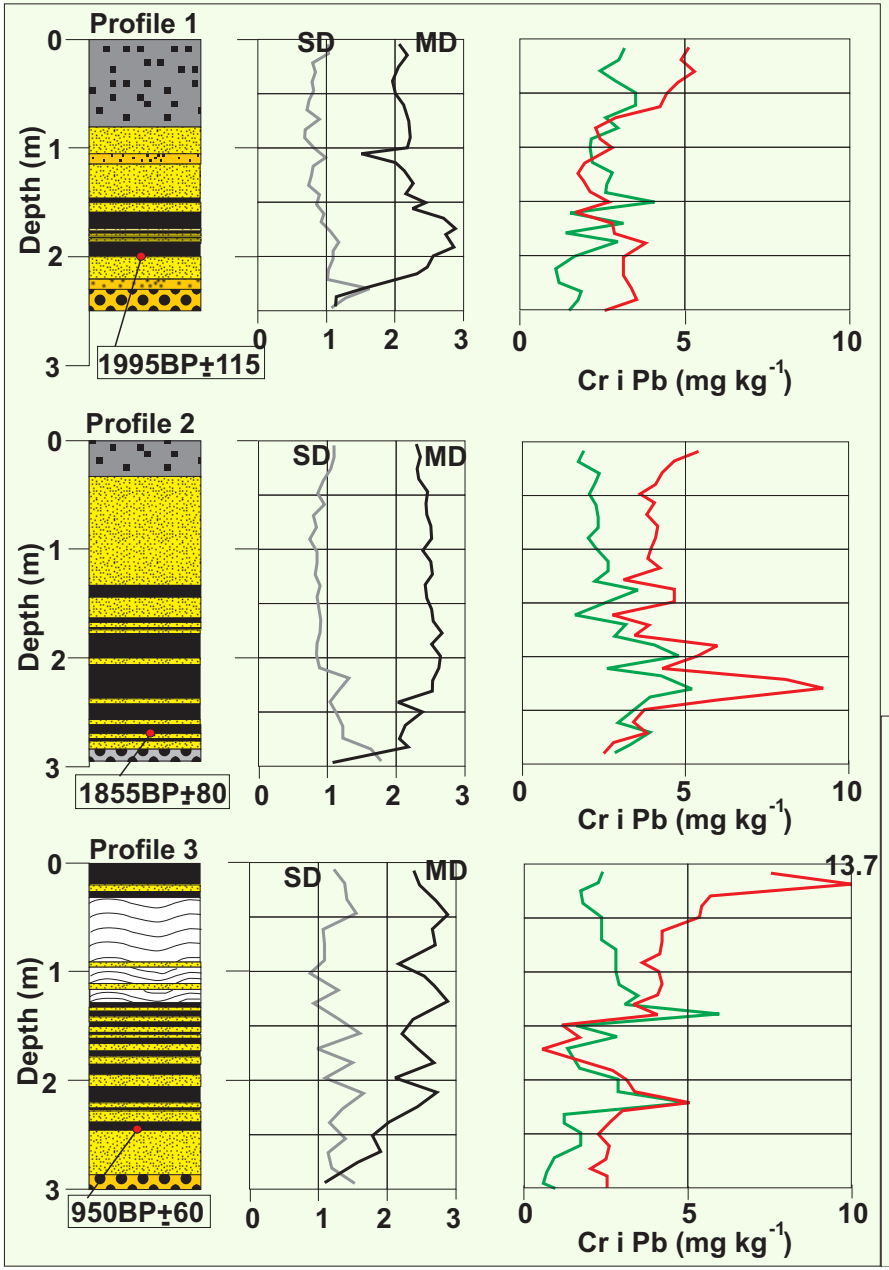
Results: field experiment

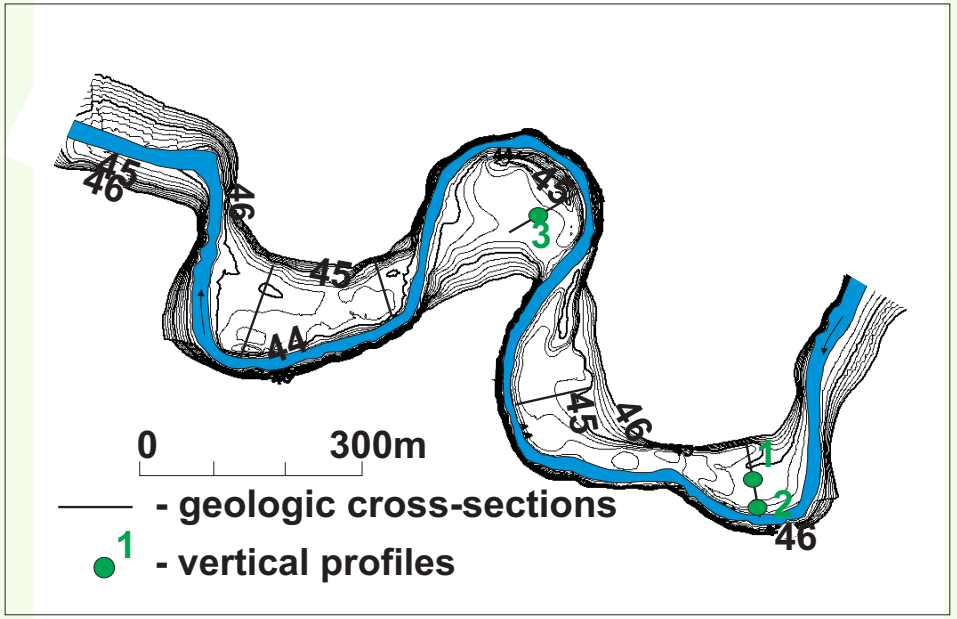




Cr (III), Cr (VI) and Pb contents in vertical profiles on site 3.

Results: Cr and Pb concentration in vertical profiles unaffected by field experiment and radiocarbon datings





- Cr concentration
- Pb concentration
- C^{14} samples

MD - mean diameter
SD - standard deviation

- peats
- fine sands
- sandy silts
- fine sands with organic matter
- medium sands
- coarse sands

Conclusions:

- On the basis of laboratory experiments of vertical chromium and lead migration it is suggested that studied chemical elements can be used as indicators of vertical accretion of floodplain deposits.

- Results of laboratory experiments have shown that horizontal migration of studied elements is small. It can influence results of relative dating of floodplain deposits only within near bed zone.

- Field experiment has shown that trivalent Cr has lower ability to migrate in groundwater environment in comparison with Pb and hexavalent Cr. It should also be noted that the results of the field experiment indicated more active migration of studied elements than was observed in laboratory experiments.

- Changes of “natural” Cr and Pb concentrations and C^{14} dating have shown that, presumably, it is possible to apply the changes to estimate relative age of alluvial sediments, excluding profiles from near bed zone of floodplain.

Acknowledgements

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Thank you for your attention.