Chemical composition and morphological analysis of two-layered attic dust samples from a former industrial area (Ózd city, Hungary): insights into historical environmental contamination

Mona Maghsoudlou[1*], Davaakhuu Tserendorj[1,2], Gorkhmaz Abbaszade[1,3], Nelson Salazar-Yanez[1], Péter Völgyesi[4], Csaba Szabó[1,5]

Corresponding author*: monia@student.elte.hu

[1]Lithosphere Fluid Research Laboratory (LRG), Eötvös Loránd University (ELTE), Budapest, Hungary
[2]HUN-REN, Centre for Ecological Research Institute of Aquatic Ecology, Karolina út 29, 1113, Budapest, Hungary
[3]Helmholtz Centre for Environmental Research – UFZ Permoserstr. 15, 04318 Leipzig, Germany
[4]HUN-REN, Nuclear Security Department, Centre for Energy Research, Budapest, Hungary
[5]HUN-REN, Institute of Earth Physics and Space Science, 9400, Sopron, Hungary

EGU24-15992

This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

Introduction

Study of past anthropogenic emissions of pollutants and environmental contamination involve studying various media, such as **attic dust**, which during a long-term accumulation process is preserved from external factors like precipitation, and sunlight with minimal physical, chemical, and biological alteration.

Attic dust studies
- Spatial flexibility on smaller scales
- Widespread distribution near anthropogenic sources

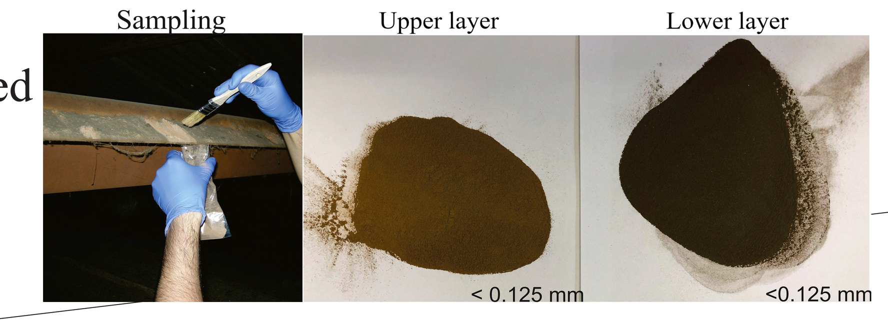
Objectives

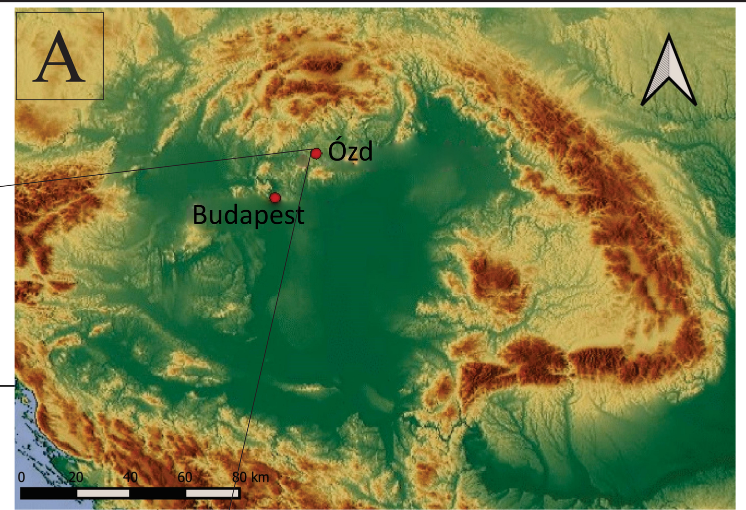
✸ Highlight the importance of studying attic dust by environmental geochemical analysis of Ózd, a former industrial city in north Hungary, for identifying past anthropogenic impacts on the urban environment.

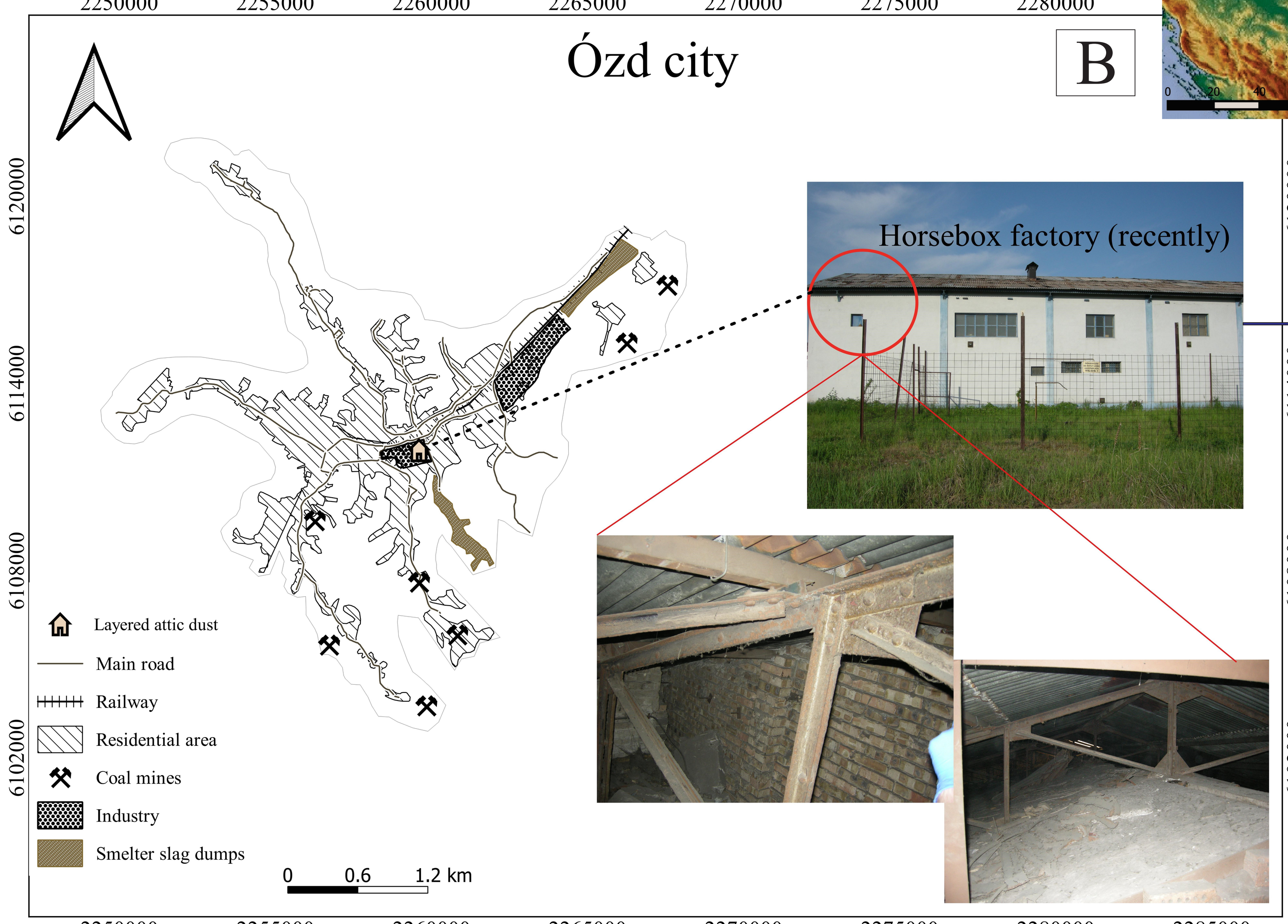
✸ Determine the morphological properties and chemical compositions of attic dust collected in the vicinity of a former iron and steel factory.

Study area and sampling

Two-layered attic dust







Located in the vicinity of a former iron and steel factory, used to be a repairing chamber during industrial activities.

Major industrial activity of Ózd city:

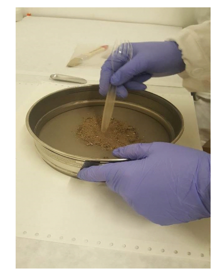
Iron and steel factory

(1835-1990)

Fig. 1. A. Carpathian-Pannonian region showing the geographic environment of the Ózd city. **B.** Map of Ózd (northern Hungary) showing two-layered attic dust sampling site.

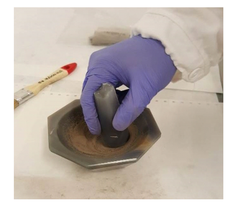
Material and method

Sample preparation



Cleaning and physical homogenization:
Sieving: through 0.125 mm mesh.

Thin section of individual grains:
Two grain size fractions were selected using magnet.



✸ Performed at the **Lithosphere Fluid Research Laboratory (LRG)** at ELTE.

Analytical chemistry

Particle size distribution (PSD):
Using a Horiba 950-V2 LA analyzer at the Laser Diffraction Particle Size Distribution Analyzer Laboratory at the **Research and Instrument Core Facility of Faculty of Sciences, ELTE.**

Analysis of bulk chemistry:
Performed by inductively coupled plasma mass spectrometry (ICP-MS) method, after modified aqua regia digestion, at the **Bureau Veritas Laboratory in Canada.**

Chemical analysis and morphological properties of individual grains:
Analyzed by a Hitachi Tm4000 Plus scanning electron microscope (SEM) equipped with EDX at the **Research and Instrument Core Facility of Faculty of Sciences, ELTE.**

Grain size distribution

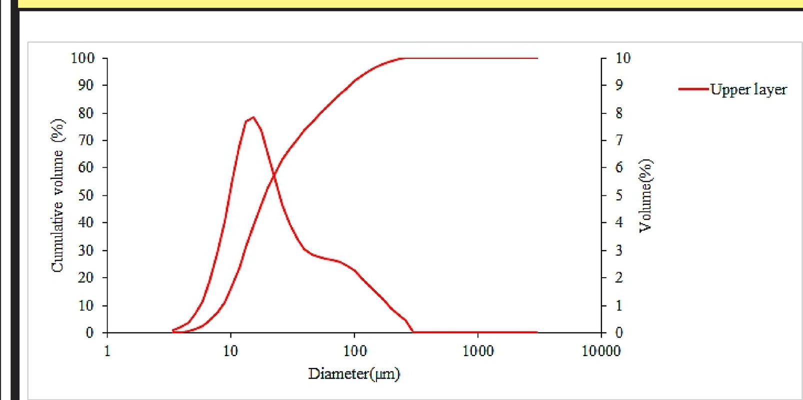


Fig. 2. particle size distribution (μm) of the upper layer.

Upper layer

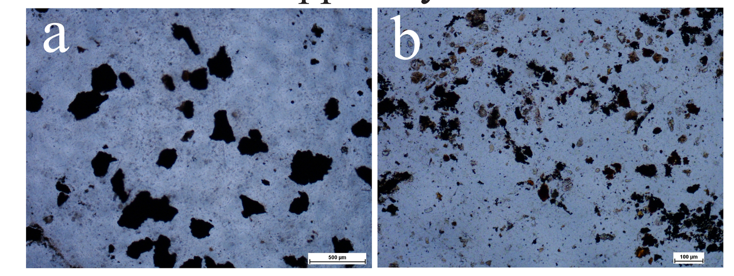


Fig. 3. Microscopic images of grains (a) irregular opaque grains (>125μm) and (b) irregular grains (<125μm) with at least 50% transparency, exhibiting a reddish-brownish color.

✸ Two different grain size distributions of the layers indicate different sources/processes.

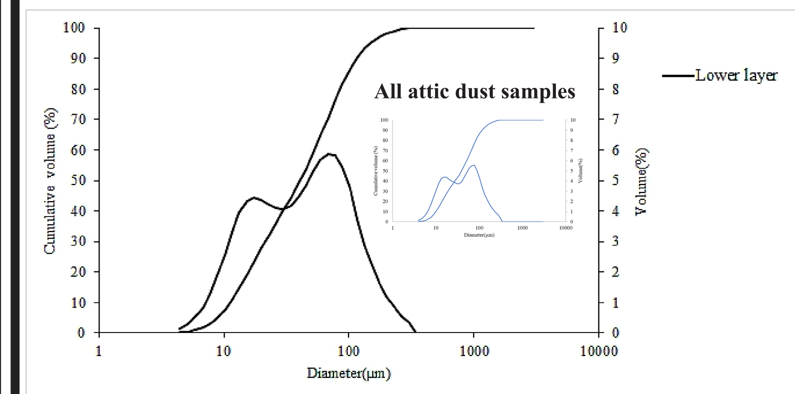


Fig. 4. particle size distribution (μm) of the lower layer.

Lower layer

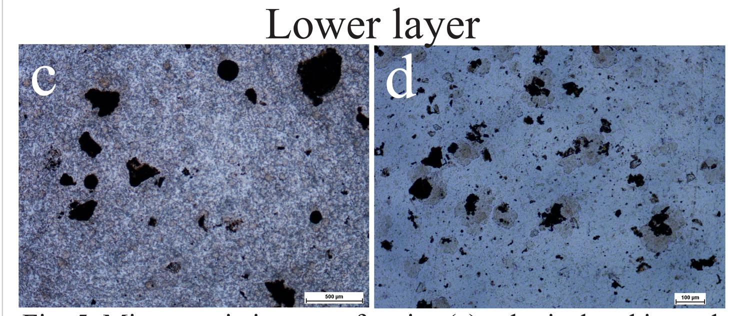
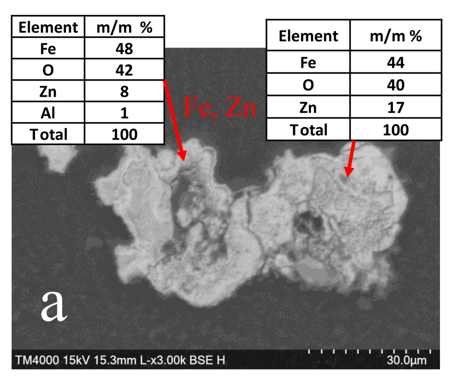


Fig. 5. Microscopic images of grains (c) spherical and irregular grains with partially transparency in irregular ones (>125μm) and (d) transparent irregular grains (<125μm).

✸ The lower layer matches the median value of all studied attic dust N=25 from the Ózd city accumulated from the same source during the long industrial activities.

SEM analysis of grains from both layers

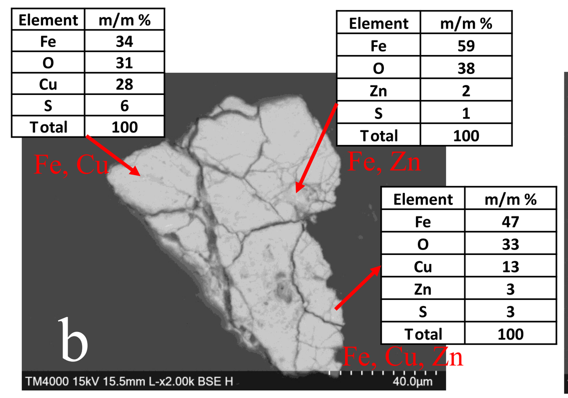
Upper layer



Element	m/m %
Fe	48
O	42
Zn	8
Al	1
Total	100

Element	m/m %
Fe	44
O	40
Zn	17
Total	100

Fig. 9a. Oxidized irregular shape grain composed mainly of Fe and Zn, with minor variations from other elements.

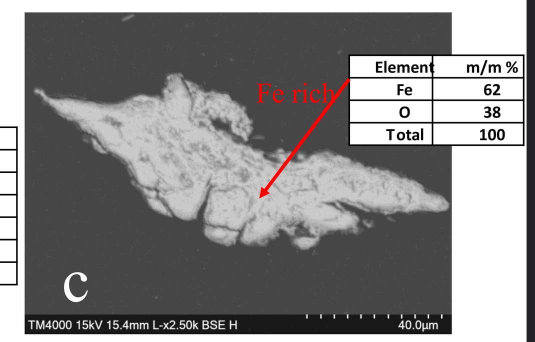


Element	m/m %
Fe	34
O	31
Cu	28
S	6
Total	100

Element	m/m %
Fe	59
O	38
Zn	2
S	1
Total	100

Element	m/m %
Fe	47
O	33
Cu	13
Zn	3
S	3
Total	100

Fig. 9b. Oxidized irregular shape grain composed mainly of Fe, Cu and Zn, with minor variations from other elements.

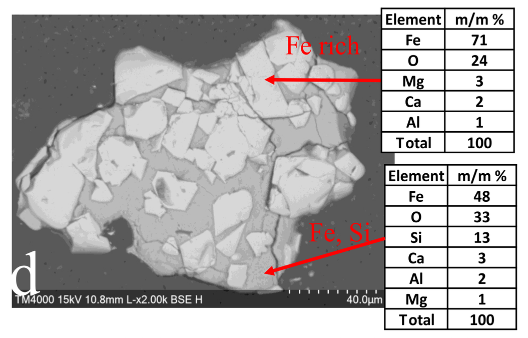


Element	m/m %
Fe	62
O	38
Total	100

Fig. 9c. Irregular shape grain composed mainly of iron oxide (Fe_2O_3, hematite) or iron oxy-hydroxide ($2Fe_2O_3 . 3H_2O$, lemonite).

✸ Grains are attributed to the **degaradation** of galvanized shingled roof structure.

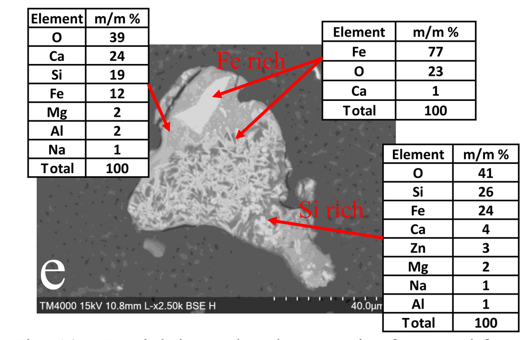
Lower layer



Element	m/m %
Fe	71
O	24
Mg	3
Ca	2
Al	1
Total	100

Element	m/m %
Fe	48
O	33
Si	13
Ca	3
Al	2
Mg	1
Total	100

Fig. 10d. Fe-rich irregular shape grain, fractured from different metallurgical processes with variations from other elements.

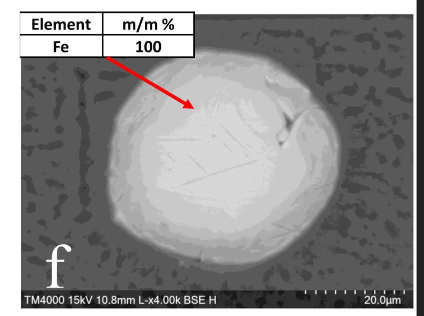


Element	m/m %
O	39
Ca	24
Si	19
Fe	12
Mg	2
Al	2
Na	1
Total	100

Element	m/m %
Fe	77
O	23
Ca	1
Total	100

Element	m/m %
O	41
Si	26
Fe	24
Ca	4
Zn	3
Mg	2
Na	1
Al	1
Total	100

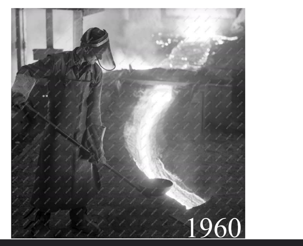
Fig. 10e. Fe-rich irregular shape grain, fractured from different metallurgical processes with variations from other elements.



Element	m/m %
Fe	100

Fig. 10d. Spherical shape grain, composed of Fe released from chimney during high T processes.

✸ Grains are attributed to the iron **metallurgical process** in former iron and steel factory.



Elemental composition of bulk samples

BFS:
Local brown forest soil (geochemical background)

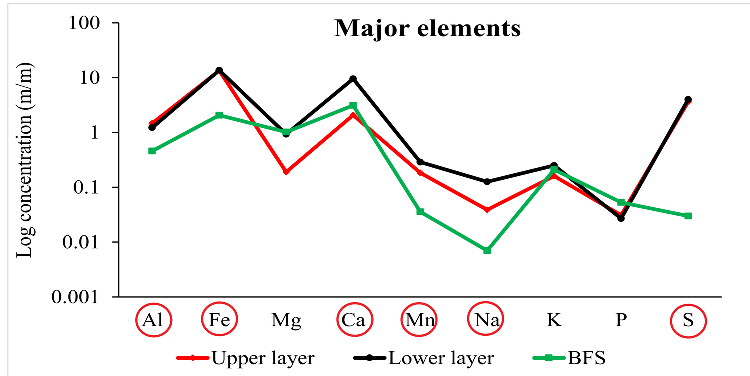


Fig. 6. Comparison of major elements in two-layered attic dust (upper layer and lower layer) and BFS (local brown forest soil).

Al, Fe: 3x and 6x higher in both layers than BFS.
Ca: 3x higher in LL than BFS.
Mn: 5x higher in UL and 8x higher in LL than BFS.
Na: 5x in UL and 18x higher in LL than BFS.
S: 120x higher in UL and 130x higher in LL than BFS due to, partially, formation of gypsum.

✸ **Upper layer** show **lower concentration** in **alkali earth metals** than lower.

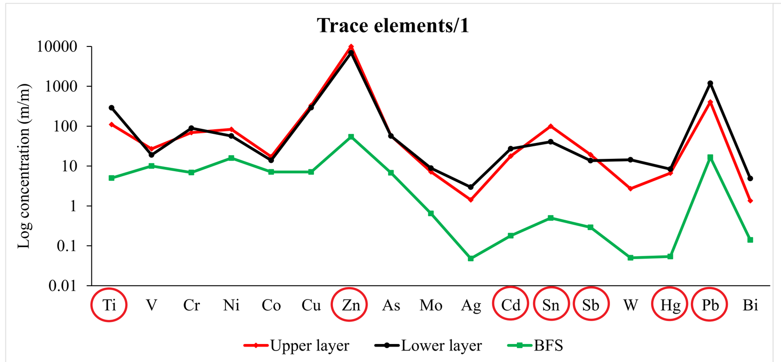


Figure. 7. Comparison of trace elements/1 in two-layered attic dust (upper layer and lower layer) and BFS (local brown forest soil).

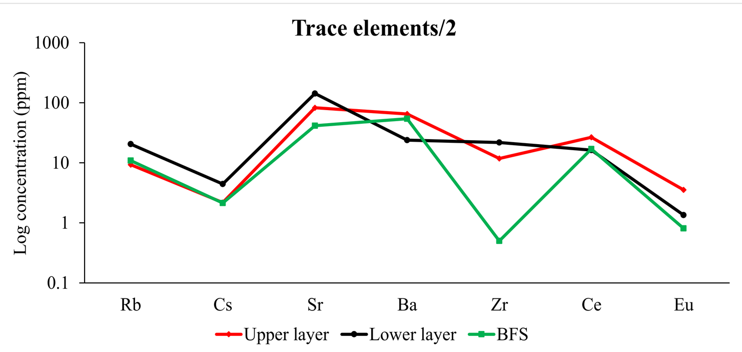


Fig. 8. Comparison of trace elements/2 in two-layered attic dust (upper layer and lower layer) and BFS (local brown forest soil).

✸ In **both layers**, the **potentially toxic metal(loid)s** show significant **enrichment** (3x – 200x) compared to BFS.

✸ **Ni, Zn, Sn, and Sb** show **higher concentration** in the **upper layer** than lower layer due to treatment (against corrosion, and welding)

✸ In the **lower layer, Rb, Cs, Sr and Zr** show at least 2x **higher concentration** than in the BFS.

✸ In the **upper layer, Ba, Ce and Eu** show at least 1.5x **higher concentration** than in the BFS.

Conclusion:
- ✸ Upper layer contains approximately four times more oxidized grains than the lower layer, mainly coming from roof structure oxidation.
- ✸ Zinc enrichment in the upper layer is mainly from degradation of roof galvanization and welding process at the horsebox factory.
- ✸ Lead and Sn can be linked to the soldering process.
- ✸ Lower layer contains iron-rich grains indicating the presence of materials originating from the long-term metallurgical activities.
- ✸ Comparison between two layers shows significant differences, reflecting historical industrial impact on urban environment.

This poster is presented at the European Geosciences Union General Assembly; Vienna, Austria, 14–19 April 2024.

Aknowledgements: This work was supported by Stipendium Hungaricum, Environmental Science Doctoral School (ELTE). We are grateful to all the LRG members for their help in completing the project.