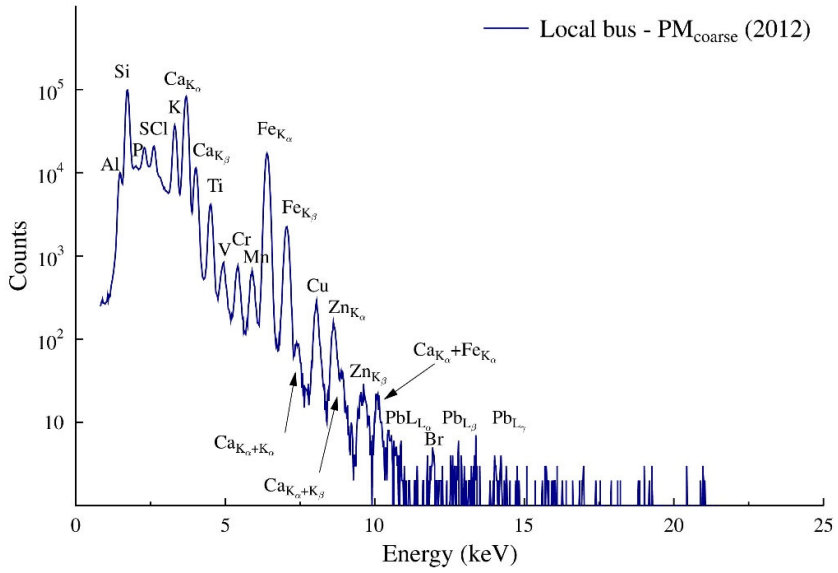
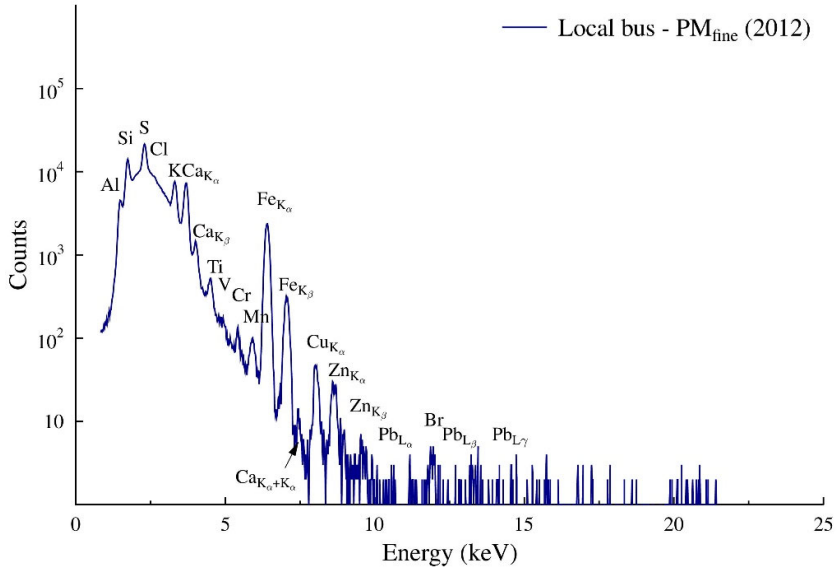
atmosphere

Case studies of aerosol pollution in different public transport vehicles in Hungarian cities -Supplementary material





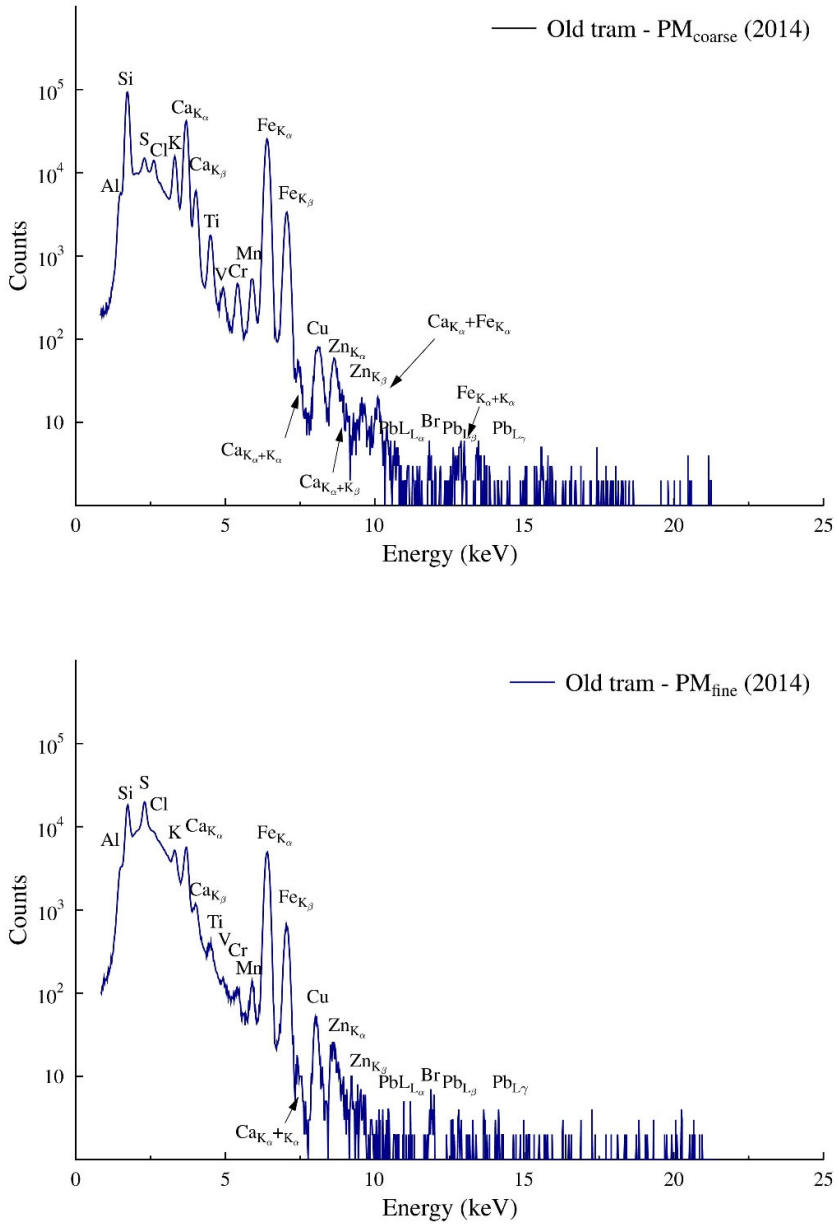
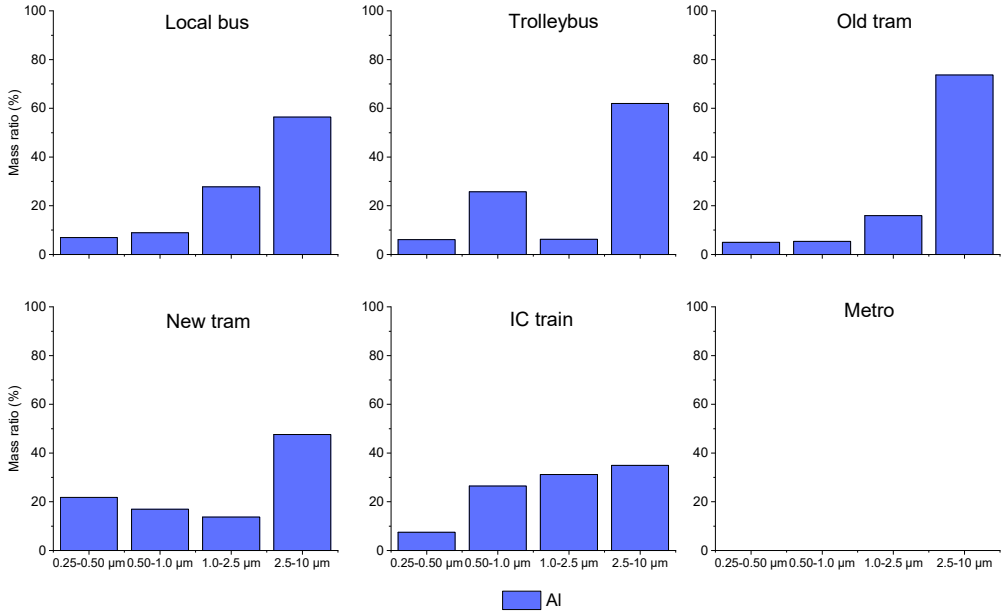
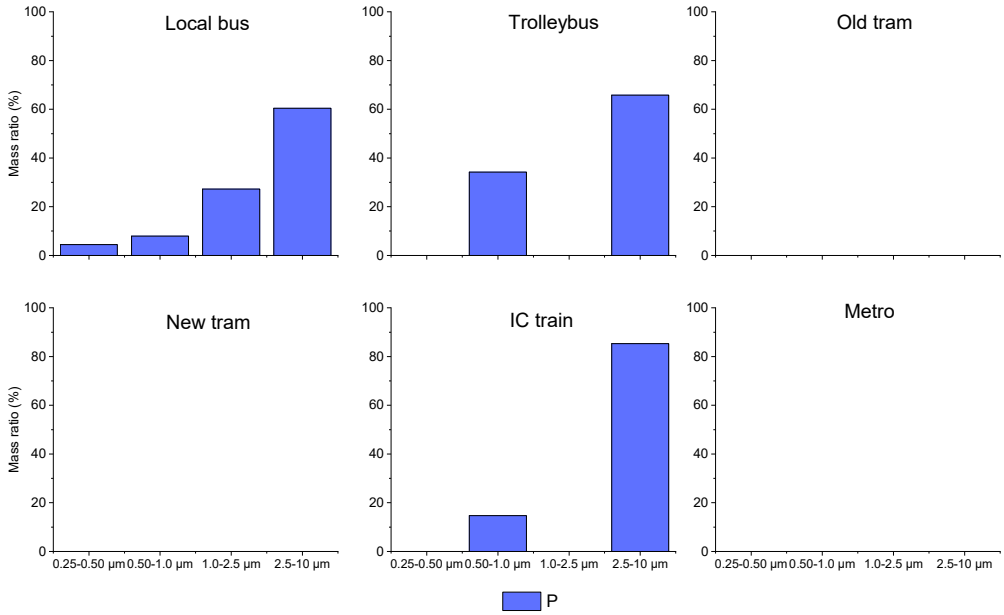
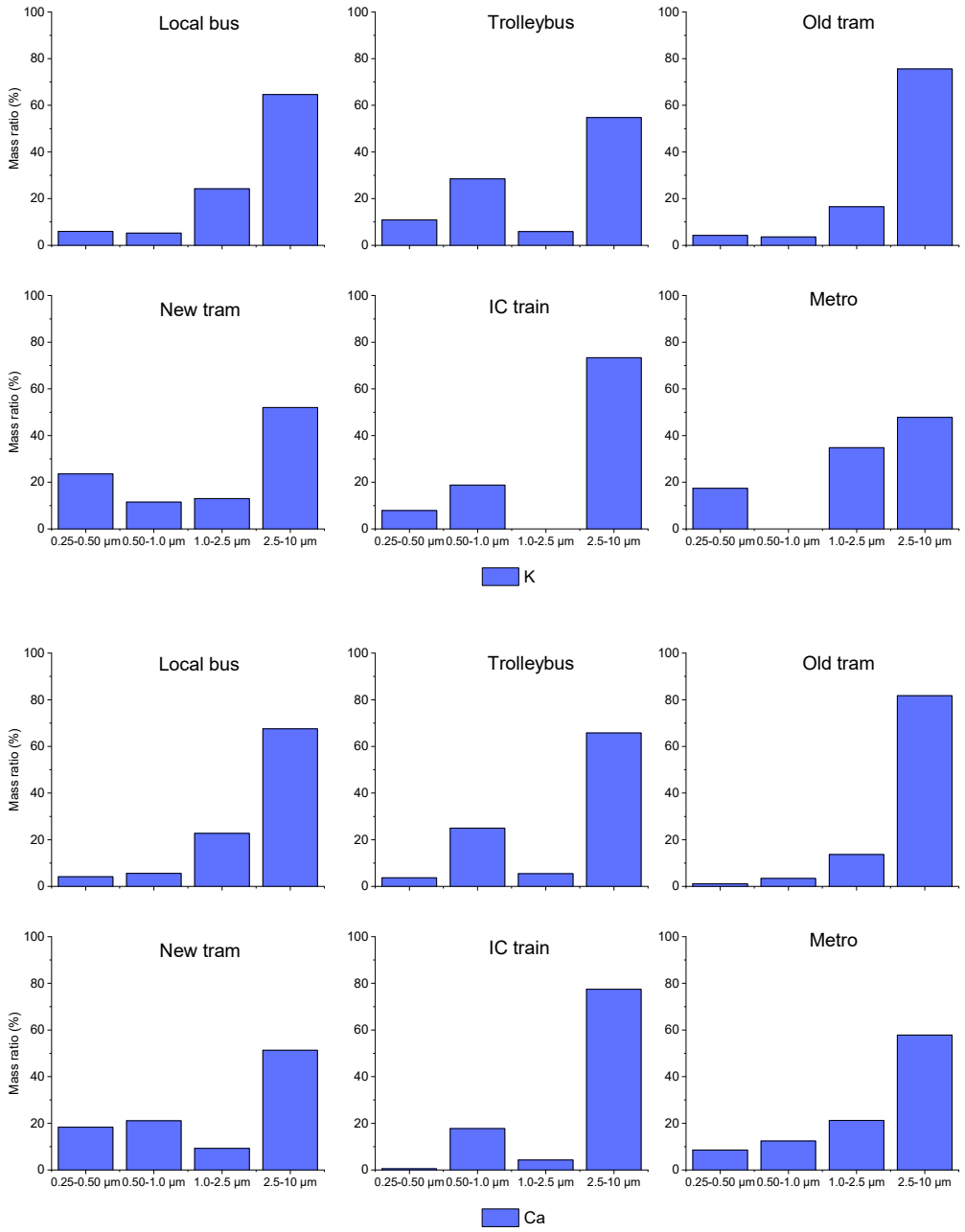
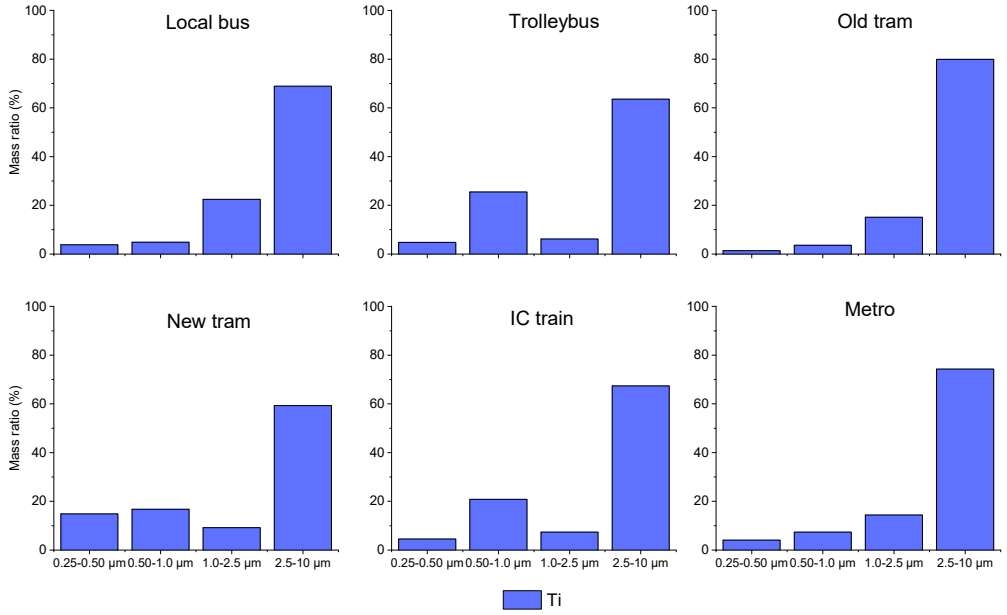


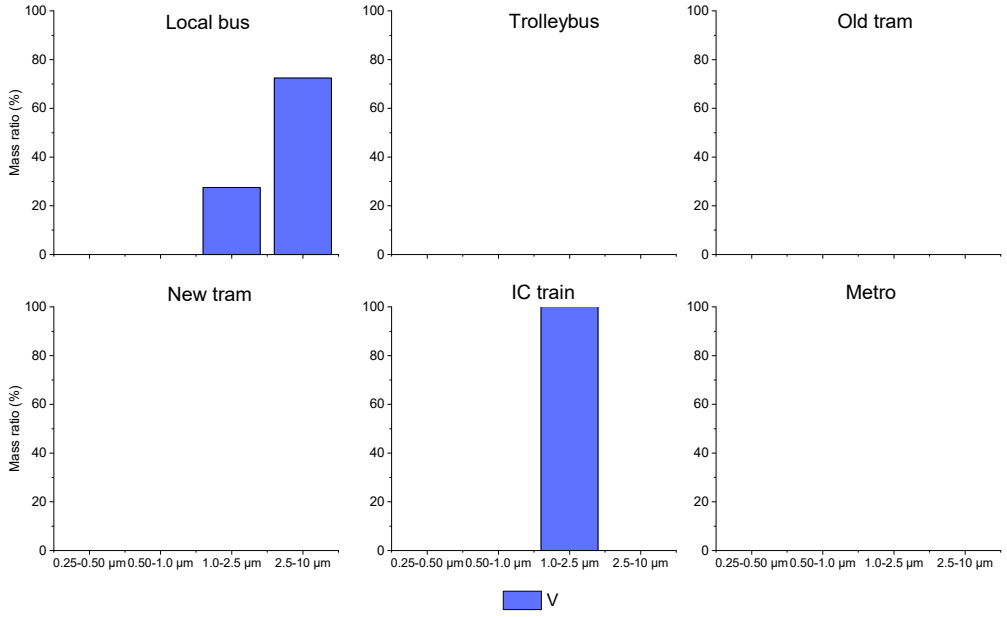
Figure S1. PM$_{coarse}$ and PM$_{fine}$ PIXE spectra from different years and different transport vehicles.

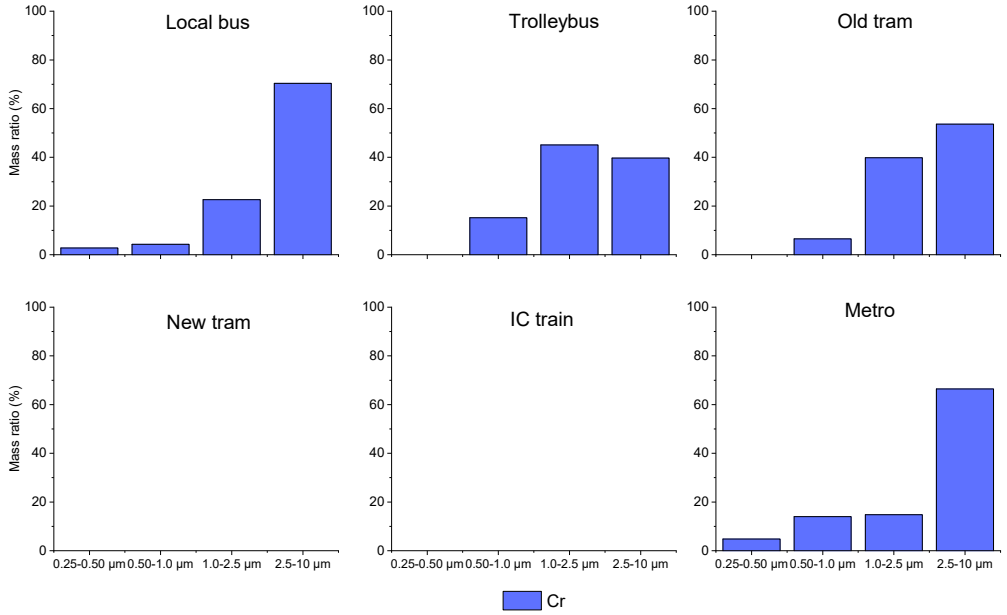

Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
Al

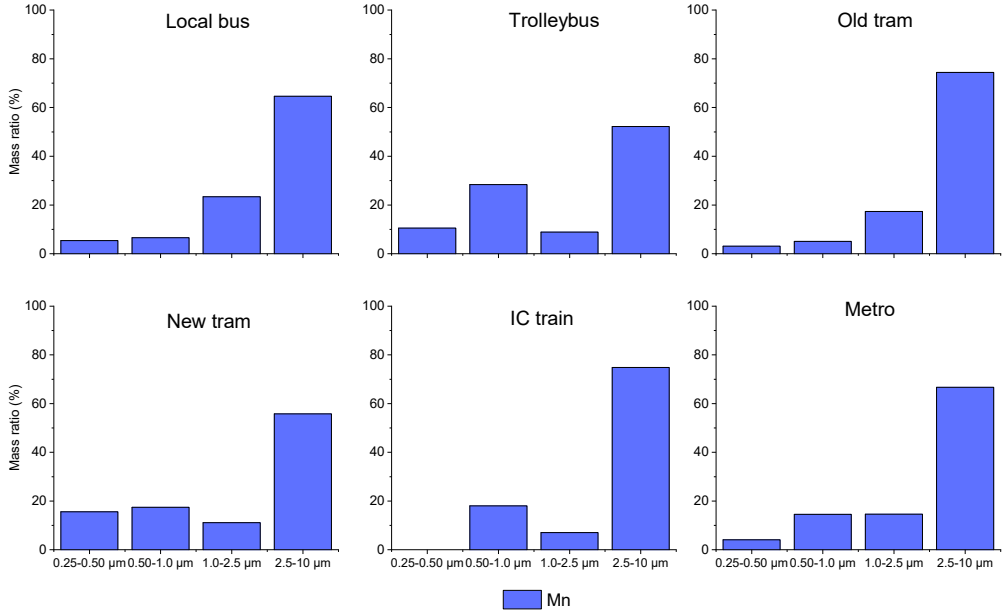

Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
P

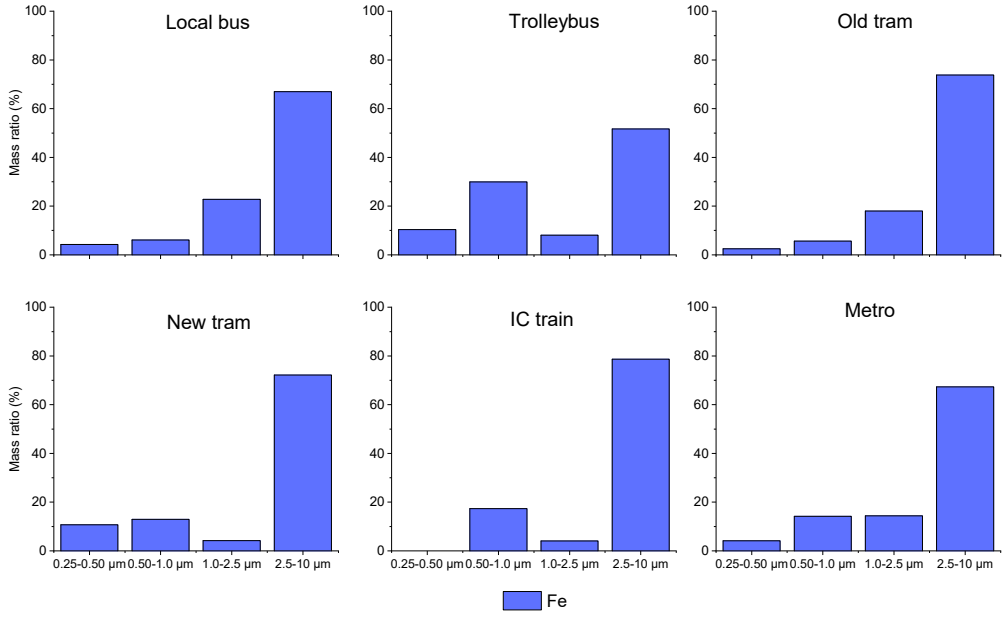

Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
K
Ca

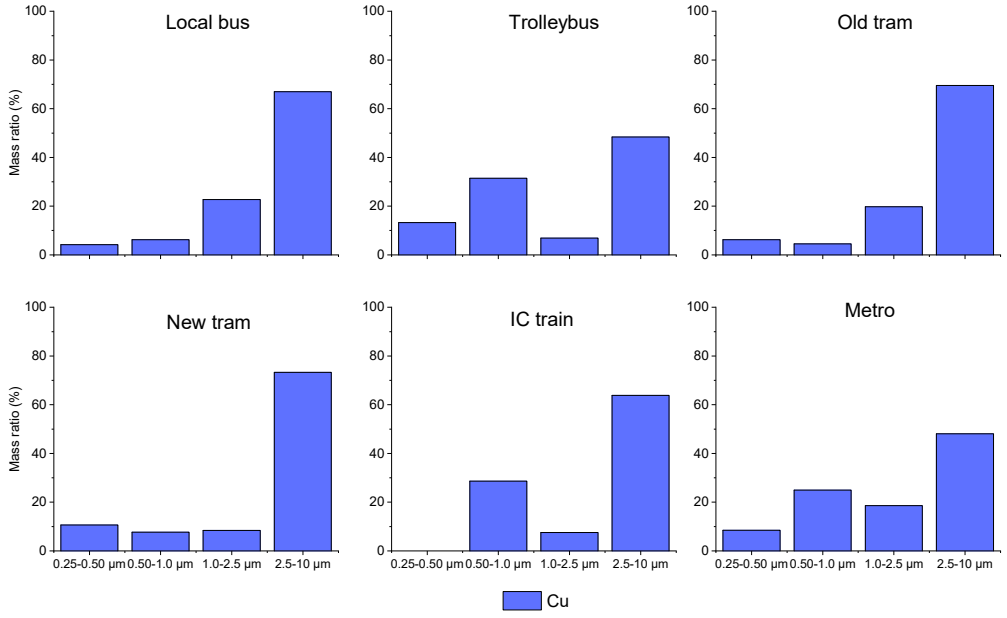

Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
Ti

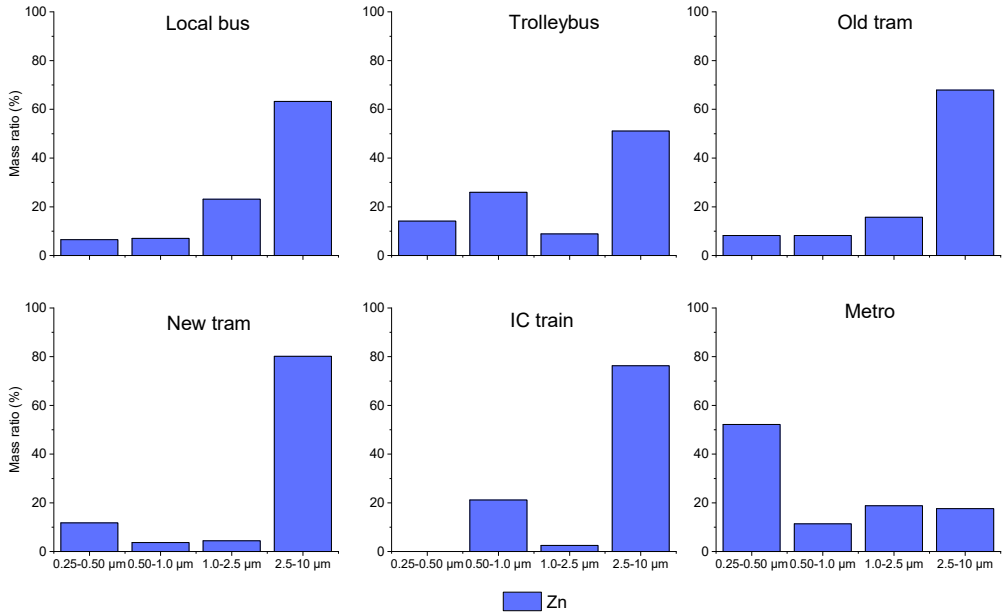

Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
V

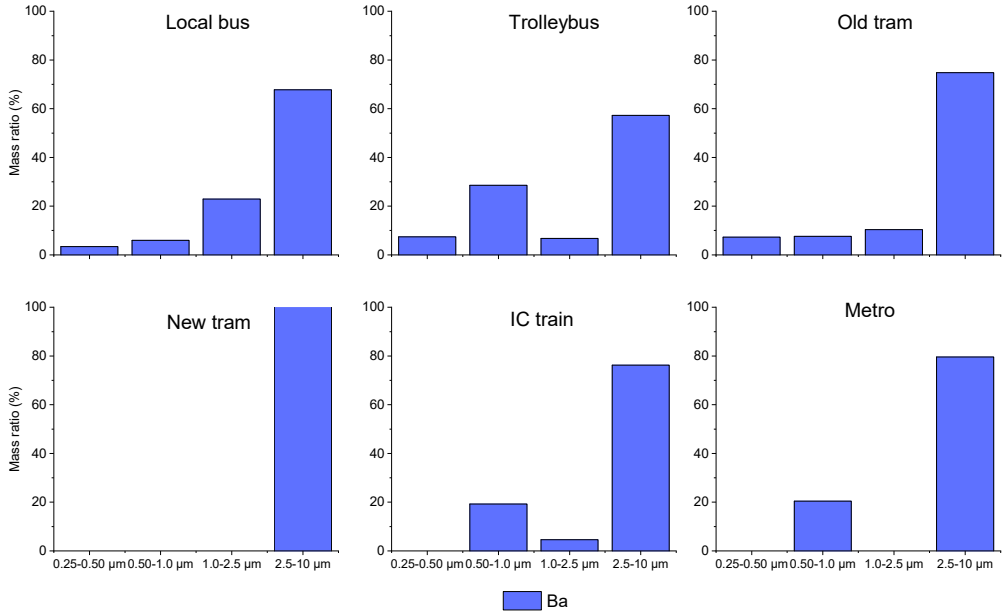

Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
Cr


Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
Mn


Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
Fe


Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
Cu


Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
Zn


Local bus
Trolleybus
Old tram
New tram
IC train
Metro
Mass ratio (%)
0
20
40
60
80
100
0.25-0.50 µm
0.50-1.0 µm
1.0-2.5 µm
2.5-10 µm
Ba

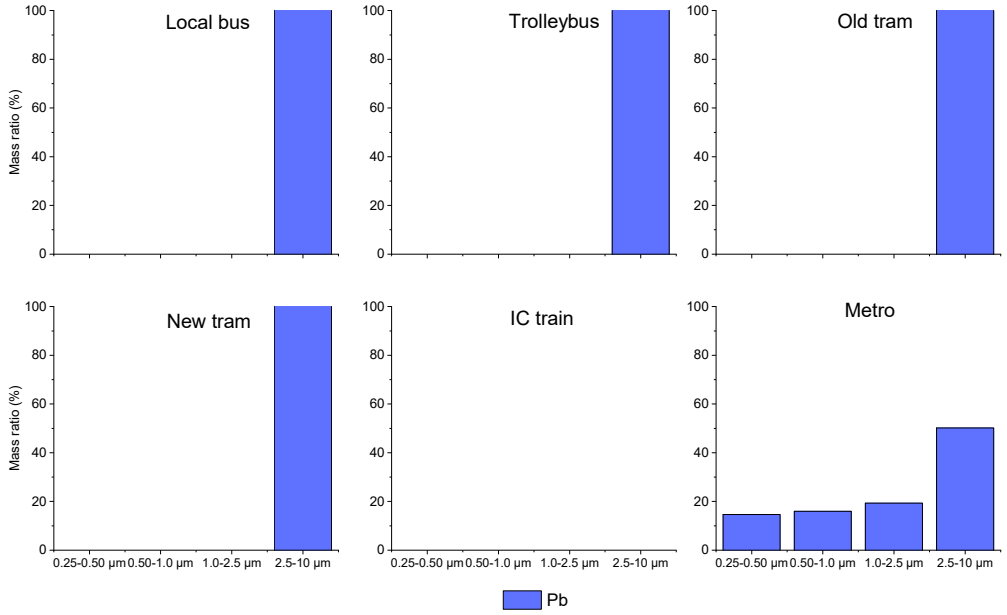


Figure S2. Mass size distributions for each element in different vehicles in 2014.

Table S1. The detection limit and the error of the analytes.

Aerosol constituent	MDL (ng m^{-3})	Analitycal uncertainty (%)	Method
$PM_{2.5}$	1000	5	Gravimetry
PM_{coarse}	1000	5	Gravimetry
Al	5.04	10	PIXE
Si	2.48	5	PIXE
P	0.94	10	PIXE
S	1.32	3	PIXE
Cl	0.77	3	PIXE
K	0.58	3	PIXE
Ca	0.89	3	PIXE
Ti	0.32	5	PIXE
V	0.35	8	PIXE
Cr	0.27	8	PIXE
Mn	0.34	5	PIXE
Fe	0.96	3	PIXE
Co	0.42	10	PIXE
Ni	0.18	10	PIXE
Cu	0.21	3	PIXE
Zn	0.25	3	PIXE
As	0.71	8	PIXE
Br	0.61	8	PIXE
Sr	1.16	10	PIXE
Ba	1.65	10	PIXE
Pb	0.92	8	PIXE

Table S2. Comparison of mean PM_{10} and $PM_{2.5}$ concentrations inside in railway and metro microenvironments.

City	Location	PM_{10} (μg m^{-3})*	$PM_{2.5}$ (μg m^{-3})
Debrecen	IC-train (2012)	373	19
	IC-train (2014)	248	66
	Metro (2014)	477	189
Budapest	Metro- in platform (2007)	155	-
Rome	Metro (2006)	407	-
London	Metro (2018)	-	800
Stockholm	Metro (2000)	470	260
Athens	Metro (2013)	400	100
Istanbul	Metro (2007)	200	-
Sydney	Train (2015)	18	15
Beijing	Train (2004)	108	37
Seoul	Train (2008)	141	121
Los Angeles	Train (2010)	16	14
Naples	Train (2006)	37	17