

Supplemental information for:

Investigation of Pb-contaminated soil and road dust in a polluted area of Philadelphia

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Environmental Monitoring and Assessment

Master tables containing relevant study information – available in associated Microsoft Excel files

Table S1a: Road Dust: Master table listing all available information for each sample site.

Table S1b: Soil: Master table listing all available information for each sample site.

Descriptive statistics for major elements

Table S2a: Descriptive statistics of the analyzed major elements found in bulk dust (top) and fine dust (bottom) (wt%). IQR stands for interquartile range.

	Element	Mean	Median	Standard	Standard	Kurtosis	Skewness	Min	Max	IQR
		Concentration	Concentration	Deviation	Error			Concentration	Concentration	
Bulk Dust	Na	0.60	0.40	0.82	0.18	10.76	3.10	0.03	3.67	0.32
	Mg	1.33	1.32	0.44	0.10	-0.39	0.34	0.63	2.23	0.58
	Al	0.34	0.32	0.07	0.02	0.61	0.92	0.26	0.51	0.09
	P	0.06	0.05	0.02	0.00	-0.18	0.58	0.03	0.09	0.02
	K	0.17	0.14	0.13	0.03	2.90	1.80	0.06	0.55	0.09
	Ca	3.42	3.24	0.88	0.20	-0.68	0.19	1.87	5.01	1.10
	Ti	0.04	0.05	0.02	0.00	-0.59	-0.18	0.01	0.07	0.03
	Fe	3.35	3.34	1.36	0.30	1.83	1.12	1.16	6.81	1.41
Fine Dust	Na	0.07	0.07	0.02	0.00	6.66	2.04	0.04	0.13	0.02
	Mg	2.39	2.40	0.88	0.20	0.22	0.31	0.96	4.48	1.13
	Al	0.44	0.42	0.09	0.02	2.97	1.42	0.33	0.70	0.10
	P	0.10	0.10	0.02	0.01	0.56	1.03	0.07	0.16	0.03
	K	0.07	0.07	0.02	0.00	0.23	0.96	0.05	0.12	0.02
	Ca	5.52	5.66	1.84	0.41	1.94	0.88	3.00	10.71	2.13
	Ti	0.07	0.06	0.02	0.01	-0.32	0.43	0.03	0.12	0.03
	Fe	3.41	3.36	1.21	0.27	-0.18	0.57	1.51	5.95	1.47

Table S2b: Descriptive statistics of the analyzed major elements found in bulk soil (top) and fine soil (bottom) (wt%). IQR stands for interquartile range.

	Element	Mean	Median	Standard	Standard	Kurtosis	Skewness	Min	Max	IQR
		Concentration	Concentration	Deviation	Error			Concentration	Concentration	
Bulk Soil	Na	0.15	0.13	0.15	0.03	-0.24	0.90	0.02	0.48	0.20
	Mg	0.67	0.47	0.52	0.12	0.58	1.19	0.13	2.00	0.79
	Al	0.60	0.53	0.16	0.04	-1.26	0.24	0.35	0.89	0.26
	P	0.22	0.20	0.10	0.02	0.01	0.59	0.07	0.45	0.12
	K	0.11	0.10	0.05	0.01	-0.20	0.78	0.03	0.23	0.08
	Ca	1.76	1.52	1.25	0.28	0.11	1.00	0.22	4.67	1.52
	Ti	0.04	0.03	0.01	0.00	-0.54	0.29	0.01	0.06	0.03
	Fe	2.48	2.43	0.87	0.19	3.10	1.42	1.24	5.08	0.73
Fine Soil	Na	0.14	0.08	0.16	0.04	2.55	1.8	0.01	0.56	0.10
	Mg	1.13	0.57	1.15	0.26	1.45	1.46	0.14	4.22	1.42
	Al	0.77	0.74	0.16	0.04	-1.22	0.09	0.52	1.03	0.23
	P	0.28	0.26	0.11	0.02	-0.78	0.34	0.11	0.48	0.17
	K	0.11	0.12	0.05	0.01	-0.23	0.48	0.05	0.21	0.05
	Ca	2.66	1.66	2.44	0.55	1.44	1.39	0.17	9.13	3.19
	Ti	0.05	0.05	0.02	0.00	0.10	0.69	0.03	0.09	0.02
	Fe	2.73	2.43	0.82	0.18	-0.15	0.84	1.67	4.62	0.98

Descriptive statistics for minor elements

Table S2c: Descriptive statistics of analyzed minor elements found in bulk dust (top) and fine dust (bottom) (ppm). IQR stands for interquartile range. Cadmium, Sb, and Hg were below the detection limit (1.5, 30, and 16.5 ppm, respectively), and thus not listed.

	Element	Mean	Median	Standard	Standard	Kurtosis	Skewness	Min	Max	IQR
		Concentration	Concentration	Deviation	Error			Concentration	Concentration	
Bulk Dust	V	42	41	20	5	4	2	14	105	26
	Cr	52	35	55	12	1	1	1	174	57
	Mn	23	21	15	3	-1	1	0	55	16
	Co	8	5	10	2	12	3	2	46	3
	Ni	2	0	6	1	13	4	0	26	0
	Cu	204	116	242	54	7	3	44	1024	96
	Zn	331	328	115	26	-1	1	122	542	181
	Sn	105	14	235	53	16	4	0	1053	107
	Pb	209	147	275	61	14	4	14	1293	198
Fine Dust	V	66	57	26	6	-1	1	31	116	36
	Cr	132	124	60	13	-1	1	62	264	130
	Mn	38	36	15	3	-1	1	16	66	20
	Co	7	7	3	1	5	2	4	17	3
	Ni	18	8	30	7	10	3	0	130	25
	Cu	242	241	96	22	-1	1	127	444	162
	Zn	714	709	243	54	7	2	414	1554	215
	Sn	168	119	176	39	11	3	41	828	59
	Pb	287	269	155	35	1	1	92	652	170

Table S2d: Descriptive statistics of analyzed minor elements found in bulk soil (top) and fine soil (bottom) (ppm). IQR stands for interquartile range. Cadmium, Sb, and Hg were below the detection limit (1.5, 30, and 16.5 ppm, respectively), and thus not listed.

	Element	Mean	Median	Standard	Standard	Kurtosis	Skewness	Min	Max	IQR
		Concentration	Concentration	Deviation	Error			Concentration	Concentration	
Bulk Soil	V	31	29	10	2	-1	1	13	51	13
	Cr	42	31	30	7	7	2	18	146	26
	Mn	42	38	28	6	-1	1	0	99	33
	Co	6	6	2	1	1	1	1	11	3
	Ni	1	0	2	1	14	4	0	10	0
	Cu	92	88	53	12	1	1	31	222	56
	Zn	663	467	622	139	3	2	134	2312	412
	Sn	25	0	63	14	11	3	0	264	6
	Pb	595	346	938	210	6	3	17	3300	348
Fine Soil	V	41	39	11	2	-1	1	26	61	15
	Cr	61	53	41	9	2	2	21	177	30
	Mn	54	51	23	5	2	1	17	119	15
	Co	8	8	3	1	1	1	4	13	2
	Ni	5	0	7	2	1	1	0	22	10
	Cu	128	97	79	18	-1	1	48	290	129
	Zn	1030	760	1139	255	4	2	136	4201	823
	Sn	13	0	29	6	4	2	0	97	0
	Pb	687	338	1042	233	7	3	37	4148	565

Spearman correlations of major elements

Table S3a: Spearman correlations of major elements in bulk dust (top) and fine dust (bottom). Statistical significance ($p < 0.05$) is shown in bold.

	Na	Mg	Al	P	K	Ca	Ti	Fe
Bulk Dust	Na	1						
	Mg	0.16	1					
	Al	-0.45	0.44	1				
	P	-0.08	0.52	0.62	1			
	K	0.83	0.42	-0.13	0.11	1		
	Ca	0.20	0.94	0.33	0.45	0.38	1	
	Ti	-0.36	0.03	0.66	0.41	-0.24	0.01	1
	Fe	-0.28	0.09	0.63	0.40	-0.16	0.10	0.42
Fine Dust	Na	1						
	Mg	-0.08	1					
	Al	0.46	0.50	1				
	P	0.34	0.59	0.71	1			
	K	0.35	0.70	0.78	0.87	1		
	Ca	-0.06	0.95	0.56	0.57	0.73	1	
	Ti	0.46	-0.26	0.11	-0.05	-0.02	-0.25	1
	Fe	0.84	0.03	0.41	0.15	0.26	0.01	0.65

Table S3b: Spearman correlations of major elements in bulk soil (top) and fine soil (bottom). Statistical significance ($p < 0.05$) is shown in bold.

	Na	Mg	Al	P	K	Ca	Ti	Fe
Bulk Soil	Na	1						
	Mg	0.34	1					
	Al	-0.02	-0.25	1				
	P	0.20	0.04	0.36	1			
	K	0.43	0.43	0.50	0.46	1		
	Ca	0.37	0.93	-0.31	0.10	0.38	1	
	Ti	-0.27	0.24	0.54	-0.01	0.35	0.06	1
	Fe	0.04	0.31	0.46	0.34	0.20	0.27	0.42
Fine Soil	Na	1						
	Mg	0.65	1					
	Al	-0.05	0.22	1				
	P	0.09	0.22	-0.04	1			
	K	0.21	0.62	0.48	0.20	1		
	Ca	0.59	0.95	0.07	0.15	0.54	1	
	Ti	0.32	0.64	0.63	-0.09	0.79	0.54	1
	Fe	0.42	0.69	0.41	-0.06	0.36	0.64	0.68

Elemental concentrations normalized to continental crust (CC) and Wissahickon Formation (WF)

Table S4: Mean major and minor element concentrations in bulk and fine dust and soil normalized to continental crust, CC (Rudnick and Gao, 2003) and to the local Wissahickon Formation, WF (Weiss et al., 1949). Minor element data were not available for the WF.

Element	Bulk Dust		Bulk Soil		Fine Dust		Fine Soil	
	CC	WF	CC	WF	CC	WF	CC	WF
Na	0.26	0.40	0.07	0.10	0.03	0.05	0.06	0.09
Mg	0.48	1.59	0.24	0.80	0.85	2.85	0.40	1.35
Al	0.04	0.05	0.07	0.08	0.05	0.06	0.09	0.10
P	1.37	1.89	5.04	6.92	2.29	3.15	6.42	8.81
K	0.11	0.08	0.07	0.05	0.05	0.03	0.07	0.05
Ca	0.75	4.72	0.38	2.43	1.21	7.61	0.58	3.67
Ti	0.10	0.07	0.10	0.07	0.17	0.13	0.12	0.09
Fe	0.64	1.49	0.48	1.10	0.65	1.52	0.52	1.21
V	0.30		0.22		0.48		0.30	
Cr	0.39		0.31		0.98		0.45	
Mn	0.03		0.05		0.05		0.07	
Co	0.30		0.23		0.26		0.30	
Ni	0.03		0.02		0.31		0.08	
Cu	7.56		3.41		8.96		4.74	
Zn	4.60		9.21		9.92		14.31	
Sn	61.76		14.71		98.82		7.65	
Pb	19.00		54.09		26.09		62.45	

Factor analysis of major elements

Table S5a: Factor analysis (varimax rotated) of major elements in bulk dust (left) and fine dust (right). Only factor loadings >0.40 are listed.

Bulk Dust	Variable	Factor 1	Factor 2	Factor 3
	Na			0.91
	Mg	0.99		
	Al		0.94	
	P	0.42	0.53	
	K			0.89
	Ca	0.94		
	Ti		0.71	
	Fe		0.60	
	Eigenvalue	2.22	2.16	1.77
Cumulative Variance	32.99%	65.05%	91.41%	

Fine Dust	Variable	Factor 1	Factor 2	Factor 3
	Na		0.90	
	Mg	0.96		
	Al			0.64
	P			0.90
	K	0.53		0.75
	Ca	0.93		
	Ti		0.58	
	Fe		0.98	
	Eigenvalue	2.39	2.27	2.06
Cumulative Variance	32.94%	64.27%	92.66%	

Table S5b: Factor analysis (varimax rotated) of major elements in bulk soil (left) and fine soil (right). Only factor loadings >0.40 are listed.

Bulk Soil	Variable	Factor 1	Factor 2	Factor 3	Factor 4
	Na		0.41	-0.44	
	Mg	0.98			
	Al	-0.42	0.54	0.40	0.51
	P		0.50		0.43
	K		0.97		
	Ca	0.94			
	Ti			0.90	
	Fe				0.85
	Eigenvalue	2.25	1.73	1.30	1.23
Cumulative Variance	32.87%	58.15%	77.12%	95.06%	

Fine Soil	Variable	Factor 1	Factor 2	Factor 3
	Na	0.62		
	Mg	0.91		
	Al		0.58	0.54
	P			
	K		0.89	
	Ca	0.97		
	Ti		0.81	
	Fe	0.57		0.63
	Eigenvalue	2.75	1.99	0.93
Cumulative Variance	42.48%	73.25%	87.65%	

Spearman correlations of minor elements

Table S6a: Spearman correlations of minor elements in bulk dust (top) and fine dust (bottom). Statistical significance ($p < 0.05$) is shown in bold.

	V	Cr	Mn	Co	Ni	Cu	Zn	Sn	Pb
Bulk Dust	V	1							
	Cr	-0.17	1						
	Mn	0.67	0.22	1					
	Co	0.79	-0.26	0.79	1				
	Ni	0.30	0.32	0.62	0.30	1			
	Cu	0.25	0.14	0.65	0.49	0.51	1		
	Zn	0.11	0.54	0.59	0.34	0.30	0.49	1	
	Sn	0.07	-0.45	0.09	0.15	0.17	0.44	-0.21	1
	Pb	-0.19	0.19	0.15	0.11	-0.05	0.48	0.43	0.17
Fine Dust	V	1							
	Cr	0.42	1						
	Mn	0.48	0.85	1					
	Co	0.84	0.57	0.71	1				
	Ni	0.34	0.89	0.89	0.54	1			
	Cu	0.51	0.77	0.74	0.56	0.70	1		
	Zn	0.32	0.64	0.74	0.47	0.69	0.71	1	
	Sn	-0.22	0.16	0.02	-0.13	0.15	0.20	0.20	1
	Pb	-0.24	0.44	0.22	-0.13	0.37	0.32	0.32	0.57

Table S6b: Spearman correlations of minor elements in bulk soil (top) and fine soil (bottom). Statistical significance ($p < 0.05$) is shown in bold.

	V	Cr	Mn	Co	Ni	Cu	Zn	Sn	Pb	
Bulk Soil	V	1								
	Cr	0.41	1							
	Mn	0.85	0.39	1						
	Co	0.64	0.46	0.81	1					
	Ni	0.16	0.44	0.18	0.18	1				
	Cu	0.45	0.71	0.36	0.21	0.52	1			
	Zn	-0.10	0.27	-0.08	0.01	0.37	0.31	1		
	Sn	0.43	0.15	0.06	-0.22	0.13	0.43	-0.06	1	
	Pb	0.46	0.35	0.23	-0.02	0.37	0.76	0.32	0.56	1
	Fine Soil	V	1							
Cr		0.45	1							
Mn		0.29	0.24	1						
Co		0.41	0.39	0.64	1					
Ni		0.50	0.72	0.33	0.50	1				
Cu		0.65	0.79	0.35	0.30	0.82	1			
Zn		0.27	0.66	0.10	0.25	0.49	0.54	1		
Sn		0.26	0.31	-0.04	0.07	0.37	0.39	0.11	1	
Pb		0.61	0.41	0.20	0.05	0.53	0.76	0.40	0.23	1

Factor analysis of minor elements

Table S7a: Factor analysis (varimax rotated) of minor elements in bulk dust (left) and fine dust (right). Only factor loadings >0.40 are listed.

Bulk Dust	Variable	Factor 1	Factor 2	Factor 3	Factor 4
	V	0.88			
	Cr		0.91		
	Mn	0.78			0.47
	Co	0.97			
	Ni				0.81
	Cu			0.66	0.53
	Zn		0.54	0.47	
	Sn		-0.67		
	Pb			0.81	
	Eigenvalue	2.61	1.68	1.55	1.38
	Cumulative Variance	34.16%	56.11%	76.36%	94.41%

Fine Dust	Variable	Factor 1	Factor 2	Factor 3
	V		0.88	
	Cr	0.90		
	Mn	0.89		
	Co	0.43	0.86	
	Ni	0.92		
	Cu	0.81		
	Zn	0.62		
	Sn			0.71
	Pb			0.76
	Eigenvalue	3.57	1.99	1.28
	Cumulative Variance	45.92%	71.53%	88.00%

Table S7b: Factor analysis (varimax rotated) of minor elements in bulk soil (left) and fine soil (right). Only factor loadings >0.40 are listed.

Bulk Soil	Variable	Factor 1	Factor 2	Factor 3	Factor 4
	V	0.87			0.40
	Cr			0.80	
	Mn	0.95			
	Co	0.86			
	Ni			0.41	
	Cu		0.65	0.70	
	Zn				
	Sn				0.81
	Pb		0.87		
	Eigenvalue	2.58	1.58	1.47	1.03
	Cumulative Variance	35.03%	56.42%	76.32%	90.25%

Fine Soil	Variable	Factor 1	Factor 2	Factor 3
	V		0.63	
	Cr	0.81		
	Mn			0.62
	Co			0.97
	Ni	0.77		
	Cu	0.81	0.57	
	Zn	0.45		
	Sn	0.41		
	Pb		0.89	
	Eigenvalue	2.51	1.75	1.62
	Cumulative Variance	34.28%	58.12%	80.36%