Supporting Information for

Detection and quantification of anthropogenic Ti, Ce, and La-bearing particles home dust

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1. Sampling location

Figure S1. Approximate locations of homes from which dust samples were collected.

Table S1. Perkin Elmer NexION 350D inductively coupled plasma-mass spectrometry (ICP-MS) operating conditions.

Instrument Parameter	**Value**
Nebulizer Gas Flow	0.85 to 1 L/min
Auxiliary Gas Flow	1.02 L/min
Plasma Gas Flow	16 L/min
ICP RF Power	1600 W
Analog Stage Voltage	-1600 V
Pulse Stage Voltage	1600 V
Discriminator Threshold	12
Deflector Voltage	-9.5 V
Dwell time	ICP-MS/AF4-ICP-MS: 50 ms
Sample Flow Rate	0.3 mL/min

Table S2. Elemental concentrations (µg kg^{-1}) of the USGS reference materials BHVO-2 Hawaiian basalts.

Concentration	Mean ± SD	Recommended values [86]	Precision (%)	Error (%)	Accuracy (%)
^{27}Al	$7.55 \times 10^7 \pm 3.13 \times 10^6$	7.11×10^7	4.15	6.1	93.9
^{47}Ti	$1.52 \times 10^7 \pm 5.73 \times 10^5$	1.64×10^7	3.78	4.1	95.9
^{51}V	$2.84 \times 10^5 \pm 8.64 \times 10^3$	3.18×10^5	3.04	7.7	92.3
^{53}Cr	$2.53 \times 10^5 \pm 8.69 \times 10^3$	2.87×10^5	3.43	8.3	91.7
^{55}Mn	$1.11 \times 10^6 \pm 4.32 \times 10^4$	1.31×10^6	3.89	9.1	90.9
^{57}Fe	$9.43 \times 10^7 \pm 3.44 \times 10^6$	8.67×10^7	3.65	8.8	91.2
^{59}Co	$4.02 \times 10^4 \pm 1.55 \times 10^3$	4.49×10^4	3.84	6.1	93.9
^{60}Ni	$1.08 \times 10^5 \pm 4.52 \times 10^3$	1.20×10^5	4.18	4.9	95.1
^{65}Cu	$1.30 \times 10^5 \pm 6.07 \times 10^3$	1.29×10^5	4.67	0.7	99.3
^{66}Zn	$5.38 \times 10^4 \pm 1.29 \times 10^4$	1.04×10^5	23.9	48.2	51.8
^{88}Sr	$3.51 \times 10^5 \pm 9.71 \times 10^3$	3.94×10^5	2.77	4.1	95.9
^{89}Y	$2.25 \times 10^4 \pm 5.31 \times 10^2$	2.59×10^4	2.36	3.9	96.1
^{90}Zr	$1.51 \times 10^5 \pm 4.45 \times 10^3$	1.71×10^5	2.94	8.1	91.9
^{93}Nb	$1.57 \times 10^4 \pm 1.24 \times 10^2$	1.81×10^4	0.79	11.0	89.0
^{98}Mo	$6.46 \times 10^3 \pm 5.25 \times 10^1$	4.07×10^3	0.81	22.3	77.7
^{137}Ba	$1.15 \times 10^5 \pm 3.35 \times 10^3$	1.31×10^5	2.91	6.7	93.3
^{139}La	$1.38 \times 10^4 \pm 3.98 \times 10^2$	1.52×10^4	2.89	2.9	97.1
^{140}Ce	$3.39 \times 10^4 \pm 9.29 \times 10^2$	3.75×10^4	2.74	4.3	95.7
^{141}Pr	$4.77 \times 10^3 \pm 1.20 \times 10^2$	5.34×10^3	2.52	4.8	95.2
^{142}Nd	$2.23 \times 10^4 \pm 4.01 \times 10^2$	2.43×10^4	1.80	2.0	98.0
^{152}Sm	$5.70 \times 10^3 \pm 1.24 \times 10^1$	6.02×10^3	0.22	5.3	94.7
^{153}Eu	$1.91 \times 10^3 \pm 1.77 \times 10^0$	2.04×10^3	0.09	6.3	93.7
^{158}Gd	$6.33 \times 10^3 \pm 1.96 \times 10^2$	6.21×10^3	3.10	1.9	98.1
^{159}Tb	$9.06 \times 10^2 \pm 4.12 \times 10^0$	9.39×10^2	0.45	3.5	96.5
^{164}Dy	$5.01 \times 10^3 \pm 3.66 \times 10^1$	5.28×10^3	0.73	5.1	94.9
^{165}Ho	$9.42 \times 10^2 \pm 3.15 \times 10^1$	9.89×10^2	3.34	4.7	95.3
^{166}Er	$2.44 \times 10^3 \pm 4.12 \times 10^0$	2.51×10^3	0.17	3	97.0
^{169}Tm	$3.36 \times 10^2 \pm 2.38 \times 10^1$	3.35×10^2	7.09	0.3	99.7
^{174}Yb	$1.92 \times 10^3 \pm 3.20 \times 10^1$	1.99×10^3	1.67	3.7	96.3
^{175}Lu	$3.24 \times 10^2 \pm 2.61 \times 10^1$	2.75×10^2	8.07	14.2	85.8
^{180}Hf	$5.52 \times 10^3 \pm 1.77 \times 10^2$	4.47×10^3	3.21	23.5	76.5
^{181}Ta	$1.80 \times 10^3 \pm 1.95 \times 10^2$	1.15×10^3	10.84	56.1	43.9
^{208}Pb	$2.43 \times 10^3 \pm 9.83 \times 10^1$	1.65×10^3	4.04	47.1	52.9
^{232}Th	$1.57 \times 10^3 \pm 1.73 \times 10^2$	1.22×10^3	11.04	28	72

Precision (%) = standard deviation/mean * 100
Error (%) = |(Measured concentration – recommended value)| / recommended value * 100
Accuracy = 100 –Error (%)

Table S3. Flow-field flow fractionation (AF4) separation conditions.

Injection time (min)	5
Focus time (min)	10
Injection volume (mL)	900.0
Injection rate (ml min^{-1})	0.2
Cross flow rate (mL min^{-1})	0.5
Detector flow rate (mL min^{-1})	1.0
Elution time (min)	70
ICP-MS Data collection	Starts immediately following the end of the injection time
Delay (dead time) between AF4 and ICP-MS (min)	1.45
Carrier	0.0125% FL-70 surfactant, 0.01% NaN_3, and 10 mM $NaNO_3$
Membrane type	Regenerated cellulose (RC), cutoff 10 kDa
Channel	24.6 cm long trapezoidal channel with 350 µm spacer
Calibration standards	Latex nanosphere size standards, 20, 40, 80 and 150 nm

1.1. Metal concentrations in the digested blank filters

The digested blank filters show detectable concentrations of most elements, but these concentrations are much lower than the detected metal concentrations in the dust samples (**Figure 1a and Table S2**). The Ti and Ce concentrations in the blank filters varied in the range of 0.7 ± 0.6 to 1,952 ± 282, and 0 to 0.1 ± 0.2 mg kg^{-1}. Titanium concentrations in two of the five blank filters were higher than those measured in all dust samples, except home 7 and 8 (**Figure 1a**). Lanthanum concentrations in the blank filters were below the ICP-MS limit of detection (0.0096 µg L^{-1}). The high concentration of Ti in some filters might be attributed to the use of TiO_2 in some filters as a whitening agent.

Table S4. Metal concentration (µg kg^{-1}) in five blank filters purchased from the market. These filters do not necessarily represent those used in the homes from which dust was collected.

Element	Basic Pleated (BP)	Advanced Allergen (AA)	Micro Particle Reduction (MR)	Allergen Reduction (AR)	Dust Reduction (DR)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Al	12800±3551	6751±3611	22818±9473	42252±3420	38391±10360
Ti	719±639	1186±916	1579±1029	1138530±186585	1952402±282800
V	11±8	8±5	6±3	151±18	237±39
Cr	575±414	614±442	394±113	1092±229	1123±383
Mn	152±151	156±115	84±41	108±14	185±133
Fe	3042±3092	5565±4725	4505±2831	6811±463	7843±3761
Co	12±11	11±9	7±3	16±1	30±16
Ni	297±206	291±206	206±119	314±12	546±187
Cu	405±416	0±0	291±286	1114±108	1701±284
Zn	664±1151	7749±7106	222±384	23023±1749	30363±4968
Sr	58±54	28±12	40±11	63±13	72±50
Y	0±0	0±0	0±0	0±0	0±0
Zr	34±30	0±0	35±32	219±52	116±46
Nb	5±2	3±1	3±1	56±8	9±2
Mo	33±32	42±35	17±11	72±8	109±49

Ba	163±195	60±32	128±49	175±94	256±250
La	0±0	0±0	0±0	0±0	0±0
Ce	112±194	0±0	36±62	0±0	11±20
Pr	0±0	0±0	0±0	0±0	0±0
Nd	28.9±50	0±0	10±17	0±0	0±0
Sm	0±0	0±0	0±0	1±2	1.7±3
Eu	0.8±1	0±0	0.4±1	0.8±1	0.7±1
Gd	8.4±15	0±0	3.2±6	0±0	3.4±3
Tb	0±0	0±0	0±0	0±0	0±0
Dy	0±0	0±0	0±0	0±0	1.2±2
Ho	0.6±1	0±0	0.4±1	0±0	0.3±1
Er	0.8±1	0±0	0±0	0±0	1±2
Tm	0.6±1	0.2±0	0.4±1	0.4±0	0.7±0
Yb	0.8±1	0±0	0±0	0.6±1	0.9±2
Lu	0.6±1	0±0	0.4±1	0±0	0±0
Hf	0±0	0±0	0±0	0±0	0±0
Ta	10.5±1	5.5±1	5.4±1	11.4±2	7.9±2
Pb	19.7±34	5.5±10	5.8±10	29.9±17	22.7±39
Th	1.3±1	0.5±0	1.1±1	1.6±0	2±1

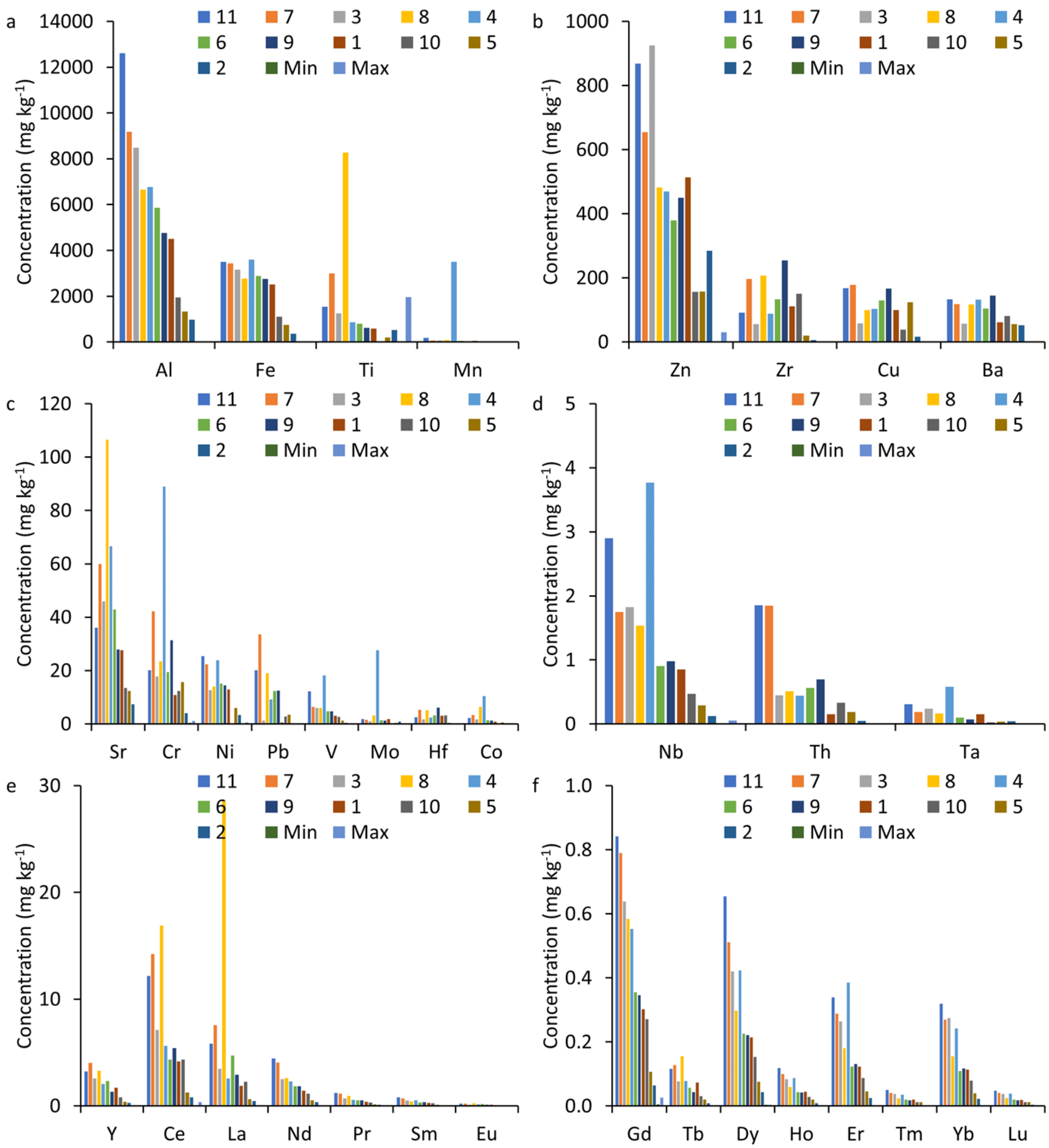

Figure S2. Metal concentrations in the eleven home dusts and the minimum and maximum metal content in the blank HVAC filters: (a) Al, Fe, Ti, and Mn, (b) Zn, Zr, Cu and Ba, (c) Sr, Cr, Ni, V, Mo, Hf, and Co, (d) Pb, Nb, Th, and Ta, (e) Y, Ce, La, Nd, Pr, Sm and Eu, and (f) Gd, Tb, Cy, Ho, Er, Tm, Yb, and Lu concentrations.

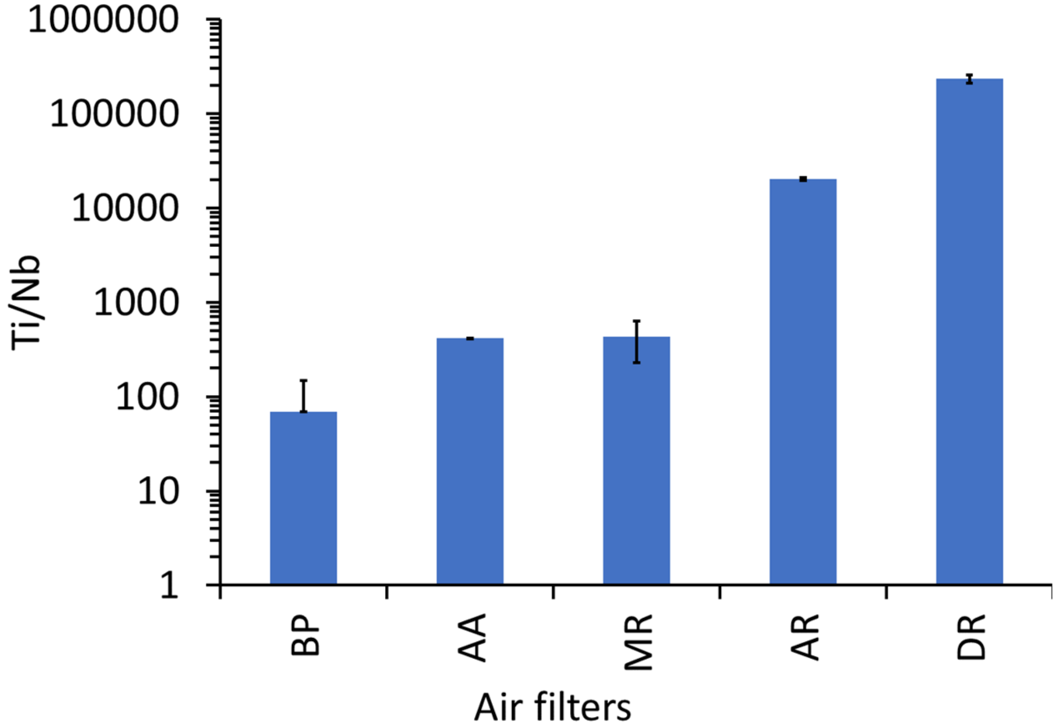

Figure S3. The elemental ratio of Ti/Nb in the blank heat, ventilation, and air conditioning (HVAC) filters. BP: Basic Pleated, AA: Advanced Allergen, MR: Microparticle Reduction, AR: Allergen Reduction, and DR: Dust Reduction.

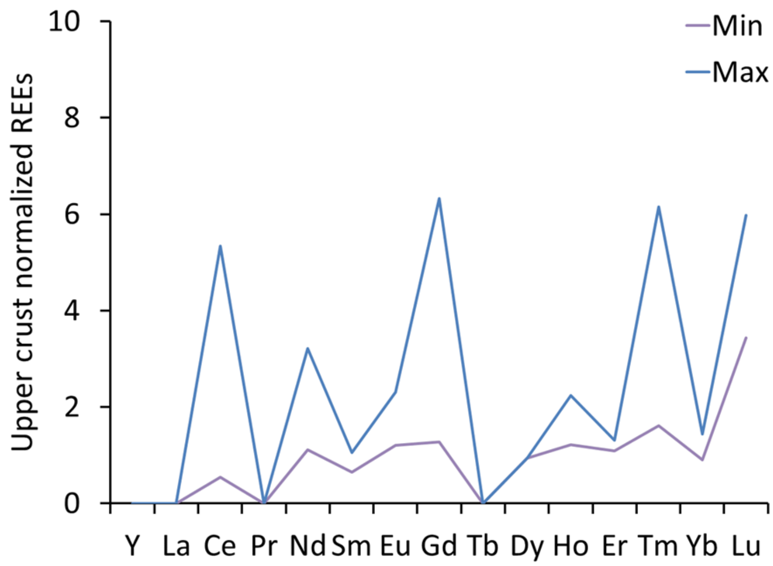

Figure S4. Upper crust normalized rare earth element (REE) concentrations in the blank heating, ventilation, and air conditioning (HVAC) filters Min and Max refers to the minimum and maximum measured REE concentrations in the blank filters.

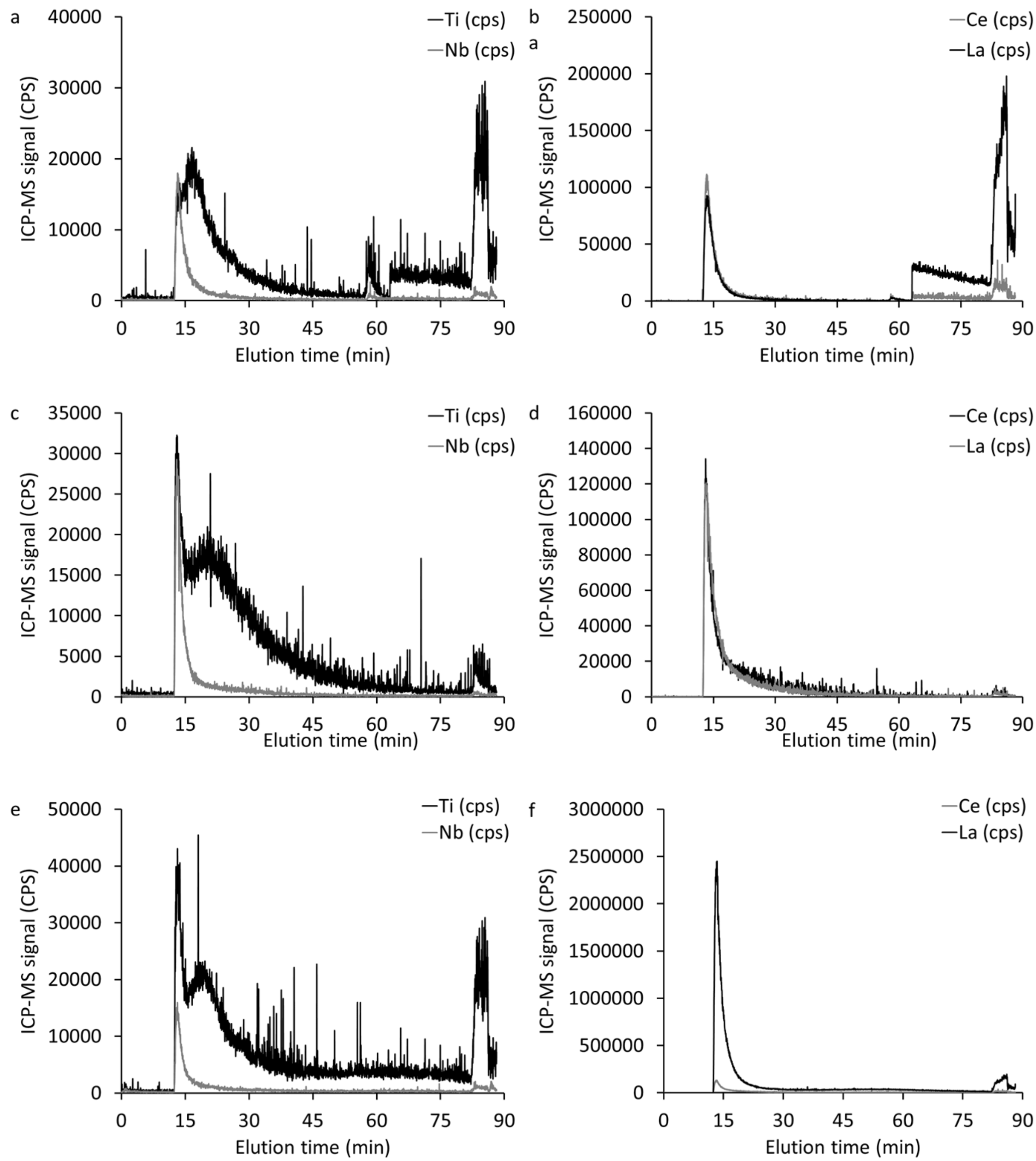

Figure S5. Raw asymmetrical flow-field flow fractionation-inductively coupled plasma-mass spectrometry (AF4-ICP-MS) fractograms of the < 450 nm fractions extracted from dusts collected from homes (a, b) 4, (c, d) 7, and (f, e) 8.

Table S5. Mean metal concentration (mg kg^{-1}) in the eleven home dusts.

Element	1	2	3	4	5	6	7	8	9	10	11
Al	4497.7	973.8	8489.5	6762.1	1330.4	5864.5	9183.6	6651.9	4764.9	1942.4	12609.8
Fe	2514.7	368.1	3158.6	3595.3	747.3	2877.3	3428.4	2777.2	2752.8	1099.6	3492.2
Ti	582.4	521.4	1251.8	860.7	193.0	804.2	2995.4	8271.4	617.5		1545.7
Mn	48.0	8.3	75.4	3493.4	17.2	58.9	69.7	85.4	35.4	16.7	190.8
Zn	513.5	284.1	924.9	469.8	157.8	378.7	654.8	481.8	450.3	156.6	868.2
Zr	111.5	5.5	56.0	87.9	20.1	132.7	197.0	207.4	254.6	150.2	90.9
Cu	99.5	16.6	57.3	103.0	124.1	129.6	178.3	99.7	166.7	37.9	167.2
Ba	61.2	51.5	56.2	131.8	55.9	104.4	118.4	116.7	144.4	80.6	132.7
Sr	27.7	7.3	46.0	66.6	12.4	42.9	60.0	106.5	27.8	13.5	36.0
Cr	10.9	4.1	17.8	88.9	15.7	19.4	42.1	23.5	31.4	12.3	20.1
Ni	12.9	3.4	12.6	23.9	6.0	15.1	22.3	14.0	14.4		25.4
Pb	0.5	0.1	1.3	9.2	3.4	12.4	33.6	19.1	12.5	2.8	20.1
V	3.1	0.5	6.0	18.1	1.3	4.7	6.4	5.9	4.7	2.6	12.2
Mo	1.8	0.8	1.0	27.6	0.5	1.3	1.5	3.2	1.3		1.8
Hf	3.0	0.1	1.6	2.4	0.5	3.2	5.3	5.2	6.2	3.2	2.5
Co	0.8	0.3	1.7	10.4	0.6	1.4	3.3	6.4	1.2		2.2
Nb	0.9	0.1	1.8	3.8	0.3	0.9	1.7	1.5	1.0	0.5	2.9
Th	0.2	0.1	0.4	0.4	0.2	0.6	1.8	0.5	0.7	0.3	1.9
Ta	0.1	0.04	0.2	0.6	0.04	0.1	0.2	0.2	0.1	0.03	0.3
Y	1.7	0.3	2.6	2.1	0.4	2.3	4.0	3.3	1.3	0.8	3.2
Ce	4.2	0.8	7.1	5.6	1.3	4.3	14.2	16.9	5.4	4.3	12.2
La	1.9	0.4	3.5	2.6	0.6	4.7	7.6	28.6	2.9	2.3	5.8
Nd	1.4	0.4	2.5	2.3	0.5	1.8	4.1	2.6	1.9	1.1	4.5
Pr	0.4	0.1	0.7	0.6	0.1	0.5	1.1	0.9	0.5	0.3	1.2
Sm	0.3	0.1	0.5	0.5	0.1	0.3	0.7	0.4	0.3	0.2	0.8
Eu	0.1	0.03	0.1	0.1	0.04	0.2	0.2	0.2	0.1	0.1	0.2
Gd	0.3	0.1	0.6	0.6	0.1	0.4	0.8	0.6	0.3	0.3	0.8
Tb	0.1	0.01	0.1	0.1	0.02	0.1	0.1	0.2	0.04	0.03	0.1
Dy	0.2	0.04	0.4	0.4	0.1	0.2	0.5	0.3	0.2	0.2	0.7
Ho	0.04	0.01	0.1	0.1	0.02	0.04	0.1	0.1	0.04	0.03	0.1
Er	0.1	0.02	0.3	0.4	0.05	0.1	0.3	0.2	0.1	0.1	0.3
Tm	0.02	0.003	0.04	0.04	0.01	0.02	0.04	0.02	0.02	0.01	0.1
Yb	0.1	0.02	0.3	0.2	0.04	0.1	0.3	0.2	0.1	0.1	0.3
Lu	0.02	0.003	0.04	0.04	0.01	0.02	0.04	0.02	0.02	0.01	0.05