Trace metal contamination in soils from less concerned mountain regions across China: Spatial distribution, sources and potential drivers

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Calculations

Geoaccumulation index (I_{geo}) was used to assess the contamination degree of trace metals in soils (Muller, 1969).

$$I_{geo} = \log_2 \frac{C}{1.5 \times B} \qquad (1)$$

where C is the concentration of a metal in a sample, B is its background, and 1.5 is the coefficient considering the soil heterogeneity. The classification of I_{geo} is uncontaminated ($I_{geo} \leq 0$), uncontaminated to moderately contaminated ($0 < I_{geo} \leq 1$), moderately contaminated ($1 < I_{geo} \leq 2$), moderately to heavily contaminated ($2 < I_{geo} \leq 3$), heavily contaminated ($3 < I_{geo} \leq 4$), heavily to extremely contaminated ($4 < I_{geo} \leq 5$), and extremely contaminated ($I_{geo} > 5$).

Enrichment factor (*EFs*) was used to reflect the mass balance of trace metals in soil profiles, and Ti was selected as the reference element (Taylor and McLennan, 1995).

$$EFs = \frac{Me_{sample}/Ti_{sample}}{Me_{background}/Ti_{background}} \qquad (2)$$

where $(Me/Ti)_{sample}$ is the concentration ratio of a metal to Ti in the O or A horizon; $(Me/Ti)_{background}$ is the ratio in the C horizon. The classification of *EF* is depletion to mineral enrichment ($EFs < 2$), moderate enrichment ($2 \leq EFs < 5$), significant enrichment ($5 \leq EFs < 20$), very high enrichment ($20 \leq EFs < 40$), and extremely high enrichment ($EFs \geq 40$).

The chemical index of alteration (CIA) was used to evaluate the chemical weathering degree of the soil parent materials, which is calculated by following function (Shao and Yang, 2012).

$$CIA = [x(Al_2O_3)/(x(Al_2O_3) + x(CaO) + x(Na_2O) + x(K_2O))] \times 100\% \qquad (3)$$

where the contents of each metal oxide represent their molar mass ratios.

Table S1 The basic information of altitude, climate, vegetation in the study area (n = 29)

Divisions	Mts.	Latitude (°)	Longitude (°)	Altitude (m)	MAT (℃)	MAP (mm)	NDVI	Forest type	Climatic zone
East China	DB	31.09-31.10	115.77-115.81	400-1630	11.4-11.4	1562-1562	0.58-0.58	Coniferous-broadleaf mixed forest, Coniferous forest	Subtropical
	DY	25.64-25.65	118.22-118.23	1100-1660	15.9-15.9	1546-1546	0.69-0.69	Coniferous-broadleaf mixed forest	Subtropical
	JGS	26.50-26.63	114.11-114.17	925-1350	12.9-15.1	1657-1809	0.69-0.79	Broadleaf forest, Coniferous-broadleaf mixed forest	Subtropical
	LQ	27.87-27.93	119.18-119.21	720-1929	11.7-16.3	1298-1540	0.41-0.70	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest, Shrub	
	TM	30.31-30.58	119.43-119.96	350-1460	11.7-16.3	1298-1540	0.41-0.70	Coniferous-broadleaf mixed forest	Subtropical
	WG	27.46-27.47	114.16-114.17	778-1175	13.5-14.0	1743-1773	0.69-0.74	Broadleaf forest	Subtropical
North China	BCW	40.82-40.83	117.60-117.61	1120-1710	6.0-6.0	539-539	0.57-0.57	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest	Warm-temperate
	GD	37.89-37.90	111.43-111.44	1310-2200	2.4-2.4	521-521	0.57-0.57	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest	Warm-temperate
	HS	44.19-44.27	118.41-118.72	1100-1400	0.4-1.6	383-413	0.43-0.50	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest	Temperate
	SHB	42.33-42.47	117.29-117.51	1560-1870	0.5-1.5	434-463	0.47-0.51	Broadleaf forest, Coniferous-broadleaf mixed forest	Temperate
	WYZ	38.72-38.73	113.84-113.86	1210-1880	6.9-6.9	476-476	0.51-0.51	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest	Warm-temperate
NE China	DX	49.25-53.45	122.34-124.28	360-1370	-5.0-0.0	429-543	0.44-0.59	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest	Cold-temperate
	XX	45.3 -48.85	127.68-129.65	240-1420	-0.8-2.7	592-671	0.55-0.64	Broadleaf forest, Coniferous-broadleaf mixed forest	Temperate

	CB	42.06-42.30	127.83-128.13	1025-2000	-3.7-1.5	741-930	0.44-0.65	Broadleaf forest, Coniferous forest, Shrub	Temperate
NW China	AS	33.79-33.96	107.30-107.50	1260-3150	5.9-8.3	760-793	0.61-0.63	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest	Warm-temperate
	JF	33.68-33.69	105.68-105.68	1785-1900	12.2-12.2	670-670	0.48-0.48	Coniferous forest	Warm-temperate
	QF	34.00-34.04	107.44-107.44	1530-2100	7.6-7.6	737-737	0.60-0.60	Broadleaf forest, Coniferous-broadleaf mixed forest	Warm-temperate
	SYK	38.73-38.75	105.91-105.92	2030-2350	3.3-6.3	223-253	0.26-0.41	Coniferous forest	Temperate
	QL	34.02-34.16	107.61-107.80	870-2350	5.3-10.5	707-761	0.54-0.59	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest	Temperate
South China	DH	23.17-23.18	112.52-112.54	210-586	21.1-21.1	1788-1788	0.67-0.67	Coniferous-broadleaf mixed forest	Subtropical
	JG	29.38-29.40	114.58-114.65	580-1500	13.5-14.5	1592-1657	0.66-0.70	Broadleaf forest, Coniferous forest	
	SN	31.37-31.76	110.15-110.55	780-3090	5.7-10.1	1195-1335	0.59-0.65	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest	Subtropical
	SWD	21.88-21.90	107.90-107.92	393-708	19.8-20.0	1902-1934	0.78-0.79	Broadleaf forest, Coniferous-broadleaf mixed forest	Subtropical
	WZ	18.89-18.90	109.69-109.71	862-1818	20.8-20.8	1694-1694	0.85-0.85	Broadleaf forest	Tropical
SW China	AL	24.50-24.54	100.99-101.03	2190-2655	13.4-16.7	963-973	0.68-0.79	Broadleaf forest, Coniferous-broadleaf mixed forest	Subtropical
	FJ	27.90-27.91	108.70-108.72	1482-2095	12.1-13.7	1253-1315	0.63-0.68	Broadleaf forest, Coniferous-broadleaf mixed forest, Shrub	Subtropical
	GG	29.54-29.60	101.96-102.07	2000-4225	1.5-14.2	883-1947	0.59-0.65	Broadleaf forest, Coniferous-broadleaf mixed forest, Coniferous forest, Shrub	Subtropical
	LG	26.36-26.38	108.16-108.21	1223-2155	12.1-13.7	1253-1315	0.63-0.68	Broadleaf forest, Coniferous forest, Shrub	Subtropical
	LJ	27.57-27.58	102.37-102.42	2200-3830	6.4-13.9	939-940	0.59-0.65	Broadleaf forest, Coniferous forest	Subtropical

The data of mean annual temperature (MAT) and mean annual precipitation (MAP) were extracted from Worldclim dataset with 1 km resolution (https://www.worldclim.org). The data of total nitrogen deposition and acid rain across China (1980-2015) were cited from National Earth System Science Data Center (http://www.geodata.cn) and Yu et al. (2019). The normalized difference vegetation index (NDVI, 2001-2015) was extracted from the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's Terra satellites with a horizontal resolution of 250 m × 250 m (Peters et al., 2016). AL: Mt. Ailao, AS: Mt. Ao, BCW: Mt. Baicaowa, CB: Mt. Changbai, DB: Mt. Dabie, DH: Mt. Dinghu, DX: Daxinganling, DY: Mt. Daiyun, FJ: Mt. Fanjing, GD: Mt. Guandi, GG: Mt. Gongga, HS: Mt. Han, JF: Mt. Jifeng, JG: Mt. Jiugong, JGS: Mt. Jinggang, LG: Mt. Leigong, LJ: Mt. Luoji, LQ: Mt. Longquan, QF: Mt. Qingfengxia, QL: Mt. Qinling, SHB: Mt. Saihanba, SN: Mt. Shennongjia, SWD: Mt. Shiwandashan, SYK: Suyukou, TM: Mt. Tianmu, WG: Mt. Wugong, WYZ: Wuyuezhai, WZ: Mt. Wuzhi, XX: Xiaoxinganling

Table S2 The basic characteristics of soil properties at each mountain

Divisions	Mts.	Horizon	pH	SOC (mg/g)	Al (mg/g)	Ca (mg/g)	K (mg/g)	Na (mg/g)	Ti (mg/g)
East China	DB	O	3.7 - 5.6	2.9 - 28.0	29.8 - 79.5	6.2 - 20.2	9.0 - 22.5	5.0 - 25.3	1.5 - 4.9
		A	3.7 - 5.9	2.9 - 15.6	52.0 - 83.2	6.2 - 18.9	17.9 - 25.7	8.9 - 25.6	2.3 - 5.4
		C	4.7 - 5.9	0.4 - 1.5	68.4 - 95.5	2.5 - 22.5	18.9 - 31.0	6.6 - 29.7	2.2 - 6.5
	DYS	O	-	-	-	-	-	-	-
		A	3.3 - 4.3	2.8 - 22.6	30.9 - 91.9	0.2 - 1.8	9.5 - 22.2	0.6 - 5.7	1.1 - 2.5
		C	3.6 - 4.3	2.1 - 19.7	71.0 - 104.8	0.2 - 0.4	14.1 - 24.6	0.6 - 5.3	1.8 - 2.7
	JGS	O	-	-	-	-	-	-	-
		A	3.2 - 4.9	3.8 - 23.1	26.6 - 117.0	0.4 - 1.2	5.2 - 36.2	0.4 - 1.3	2.4 - 4.4
		C	3.9 - 4.8	0.5 - 23.0	44.5 - 122.4	0.2 - 0.5	8.2 - 39.5	0.4 - 1.2	2.6 - 5.3
	LQ	O	-	-	-	-	-	-	-
		A	4.0 - 6.2	2.3 - 36.0	11.8 - 93.9	0.3 - 3.8	2.9 - 30.6	0.2 - 5.4	0.2 - 3.3
		C	4.1 - 6.5	1.0 - 9.1	48.0 - 103.9	0.2 - 2.8	13.4 - 40.7	0.5 - 7.4	0.7 - 3.7
	TM	O	3.8 - 7.8	2.0 - 12.6	59.3 - 78.0	1.1 - 21.1	16.4 - 31.3	2.0 - 4.0	2.9 - 4.3
		A	3.7 - 7.8	1.6 - 7.1	63.8 - 81.4	1.1 - 21.4	15.8 - 30.8	2.1 - 4.4	3.2 - 4.8
		C	4.5 - 4.7	1.1 - 15.8	81.0 - 83.6	1.3 - 1.3	21.2 - 31.7	3.2 - 3.8	3.7 - 4.6
	WGS	O	-	-	-	-	-	-	-
		A	3.9 - 5.3	1.9 - 18.9	53.9 - 105.1	1.2 - 21.4	11.3 - 30.2	1.9 - 5.6	1.8 - 5.1
		C	3.9 - 5.7	2.3 - 40.7	65.1 - 115.3	1.5 - 23.6	9.6 - 33.4	1.7 - 7.4	1.8 - 5.2
North China	BCW	O	4.3 - 6.7	10.2 - 24.0	29.7 - 55.2	9.0 - 27.4	9.0 - 20.5	4.6 - 14.5	1.8 - 3.2
		A	4.9 - 6.5	5.9 - 17.0	43.5 - 63.2	12.2 - 22.3	13.0 - 22.9	7.8 - 17.0	2.6 - 3.7
		C	5.7 - 7.4	1.9 - 3.7	66.3 - 75.0	5.5 - 19.3	20.2 - 25.5	10.5 - 20.1	3.7 - 4.7
	GD	O	5.4 - 6.7	15.8 - 29.2	26.1 - 49.0	16.2 - 30.6	8.2 - 14.8	4.8 - 9.5	1.5 - 2.9
		A	5.6 - 6.7	8.0 - 17.0	43.1 - 58.0	14.5 - 23.9	13.3 - 17.6	9.1 - 12.9	2.5 - 3.6

		C	6.3 - 7.1	1.0 - 18.0	67.1 - 80.0	8.4 - 16.0	18.4 - 30.1	12.1 - 20.1	3.4 - 4.8
	HS	O	5.5 - 6.8	4.9 - 24.3	34.7 - 54.6	8.0 - 18.5	12.7 - 24.5	6.9 - 13.0	2.3 - 3.3
		A	5.2 - 6.6	2.3 - 17.2	39.6 - 62.4	7.0 - 16.1	16.0 - 25.5	8.9 - 13.9	2.4 - 3.7
		C	5.7 - 6.6	1.5 - 3.8	53.7 - 67.4	6.7 - 10.0	21.9 - 25.5	13.3 - 14.4	2.7 - 4.1
	SHB	O	5.7 - 7.1	14.8 - 25.1	35.4 - 49.4	15.0 - 22.2	11.7 - 17.6	6.2 - 9.2	2.1 - 3.0
		A	5.5 - 6.7	4.1 - 21.8	39.1 - 60.2	8.9 - 19.8	12.7 - 22.0	6.6 - 11.1	2.3 - 3.6
		C	5.4 - 6.4	1.0 - 9.0	48.8 - 68.1	6.1 - 9.0	21.8 - 25.2	11.2 - 14.1	2.3 - 4.4
	WYZ	O	4.1 - 7.1	8.3 - 27.5	30.6 - 58.7	10.5 - 28.4	8.2 - 16.1	4.7 - 12.3	1.8 - 3.7
		A	4.7 - 7.0	4.6 - 21.5	40.7 - 66.1	8.7 - 20.8	10.9 - 19.7	7.0 - 13.0	2.3 - 4.2
		C	5.8 - 6.3	1.9 - 11.2	67.8 - 74.4	6.4 - 13.0	15.0 - 21.1	12.4 - 16.3	4.1 - 4.8
NE China	DX	O	3.4 - 6.7	14.5 - 40.8	6.6 - 55.5	1.9 - 30.7	2.2 - 16.6	1.0 - 16.7	0.5 - 3.6
		A	3.1 - 6.5	4.1 - 42.6	15.6 - 77.9	1.5 - 21.7	4.5 - 23.1	2.7 - 19.5	1.3 - 6.4
		C	3.7 - 6.4	0.6 - 93.2	56.8 - 89.5	1.1 - 9.9	17.0 - 33.8	5.7 - 24.1	2.4 - 7.0
	XX	O	4.6 - 6.4	13.1 - 41.7	9.6 - 53.1	7.8 - 27.5	3.2 - 15.8	1.5 - 9.7	0.5 - 3.3
		A	4.1 - 6.1	4.5 - 24.6	29.3 - 67.5	6.0 - 16.4	7.3 - 20.9	4.2 - 16.2	1.7 - 4.2
		C	4.9 - 6.1	1.2 - 20.6	69.9 - 85.8	5.1 - 13.6	18.2 - 28.8	8.4 - 21.7	3.1 - 5.0
	CB	O	4.8 - 6.3	16.3 - 36.9	17.7 - 52.5	8.6 - 31.1	6.0 - 18.2	3.2 - 12.0	1.0 - 2.9
		A	4.3 - 6.4	7.6 - 25.4	36.1 - 65.6	3.3 - 20.9	10.7 - 29.5	6.1 - 26.1	2.2 - 3.6
		C	4.6 - 5.6	0.5 - 12.5	59.4 - 78.1	3.8 - 8.4	21.6 - 46.4	11.9 - 37.5	2.4 - 5.0
NW China	AS	O	3.7 - 6.3	14.9 - 36.7	16.7 - 52.2	8.8 - 20.7	5.2 - 14.6	2.7 - 9.6	1.0 - 3.2
		A	4.1 - 6.6	7.7 - 31.7	30.2 - 88.0	3.1 - 28.3	7.6 - 30.6	4.8 - 14.6	1.8 - 6.6
		C	4.7 - 6.4	2.3 - 7.3	57.0 - 85.4	2.1 - 24.2	14.2 - 31.4	8.2 - 19.9	2.7 - 8.5
	JF	O	4.2 - 6.3	14.5 - 34.7	18.7 - 48.9	10.8 - 19.7	5.8 - 13.6	2.3 - 5.6	1.1 - 3.0
		A	4.3 - 5.4	8.2 - 29.4	28.0 - 62.4	9.0 - 12.6	7.7 - 16.7	3.5 - 6.5	1.6 - 3.7
		C	5.5 - 6.3	0.8 - 10.8	68.4 - 80.1	4.6 - 7.0	14.8 - 19.3	5.2 - 9.9	4.2 - 4.6
	QF	O	5.7 - 6.4	7.2 - 21.1	22.2 - 59.0	17.2 - 28.4	7.3 - 25.5	3.2 - 20.6	1.2 - 2.5

		A	5.6 - 6.3	8.6 - 16.5	42.0 - 70.5	13.8 - 23.2	12.6 - 23.5	6.3 - 19.0	1.9 - 3.7
		C	6.0 - 6.4	0.3 - 10.8	71.1 - 76.2	9.7 - 15.7	20.2 - 31.3	10.9 - 27.3	2.0 - 4.5
	SYK	O	7.2 - 7.8	6.5 - 10.6	56.8 - 61.3	22.9 - 27.1	18.0 - 19.5	10.4 - 11.8	3.2 - 3.6
		A	7.3 - 7.9	3.9 - 7.1	56.9 - 62.8	21.5 - 30.3	18.3 - 19.8	11.1 - 12.7	3.3 - 3.8
		C	7.5 - 8.2	1.6 - 12.8	62.0 - 70.9	10.4 - 21.0	19.8 - 22.6	12.0 - 13.7	3.6 - 4.3
	QL	O	5.6 - 7.2	12.5 - 35.3	19.7 - 50.3	19.4 - 37.5	6.6 - 15.5	3.1 - 9.2	1.1 - 2.8
		A	5.4 - 7.6	6.2 - 22.8	42.9 - 67.2	11.9 - 47.3	12.5 - 20.4	7.5 - 12.4	2.2 - 4.1
		C	5.6 - 8.1	1.0 - 13.6	63.1 - 88.4	5.7 - 70.6	18.4 - 32.2	10.8 - 27.8	3.1 - 5.4
South China	DH	O	3.7 - 4.1	1.9 - 9.1	37.2 - 57.6	0.1 - 0.9	9.1 - 20.5	0.1 - 0.4	2.4 - 3.9
		A	3.8 - 4.2	1.3 - 4.8	42.4 - 68.7	0.1 - 0.3	9.9 - 24.7	0.1 - 0.5	2.8 - 4.5
		C	4.0 - 4.3	0.8 - 1.9	46.7 - 76.4	0.1 - 0.2	11.3 - 26.7	0.1 - 0.4	3.0 - 4.8
	JG	O	3.5 - 4.4	9.1 - 30.7	27.6 - 69.1	2.0 - 6.7	12.2 - 34.4	0.9 - 14.7	0.9 - 4.3
		A	3.6 - 5.1	3.1 - 10.6	63.6 - 88.7	1.1 - 2.9	15.5 - 44.5	1.4 - 17.2	1.4 - 4.6
		C	4.4 - 5.2	0.6 - 6.4	69.9 - 113.7	0.2 - 4.2	16.8 - 52.0	1.2 - 16.5	0.6 - 5.3
	SN	O	4.1 - 6.6	9.6 - 39.3	12.1 - 52.3	5.4 - 43.5	3.8 - 18.9	1.0 - 5.6	0.7 - 3.6
		A	3.7 - 7.3	3.5 - 34.9	19.0 - 67.6	2.3 - 49.3	5.9 - 33.1	1.3 - 7.2	1.2 - 5.4
		C	4.2 - 6.8	0.6 - 47.4	52.5 - 91.5	0.7 - 11.2	13.5 - 36.0	1.0 - 10.2	3.9 - 6.9
	SWD	O	3.6 - 5.8	5.4 - 12.5	19.8 - 47.8	0.2 – 1.0	1.5 - 12.3	0.1 - 0.5	2.3 - 3.8
		A	3.3 - 7.2	2.3 - 6.9	25.9 - 54.4	0.1 - 0.3	1.6 - 13.1	0.1 - 0.5	2.8 - 4.3
		C	3.7 - 4.3	0.7 - 6.2	29.1 - 66.7	0.1 - 0.2	2.4 - 17.3	0.2 - 0.7	3.4 - 4.8
	WZ	O	-	-	-	-	-	-	-
		A	3.5 - 4.0	2.6 - 9.8	33.7 - 78.2	0.1 - 0.3	4.3 - 18.1	0.3 - 0.4	0.9 - 1.9
		C	4.0 - 4.4	1.5 - 4.0	53.0 - 95.6	0.1 - 0.2	5.4 - 19.1	0.3 - 0.5	1.0 - 1.9
SW China	AL	O	3.6 - 5.5	23.2 - 28.8	17.7 - 56.1	0.4 - 12.7	4.4 - 12.6	0.3 - 0.7	1.3 - 5.4
		A	3.8 - 5.5	12.3 - 13.7	42.1 - 73.1	0.2 - 6.4	6.6 - 19.3	0.3 - 1.2	3.5 - 6.9
		C	4.6 - 5.5	4.1 - 6.9	63.0 - 108.9	0.1 - 0.5	12.8 - 28.6	0.3 - 1.1	3.9 - 8.7

FJ	O	3.9 - 4.7	22.4 - 31.0	19.5 - 53.4	1.0 - 5.6	3.4 - 12.7	0.4 - 2.0	1.2 - 4.0
	A	4.1 - 4.7	9.9 - 17.6	44.9 - 78.2	1.3 - 4.7	5.5 - 14.8	0.8 - 2.3	3.2 - 5.8
	C	4.3 - 4.9	4.5 - 11.3	77.4 - 101.3	1.7 - 5.4	5.9 - 17.7	0.9 - 2.7	5.6 - 7.3
GG	O	3.4 - 6.8	12.5 - 35.0	14.5 - 64.9	8.0 - 36.0	4.6 - 27.8	2.3 - 19.7	0.9 - 7.8
	A	3.6 - 7.2	6.6 - 25.5	45.9 - 74.3	13.5 - 42.1	10.5 - 30.6	4.6 - 20.8	3.0 - 9.8
	C	4.3 - 8.0	0.3 - 3.9	58.2 - 85.4	14.1 - 48.7	10.7 - 55.5	4.5 - 31.1	3.2 - 9.9
LG	O	4.1 - 4.7	30.7 - 33.8	34.6 - 62.9	1.7 - 5.2	7.8 - 12.5	0.7 - 3.5	1.5 - 3.4
	A	4.3 - 4.7	9.5 - 21.2	60.8 - 85.6	0.4 – 2.0	14.6 - 16.4	0.7 - 4.2	2.8 - 4.6
	C	4.6 - 4.8	2.2 - 15.1	79.9 - 105.8	0.1 - 0.5	17.1 - 20.5	0.3 - 5.0	2.6 - 5.5
LJ	O	3.6 - 3.9	26.1 - 31.1	4.6 - 51.1	1.7 - 6.1	1.8 - 14.8	0.4 - 7.1	0.4 - 2.6
	A	3.7 - 5.8	8.7 - 15.4	11.1 - 67.2	1.4 - 5.8	3.5 - 26.8	0.9 - 17.0	1.1 - 4.4
	C	3.8 - 6.3	4.3 - 7.3	49.2 - 78.6	0.6 - 3.9	15.7 - 25.6	1.0 - 21.9	3.0 - 5.3

AL: Mt. Ailao, AS: Mt. Ao, BCW: Mt. Baicaowa, CB: Mt. Changbai, DB: Mt. Dabie, DH: Mt. Dinghu, DX: Daxinganling, DY: Mt. Daiyun, FJ: Mt. Fanjing, GD: Mt. Guandi, GG: Mt. Gongga, HS: Mt. Han, JF: Mt. Jifeng, JG: Mt. Jiugong, JGS: Mt. Jinggang, LG: Mt. Leigong, LJ: Mt. Luoji, LQ: Mt. Longquan, QF: Mt. Qingfengxia, QL: Mt. Qinling, SHB: Mt. Saihanba, SN: Mt. Shennongjia, SWD: Mt. Shiwandashan, SYK: Suyukou, TM: Mt. Tianmu, WG: Mt. Wugong, WYZ: Wuyuezhai, WZ: Mt. Wuzhi, XX: Xiaoxinganling

Table S3 The relationships between trace metals in the soils by Spearman correlation analysis. The bold numbers are defined as the extreme significance of the correlation between the metals when the correlation coefficient higher than 0.6 ($r > 0.6$).

	Cd	Cr	Cu	Ni	Pb	Zn
All horizons						
Cd	1.00					
Cr	-0.118*	1.00				
Cu	0.442*	0.498*	1.00			
Ni	0.100*	**0.814***	**0.732***	1.00		
Pb	**0.702***	-0.079	0.330*	0.019	1.00	
Zn	**0.605***	0.040	0.515*	0.344*	0.487*	1.00
O horizon						
Cd	1.00					
Cr	-0.035	1.00				
Cu	0.508*	0.422*	1.00			
Ni	0.181*	**0.743***	**0.659***	1.00		
Pb	**0.752***	0.144*	0.534*	0.209**	1.00	
Zn	**0.601***	-0.009	0.510*	0.321**	0.471**	1.00
A horizon						
Cd	1.00					
Cr	0.129*	1.00				
Cu	0.504*	0.549*	1.00			
Ni	0.301*	**0.790***	**0.784***	1.00		
Pb	**0.699***	0.011	0.287*	0.055	1.00	
Zn	0.591*	0.184*	0.561*	0.470*	0.454*	1.00
C horizon						
Cd	1.00					
Cr	0.274*	1.00				
Cu	0.487*	**0.646***	1.00			
Ni	0.384*	**0.833***	**0.813***	1.00		
Pb	0.390*	0.027	0.192*	0.035	1.00	
Zn	**0.615***	0.181*	0.474*	0.408*	0.353*	1.00

* the significant level at the 0.01 level.

Figure S1 The spatial distribution of trace metals (mean, mg/kg) in the mountain soils across China. The figure was mapped by the R 4.0.3 software.

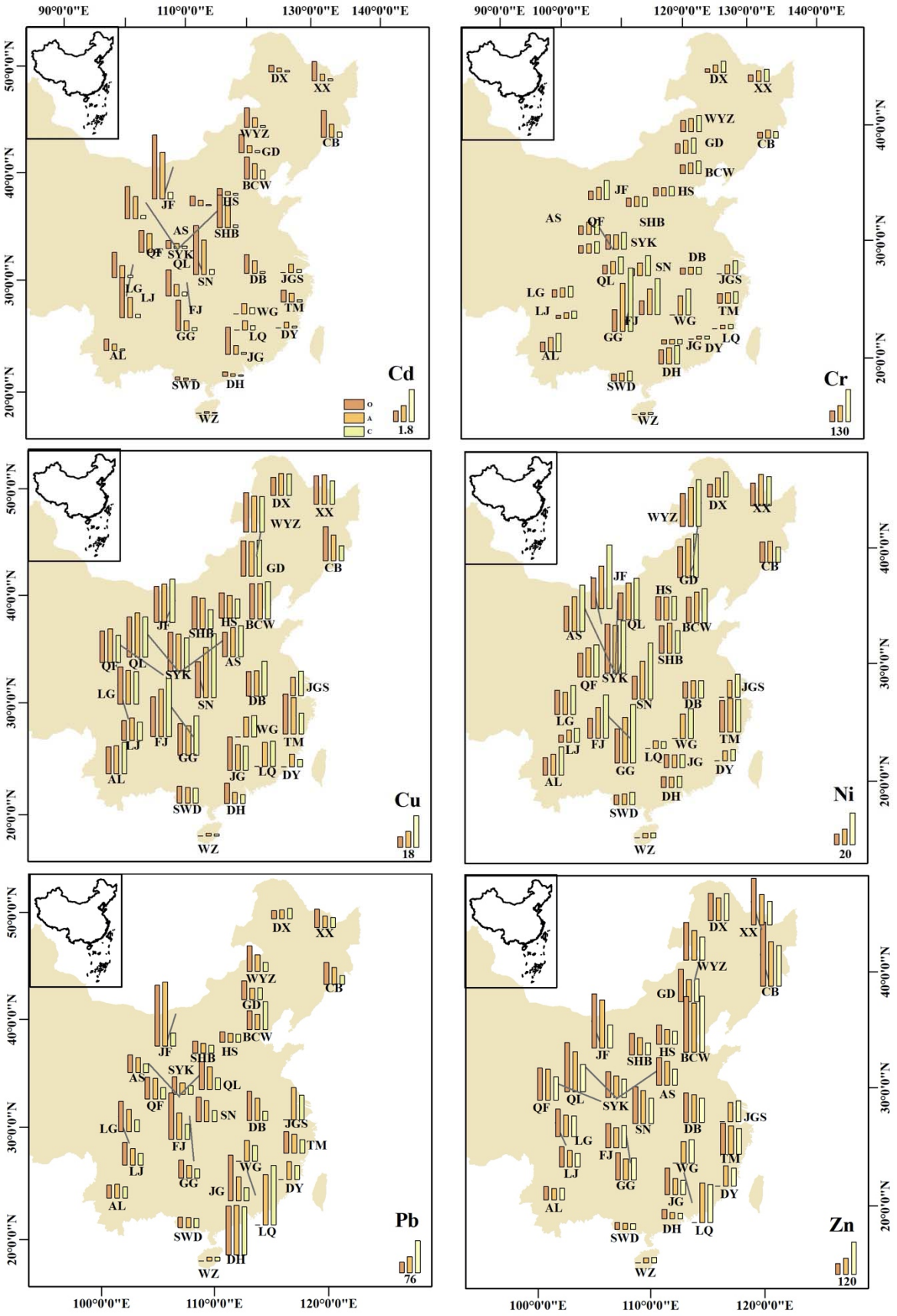
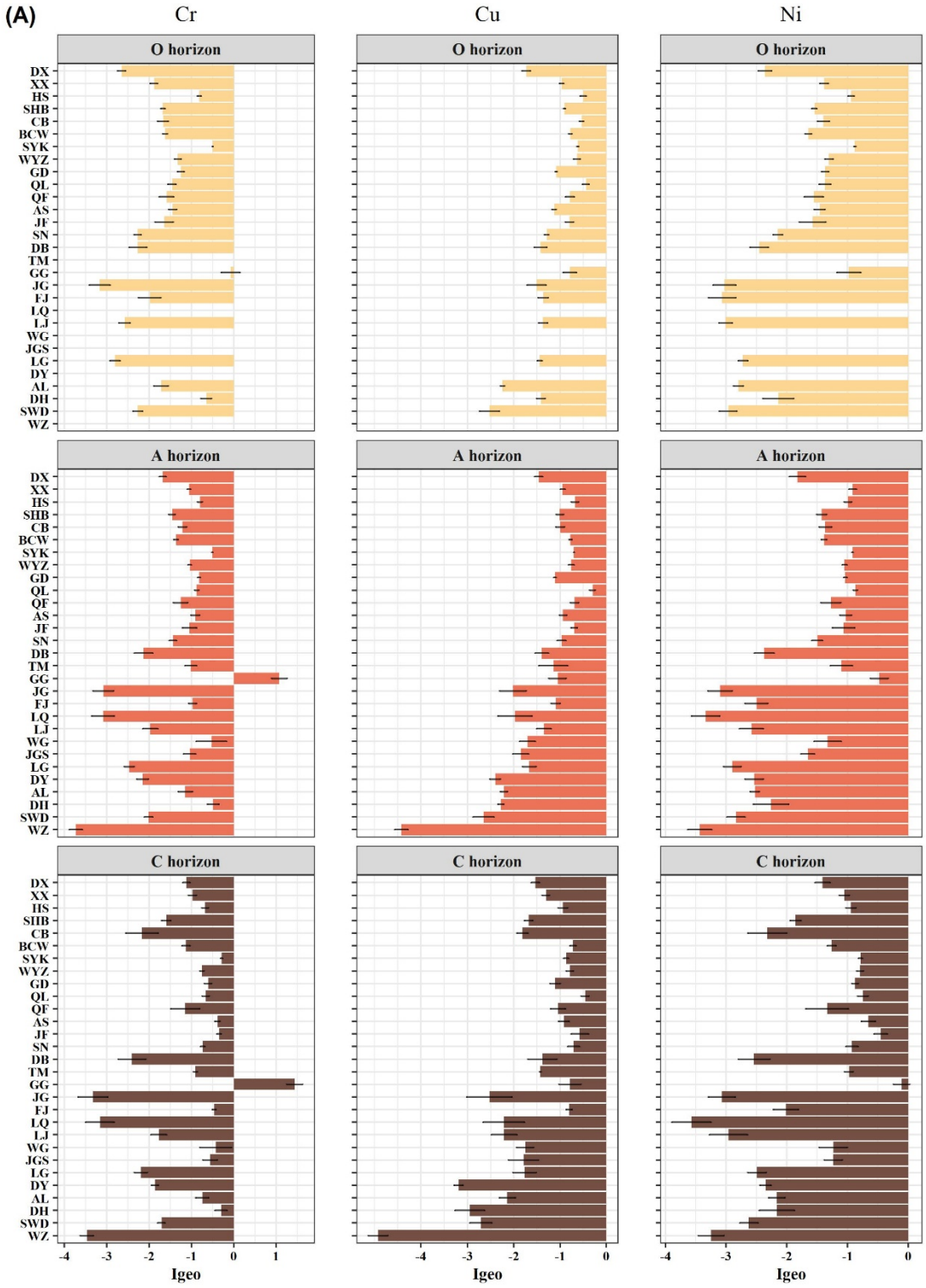


Figure S2 The contamination characteristics (mean ± standard error) of Cr, Cu and Ni with depth in each mountain indicated by the geoaccumulation index (I_{geo}). The values of I_{geo} in Figure S2A were calculated by the background of trace metals in each province the mountain located, and the values in Figure S2B were calculated by the local background concentrations of trace metals in the C horizon. The sequence of the mountains from up to down in the figure was from north to south China according to the latitude. The specific mountain names can be found in Table S1.



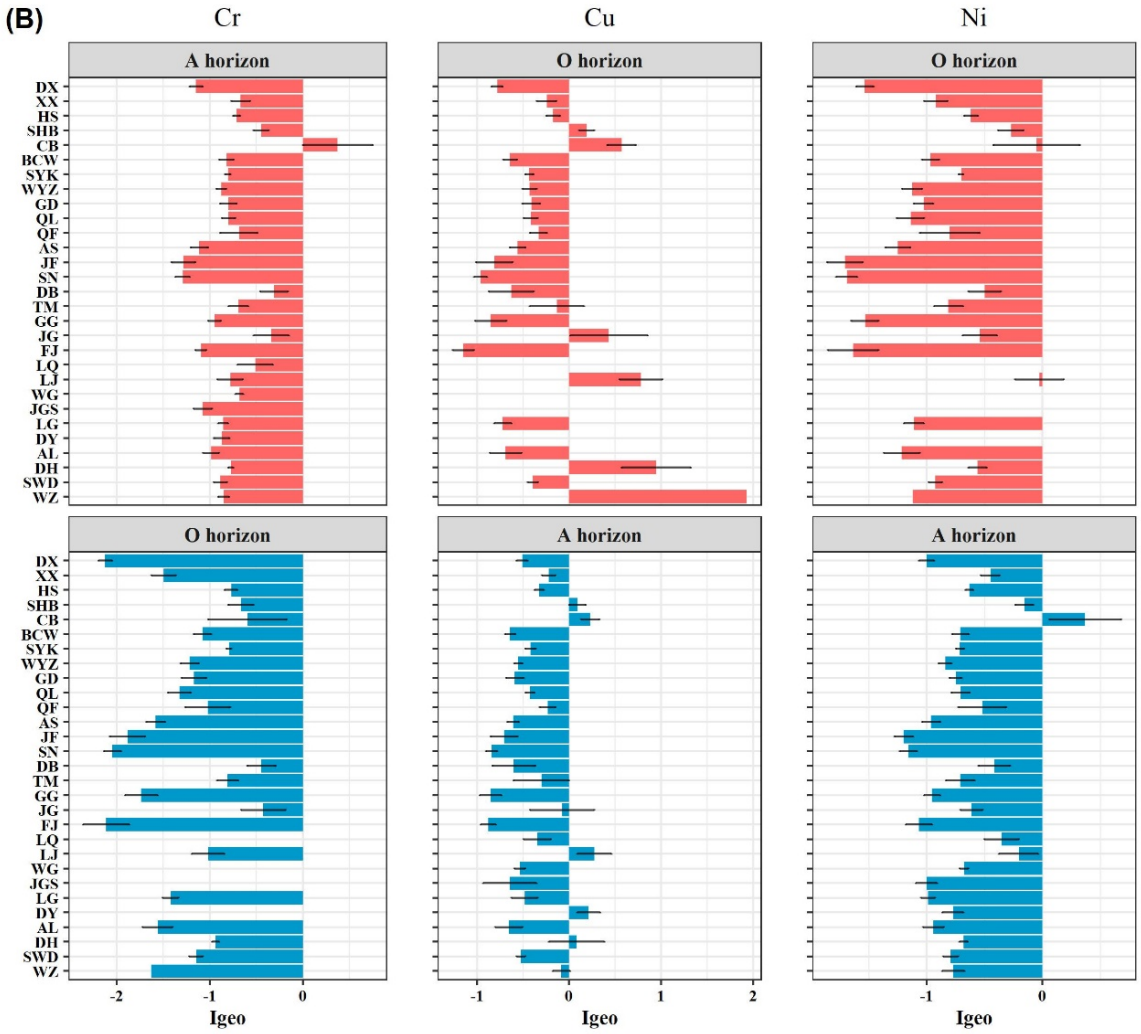

(B)
Cr
Cu
Ni
A horizon
O horizon
O horizon
O horizon
A horizon
A horizon
DX
XX
HS
SHB
CB
BCW
SYK
WYZ
GD
QL
QF
AS
JF
SN
DB
TM
GG
JG
FJ
LQ
LJ
WG
JGS
LG
DY
AL
DH
SWD
WZ
-2
-1
0
-1
0
1
2
-1
0
Igeo
Igeo
Igeo

Figure S3 The enrichment characteristics (mean ± standard error) of Cr, Cu and Ni in the O and A horizons of each mountain indicated by the index of enrichment factor (*EF*). Note the numbers in Y axis that indicate the enrichment level of the metal according to the classification standard of the *EF*. The sequence of the mountains from left to right in the figure was from south to north China according to the latitude. The specific mountain names can be found in Table S1.

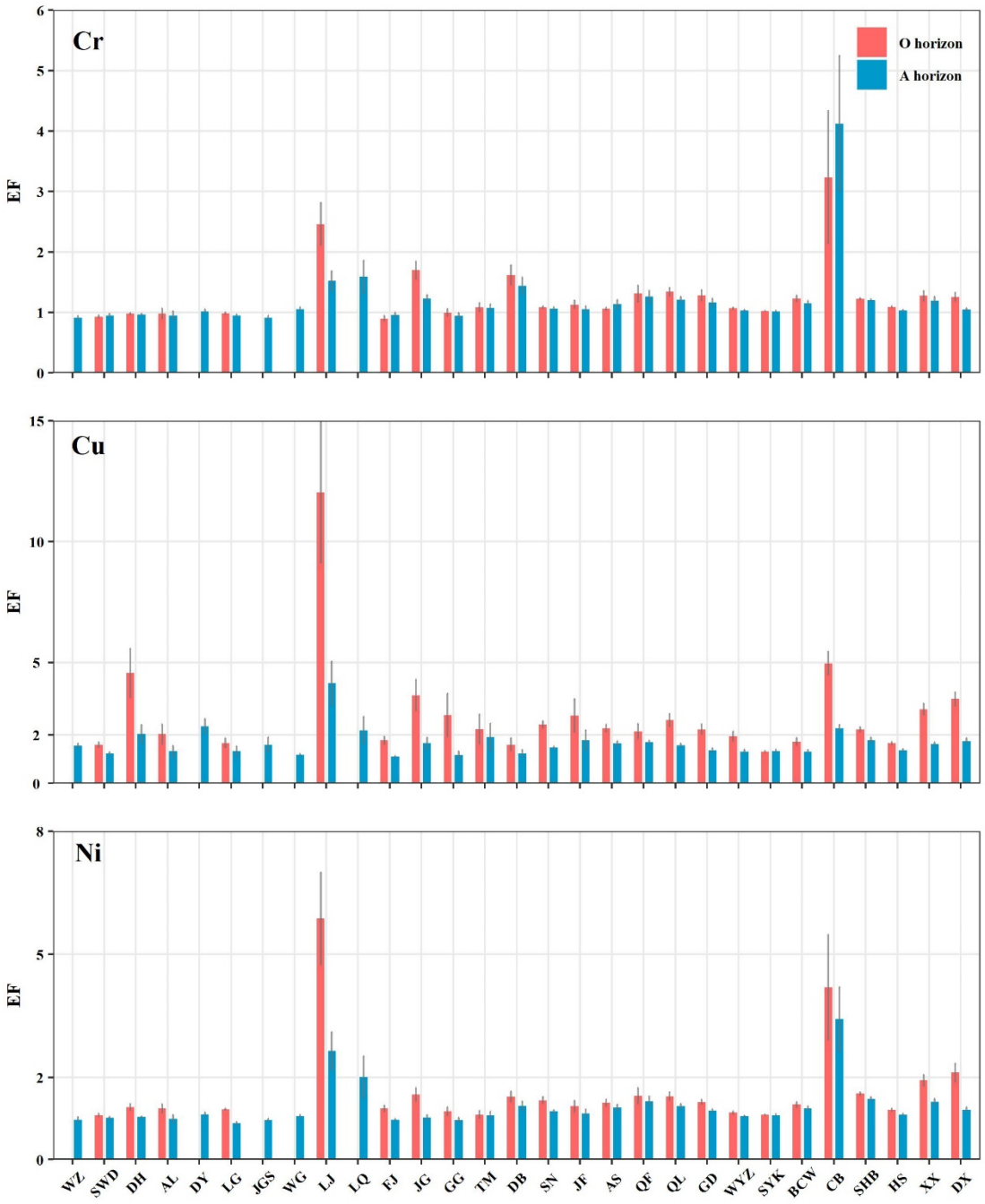


Figure S4 The ratios of $^{206}Pb/^{207}Pb$ in the soils of each mountain. The grey area represents the main range of the ratios in the Chinese ores and fuel combustion emissions, and the values below the area indicate that the sources of Pb in the soils may be from other anthropogenic contributions such as aerosols and dusts, vehicle emissions, or special local minerals (e.g., CB, BCW and DB in the C horizon). The specific ratios of $^{206}Pb/^{207}Pb$ from anthropogenic sources can be found in Table 4.

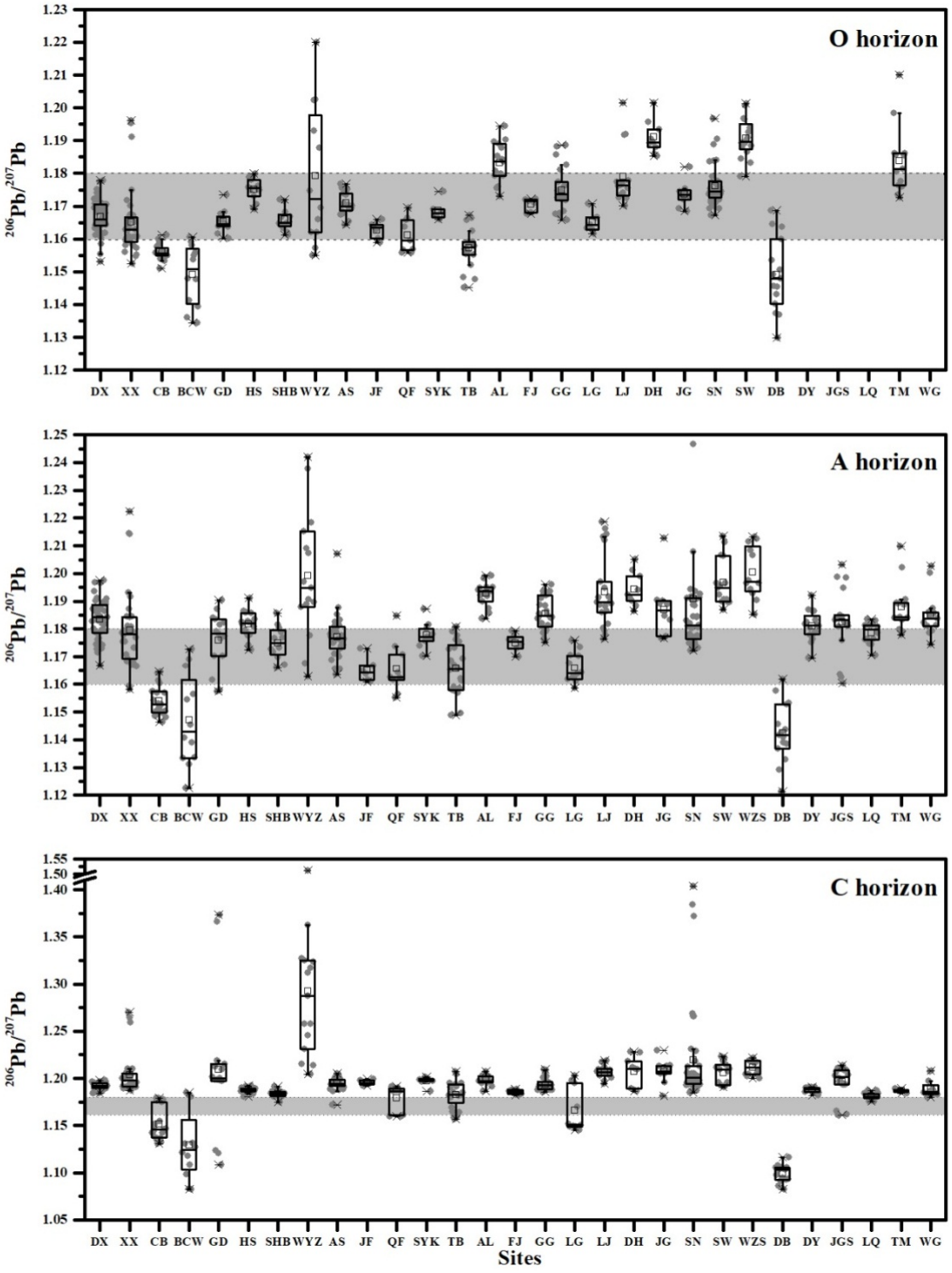
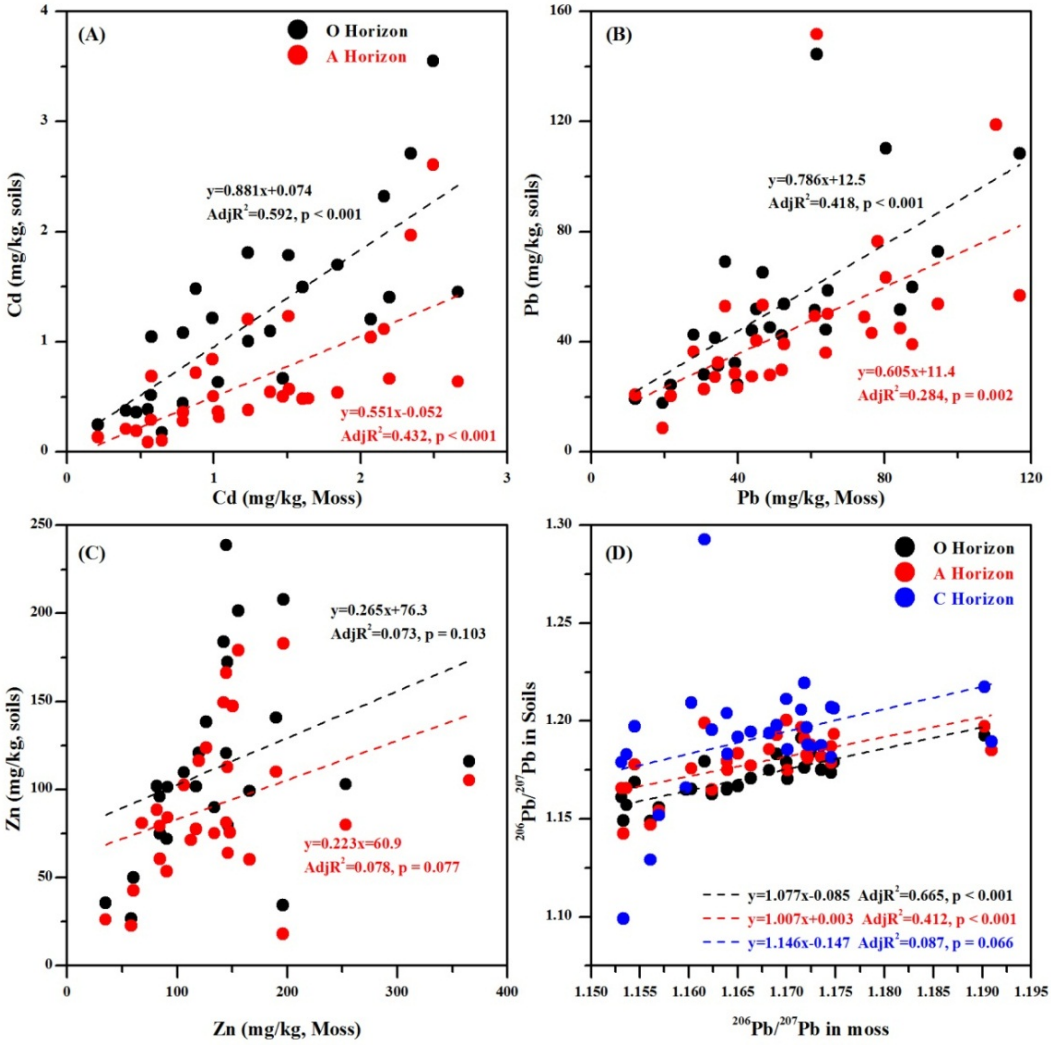


Figure S5 Relationships of trace metal concentrations (A-C) and the ratios of $^{206}Pb/^{207}Pb$ (D) in the O and A horizons with those in the mosses. The data of trace metal concentrations and the ratios of $^{206}Pb/^{207}Pb$ in the mosses were taken from Bing et al. (2019).



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