Estimating the bioaccessibility of atmospheric trace elements within the Athabasca Bituminous Sands region using the acid soluble ash fraction of *Sphagnum* moss

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Supporting Information

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Number of tables: 4
Number of figures: 23

Presentation of Geochemical Data

This study generated a considerable volume of geochemical data: mosses were collected in triplicate during 3 seasons from a total of 38 peatlands, and both bulk samples and the acid soluble ash (ASA) fraction were analyzed for 5 major and 36 trace elements (TEs). For the convenience of the reader, the Supporting Information includes: i) quality assurance/control tables; ii) a set of maps for the samples collected in 2015, showing the spatial variation in TE concentrations for the bulk moss and ASA fractions; iii) bar graphs summarizing the ranges of concentrations (total and ASA) for industrial and reference sites for 2015, 2019, and 2020, and average TE concentrations for 2020; iv) statistical analyses of the data (i.e. correlograms of all elements and linear regressions of TE concentrations versus Y); v) box plots to evaluate temporal trends in TE concentrations; and vi) enrichment factors.

Enrichment factors were calculated as the ratio of the concentrations of a given TE to that of yttrium (Y), a conservative lithophile element, normalized to the corresponding ratio in the Upper Continental Crust (UCC).[1]

$$EF = \frac{[TE/Y]_{sample}}{[TE/Y]_{UCC}}$$

Table S1. Limit of detection (LOD), limit of quantification (LOQ), method detection limit (MDL), and standard reference materials (SRMs) recoveries for **total** concentrations analyzed using **ICP-MS**.

			NIST 1643f Freshwater				
	LOD	LOQ	Certified value	Measured value*10 (mean, n=7)	Recovery	Measured value*100 (mean, n=7)	Recovery
	µg/L	µg/L	µg/L	µg/L	%	µg/L	%
Ag	0.000	0.001	0.9703	0.905	93	0.936	96
As	0.002	0.008	57.42	54.2	94	54.2	94
Ba	0.001	0.004	518.2	492	95	513	99
Be	0.000	0.002	13.67	12.4	90	12.9	94
Cd	0.000	0.001	5.89	5.61	95	5.75	98
Ce	0.000	0.000					
Co	0.000	0.000	25.3	23.2	92	23.6	93
Cr	0.000	0.006	18.5	16.5	89	18.2	98
Cs	0.000	0.000					
Cu	0.001	0.010	21.66	19.2	89	21.0	97
Dy	0.000	0.000					
Er	0.000	0.000					
Eu	0.000	0.000					
Fe	0.014	0.066	93.44	88.8	95	94.6	101
Ga	0.000	0.001					
Gd	0.000	0.000					
Ho	0.000	0.000					
La	0.000	0.000					
Li	0.000	0.002	16.59	14.7	89	15.7	95
Lu	0.000	0.000					
Mn	0.001	0.003	37.14	41.0	110	43.0	116
Mo	0.000	0.001	115.3	102	89	105	92
Nd	0.000	0.000					
Ni	0.002	0.025	59.8	54.5	91	55.7	93
Pb	0.000	0.000	18.488	16.8	91	17.9	97
Pr	0.000	0.000					
Rb	0.000	0.001	12.64	12.0	95	12.3	97
Re	0.000	0.000					
Sb	0.002	0.009	55.45	57.6	104	58.8	106
Se	0.024	0.112	11.7	11.0	94	11.3	97
Sm	0.000	0.000					
Sr	0.001	0.004	314	300	96	312	99
Tb	0.000	0.000					
Th	0.000	0.000					
Tl	0.000	0.000	6.892	6.16	89	6.52	95
Tm	0.000	0.000					
U	0.000	0.000					
V	0.000	0.001	36.07	33.3	92	34.6	96
Y	0.000	0.000					
Yb	0.000	0.000					
Zn	0.007	0.056	74.4	71.2	96	71.9	97

Note: NIST = National Institute of Standards and Technology; SPS = Spectrapure Standards AS; FFRI = Finnish Forest Research Institute.

Table S1. Limit of detection (LOD), limit of quantification (LOQ), method detection limit (MDL), and standard reference materials (SRMs) recoveries for **total** concentrations analyzed using **ICP-MS** (continued).

	SPS-SW2 Surface Water				
	Certified value	Measured value*100 (mean, n=7)	Recovery	Measured value*500 (mean, n=7)	Recovery
	µg/L	µg/L	%	µg/L	%
Ag					
As	50	46.3	93	47.0	94
Ba	250	239	96	243	97
Be					
Cd	2.5	2.44	98	2.37	95
Ce	2.5	2.44	98	2.48	99
Co	10	9.17	92	9.11	91
Cr	10	9.03	90	9.12	91
Cs					
Cu	100	91.8	92	92.9	93
Dy	2.5	2.44	98	2.43	97
Er	2.5	2.42	97	2.43	97
Eu	2.5	2.43	97	2.43	97
Fe	100	94.0	94	92.4	92
Ga					
Gd	2.5	2.44	98	2.40	96
Ho	2.5	2.42	97	2.47	99
La	2.5	2.41	96	2.39	96
Li					
Lu	2.5	2.38	95	2.38	95
Mn	50	56.7	113	57.1	114
Mo	50	44.1	88	45.0	90
Nd	2.5	2.43	97	2.44	98
Ni	50	46.3	93	46.6	93
Pb	25	22.9	92	22.9	92
Pr	2.5	2.43	97	2.44	98
Rb	50	47.3	95	45.9	92
Re					
Sb					
Se	10	12.4	124	14.0	140
Sm	2.5	2.55	102	2.51	101
Sr	250	239	96	244	98
Tb	2.5	2.49	99	2.47	99
Th	2.5	2.36	94	2.30	92
Tl	2.5	2.28	91	2.30	92
Tm	2.5	2.44	98	2.45	98
U	2.5	2.35	94	2.52	101
V	50	46.4	93	46.9	94
Y	2.5	2.39	96	2.33	93
Yb	2.5	2.37	95	2.37	95
Zn	100	96.2	96	91.6	92

Note: FFRI = Finnish Forest Research Institute; NIST = National Institute of Standards and Technology; SPS = Spectrapure Standards AS.

Table S1. Limit of detection (LOD), limit of quantification (LOQ), method detection limit (MDL), and standard reference materials (SRMs) recoveries for **total** concentrations analyzed using **ICP-MS** (continued).

		NIST 1515 Apple Leaves			FFRI-Moss-1343		
	MDL	Certified value	Measured value (mean, n=6)	Recovery	Recommended value	Measured value (mean, n=6)	Recovery
	µg/L	µg/g	µg/g	%	µg/g	µg/g	%
Ag	0.18				0.027	0.0229	85
As	70.78				0.105	0.768	732
Ba	4.35	**48.8**	49.4	101	13.7	14.1	103
Be	0.05						
Cd	0.07	**0.0132**	0.0149	113	0.106	0.119	112
Ce	0.16	3	3.35	112	0.25	0.271	108
Co	0.96	0.09	0.102	114	0.115	0.108	94
Cr	7.09	0.3	0.360	120	0.67	0.740	110
Cs	1.73				0.189	0.177	94
Cu	7.10	**5.69**	5.77	101	3.76	3.45	92
Dy	0.02						
Er	0.00						
Eu	0.00	0.2	0.264	132			
Fe	451.52	**82.7**	89.4	108	138	166	120
Ga	0.07				0.084	0.118	140
Gd	0.01	3	3.16	105			
Ho	0.00						
La	0.06	20	21.1	106	0.131	0.139	106
Li	3.38						
Lu	0.00						
Mn	616.41	**54.1**	62.4	115	535	566	106
Mo	0.82	**0.095**	0.0958	101	0.1	0.0563	56
Nd	0.12	17	17.0	100			
Ni	32.36	**0.936**	1.05	112	0.95	1.07	112
Pb	0.53	**0.47**	0.407	87	3.33	3.54	
Pr	0.01						
Rb	0.70	**10.2**	9.93	97	19.5	18.8	96
Re	0.00						
Sb	0.63	0.013	0.0163	125	0.052	0.0532	102
Se	17.86				0.115	0.132	115
Sm	0.09	3	3.06	102			
Sr	38.71	**25.1**	26.6	106	4.64	4.70	101
Tb	0.00	0.4	0.391	98			
Th	0.02	0.03	0.0280	93	0.027	0.0341	
Tl	0.03				0.085	0.0473	
Tm	0.00						
U	0.19	0.006	0.00844	141	0.085	0.0152	
V	0.38	**0.254**	0.236	93	1.19	1.18	99
Y	0.06				0.067	0.0782	117
Yb	0.00	0.3	0.194	65			
Zn	10.77	**12.45**	15.0	120	25.4	28.0	110

Note: NIST = National Institute of Standards and Technology; SPS = Spectrapure Standards AS; FFRI = Finnish Forest Research Institute; bold values correspond to certified concentrations; values in red indicate low recoveries, below 80%.

Table S2. Limit of detection (LOD), limit of quantification (LOQ), method detection limit (MDL), and standard reference materials (SRMs) recoveries for concentrations in **acid soluble ash** (ASA) analyzed using **ICP-MS**.

				NIST 1643f Freshwater				
	LOD	LOQ	MDL	Certified value	Measured value*10 (mean, n=7)	Recovery	Measured value*100 (mean, n=7)	Recovery
	µg/L	µg/L	µg/L	µg/L	µg/L	%	µg/L	%
Ag	0.000	0.000	0.001	0.9703	0.958	99	1.01	104
As	0.003	0.011	<LOQ	57.42	57.2	100	58.5	102
Ba	0.000	0.003	0.059	518.2	500	97	524	101
Be	0.000	0.001	<LOD	13.67	13.5	99	13.7	100
Cd	0.000	0.000	<LOQ	5.89	5.79	98	6.10	104
Ce	0.000	0.000	0.006					
Co	0.000	0.000	0.001	25.3	25.7	102	26.5	105
Cr	0.001	0.007	0.033	18.5	18.2	98	19.3	104
Cs	0.000	0.000	<LOQ					
Cu	0.003	0.020	0.456	21.66	22.6	104	25.1	116
Dy	0.000	0.000	0.000					
Er	0.000	0.000	<LOQ					
Eu	0.000	0.000	0.000					
Fe	0.004	0.033	0.452	93.44	97.8	105	102	109
Ga	0.000	0.001	0.005					
Gd	0.000	0.000	0.019					
Ho	0.000	0.000	0.001					
La	0.000	0.000	0.001					
Li	0.000	0.002	0.007	16.59	16.5	99	16.9	102
Lu	0.000	0.000	<LOQ					
Mn	0.001	0.005	0.158	37.14	35.6	96	39.4	106
Mo	0.000	0.001	0.006	115.3	118	103	122	106
Nd	0.000	0.000	0.028					
Ni	0.002	0.014	0.102	59.8	60.6	101	62.6	105
Pb	0.000	0.001	0.004	18.488	17.8	96	19.4	105
Pr	0.000	0.000	0.007					
Rb	0.000	0.002	0.005	12.64	12.5	99	12.6	100
Re	0.000	0.000	<LOD					
Sb	0.000	0.001	0.002	55.45	53.6	97	56.2	101
Se	0.007	0.043	<LOQ	11.7	12.1	103	12.7	108
Sm	0.000	0.000	<LOQ					
Sr	0.001	0.004	0.094	314	314	100	326	104
Tb	0.000	0.000	0.000					
Th	0.000	0.000	<LOQ					
Tl	0.000	0.000	<LOD	6.892	6.57	95	7.05	102
Tm	0.000	0.000	0.000					
U	0.000	0.000	0.001					
V	0.000	0.001	0.002	36.07	35.2	98	37.0	103
Y	0.000	0.000	0.001					
Yb	0.000	0.000	0.000					
Zn	0.011	0.102	2.234	74.4	79.1	106	88.6	119

Note: NIST = National Institute of Standards and Technology; SPS = Spectrapure Standards AS.

Table S2. Limit of detection (LOD), limit of quantification (LOQ), method detection limit (MDL), and standard reference materials (SRMs) recoveries for concentrations in acid soluble ash (ASA) analyzed using **ICP-MS** (Continued).

	SPS-SW2 Surface Water				
	Certified value	Measured value*100 (mean, n=7)	Recovery	Measured value*500 (mean, n=7)	Recovery
	µg/L	µg/L	%	µg/L	%
Ag					
As	50	49.8	100	52.1	104
Ba	250	241	97	245	98
Be					
Cd	2.5	2.49	99	2.52	101
Ce	2.5	2.65	106	2.67	107
Co	10	10.2	102	10.1	101
Cr	10	9.93	99	10.4	104
Cs					
Cu	100	107	108	129	130
Dy	2.5	2.57	103	2.54	102
Er	2.5	2.59	104	2.62	105
Eu	2.5	2.59	104	2.58	103
Fe	100	104	104	107	107
Ga					
Gd	2.5	2.59	104	2.56	102
Ho	2.5	2.54	101	2.51	100
La	2.5	2.58	103	2.57	103
Li					
Lu	2.5	2.51	100	2.45	98
Mn	50	49.6	99	56.4	113
Mo	50	50.4	101	52.1	104
Nd	2.5	2.60	104	2.56	102
Ni	50	51.5	103	51.5	103
Pb	25	24.3	97	24.1	97
Pr	2.5	2.60	104	2.60	104
Rb	50	47.8	96	46.8	94
Re					
Sb					
Se	10	15.3	152	18.8	188
Sm	2.5	2.70	108	2.65	106
Sr	250	246	99	252	101
Tb	2.5	2.57	103	2.54	102
Th	2.5	2.59	104	2.51	100
Tl	2.5	2.42	97	2.40	96
Tm	2.5	2.55	102	2.55	102
U	2.5	2.46	98	2.58	103
V	50	48.8	98	48.9	98
Y	2.5	2.70	108	2.66	107
Yb	2.5	2.53	101	2.53	101
Zn	100	120	121	133	134

Note: NIST = National Institute of Standards and Technology; SPS = Spectrapure Standards AS.

Table S3. Limit of detection (LOD), limit of quantification (LOQ), method detection limit (MDL), and standard reference materials (SRMs) recoveries for **total** concentrations analyzed using **ICP-OES**.

				NIST 1515 Apple Leaves			FFRI-Moss-1343		
	LOD	LOQ	MDL	Certified value	Measured value (mean, n=6)	Recovery	Recommended value	Measured value (mean, n=6)	Recovery
	mg/L	mg/L	mg/L	mg/kg	mg/kg	%	mg/kg	mg/kg	%
Al	0.004	0.013	<LOD	284.5	232	81	169	224	132
Ca	0.004	0.012	<LOD	15250	12700	83	1920	1830	95
Fe	0.001	0.005	<LOD	82.7	68.8	83	138	150	109
K	0.083	0.264	<LOD	16080	13700	85	4510	4700	104
Mg	0.005	0.018	<LOD	2710	2340	86	755	719	95
Mn	0.001	0.001	0.444	54.1	50.7	94	535	466	87
P	0.012	0.035	<LOD	1593	1360	86	1050	911	87
S	0.009	0.012	<LOD		1630		830	789	95

Note: NIST = National Institute of Standards and Technology; NRCC = National Research Council of Canada.

Table S4. Limit of detection (LOD), limit of quantification (LOQ), method detection limit (MDL), and standard reference materials (SRM) recoveries for concentrations in **acid soluble ash** (ASA) analyzed using **ICP-OES**.

				NIST 1643f Freshwater			**NRCC SLRS-6 River Water**		
	LOD	LOQ	MDL	Certified value	Measured value*50 (mean, n=2)	Recovery	Certified value	Measured value*50 (mean, n=2)	Recovery
	mg/L	mg/L	mg/L	mg/L	mg/L	%	mg/L	mg/L	%
Al	0.004	0.013	<LOD	0.13	0.145	109	0.03	<LOQ	
Ca	0.004	0.012	<LOD	29.14	28.5	98	8.76	8.33	95
Fe	0.001	0.005	<LOD	0.09	0.0975	105	0.08	0.0850	101
K	0.083	0.264	<LOD	1.91	1.84	96	0.65	<LOQ	
Mg	0.005	0.018	<LOD	7.38	7.63	103	2.13	2.19	103
Mn	0.001	0.001	<LOD	0.04	0.0400	109	0.00	<LOD	
P	0.012	0.035	<LOD						
S	0.009	0.012	0.187					1.76	

Note: NIST = National Institute of Standards and Technology; NRCC = National Research Council of Canada.

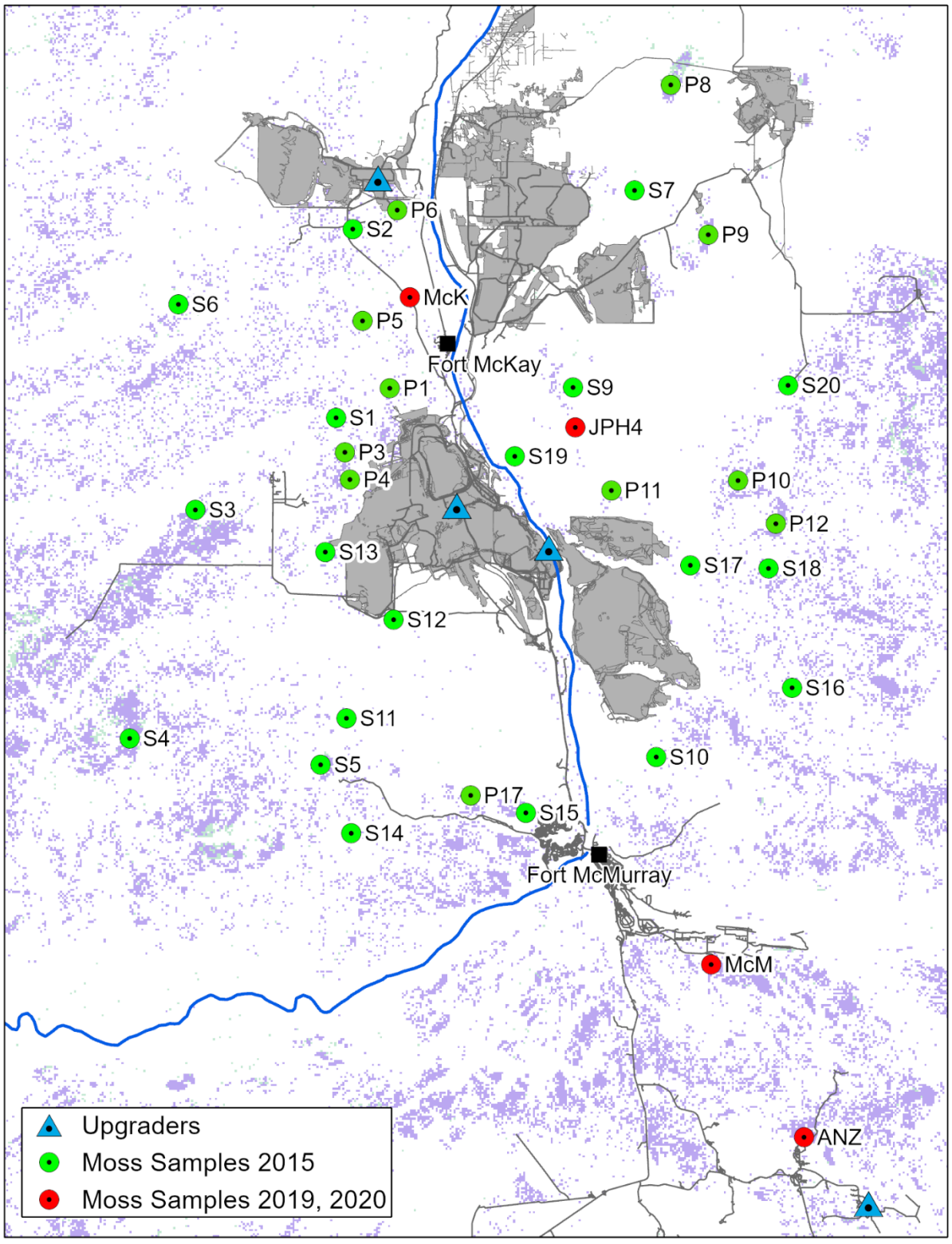

Fig. S1. Moss sampling sites within the Athabasca Bituminous Sands Regions in fall 2015, 2019, and 2020.

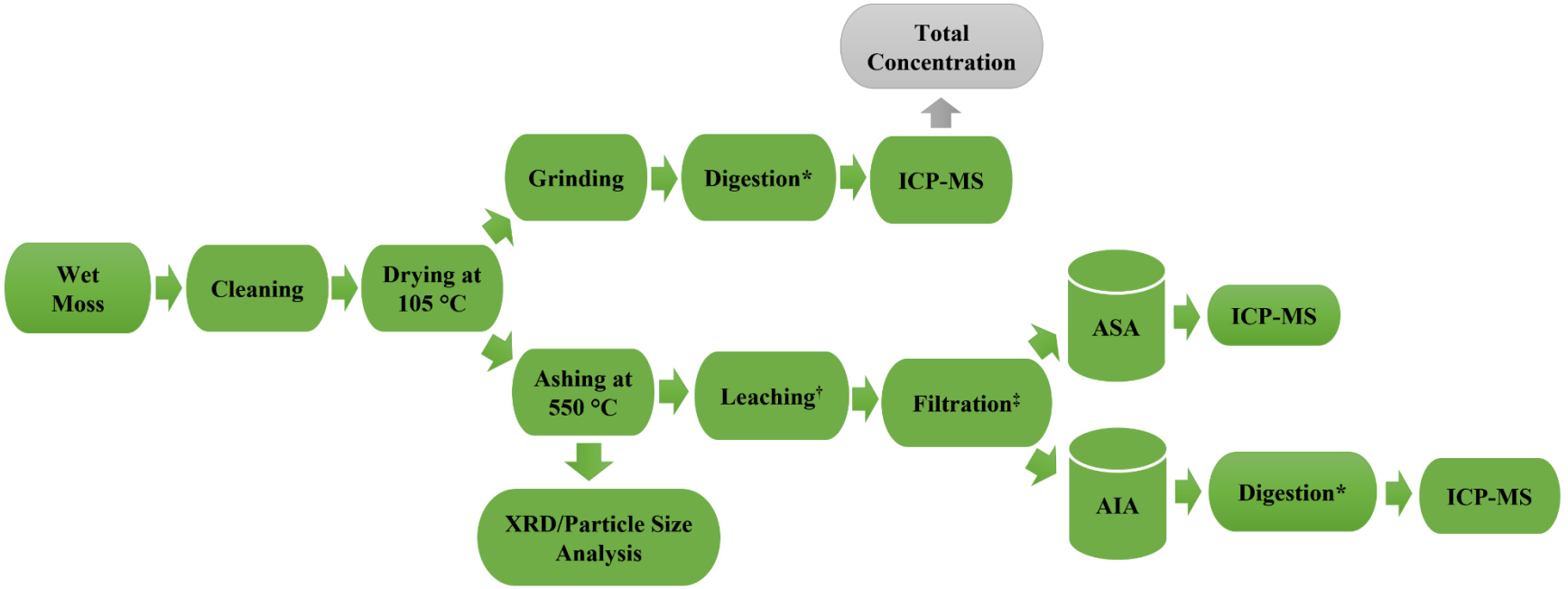

Fig. S2. Schematic flow of sample treatments.
*Digestion: Reaction with concentrated HNO_3 (sub-boiled twice) and HBF_4 for 80 min in a microwave under high temperature and pressure.
†Leaching: Reaction with 2% HNO_3 for 15 min under room temperature and pressure.
‡Filtration: Polypropylene syringes and 0.45 μm polytetrafluoroethylene filter membranes, with polypropylene filter holders and silicone gaskets for sealing. All were acid-cleaned before use.
Note: ASA = Acid Soluble Ash. AIA = Acid Insoluble Ash.

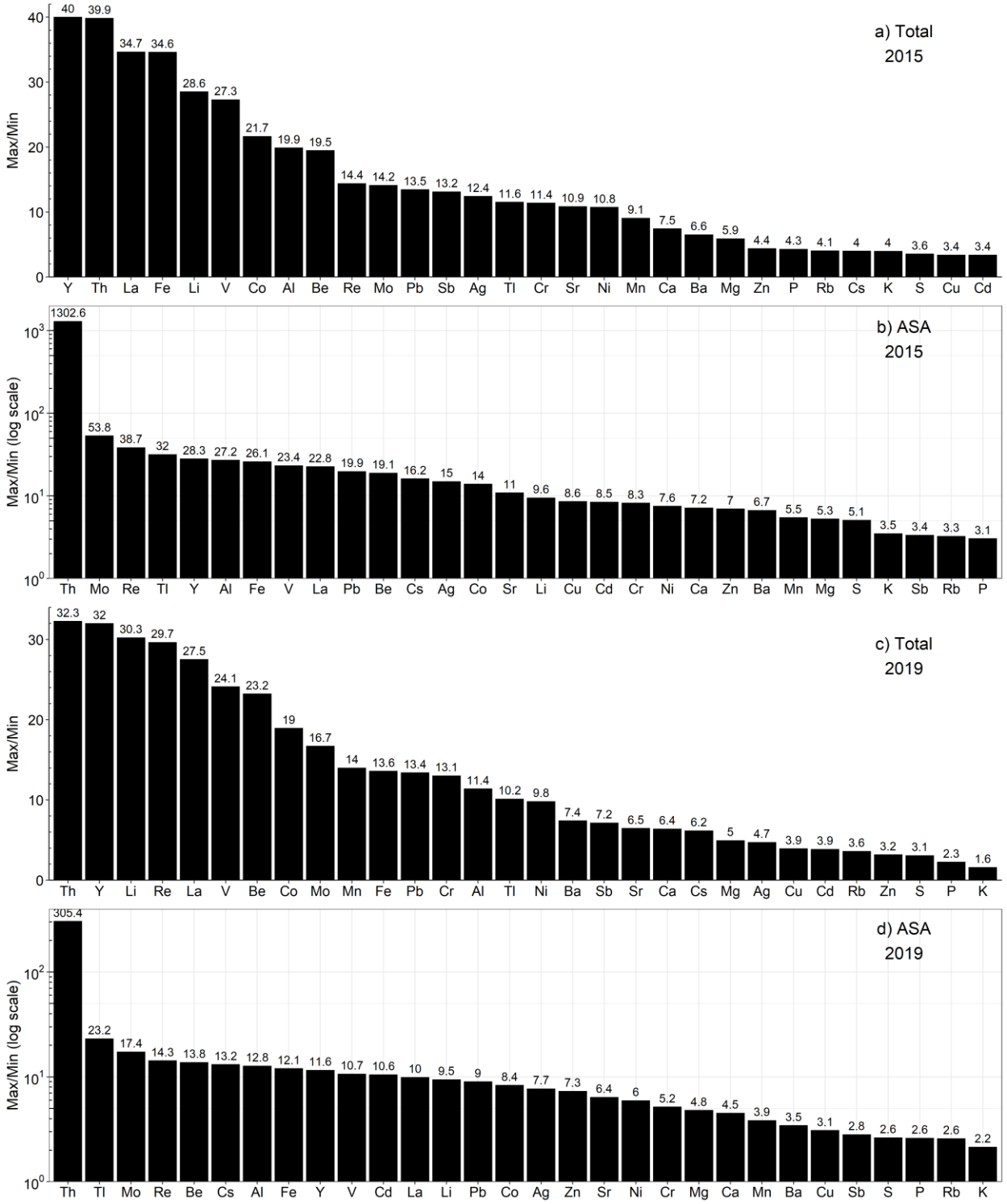

Fig. S3. Ratios of maximum (Max) to minimum (Min) element concentrations out of bulk moss and acid soluble ash (ASA) of *Sphagnum* mosses collected in fall 2015 (sites EINP and WAG were excluded) and 2019.

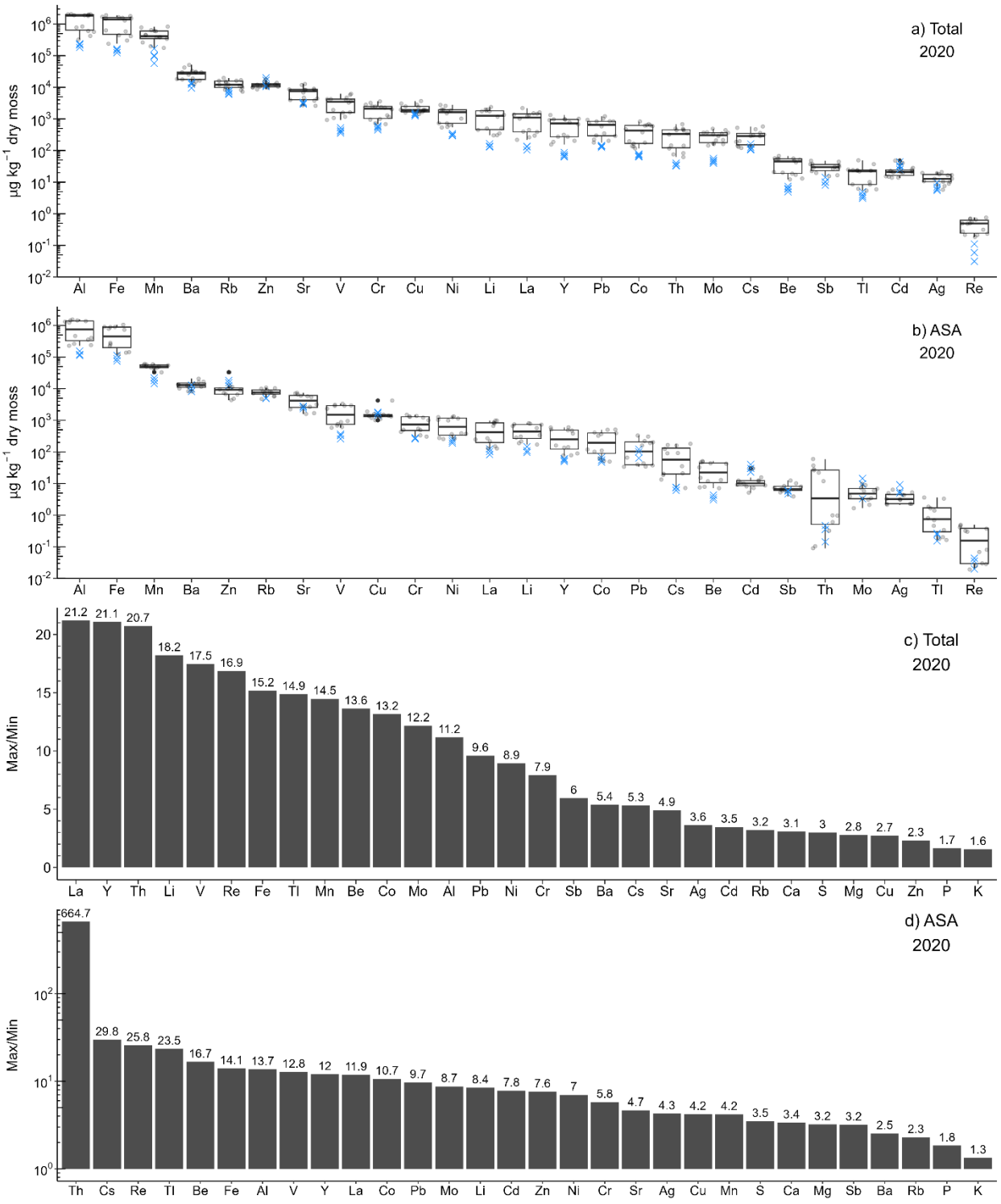

Fig. S4. Box plots of element concentrations and element ratios for samples collected in fall 2020. a) and b) Boxplots of elemental concentrations for bulk moss (i.e. total) and acid soluble ash (ASA) at industrial sites. Elemental concentrations in samples from the reference site (UTK) are indicated in blue using the multiplication sign "x". All values represent concentrations (µg kg^{-1}) in dry moss. c) and d) Ratios of maximum (Max) to minimum (Min) elemental concentrations for bulk moss and ASA.

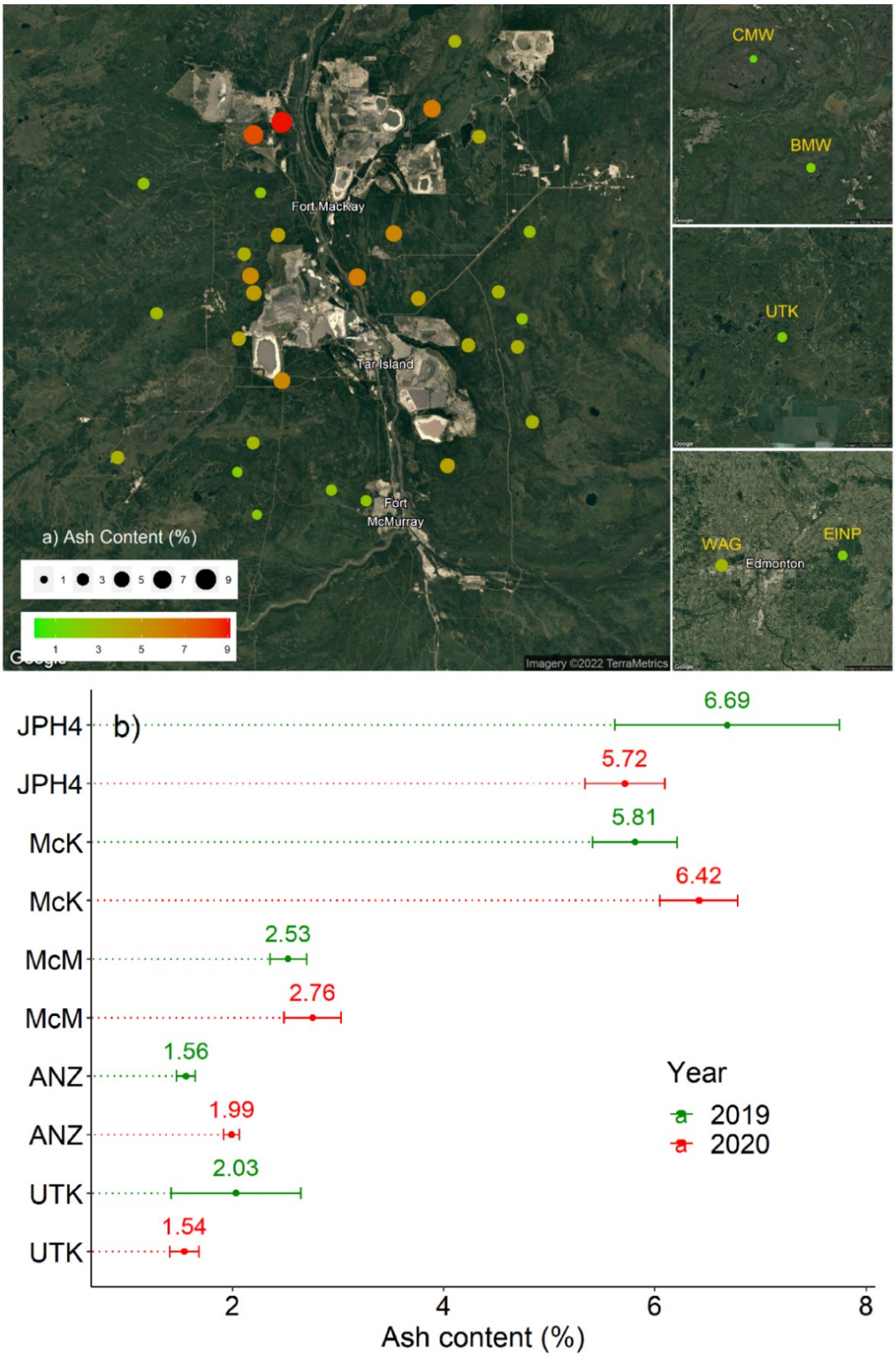

Fig. S5. Ash content (%) of *Sphagnum* mosses collected in fall a) 2015 and b) 2019 and 2020. CMW = Caribou Mountains Wildland, BMW = Birch Mountains Wildland, UTK = Utikuma, WAG = Wagner Natural Area, EINP = Elk Island National Park, McK = Fort McKay, McM = Fort McMurray, ANZ = Anzac.

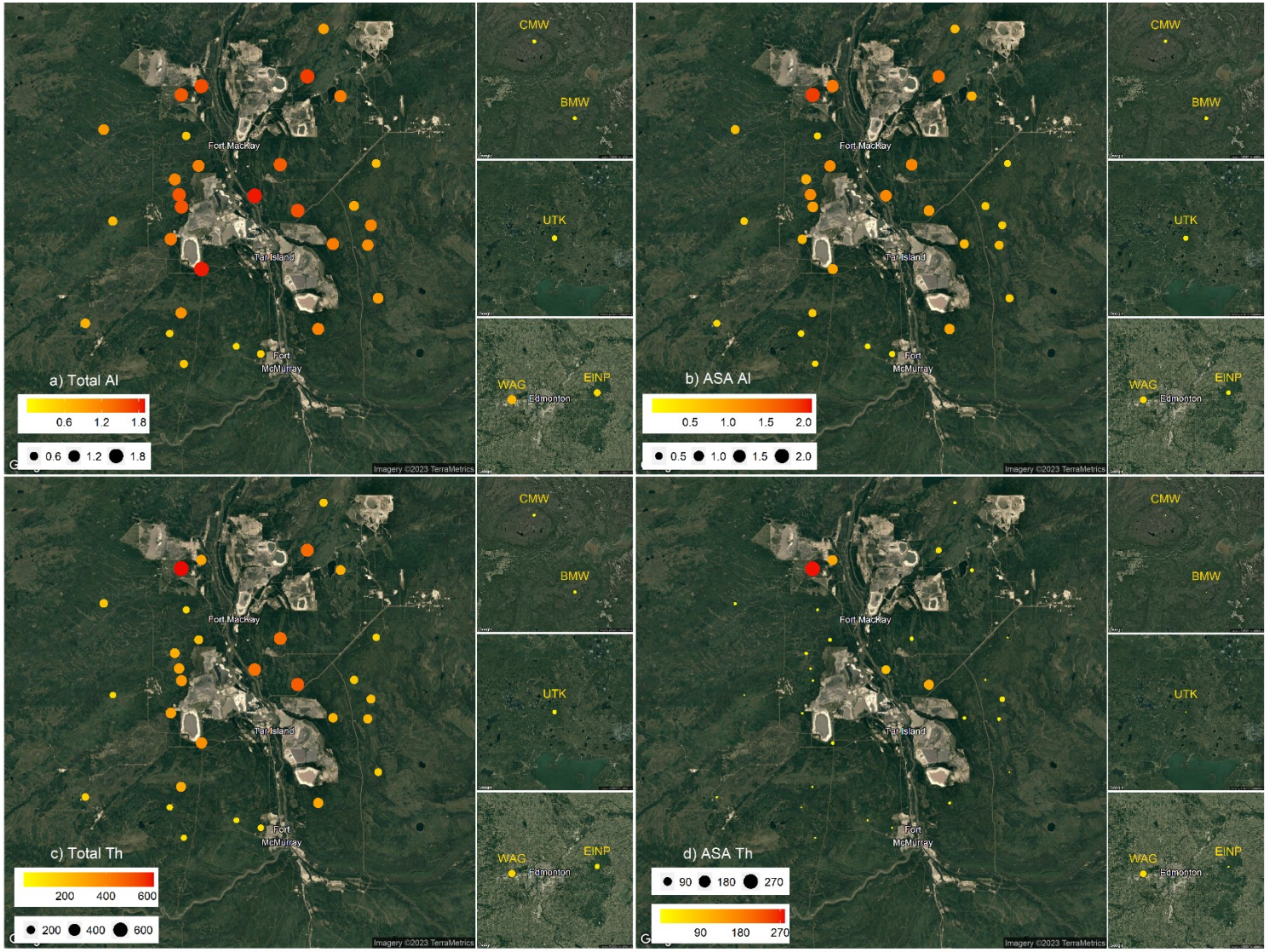

Fig. S6. Spatial distribution of a) total and b) acid soluble **Al** (g kg^{-1} dry moss), and c) total and d) acid soluble **Th** (µg kg^{-1} dry moss) concentrations in *Sphagnum* mosses collected in fall 2015. ASA = Acid Soluble Ash, CMW = Caribou Mountains Wildland, BMW = Birch Mountains Wildland, UTK = Utikuma, WAG = Wagner Natural Area, EINP = Elk Island National Park.

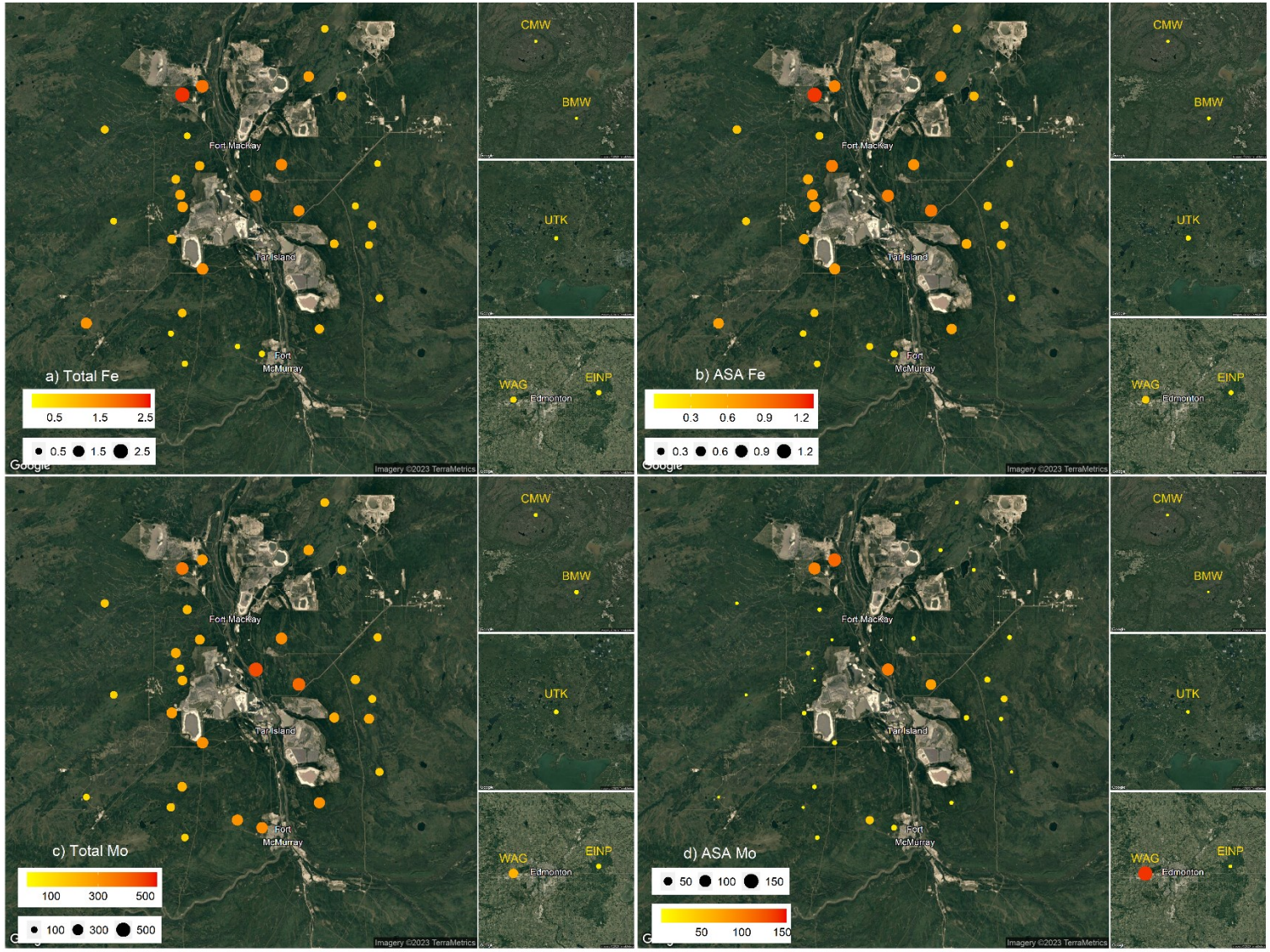

Fig. S7. Spatial distribution of a) total and b) acid soluble **Fe** (mg kg^{-1} dry moss), and c) total and d) acid soluble **Mo** (µg kg^{-1} dry moss) concentrations in *Sphagnum* mosses collected in fall 2015. ASA = Acid Soluble Ash, CMW = Caribou Mountains Wildland, BMW = Birch Mountains Wildland, UTK = Utikuma, WAG = Wagner Natural Area, EINP = Elk Island National Park.

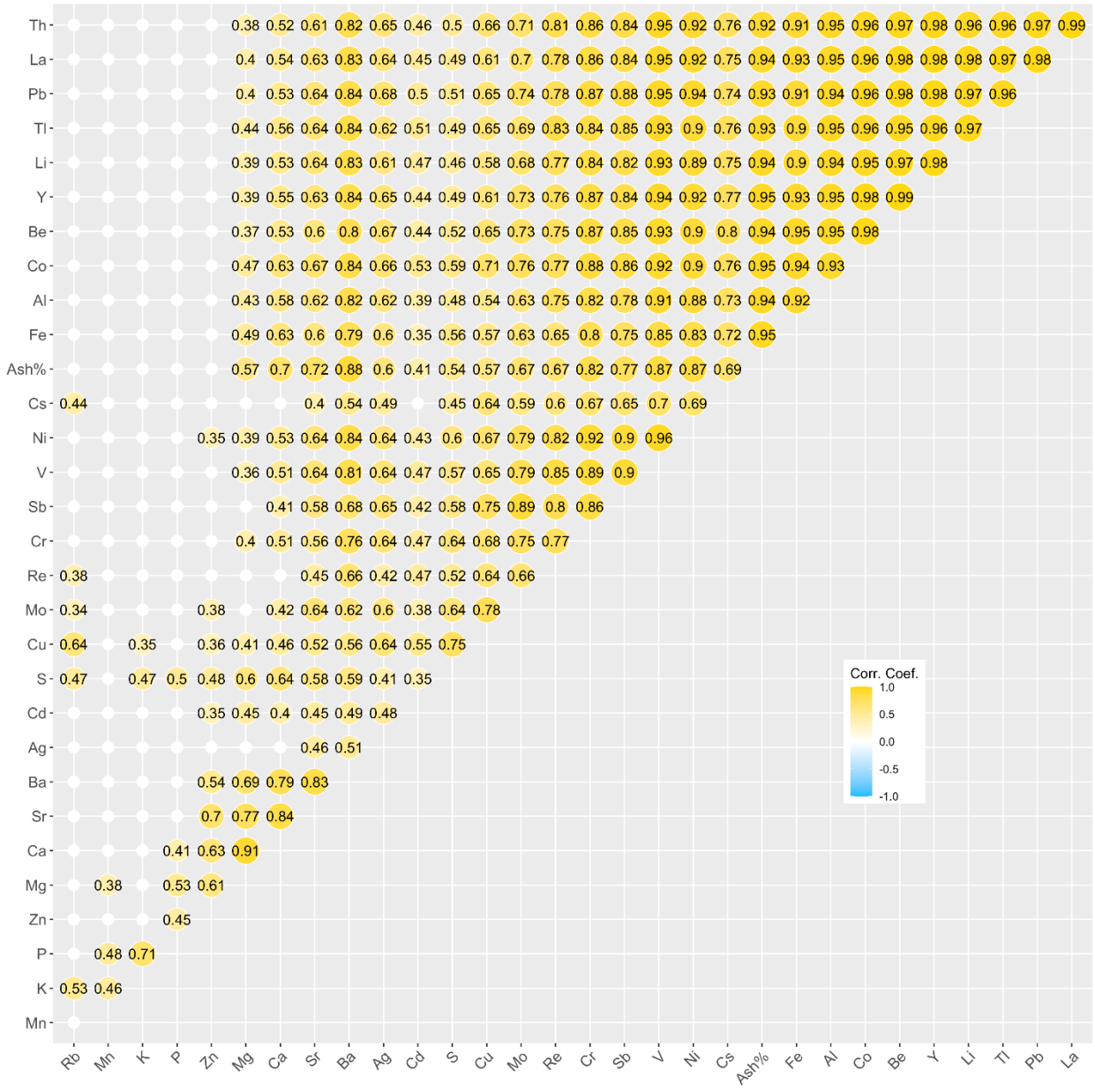

Fig. S8. Correlogram of **total** concentrations and ash content of fall 2015 *Sphagnum* mosses based on the Spearman rank-based correlation test. Sites EINP and WAG were excluded. Corr. Coef. = Correlation coefficient. Significance level = 0.05. Only significant correlations are presented.

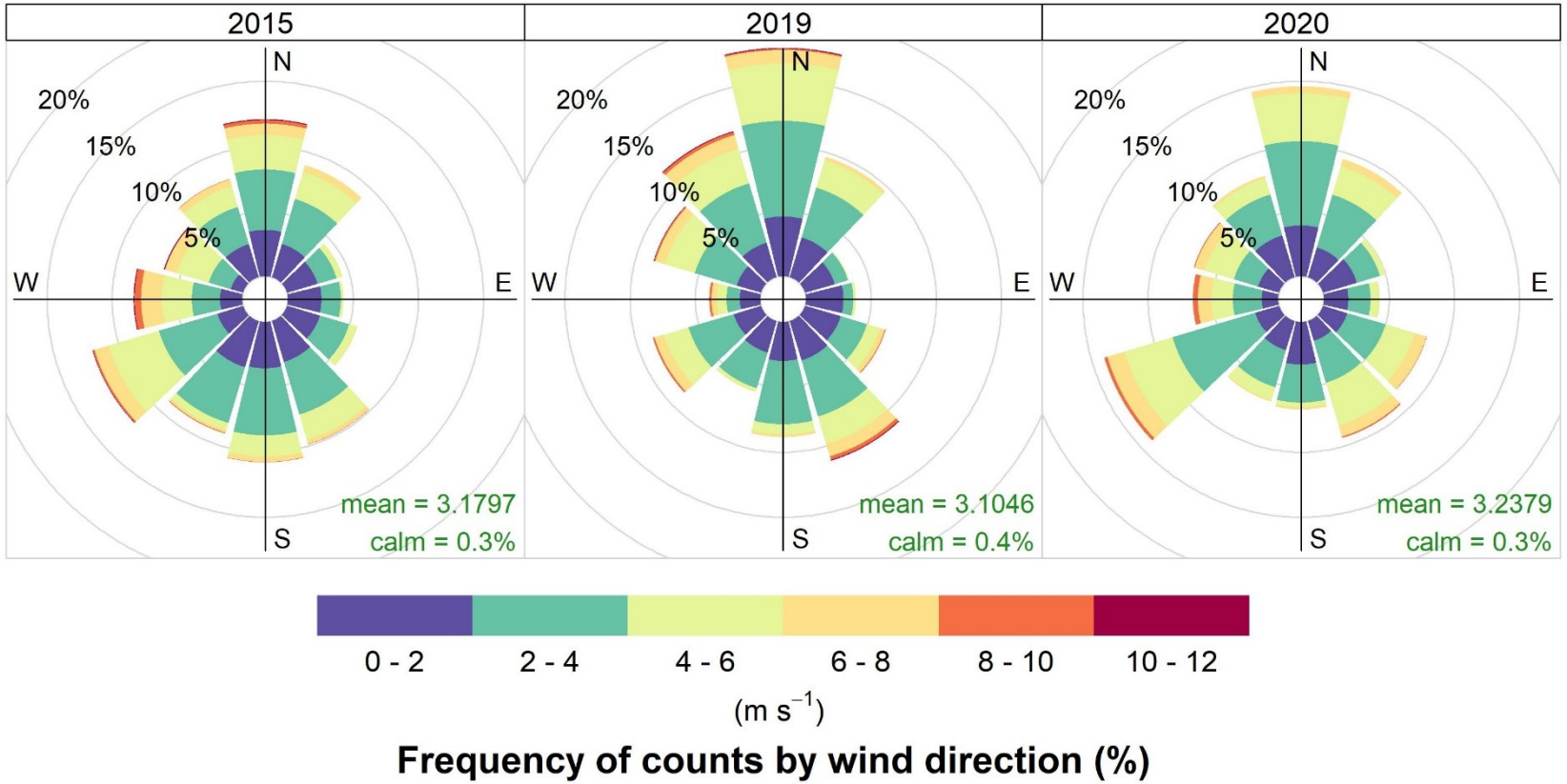

Fig. S9. Wind rose diagrams for 2015, 2019, and 2020 at Mildred Station. Historic hourly weather data from May 1 to August 31 of each year was downloaded from the Government of Canada climate station: Mildred Lake (Latitude: 57°02'28.000" N, Longitude: 111°33'32.000" W, Elevation: 310.00 m, Climate Identifier (ID): 3064528, World Meteorological Organization (WMO) ID: 71255, Transport Canada (TC) ID: WMX). Data was processed in R 4.1.1,[2] and visualized using the *openair* package.[3] Wind rose diagram for 2015 was also used in our previous study by Mullan-Boudreau et al.[4]

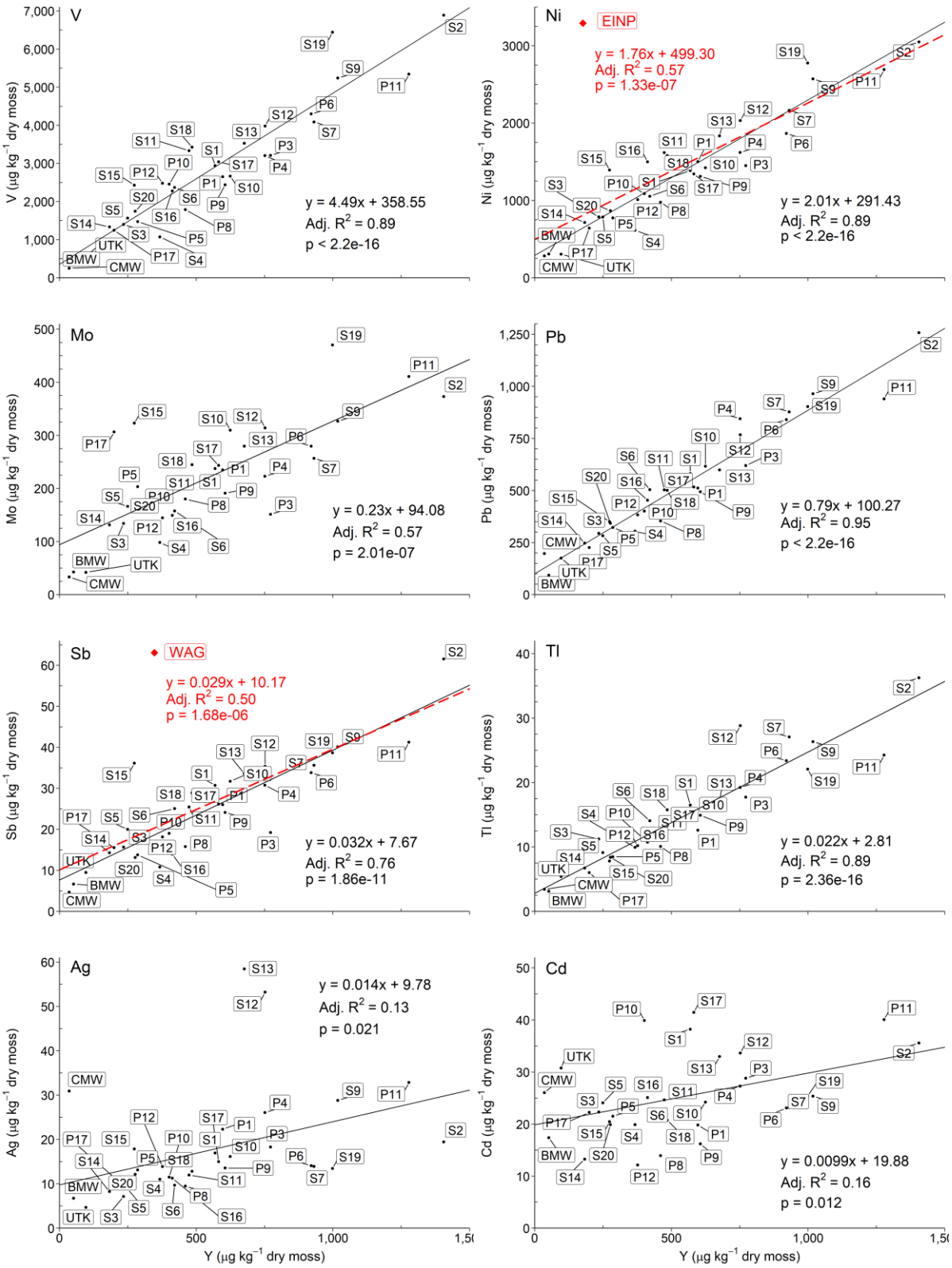

Fig. S10. Total V, Ni, Mo, Pb, Sb, Tl, Ag, and Cd concentration versus total Y concentration (µg kg^{-1} dry moss) in *Sphagnum* mosses collected in fall 2015. CMW = Caribou Mountains Wildland, BMW = Birch Mountains Wildland, UTK = Utikuma, WAG = Wagner Natural Area, EINP = Elk Island National Park.

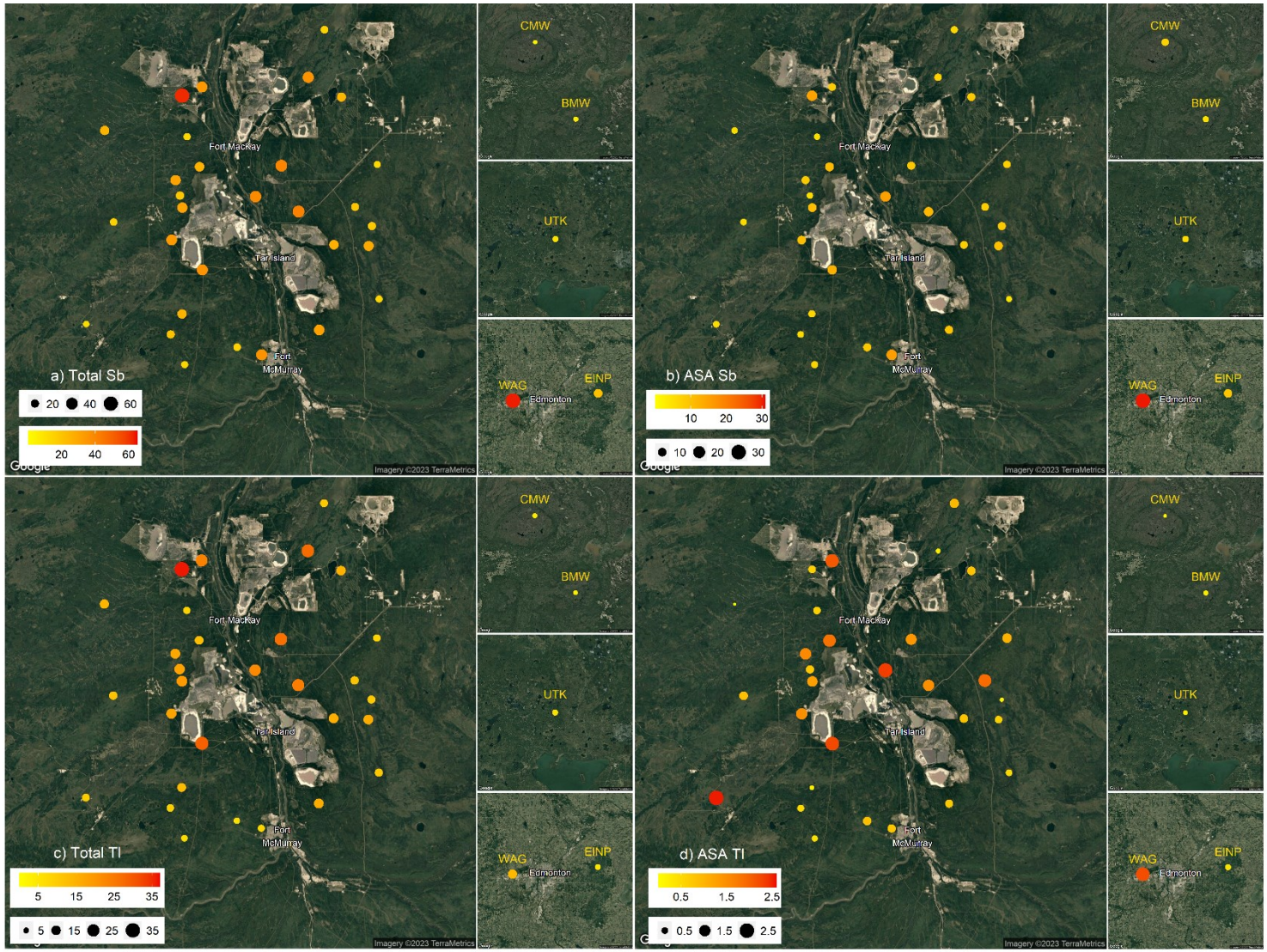

Fig. S11. Spatial distribution of a) total and b) acid soluble **Sb**, and c) total and d) acid soluble **Tl** concentrations (μg kg^{-1} dry moss) in *Sphagnum* mosses collected in fall 2015. ASA = Acid Soluble Ash, CMW = Caribou Mountains Wildland, BMW = Birch Mountains Wildland, UTK = Utikuma, WAG = Wagner Natural Area, EINP = Elk Island National Park.

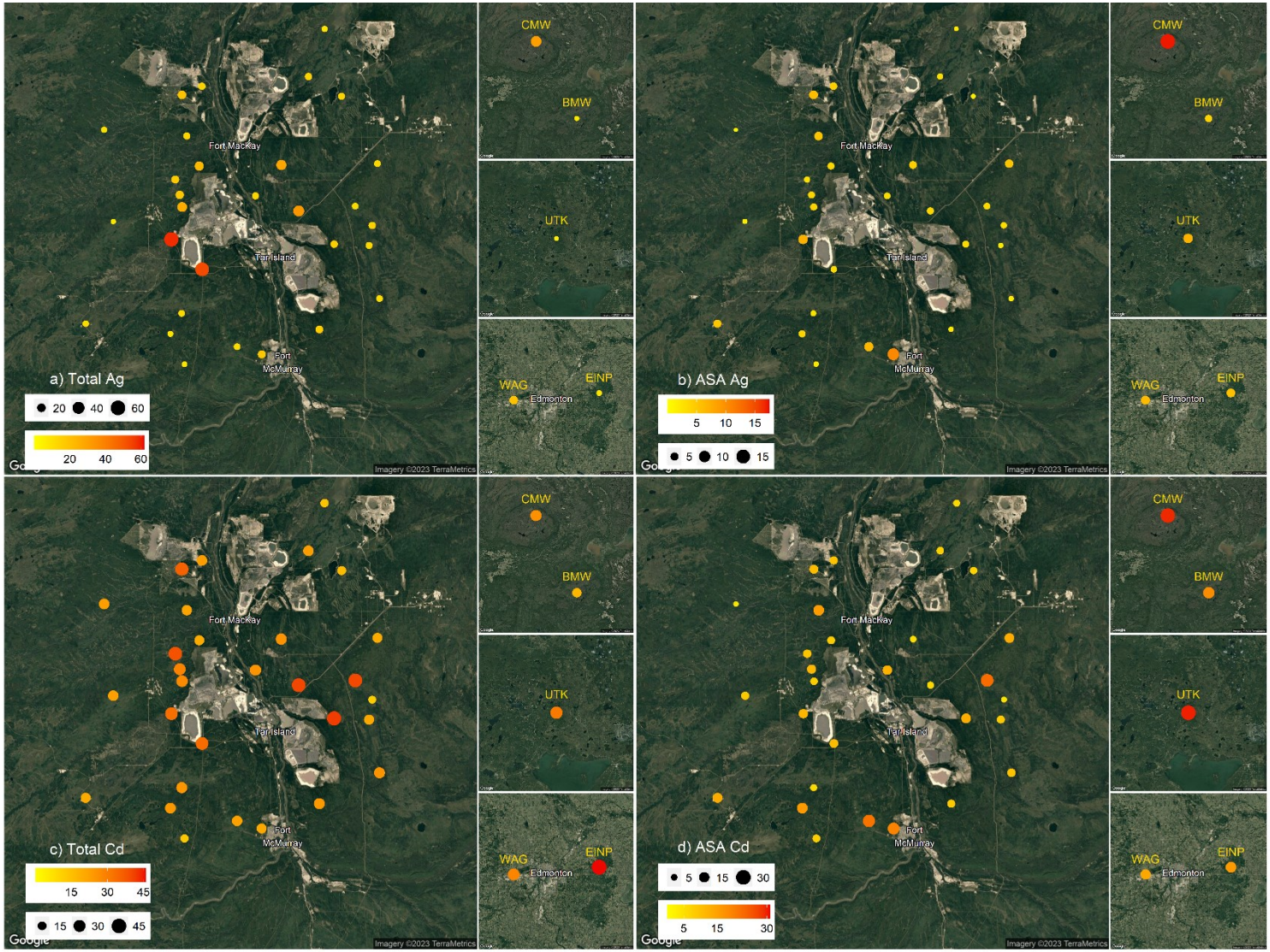

Fig. S12. Spatial distribution of a) total and b) acid soluble **Ag**, and c) total and d) acid soluble **Cd** concentrations (μg kg^{-1} dry moss) in *Sphagnum* mosses collected in fall 2015. ASA = Acid Soluble Ash, CMW = Caribou Mountains Wildland, BMW = Birch Mountains Wildland, UTK = Utikuma, WAG = Wagner Natural Area, EINP = Elk Island National Park.

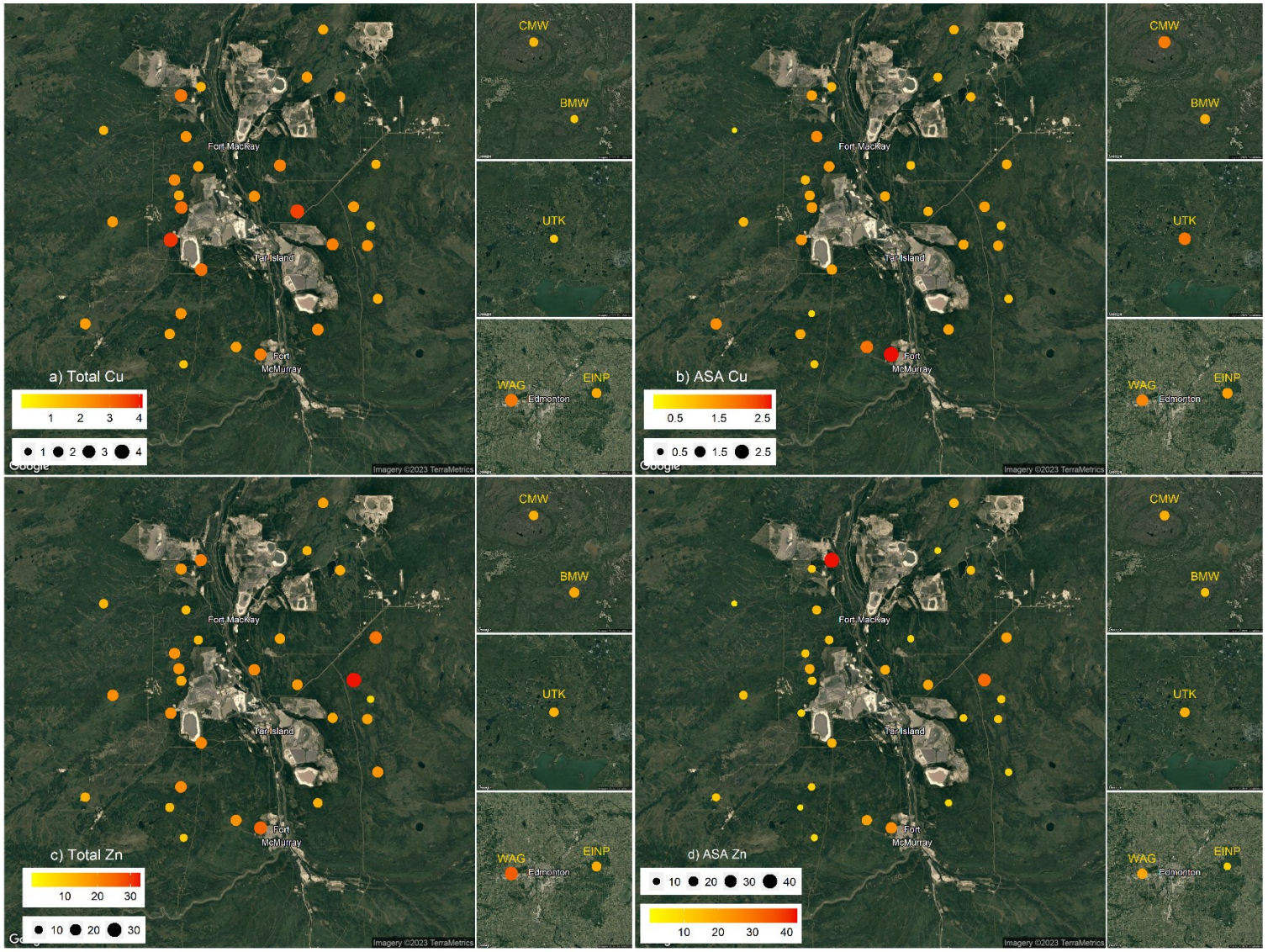

Fig. S13. Spatial distribution of a) total and b) acid soluble **Cu**, and c) total and d) acid soluble **Zn** concentrations (mg kg^{-1} dry moss) in *Sphagnum* mosses collected in fall 2015. ASA = Acid Soluble Ash, CMW = Caribou Mountains Wildland, BMW = Birch Mountains Wildland, UTK = Utikuma, WAG = Wagner Natural Area, EINP = Elk Island National Park.

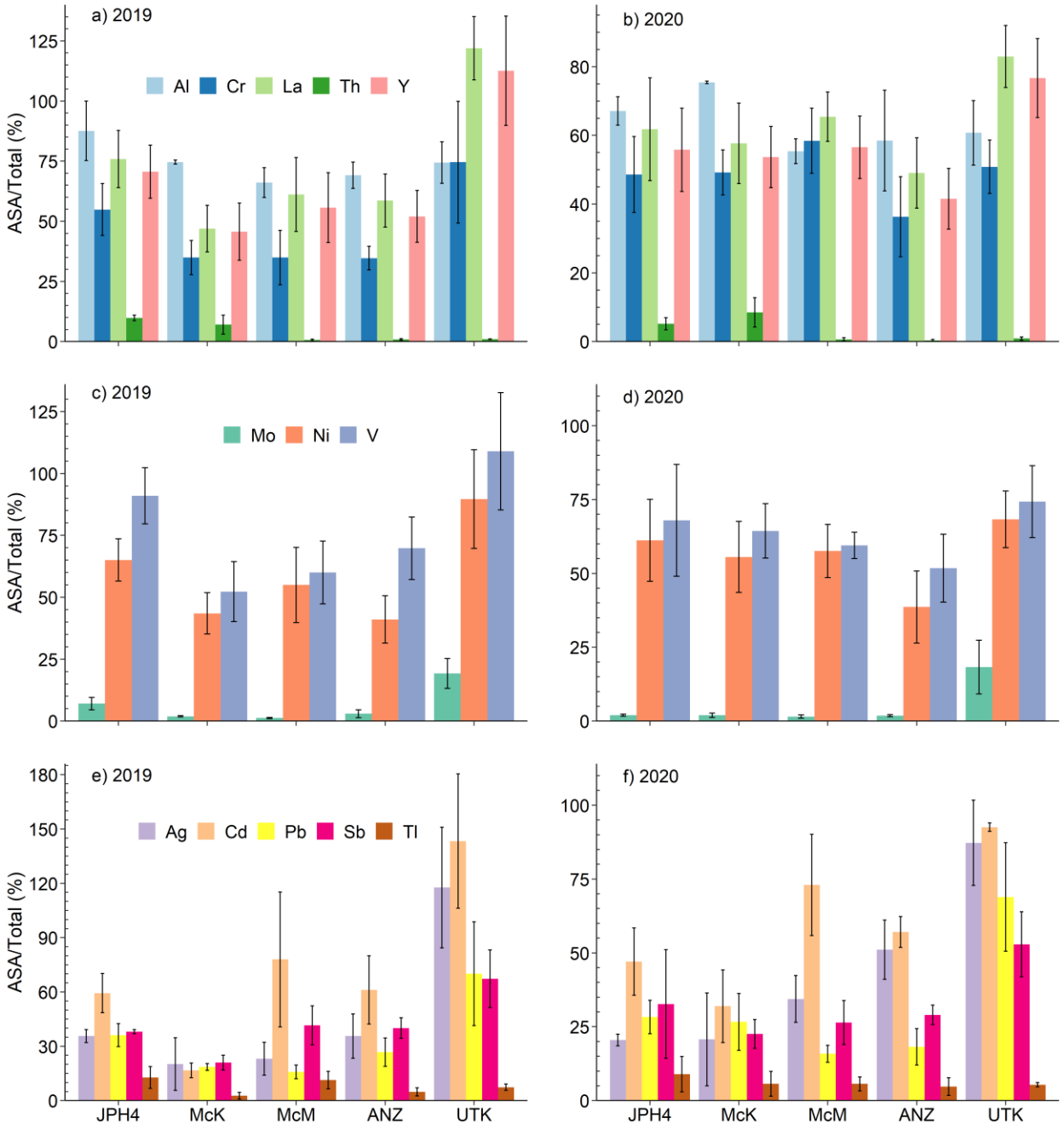

Fig. S14. Proportion of acid soluble to total concentration of trace elements in *Sphagnum* mosses collected in fall 2019 (a, c, & e) and 2020 (b, d, & f). ASA = Acid Soluble Ash, McK = Fort McKay, McM = Fort McMurray, ANZ = Anzac, UTK = Utikuma. Error bars represent ± standard deviation.

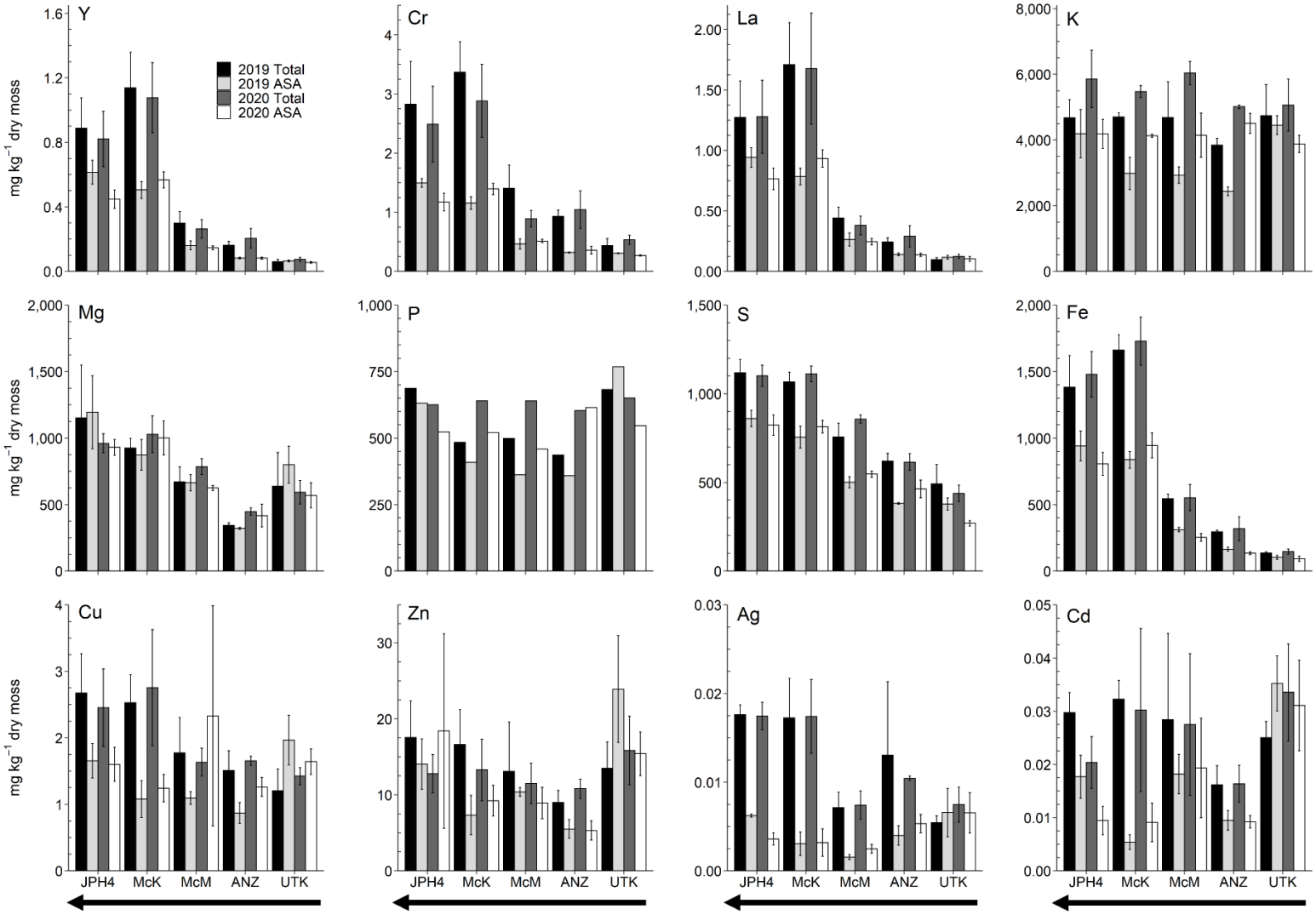

Fig. S15. Total and acid soluble concentrations (mg kg^{-1} dry moss) of conservative lithophile elements (Y, Cr, La), essential elements (K, Mg, P, S, Fe, Cu, Zn), and potentially toxic elements (Ag, Cd) in *Sphagnum* mosses collected in fall 2019 and 2020. ASA = Acid Soluble Ash, McK = Fort McKay, McM = Fort McMurray, ANZ = Anzac, UTK = Utikuma. The arrow points from the reference site (UTK) toward industry. Error bars represent ± standard deviation.

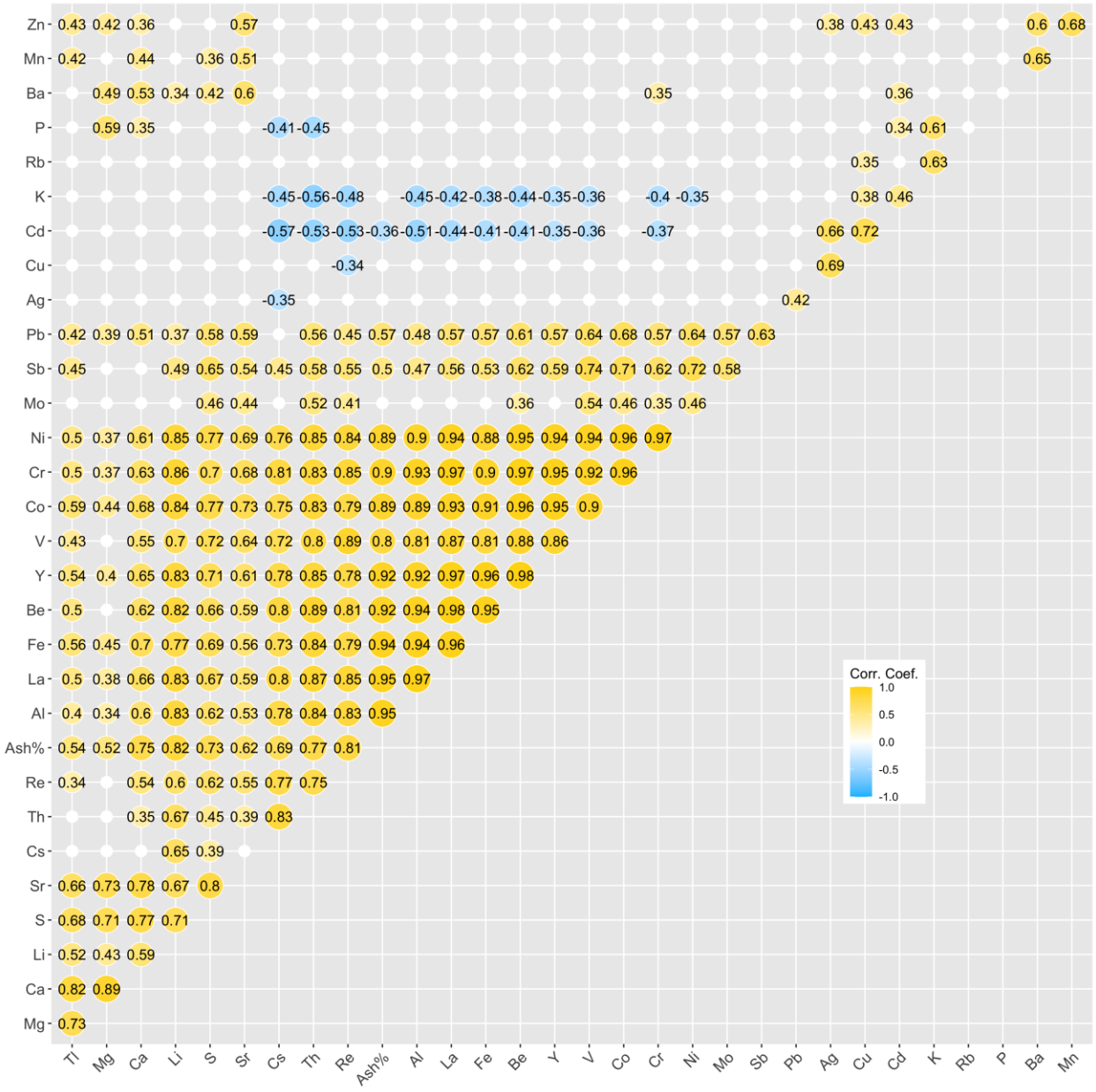

Fig. S16. Correlogram of element concentrations in Acid Soluble Ash (**ASA**) and ash content of fall 2015 *Sphagnum* mosses based on the Spearman rank-based correlation test. Sites EINP and WAG were excluded. Corr. Coef. = Correlation coefficient. Significance level = 0.05. Only significant correlations are presented.

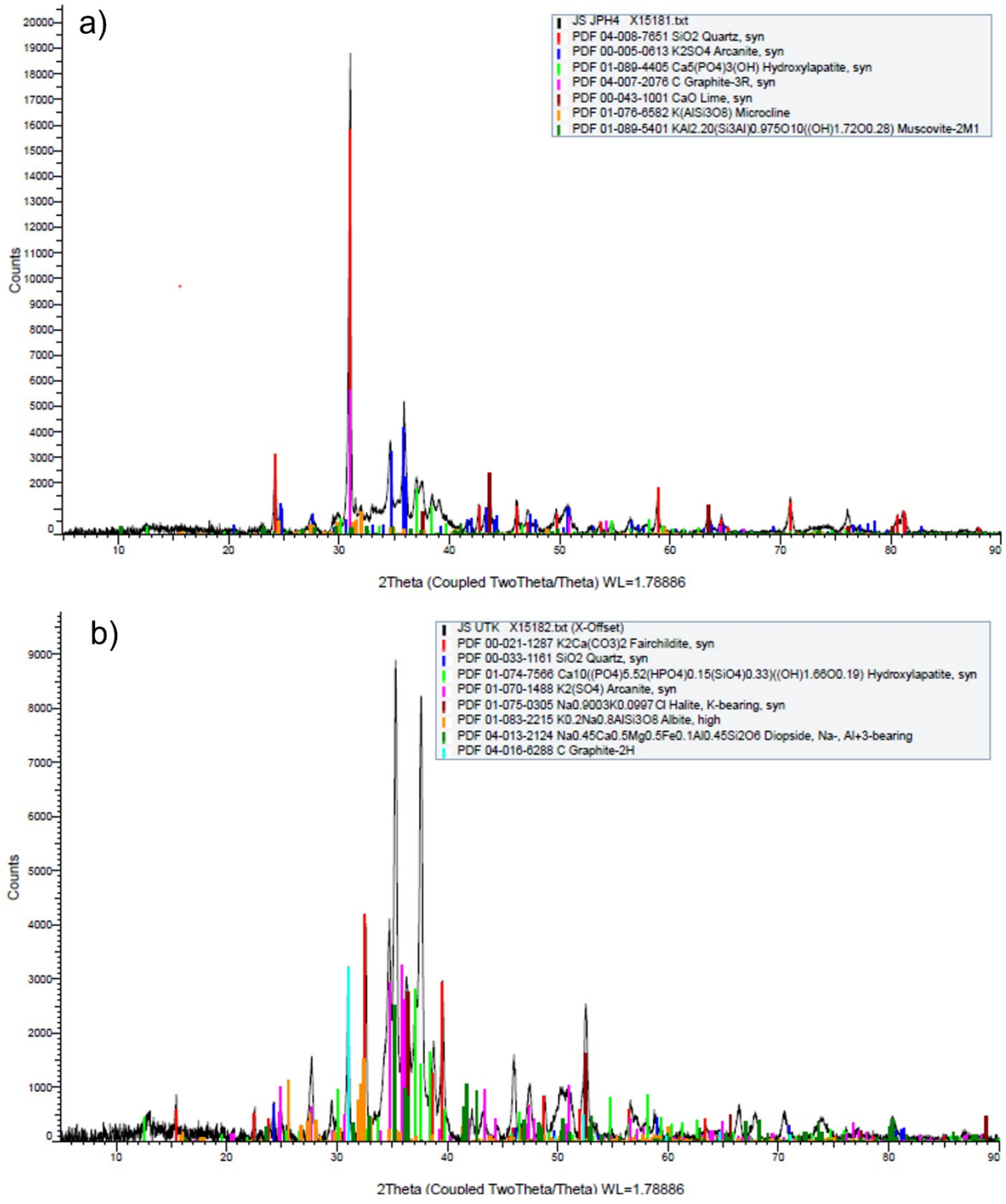

Fig. S17. X-ray diffraction (XRD) analysis of a) JPH4 and b) UTK ash samples (both from 2020). UTK = Utikuma.

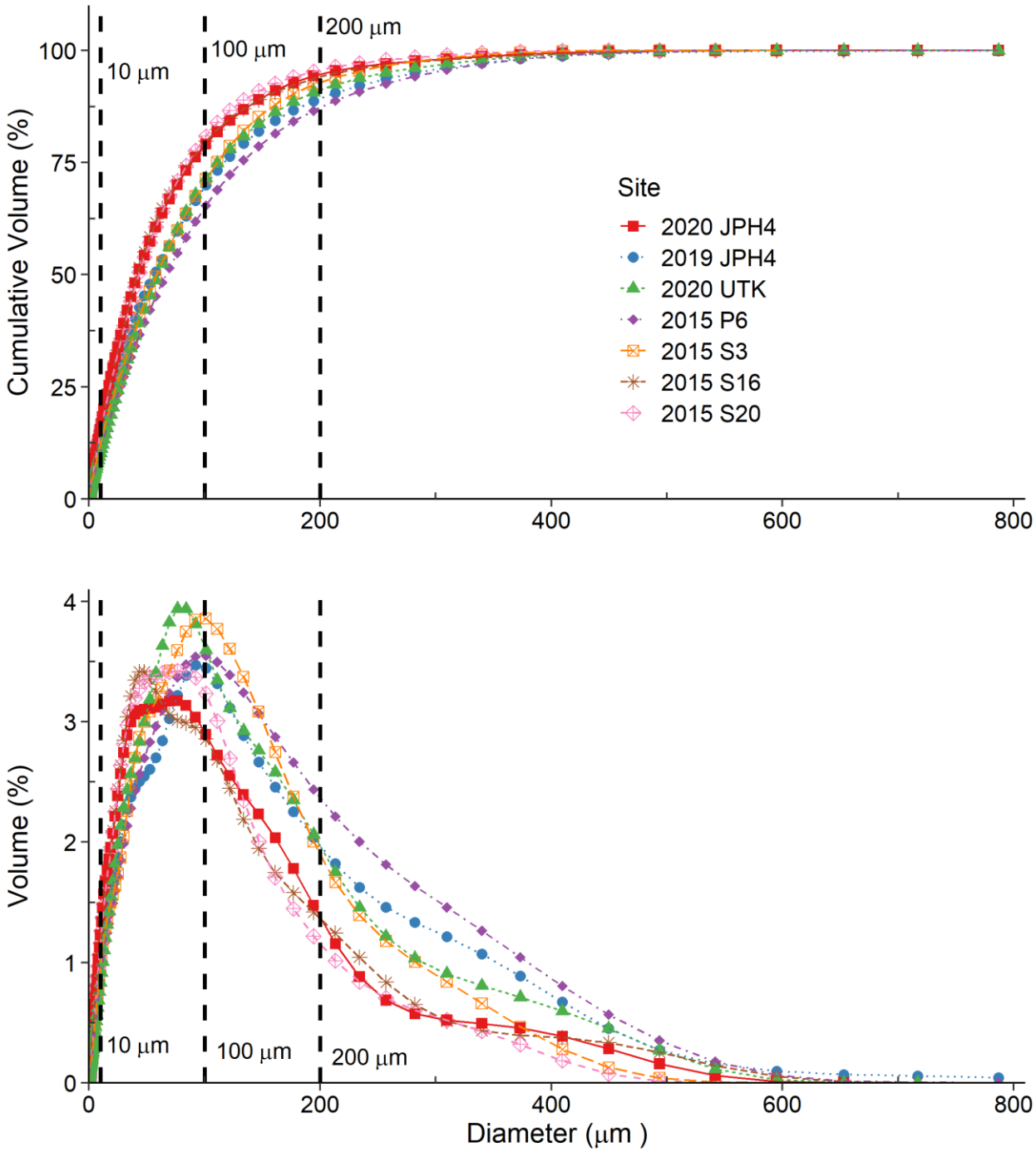

Fig. S18. Particle size distribution of ash samples of *Sphagnum* mosses by laser diffraction. UTK = Utikuma.

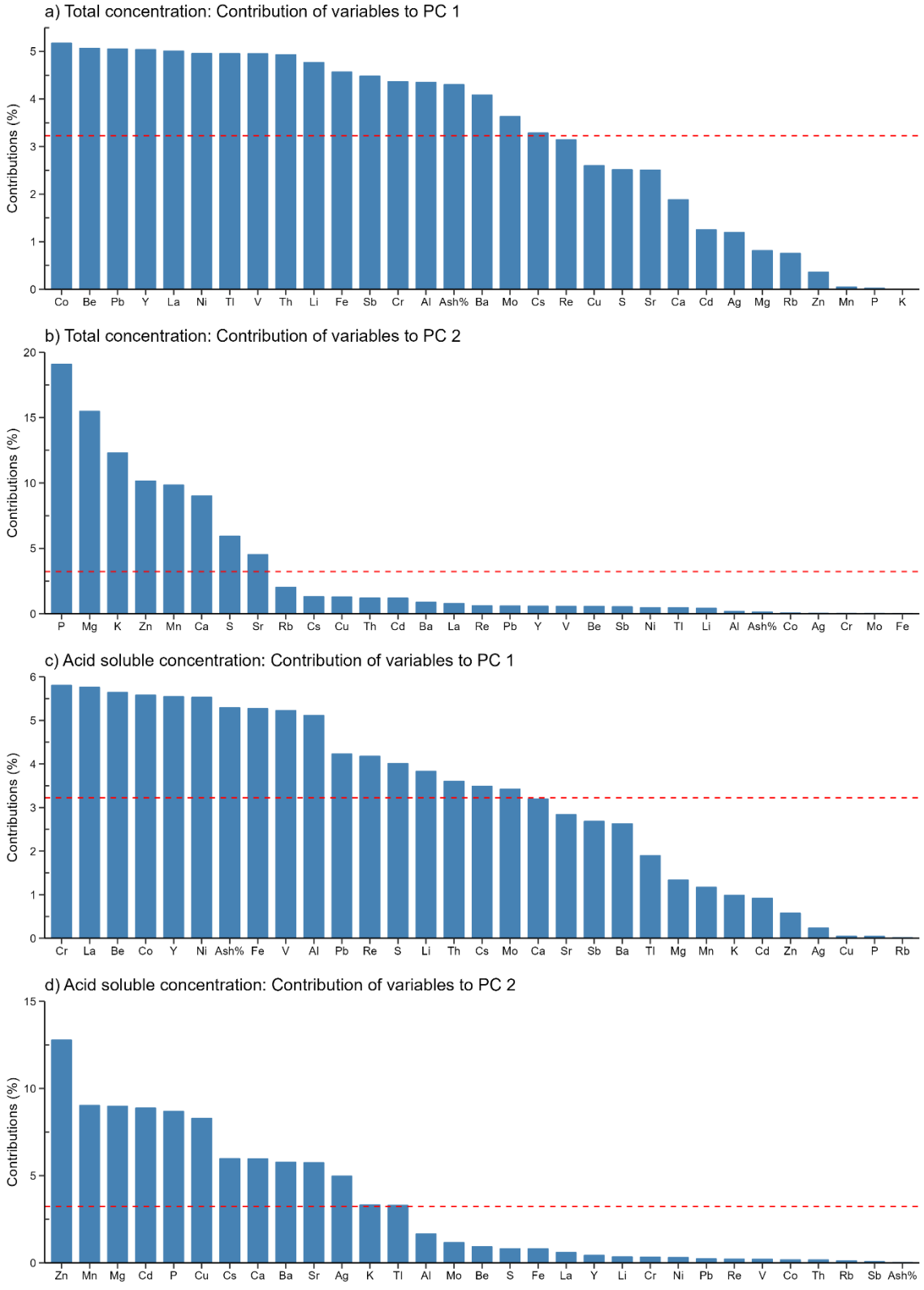

Fig. S19. Contributions of variables in accounting for the variability in principal component (PC) 1 and PC 2 from principal component analysis of fall 2015 *Sphagnum* mosses using total concentrations (a, b) and acid soluble concentrations (c, d). The red dashed line indicates the average contribution.

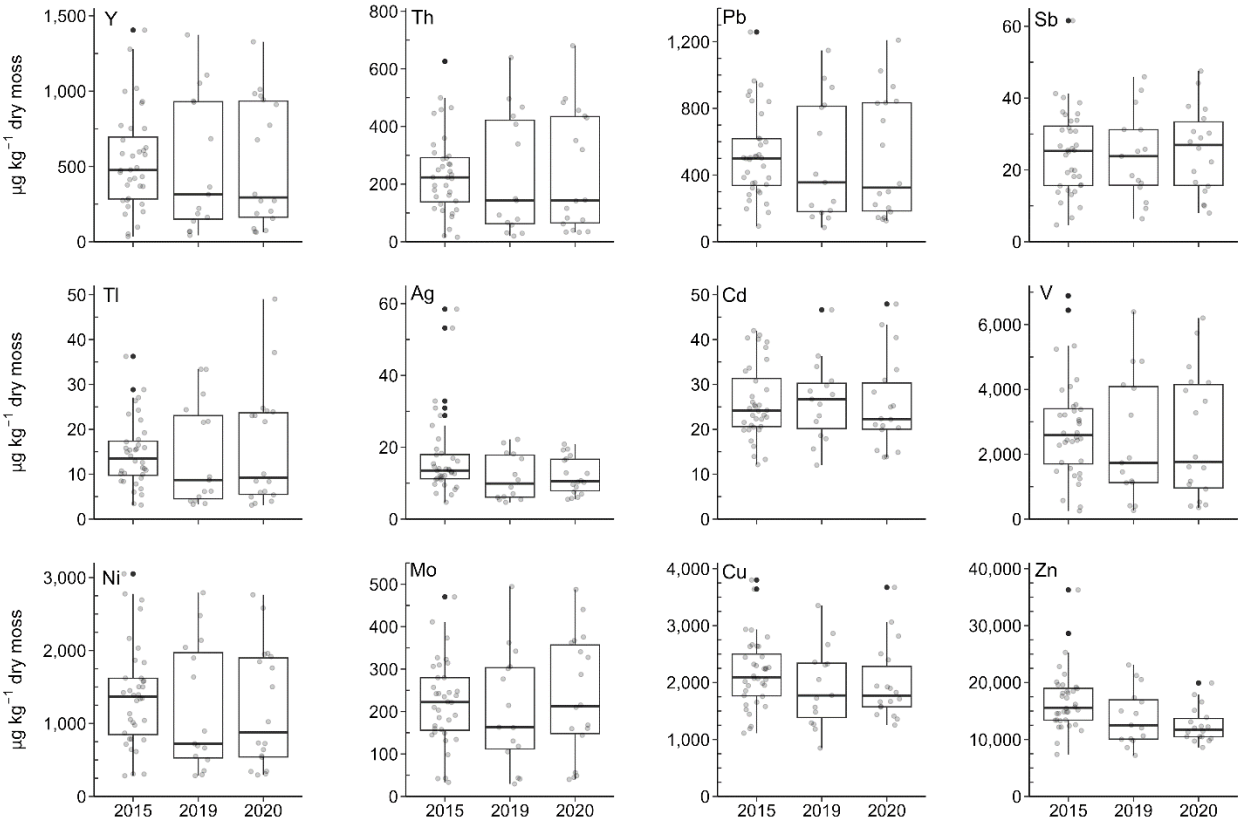

Fig. S20. Temporal trends of **total** concentration (µg kg^{-1} dry moss) of selected elements in *Sphagnum* moss collected in fall 2015 (sites EINP and WAG were excluded), 2019, and 2020. Boxplots show the range, 25th percentile, median, and 75th percentile of each element.

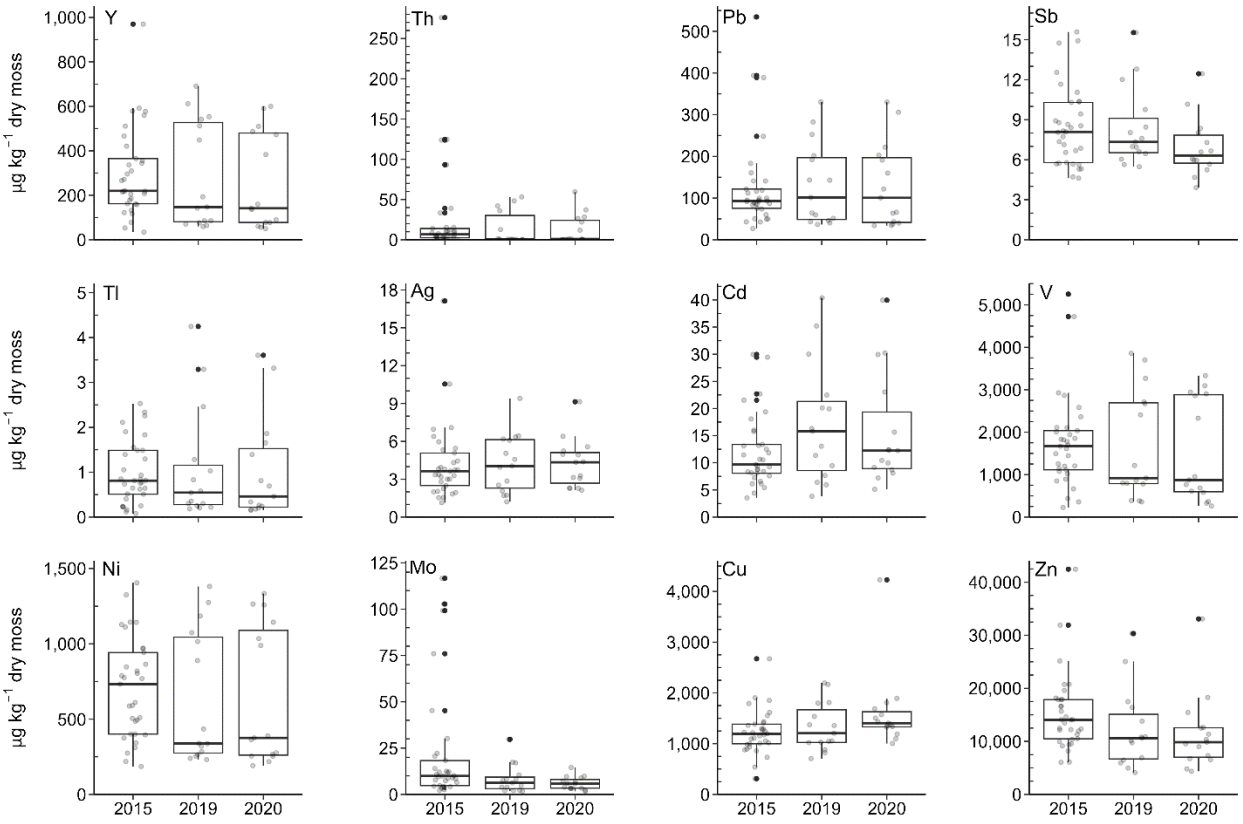

Fig. S21. Temporal trends of trace element concentration (µg kg^{-1} dry moss) in the Acid Soluble Ash (**ASA**) fraction of *Sphagnum* moss collected in fall 2015 (sites EINP and WAG were excluded), 2019, and 2020. Boxplots show the range, 25th percentile, median, and 75th percentile of each element.

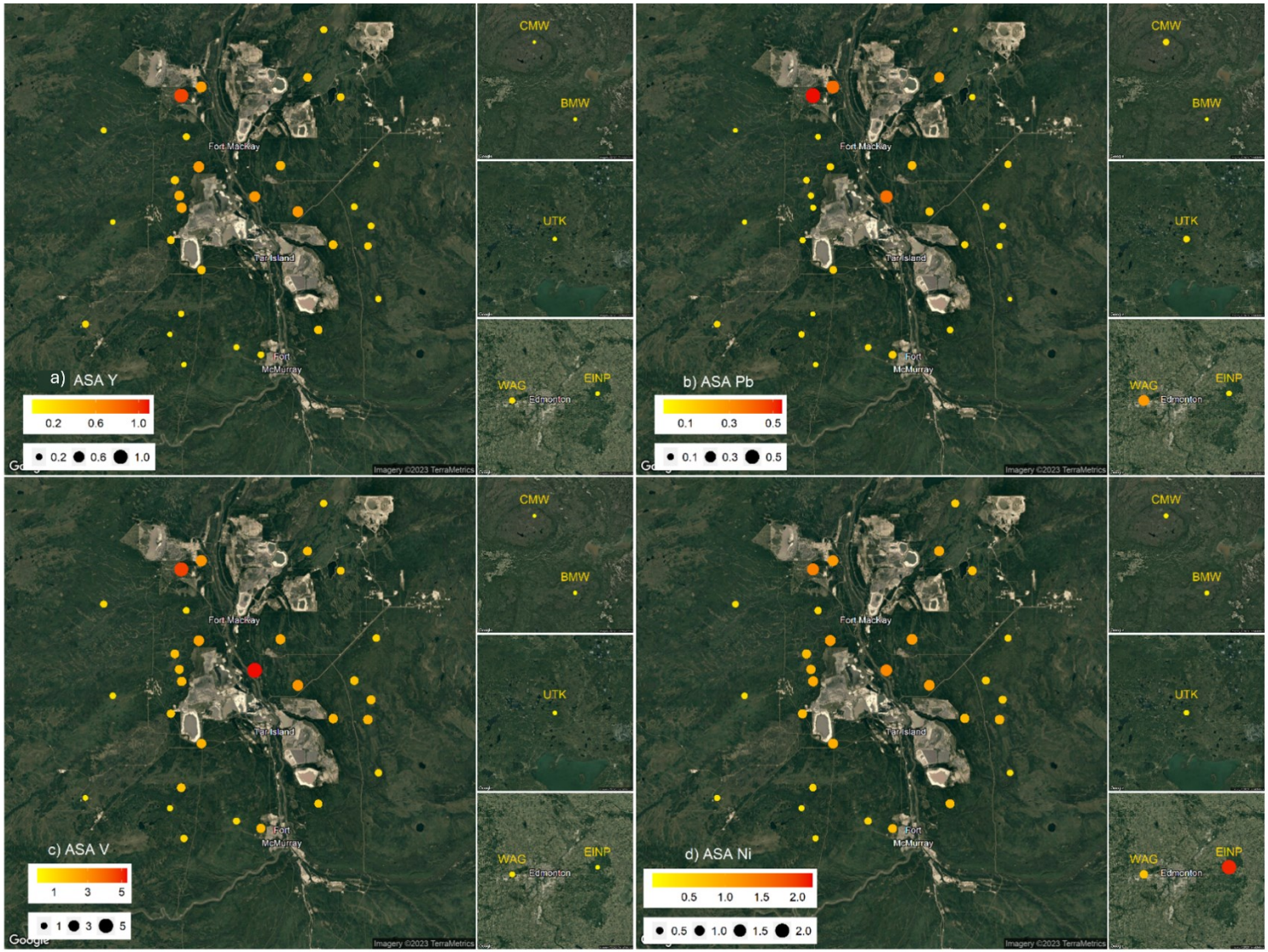

Fig. S22. Spatial distribution of acid soluble a) **Y**, b) **Pb**, c) **V**, and d) **Ni** concentrations (mg kg^{-1} dry moss) in *Sphagnum* mosses collected in fall 2015. ASA = Acid Soluble Ash, CMW = Caribou Mountains Wildland, BMW = Birch Mountains Wildland, UTK = Utikuma, WAG = Wagner Natural Area, EINP = Elk Island National Park.

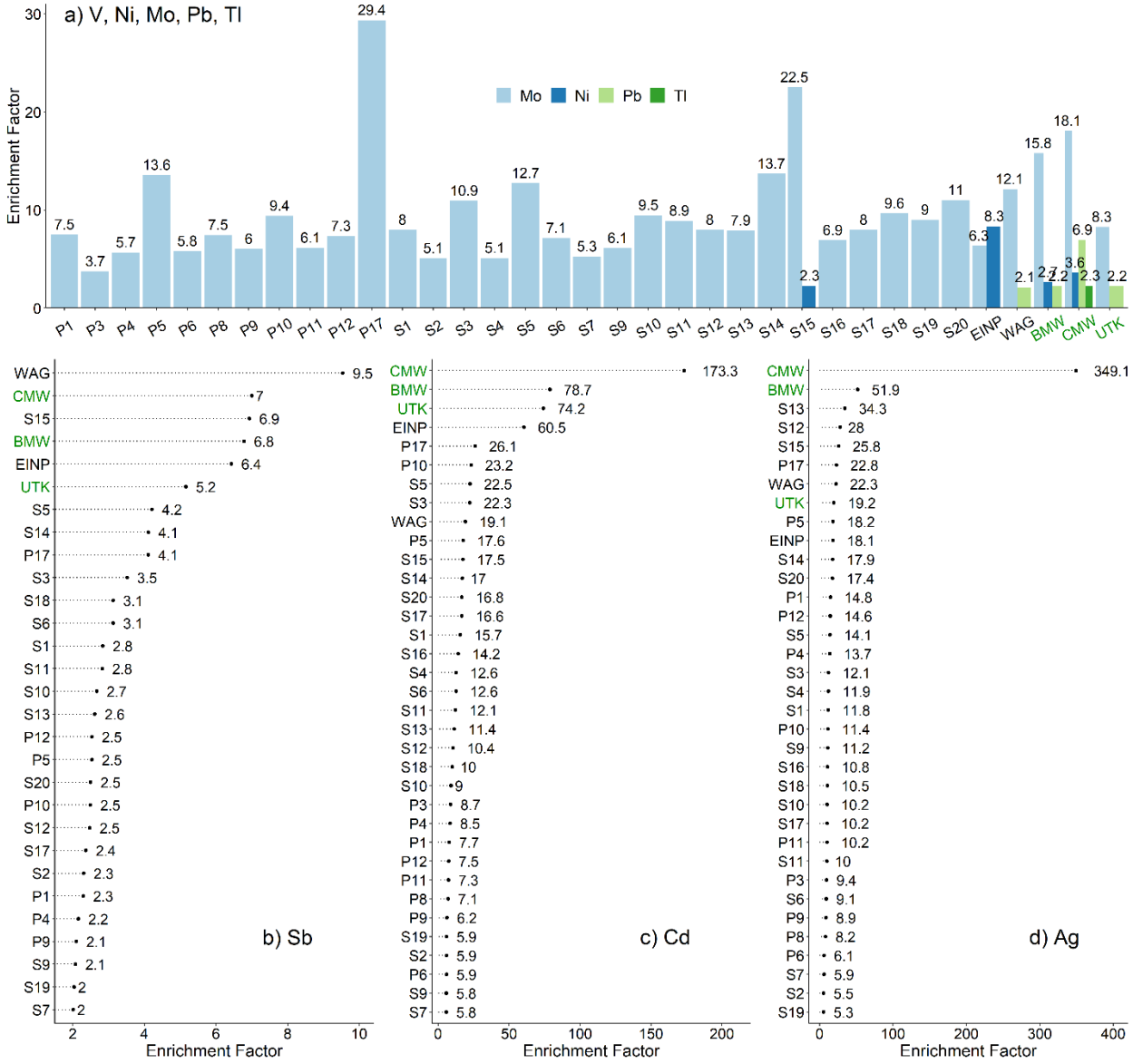

Fig. S23. Enrichment factors using **Y** as the reference element with values greater than 2 of a) V, Ni, Mo, Pb, Tl, b) Sb, c) Ag, and d) Cd of *Sphagnum* mosses collected in fall 2015. Enrichment factors of V were all below 2 and are not shown in the plot. CMW = Caribou Mountains Wildland, BMW = Birch Mountains Wildland, UTK = Utikuma, WAG = Wagner Natural Area, EINP = Elk Island National Park.

References

(1) Rudnick, R. L.; Gao, S. Composition of the continental crust. In *Treatise on Geochemistry*, 2nd ed.; Holland, H., Turekian, K., Eds.; Elsevier, 2014; pp 1–51. DOI: 10.1016/B978-0-08-095975-7.00301-6.

(2) R Core Team. *R: A language and environment for statistical computing*; R Foundation for Statistical Computing, 2021. https://www.r-project.org/.

(3) Carslaw, D. C.; Ropkins, K. openair - An R package for air quality data analysis. *Environ. Model. Softw.* **2012**, *27-28* (0), 52–61. DOI: 10.1016/j.envsoft.2011.09.008.

(4) Mullan-Boudreau, G.; Belland, R.; Devito, K.; Noernberg, T.; Pelletier, R.; Shotyk, W. *Sphagnum* moss as an indicator of contemporary rates of atmospheric dust deposition in the Athabasca Bituminous Sands Region. *Environ. Sci. Technol.* **2017**, *51* (13), 7422–7431. DOI: 10.1021/acs.est.6b06195.