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Airborne radionuclides and heavy metals in high Arctic terrestrial environment as the indicators of sources and transfers of contamination

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Tab. S1. Coordinates and selected morphology properties of cryoconite holes on Waldemarbreen.

N	GPS coordinates UTM 33N (m)	Altitude a.s.l. (m)	Area (cm^2)	Depth (cm)
2	435222.3 8735590	223	165	29
3	435869.9 8735874	308	156	10
4	436175.5 8736001	357	476	28
5	435295.8 8735921	255	80	9
6	435512.6 8734906	201	12.3	1
7	435954.4 8735202	233	25	2.5
8	435668.5 8735657	264	121	5.5
9	434772.3 8735363	165	340	4
10	434772.3 8735363	165	380	7
11	435668.5 8735657	264	20	8
12	436175.5 8736001	357	170	7
13	436858.6 8735885	423	1200	16

Tab. S2. Activity concentrations of anthropogenic radionuclides (^{137}Cs, Pu isotopes, ^{241}Am) expressed in Bq kg^{-1} and radionuclide activity ratios and mass ratios in soil profiles. All data were corrected for August 2014, the sampling date.

Soil	Depth (cm)	^{238}Pu (Bq/kg)	$^{239+240}$Pu (Bq/kg)	^{241}Am (Bq/kg)	^{137}Cs (Bq/kg)	^{238}Pu/$^{239+240}$Pu	^{241}Am/$^{239+240}$Pu	$^{239+240}$Pu/^{137}Cs	^{238}Pu (Bq/m^2)	$^{239+240}$Pu (Bq/m^2)	^{241}Am (Bq/m^2)	^{137}Cs (Bq/m^2)	LOI (%)
S01-1	2	<0.03	<0.03	<0.1	31 ± 4	-	-	-	-	-	-	340 ± 41	15
S01-2	4	<0.05	1.07 ± 0.08	0.59 ± 0.11	<5	-	0.55 ± 0.11	-	-	25.7 ± 1.9	14.2 ± 2.6	120 ± 24	8
S01-3	6	<0.03	0.08 ± 0.01	<0.1	<5	-	-	-	-	1.8 ± 0.2	-	44 ± 22	8
S01-4	9	<0.07	<0.07	<0.03	<2	-	-	-	-	-	-		9
S01-5	13	<0.08	<0.08	<0.08	<2	-	-	-	-	-	-		8
Inventory (Bq m^{-2})									-	**28 ± 2**	**14 ± 3**	**500 ± 90**	
S03-1	2	<0.03	0.32 ± 0.03	0.09 ± 0.01	8 ± 2	-	0.28 ± 0.04	0.042 ± 0.013	-	6.8 ± 0.6	1.9 ± 0.2	148 ± 42	8
S03-2	4.5	<0.03	<0.03	<0.03	<4			-	-	-	-	-	9
S03-3	8	<0.03	<0.03	<0.03	<5			-	-	-	-	-	8
S03-4	12.5	<0.03	<0.03	<0.03	<5			-	-	-	-	-	10
Inventory (Bq m^{-2})									-	**6.8 ± 0.6**	**1.9 ± 0.2**	**150 ± 40**	
S04-1	1	0.08 ±0.01	2.13 ± 0.16	0.90 ± 0.06	63 ± 7	0.038 ± 0.005	0.39 ± 0.03	0.034 ± 0.004	0.58 ± 0.1	15.6 ± 1.2	6.1 ± 0.2	475 ± 51	7
S04-2	4	<0.04	0.56 ± 0.04	0.30 ± 0.03	16 ± 7	-	0.48 ± 0.06	0.034 ± 0.006	0.35 ± 0.1	5.0 ± 0.4	2.4 ± 0.3	150 ± 27	8
S04-3	8	<0.02	0.08 ± 0.01	<0.03	2 ± 1	-	-	0.041 ± 0.021	-	1.9 ± 0.2		47 ± 24	9
S04-4	12	<0.03	<0.03		<4	-	-		-			-	9
Inventory (Bq m^{-2})									**0.94 ± 0.2**	**22 ± 2**	**9 ± 1**	**670 ± 100**	
S05-1	2	<0.04	0.51 ± 0.04	0.25 ± 0.03	9 ± 1	-	0.49 ± 0.07	0.059 ± 0.009	-	15.6 ± 1.1	5.0 ± 0.6	238 ± 20	8
S05-2	4	0.03 ± 0.01	1.04 ± 0.08	0.47 ± 0.06	18 ± 1	0.029 ± 0.010	0.45 ± 0.07	0.056 ± 0.005	1.2 ± 0.4	5.0 ± 0.4	18.6 ± 2.4	174 ± 15	9
S05-3	7	<0.03	<0.03	<0.06	<2	-	-	-	-	1.9 ± 0.2	-	-	8
S05-4	12	<0.02	<0.02		<2	-	-	-	-	-	-	-	9
Inventory (Bq m^{-2})									**1.2 ± 0.4**	**22 ± 2**	**24 ± 3**	**400 ± 30**	
S06-1	2	0.03 ± 0.01	0.58 ± 0.05	0.28 ± 0.03	23 ± 1	0.052 ± 0.018	0.045 ± 0.05	0.025 ± 0.003	-	15.3 ± 1.3	6.9 ± 0.6	449 ± 26	8
S06-2	5	<0.03	<0.03	<0.03	<2	-	-	-	-	-	-	-	9
S06-3	10	<0.02	<0.02	<0.03	<2	-	-	-	-	-	-	-	9
S06-4	17	<0.06	<0.06	<0.03	<3	-	-	-	-	-	-	-	8
Inventory (Bq m^{-2})									-	**15 ± 1**	**7 ± 1**	**450 ± 30**	

Tab. S3. Activity concentrations of natural radionuclides (^{210}Pb, ^{234,238}U, ^{230,232}Th) expressed in Bq kg^{-1} and activity ratio of ^{234}U/^{238}U in soil profiles. Data for ^{210}Pb were corrected for August 2014, the sampling date.

soil	Depth (cm)	^{210}Pb (Bq/kg)	^{234}U (Bq/kg)	^{238}U (Bq/kg)	^{234}U/^{238}U	^{230}Th (Bq/kg)	^{232}Th (Bq/kg)
S01-1	2	65±2	23±2	22±2	1.0±0.1	17±1	32±3
S01-2	4	43±1	21±1	22±2	0.9±0.1	22±2	42±3
S01-3	6	15±1	22±2	23±2	1.0±0.1	9±1	8±1
S01-4	9	17±1	21±1	22±1	1.0±0.1	12±2	14±2
S01-5	13	15±1	21±1	22±1	1.0±0.1	-	-
S03-1	2	37±5	16±1	16±1	1.0±0.1	9±1	17±2
S03-2	4.5	15±4	16±1	15±1	1.1±0.1	10±1	18±2
S03-3	8	17±4	15±1	14±1	1.0±0.1	11±1	20±2
S03-4	12.5	16±4	17±1	14±1	1.2±0.1	10±1	19±1
S04-1	1	173±4	21±1	20±1	1.1±0.1	10±1	21±2
S04-2	4	31±1	20±1	18±1	1.1±0.2	10±1	27±2
S04-3	8	29±2	19±1	18±1	1.1±0.1	11±1	29±2
S04-4	12	27±3	21±1	20±1	1.0±0.1	10±1	29±2
S05-1	2	83±7	23±2	21±1	1.1±0.1	11±1	19±1
S05-2	4	57±8	28±2	30±2	0.9±0.1	15±1	34±3
S05-3	7	21±2	17±1	17±1	1.0±0.1	10±1	15±1
S05-4	12	18±2	15±1	16±1	1.0±0.1	10±1	20±2
S06-1	2	82±6	24±2	22±2	1.1±0.1	11±1	16±1
S06-2	5	21±4	14±1	13±1	1.0±0.1	10±1	17±1
S06-3	10	18±2	19±1	19±1	1.0±0.1	10±1	21±2
S06-4	17	19±2	13±1	12±1	1.1±0.1	9±1	13±1

Tab. S4. Activity concentrations of anthropogenic radionuclides (^{137}Cs, Pu isotopes, ^{241}Am) expressed in Bq kg^{-1} and radionuclide activity ratios and mass ratios in all cryoconite samples. All data were corrected for August 2014, the sampling date.

No.	^{137}Cs (Bq/kg)	$^{239+240}$Pu (Bq/kg)	^{238}Pu (Bq/kg)	^{241}Am (Bq/kg)	^{238}Pu/$^{239\pm240}$Pu	$^{239\pm240}$Pu/^{137}Cs	^{241}Am/$^{239\pm240}$Pu	^{240}Pu/^{239}Pu
2	642 ± 84	16.73 ± 1.12	0.80 ± 0.10	7.56 ± 0.54	0.048±0.007	0.026±0.004	0.45±0.04	0.159±0.002
3	1021 ± 136	16.93 ± 1.15	0.59 ± 0.08	7.52 ± 0.57	0.035±0.005	0.017±0.002	0.44± 0.05	0.145±0.001
4	2030 ± 257	33.54 ± 2.30	2.09 ± 0.22	18.77 ± 1.27	0.062±0.008	0.017±0.002	0.56±0.05	0.141±0.001
5	109 ± 22	1.59 ± 0.16	0.08 ± 0.02	1.04 ± 0.16	0.050±0.013	0.015±0.003	0.65±0.12	0.196±0.019
6	<3	0.09 ± 0.02	<0.03	<0.25	-	-	-	-
7	17 ± 7	0.12 ± 0.02	<0.02	<0.20	-	0.007±0.003	-	-
8	440 ± 58	7.20 ± 0.57	0.45 ± 0.07	3.02 ± 0.26	0.063±0.011	0.016±0.003	0.42±0.05	0.161±0.004
9	13 ± 3	0.47 ± 0.07	<0.04	0.25 ± 0.06	-	0.035±0.010	0.53±0.16	0.121±0.039
10	76 ± 13	2.88 ± 0.27	0.15 ± 0.06	1.45 ± 0.20	0.052±0.022	0.038±0.008	0.50±0.08	0.131±0.015
11	513 ± 88	7.40 ± 0.54	0.23 ± 0.04	1.80 ± 0.36	0.031±0.006	0.014±0.003	0.24±0.05	0.137±0.004
12	1886 ± 264	33.64 ± 2.33	2.08 ± 0.23	18.13 ± 1.24	0.062±0.008	0.018±0.003	0.54±0.05	0.140±0.001
13	1905 ± 266	42.77 ± 2.81	2.10 ± 0.20	24.48 ± 1.47	0.049±0.006	0.022±0.003	0.57±0.05	0.143±0.001

Tab. S5. Activity concentrations of natural radionuclides (^{210}Pb, ^{234,238}U, ^{230,232}Th) expressed in Bq kg^{-1} and activity ratio of ^{234}U/^{238}U in all cryoconite samples. Data for ^{210}Pb were corrected for August 2014, the sampling date.

No.	^{210}Pb (Bq/kg)	^{234}U (Bq/kg)	^{238}U (Bq/kg)	^{234}U/^{238}U	^{230}Th (Bq/kg)	^{232}Th (Bq/kg)	LOI (%)
2	3577±196	18±2	18±2	1.0±0.2	18±1	16±1	6
3	4460± 230	43±4	37±4	1.2±0.2	54±4	50±4	6
4	12269±634	34±3	36±4	0.9±0.1	45±3	48±4	11
5	1028±73	25±2	25±3	1.0±0.1	33±2	57±4	2
6	485±56	16±2	12±2	1.4±0.3	25±2	56±4	3
7	497±35	12±1	10±1	1.2±0.2	16±1	35±3	3
8	4443±224	22±2	23±2	1.0±0.1	27±2	51±4	8
9	1744±95	26±2	24±2	1.1±0.1	27±2	58±4	6
10	2739±142	20±2	20±2	1.0±0.1	27±2	54±4	7
11	5053±292	23±2	24±2	1.0±0.1	34±2	50±4	8
12	5081±259	39±3	31±3	1.3±0.2	47±4	47±4	11
13	5236±263	36±3	33±2	1.1±0.1	41±3	48±4	11

Table S6. Concentrations of measured metals in soil samples, together with $^{206}Pb/^{207}Pb$ and $^{208}Pb/^{206}Pb$ ratios. The calculated anthropogenic metal enrichment factors (EF) results are also given after normalization for Fe and Al content ($_{Fe\ norm}$ or $_{Al\ norm}$).

	Pb (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Cd (mg/kg)	Fe (g/kg)	Al (g/kg)	Cr (mg/kg)	Co (mg/kg)	Ni (mg/kg)	Mn (mg/kg)	$^{206}Pb/^{207}Pb$	$^{208}Pb/^{206}Pb$	EF Pb $_{Fe\ norm}$	EF Pb $_{Al\ norm}$	EF Zn $_{Fe\ norm}$	EF Zn $_{Al\ norm}$	EF Cu $_{Fe\ norm}$	EF Cu $_{Al\ norm}$	EF Cd $_{Fe\ norm}$	EF Cd $_{Al\ norm}$
S01-1	20.75	66.56	22.93	0.12	38.02	51.79	55.26	11.12	30.25	0.67	1.205	2.046	1.6	1.3	1.0	0.9	1.4	1.2	1.1	0.7
S01-2	21.13	75.26	26.57	0.05	42.91	64.47	61.20	12.37	32.22	0.83	1.205	2.035	1.4	1.1	1.0	0.8	1.4	1.1	0.4	0.4
S01-3	20.94	71.30	25.95	0.09	44.18	62.30	52.20	12.46	30.63	0.78	1.205	2.036	1.4	1.1	0.9	0.8	1.4	1.1	0.7	0.4
S01-4	19.19	65.67	23.88	0.60	39.95	58.99	53.61	11.74	28.16	0.87	1.203	2.048	1.4	1.1	1.0	0.7	1.4	1.1	5.3	3.1
S01-5	18.92	66.04	24.55	0.07	39.72	62.58	50.27	11.60	28.61	0.72	1.208	2.036	1.4	1.0	1.0	0.7	1.4	1.0	0.6	0.4
S05-1	14.73	58.41	16.90	0.10	26.18	47.41	33.24	8.86	60.27	0.49	1.206	2.036	1.6	1.0	1.3	0.8	1.5	1.0	1.3	0.6
S05-2	16.67	49.83	16.50	0.08	26.61	49.60	43.43	8.76	21.46	0.45	1.196	2.019	1.8	1.1	1.1	0.7	1.4	0.9	1.0	0.5
S05-3	9.59	45.80	12.24	0.27	27.46	37.19	28.85	6.13	18.70	0.39	1.211	2.039	1.0	0.9	1.0	0.8	1.0	0.9	3.4	2.2
S05-4	20.24	62.94	20.61	0.36	32.45	54.91	46.49	10.55	27.31	0.38	1.208	2.040	1.8	1.2	1.1	0.8	1.5	1.0	3.9	2.0
S06-1	10.07	48.05	12.95	0.21	35.62	42.22	32.47	7.23	23.86	0.35	1.209	2.030	0.8	0.8	0.8	0.8	0.8	0.8	2.1	1.5
S06-2	12.70	47.45	14.71	0.60	27.41	41.18	34.42	6.98	24.13	0.34	1.197	2.057	1.4	1.0	1.0	0.8	1.3	1.0	7.7	4.4
S06-3	15.51	50.78	26.18	0.50	28.58	38.52	46.85	10.67	28.86	0.52	1.217	2.050	1.6	1.3	1.0	0.9	2.1	1.8	6.2	3.9
S06-4	15.80	53.17	22.52	0.60	28.87	43.24	42.65	10.87	28.41	0.57	1.208	2.042	1.6	1.2	1.1	0.8	1.8	1.4	7.3	4.2
S04-1	25.91	76.89	19.59	0.34	28.72	47.41	38.47	8.53	21.83	0.40	1.190	2.027	2.6	1.8	1.6	1.1	1.6	1.1	4.2	2.2
S04-2	17.98	58.44	21.44	0.16	28.82	53.22	52.43	10.90	26.34	0.38	1.195	2.053	1.8	1.1	1.2	0.7	1.7	1.1	1.9	0.9
S04-3	17.14	53.07	20.73	0.14	28.91	59.96	62.65	10.86	26.23	0.46	1.196	2.036	1.7	1.0	1.1	0.6	1.7	0.9	1.6	0.7
S04-4	19.36	53.42	22.40	0.16	34.00	58.64	30.21	11.58	29.12	0.48	1.203	2.033	1.7	1.1	0.9	0.6	1.5	1.0	1.6	0.8
S03-1	11.57	45.09	11.83	0.22	20.85	40.20	36.12	5.37	15.01	0.35	1.190	2.025	1.6	1.0	1.3	0.7	1.3	0.8	3.6	1.6
S03-2	11.34	51.80	12.92	0.17	30.56	43.56	37.21	6.94	18.46	0.53	1.197	2.038	1.1	0.9	1.0	0.8	1.0	0.8	2.0	1.2
S03-3	12.91	59.38	14.37	0.15	30.32	38.73	33.39	6.79	20.99	0.57	1.200	2.014	1.2	1.1	1.1	1.0	1.1	1.0	1.8	1.2
S03-4	12.82	56.62	14.42	0.18	27.89	45.30	30.11	7.26	20.32	0.74	1.204	2.022	1.3	0.9	1.2	0.8	1.2	0.8	2.2	1.2

Table S7. The Pearson's correlation matrix for soil samples. Different heavy metals concentrations, $^{206}Pb/^{207}Pb$ and $^{208}Pb/^{206}Pb$ isotopic ratios, natural and anthropogenic radionuclide activity concentrations and organic matter content (LOI).

Soils	^{234}U	^{238}U	^{230}Th	^{232}Th	Cr	Pb	Cu	Zn	Cd	Co	Ni	Mn	Fe	Al	$^{206/207}Pb$	$^{208/206}Pb$	LOI	^{137}Cs	$^{239+241}Pu$	^{241}Am
^{210}Pb	**0.65**	**0.68**	**0.80**	**0.55**	**0.63**	**0.74**	**0.53**	**0.71**	0.05	**0.45**	**0.40**	**-0.39**	0.41	**0.51**	**-0.70**	0.03	0.32	**0.90**	**0.79**	**0.71**
^{234}U		**0.95**	**0.83**	**0.53**	**0.48**	**0.42**	0.31	**0.60**	-0.22	0.34	**0.42**	-0.14	0.32	0.36	**-0.57**	0.31	0.35	0.20	0.20	0.28
^{238}U			**0.77**	**0.50**	**0.46**	**0.42**	0.31	**0.57**	-0.20	0.32	0.39	-0.12	0.32	0.35	**-0.53**	0.29	0.36	0.08	0.21	0.32
^{230}Th				**0.80**	**0.75**	**0.63**	**0.57**	**0.82**	-0.05	**0.60**	**0.45**	-0.25	**0.56**	**0.64**	**-0.69**	0.22	0.26	-0.09	0.13	0.31
^{232}Th					**0.76**	**0.50**	**0.64**	**0.74**	-0.16	**0.73**	0.36	-0.23	**0.58**	**0.78**	-0.48	0.26	0.19	0.00	0.22	0.39
Cr						**0.73**	**0.86**	**0.88**	0.01	**0.88**	**0.51**	-0.15	**0.80**	**0.89**	**-0.62**	0.26	0.17	-0.33	-0.28	0.29
Pb							**0.82**	**0.71**	0.09	**0.59**	**0.48**	-0.40	**0.53**	**0.59**	**-0.78**	-0.08	0.25	0.46	0.47	**0.90**
Cu								**0.77**	0.11	**0.89**	**0.56**	-0.12	**0.73**	**0.80**	**-0.59**	-0.01	0.07	-0.12	-0.04	0.56
Zn									-0.01	**0.80**	**0.56**	-0.08	**0.75**	**0.84**	**-0.59**	0.21	0.30	0.35	0.41	**0.83**
Cd										0.04	-0.03	-0.08	-0.04	-0.10	-0.03	-0.25	-0.11	**0.74**	0.51	0.30
Co											**0.57**	0.04	**0.84**	**0.91**	-0.43	0.19	-0.04	-0.24	-0.18	0.42
Ni												-0.04	**0.49**	**0.48**	-0.54	-0.02	-0.01	-0.24	-0.16	-0.12
Mn													0.14	-0.09	0.51	0.09	-0.25	-0.30	-0.17	0.34
Fe														**0.82**	-0.45	0.19	-0.12	-0.42	-0.42	-0.03
Al															-0.50	0.31	0.05	-0.40	-0.16	0.42
$^{206/207}Pb$																0.06	-0.12	0.04	-0.02	0.49
$^{208/206}Pb$																	0.12	-0.19	-0.26	-0.08
LOI																		**0.70**	0.45	0.34
^{137}Cs																			**0.72**	**0.74**
$^{239+240}Pu$																				**0.98**

Table S8. Concentrations of measured metals in cryoconite samples, together with $^{206}Pb/^{207}Pb$ and $^{208}Pb/^{206}Pb$ ratios. The calculated anthropogenic metal enrichment factors (EF) results are also given after normalization for Fe and Al content ($_{Fe\ norm}$ or $_{Al\ norm}$).

	Pb (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Cd (mg/kg)	Fe (g/kg)	Al (g/kg)	Cr (mg/kg)	Co (mg/kg)	Ni (mg/kg)	Mn (mg/kg)	$^{206}Pb/^{207}Pb$	$^{208}Pb/^{206}Pb$	EF Pb $_{Fe\ norm}$	EF Pb $_{Al\ norm}$	EF Zn $_{Fe\ norm}$	EF Zn $_{Al\ norm}$	EF Cu $_{Fe\ norm}$	EF Cu $_{Al\ norm}$	EF Cd $_{Fe\ norm}$	EF Cd $_{Al\ norm}$
2	82.79	85.07	34.3	0.21	49.62	83.03	83.01	13.39	37.19	0.34	1.174	2.042	5.0	3.3	1.0	0.7	1.7	1.1	1.5	0.7
3	23.04	96.89	22.4	0.23	42.56	75.50	77.22	13.16	35.89	0.51	1.183	2.061	1.6	1.0	1.4	0.9	1.3	0.8	1.9	0.9
4	95.53	92.36	34.8	0.24	37.08	69.40	75.57	13.01	36.70	0.30	1.174	2.025	7.7	4.6	1.5	0.9	2.3	1.3	2.4	1.1
5	40.91	74.22	27.5	0.20	42.75	77.55	64.01	13.73	29.15	0.39	1.192	2.035	2.9	1.8	1.0	0.6	1.5	0.9	1.7	0.8
6	36.84	87.32	33.4	0.27	51.27	89.73	80.95	17.74	34.71	0.63	1.199	2.034	2.2	1.4	1.0	0.6	1.6	1.0	1.9	0.9
7	24.02	59.57	25.8	0.24	29.38	63.57	47.55	11.42	22.56	0.40	1.197	2.036	2.5	1.3	1.2	0.6	2.1	1.1	2.9	1.1
8	20.48	86.64	22.2	0.25	41.37	90.20	72.99	13.05	28.99	0.45	1.197	2.048	1.5	0.8	1.3	0.6	1.3	0.7	2.2	0.8
9	57.91	90.04	40.1	0.21	41.38	91.87	83.22	15.21	36.70	0.51	1.181	2.039	4.2	2.1	1.3	0.7	2.3	1.2	1.8	0.7
10	45.57	83.26	34.4	0.19	46.65	79.24	81.29	14.15	33.73	0.25	1.184	2.039	2.9	1.9	1.1	0.7	1.8	1.2	1.4	0.7
11	97.28	97.55	39.6	0.60	48.16	78.80	84.04	15.31	41.80	0.31	1.180	2.038	6.1	4.1	1.2	0.8	2.0	1.3	4.5	2.3
12	97.70	86.80	34.3	0.19	37.93	65.72	76.42	12.95	36.46	0.31	1.169	2.032	7.7	5.0	1.4	0.9	2.2	1.4	1.8	0.9
13	19.87	88.14	21.5	0.26	40.18	85.90	65.98	13.00	35.83	0.46	1.194	2.047	1.5	0.8	1.3	0.7	1.3	0.7	2.3	0.9

Table S9. The Pearson's correlation matrix for cryoconite samples. Different heavy metals concentrations, $^{206}Pb/^{207}Pb$ and $^{208}Pb/^{206}Pb$ isotopic ratios, natural and anthropogenic radionuclide activity concentrations, organic matter content (LOI), and some cryoconite characteristics: localization altitude, area and depth were taken into account.

Cryoconites	^{234}U	^{238}U	^{230}Th	^{232}Th	Cr	Pb	Cu	Zn	Cd	Co	Ni	Mn	Fe	Al	$^{206/207}Pb$	$^{208/206}Pb$	LOI	^{137}Cs	$^{239+241}Pu$	^{241}Am	^{238}Pu	Altitude	Area	Depth
^{210}Pb	0.56	**0.72**	**0.59**	-0.06	0.21	0.50	0.08	0.53	0.15	-0.29	0.41	-0.41	-0.18	-0.34	-0.55	-0.19	**0.77**	**0.80**	**0.72**	**0.70**	**0.75**	**0.64**	0.38	**0.68**
^{234}U		**0.94**	**0.96**	0.25	0.19	0.13	-0.22	0.57	-0.12	-0.32	0.40	-0.02	-0.19	-0.40	-0.44	0.31	**0.60**	**0.77**	**0.72**	**0.70**	**0.67**	**0.72**	0.43	0.24
^{238}U			**0.92**	0.26	0.19	0.20	-0.18	**0.60**	-0.03	-0.34	0.41	-0.16	-0.18	-0.36	-0.46	0.22	**0.64**	**0.79**	**0.72**	**0.70**	**0.68**	**0.73**	0.47	0.41
^{230}Th				0.36	0.18	0.16	-0.19	**0.58**	0.03	-0.22	0.42	-0.05	-0.15	-0.44	-0.39	0.21	0.53	**0.74**	**0.66**	**0.63**	**0.62**	**0.73**	0.32	0.17
^{232}Th					0.13	-0.23	0.04	0.27	0.09	0.44	0.05	0.27	0.06	0.25	0.27	-0.03	-0.02	-0.12	-0.19	-0.15	-0.17	-0.05	0.07	**-0.58**
Cr						0.52	**0.65**	**0.81**	0.22	**0.62**	**0.90**	-0.03	**0.77**	**0.53**	-0.55	0.03	0.22	0.05	0.04	-0.01	0.02	-0.22	-0.03	0.20
Pb							**0.78**	0.36	0.32	0.12	**0.67**	**-0.58**	0.16	-0.11	**-0.86**	**-0.58**	0.40	0.35	0.27	0.23	0.35	0.09	-0.17	0.44
Cu								0.28	0.30	0.51	**0.62**	-0.30	0.34	0.30	**-0.59**	**-0.59**	0.04	-0.15	-0.20	-0.21	-0.12	-0.43	-0.26	0.06
Zn									0.38	0.39	**0.86**	0.09	0.51	0.30	-0.44	0.26	0.49	0.40	0.36	0.30	0.30	0.25	0.20	0.25
Cd										0.29	0.42	-0.12	0.27	0.06	-0.03	-0.02	0.10	-0.05	-0.09	-0.15	-0.15	0.06	-0.17	0.09
Co											0.41	0.42	**0.74**	**0.78**	0.14	-0.15	-0.36	-0.49	-0.52	-0.53	-0.49	-0.56	-0.41	-0.37
Ni												-0.12	**0.59**	0.20	**-0.69**	-0.01	0.37	0.31	0.27	0.21	0.23	0.08	0.05	0.33
Mn													0.1	0.44	**0.59**	0.37	-0.41	-0.25	-0.22	-0.20	-0.28	-0.12	-0.02	-0.39
Fe														**0.67**	-0.05	0.14	-0.21	-0.29	-0.24	-0.28	-0.30	-0.38	-0.16	0.07
Al															0.24	0.13	-0.32	-0.51	-0.55	-0.55	-0.54	**-0.64**	-0.23	-0.21
$^{206/207}Pb$																0.24	-0.50	-0.48	-0.42	-0.37	-0.46	-0.17	0.01	-0.53
$^{208/206}Pb$																	-0.03	-0.06	-0.01	-0.05	-0.16	0.07	0.11	-0.11
LOI																		**0.82**	**0.81**	**0.79**	**0.83**	**0.67**	**0.60**	0.40
^{137}Cs																			**0.98**	**0.98**	**0.98**	**0.91**	**0.58**	0.57
$^{239+240}Pu$																				**0.99**	**0.98**	**0.90**	**0.69**	**0.60**
^{241}Am																					**0.98**	**0.90**	**0.73**	0.57
^{238}Pu																						**0.87**	**0.63**	**0.58**
Altitude																							0.57	0.40
Area																								0.37

Table S10. Results (H, p values) of Kruskal-Wallis test showing differences in heavy metals concentrations and radionuclide activity concentrations between cryoconites and soils. Statistically significant differences are bolded.

	^{210}Pb	^{137}Cs	$^{239+240}Pu$	^{241}Am	^{234}U	^{238}U	^{230}Th	^{232}Th	Cr	Pb	Cu	Zn	Cd	Co	Ni	Mn	Fe	Al	$^{206/207}Pb$	$^{206/207}Pb$	LOI
H	22.2	8.0	6.3	9.3	4.7	4.6	20.7	16.4	19.8	18.5	13.7	19.2	2.0	19.8	11.3	5.2	12.9	21.9	14.9	0.4	3.2
p	**.00**	**.00**	**.01**	**.00**	**.03**	**.03**	**.00**	**.00**	**.00**	**.00**	**.00**	**.00**	.16	**.00**	**.00**	**.02**	**.00**	**.00**	**.00**	**.05**	.07