ANALYSIS OF THE ASH WEIGHT AND ELEMENTAL COMPOSITION IN CARIBOU (*RANGIFER TARANDUS*) FAECAL PELLETS COLLECTED AT COLOMAC AND OTHER SITES IN THE NWT

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ABSTRACT

Barren-ground caribou (*Rangifer tarandus*) faecal pellets were collected from several sites in the NWT and analysed for evidence of exposure to major dust and soil sources using two methods. The collection sites included two areas of tailings at the Colomac mine (abandoned), with on-site and off-site control areas and seasonal ranges, and sites at or near the Ekati and Diavik diamond mines. Insoluble ash content of the faecal material averaged 9.3% of the dry matter (D.M.) and varied significantly between sites. A group of samples from the tailings areas at Colomac had elevated ash contents and exceeded 30% of dry matter in five samples. Based on several assumptions, the dietary soil intake necessary to achieve the high ash contents in the faecal samples from Colomac would exceed 50% of the diet in one sample. The average ash content of all the samples collected from the tailings area at Colomac was significantly ($p<0.05$) higher than the off-site control samples. Ash from the faecal pellets was chemically similar to tailings collected at Colomac. Consistent differences were also observed between the Ekati samples and those from natural range areas, although the variance explained by the associations was relatively low. The results of the study are generally consistent with published reports on high rates of soil ingestion at lick sites by ungulates. This ingestion can result in very high levels of soil in the diet, similar to the maximum levels noted here. The ecological risk assessment for Colomac included an explicit soil ingestion model for caribou which assumed an ingestion rate of 20% of the diet. The data in the present study support the use of this average value but indicate that maximum values may range as high as 50% in some caribou. The study was not designed to describe the amount of the elements absorbed by caribou which have ingested the tailings.

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INTRODUCTION

Aboriginal elders have consistently raised concerns about the possible effects of exposure to dust from mines on caribou *Rangifer tarandus groenlandicus* from the Bathurst herd. The mines include the operating mines Lupin, Ekati and Diavik, that are situated on the spring migration and post calving migration ranges, and the abandoned Colomac mine that is situated on the winter range. The concerns are that the wind deposits mine dust on plants which are then eaten by caribou. The chemical constituents of the dust vary between the different mine sites, however, the composition of the dust source (tailings, road and waste rock pile material) is mostly known. In contrast, baseline information on the uptake of dust and soil by caribou is lacking.

Dust is a part of the caribou's environment, being blown by the wind from eskers and bare ground and kicked up by the hooves of the caribou themselves. Although we refer to such dust as "natural", we are not judging whether it is desirable or not (in the sense of Chew and Laubichler 2003). However, concerns have been expressed about dust from tailings and roads which can have elevated levels of certain elements (Ford and Hasselbach 2001, Macdonald 2003) and could be additive to background levels in the caribou. We have data on the levels of some metals in caribou organs (Elkin and Bethke and 1995) and muscle (Elkin unpubl. data) collected in the mid-1990s (before the construction of the diamond mines).

Remediation of the tailings is being planned for Colomac, Tundra and Ekati which are situated on the Bathurst caribou herd's range and the assessment of appropriate tailings management is ongoing. A major component of the remediation plan is the analysis of risk from the contamination to humans and the environment[1]. Risk analysis includes estimating the risk to caribou from eating lichen and vascular plants that may be contaminated. The exposure model also included possible ingestion of tailings by the caribou, at a level of 20% of the diet. The analysis provided an estimate of the levels of contamination to which the caribou could be exposed, but also the levels of contamination transferred to humans consuming the exposed caribou.

Observations at Colomac suggested that the 20% tailings intake used in the risk assessment might be an underestimate. Throughout the 2002 and 2003 winter, caribou were in the vicinity of Colomac mine and were cratering through the snow on Tailings Lake and Spruce Lake (solid tailings). We suspected that the caribou were attracted by the higher levels of sodium in the tailings water and solid tailings. In April 2003, caribou were observed in the tailings area and are now known to drink water or feed on tailings at the open areas in the ice covering the tailings area.

Herbivores will deliberately eat mineral soil. Uptake also occurs accidentally from soil on roots, and soil that has washed or blown onto leaves (Beyer *et al.* 1994). Soil ingestion is known at mineral licks on the Bathurst caribou herd's calving grounds. Caribou crater in snow on lakes to lick ice and congregate where there is overflow on lakes and also to lick the ice. The assumption is that the caribou are responding to their physiological need for sodium (Heard and Williams 1990, Gunn and Miller unpublished data). Levels of sodium (and calcium sulphate) were higher in areas where caribou were licking ice and in overflow than in clear lake ice.

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[1]Indian and Northern Affairs. 2004. Colomac Remediation Plan. Supporting Document I. Ecological and Human Health Risk Assessment. Contaminated Sites Office. Yellowknife, NT.

We needed to measure whether the 20% soil intake was a valid assumption in the risk assessment. We also needed to measure levels of inorganic uptake and constituent minerals across the annual ranges. The data will be used to support the exposure assessment in the remediation plan or to indicate whether further work is needed to describe caribou exposure to contaminants from exposure to dust.

This report summarizes the analysis of ash measured in caribou faecal pellets collected in 2003. The goal is to determine the exposure to dust across the Bathurst herd's annual range (indexed by faecal pellet levels) and at tailings and dust sources at known contamination sources, such as Colomac, and to test some of the assumptions used for the ecological risk assessment.

The study objectives are:

1) to determine if there are significant differences in the insoluble ash content between sites that can be attributed to exposure to tailings or known dust sources. The null hypothesis is that there is no significant difference between sites. In general, individual samples with ash weights significantly greater than 5% of dry matter probably indicates a major source of inorganic matter in the diet.
2) To determine if there is a similarity between the metal composition of the ash in the pellets and in tailings or dust samples analyzed in the same manner. This similarity will be determined by comparison of metal ratios and using principal component analysis (similar to the approach used in multi-component pollutant studies with organochlorine pesticides).

METHODS

We searched for and collected fresh fecal pellets in the vicinity of caribou either opportunistically or using the locations of satellite-collared caribou cows to find the caribou. At each site in April, fecal pellets from 10 separate groups were individually collected on 15 April 2003 while on 9 April the pellets from between 5 and 10 groups were combined as a composite sample for each site. Subsequently, we collected as many pellets from each ‘group’ as possible which then constituted an individual sample. The samples were placed in brown paper envelopes, except for winter (April) samples which were air-dried or placed in plastic bags and frozen. The July samples had surface dust adhering to some pellets (the caribou were milling and stirring up dust); we washed the pellets with tap water and to remove the surface dust and air-dried them. For Ekati and Diavik diamond mines, we requested that the environmental staff collect samples during the course of their caribou monitoring studies (Table 1). The samples were shipped to Activation Laboratories, Ancaster, Ontario (http://www.actlabs.com/) for analysis of ash and metal content.

Faecal pellets were heated at 100 ^{o}C, then ashed at 450 ^{o}C for 8 h to remove all organic material. Dried faecal material (100 ^{o}C) was analysed for metal content by aqua regia digestion (concentrated HCl and nitric acid) using Actlabs Ultratrace 1 digestion and analysis process. Mineral phases which are slightly dissolved with aqua regia include barite, zircon, monazite, sphene, chromite, gahnite, garnet, ilmenite, rutile and cassiterite. The balance of silicates and oxides are only slightly to moderately attacked, depending on the degree of alteration. Generally, most base metals and gold are usually dissolved if the sample is ground finely enough. This digestion method is slightly more aggressive at liberating metals from a mineral matrix than the standard USEPA methods with nitric acid alone.

Ultratrace 1 analysis involved the digestion of a 0.5 g sample in aqua regia at 90°C in a microprocessor controlled digestion box for 2 hours. The solution was diluted and analyzed by ICP/MS using a Perkin Elmer SCIEX ELAN 6100. International certified reference materials GXR-1, GXR-2, GXR-4 and GXR-6 from the U.S. Geological Survey were analyzed at the beginning and end of each batch of samples. Internal control standards were analyzed every 10 samples and a duplicate was run for every 10 samples.

Ash was then digested following the method of Beyer *et al*. (1994) to determine acid insoluble ash content. The product from the 450 ^{o}C digestion was extracted with 6N HCl, filtered through ashless filter paper, heated at 600 ^{o}C and re-weighed.

After ashing at 600 ^{o}C, the ash was digested using a four-acid digestion of hydrochloric (HCl), nitric (HNO_3), perchloric ($HClO_4$) and hydrofluoric acids (HF) to extract a larger proportion of the metals from the minerals present. Metals from some minerals may not go into solution with this digestion, however a larger proportion of metals are dissolved than in the aqua regia digestion. Some metals may also be volatilized using this process however all data are included in this report for comparison with tailings samples analysed in the same fashion. Following the four-acid digestion, the digest was analysed for 63 metals using the Perkin Elmer-SCIEX ELAN 6000 ICP/MS. The detection limits for selected metals analysed by the Ultratrace 1 and 4 methods are shown for comparison in Table 2.

Statistics

Ash weights and elemental concentrations were analysed using Systat 9.01 (Systat Software Inc, Port Richmond, California). Values of one-half the detection limit were used to estimate means for those samples with non-detectable values. Sets of samples with more than half the samples below detection limit are listed as below detection. Metal concentration data are reported as geometric means (GM) with geometric standard deviations (GSD). All means tests were made using Scheffé's range test.

Principal components analysis (PCA) was performed with Sirius Version 6.0 (Pattern Recognition Systems AS, Bergen, Norway). Random numbers between zero and the detection levels were used for non-detectable values to maintain normal distributions. The concentration data reported for each digestion method were normalised to the total metals to remove the influence of concentration and standardized (autoscaled) prior to PCA.

RESULTS

Fecal pellet collection

In 2003, we collected and analyzed 204 pellet groups from across the seasonal range and at (or close to) three mine sites (Table 1 and Figure 1). In late winter, we collected fecal pellets at Colomac mine site and vicinity. In June, during helicopter flights associated with the Bathurst herd census on the calving grounds, we opportunistically picked up fecal pellets at an esker (Wright River) and in a sedge-birch shrub meadow on the south Bank of the Hood River. The two sites on the calving ground were 100-150 km from the nearest mine (Lupin gold mine).

Table 1. Sampling site locations and dates for collecting caribou faecal pellet samples in the range of Bathurst caribou herd, NWT in 2003.

Site	Site name	Latitude	Longitude	Sample date	No. of samples	Comments
Colomac	Spruce Lake	64,26.014	115, 3.142	15 Apr/03	10	Solid tailings
	Spruce Lake	64,25.907	15, 3.063	9 Apr/03	2	Solid tailings
	Tailings Lake	64,26.863	115, 3.322	15 Apr/03	17	Solid tailings
	Steeves Lake	64,23.743	115, 7.072	15 Apr/03	10	On site control
	Chartrand Lake	64,26.081	115,28.063	15 Apr/03	10	Off site control
	Control Lake	64,24.172	115,15.071	15 Apr/03	10	Off site control
	Overflow			15 Apr/03	10	On site control
	Paddle Lake	64,26.302	15, 1.540	9 Apr/03	13	On site control
	Lake 315	64,26.014	115, 0.254	9 Apr/03	1	On site control
	Unknown Lake / Wetland B	64,27.815	115, 2.202	9 Apr/03	4	On site control
Calving Grounds	Wright River	66,48	110, 24	19 Jun/03	12	
	Site 31	66, 54	109, 26	18 Jun/03	10	
Summer Range (MacKay Lake)	Site 7	63, 55.79	109, 58.69	26 Jul/03	20	
	Site 8	63, 45.31	111, 08.46	26 Jul/03	25	Caribou had stirred dirt and dust up
Fall Range	Seahorse Lake	64, 19.69	111, 08.19	24 Oct	36	
Ekati Mine	Mine 23	64, 40.14	110, 41.64	23 Jul	4	
	Pultzer Pond	64, 44.04	110, 37.62	22 Sep	1	
	Airport	64, 42.72	110, 36.24	16 Aug	2	
	North of Ekati	64, 45.06	110, 31.32	22 Sep	4	
	Unnamed location	64, 45.36	110, 33.48	4 Aug	2	
Diavik	Site #1	64, 33.78	109, 53.76	7 Aug	4	
	Site #2	64, 19.20	110, 34.56	8 Aug	3	
	Site #3	64, 17.82	110, 14.04	9 Aug	1	
	Site #4	64, 31.20	109, 58.68	10 Aug	3	

Table 2. Comparison of detection limits for elements common to the two digestion methods used in the present study. The aqua regia digestion method was used on the dried material from the caribou faecal pellets, while the more aggressive digestion was used on the ash following 600 ^{o}C.

Element	Aqua Regia Detection Limit	Four Acid Digestion Detection Limit
Au	0.2 ppb	0.2 ppb
Ag	0.05	0.05
Cu	0.1	0.2
Cd	0.1	0.1
Mn	1	1
Mo	0.01	1
Pb	0.01	0.5
Ni	0.1	0.5
Zn	0.1	0.5
As	0.1	0.5
Ba	0.5	1
Sb	0.02	0.1
Al	0.01%	0.01%
Be	0.1	0.1
Bi	0.02	0.1
Ca	0.01%	0.01%
Ce	0.01	0.1
Co	0.1	0.1
Cr	0.5	1
Cs	0.1	0.05
Eu	0.1	0.1
Fe	0.01%	0.01%
Ga	0.02	0.1
Ge	0.1	0.1
In	0.02	0.1
K	0.01%	0.01%
Li	0.5	0.5
Lu	0.1	0.1
Mg	0.01%	0.01%
Na	0.001%	0.01%
Rb	0.1	0.2
Re	0.001	0.001
Se	0.1	0.1
Sn	0.05	1
Sr	0.5	1
Ta	0.05	0.1
Tb	0.1	0.1
Te	0.02	0.1
Th	0.1	0.1
U	0.1	0.1
V	1	2
Zr	0.1	1

In July, we collected samples in the vicinity of caribou milling in large groups (100s) in response to warble fly harassment. The sites were 30-60 km west and east of Snap Lake (proposed diamond mine) and about 90 km south of the Ekati diamond mine. The fall samples were collected on snow-covered ground as the caribou were migrating toward the treeline and were about 50 km southwest of Ekati, the nearest mine site.

Ash weights

The raw dry weight and ash weight data for the individual sites (Table 3 and Figure 1) reveal a wide range of values, with the mean levels reaching a maximum in the Colomac tailings samples, Ekati samples and the calving ground samples. Dry weight comprised 0.483 (SD = 0.29) of sample wet weight for all samples (n=204), with a range of 0.11 to 0.94. Mean ash (450 ^oC) content of the dry matter was 0.093 (SD = 0.074) at 450 ^oC and 0.044 (SD=0.064) at 600 ^oC. Ash weights ranged from 0.032 to 0.664 at the lower ashing temperature and 0 (too low to quantify) to 0.554 at 600 ^oC. The maximum values of 0.664 (66.4%) and 0.554 (55.4%) were observed in one sample collected from the Spruce Lake area of the Colomac site.

The distribution of ash weights (as a fraction of dry matter) for the samples from all sites (n=204) showed the majority of samples ranged from 5% to 10% ash content in feacal dry matter however several samples had substantially higher ash fractions (Figure 2). The samples with higher ash fractions included four samples from the Spruce Lake area of Colomac, one from the Tailings Lake area of Colomac and two samples from Ekati.

Samples were placed in general categories outlined in Table 4 for broad comparisons of sites using Scheffé’s means test. Mean values are also graphed in Figure 3 and the results of the means tests shown in Table 5. As a group, the samples collected on the Colomac tailings site were significantly higher ($p = 0.006$) than the off-site control samples. The ash weights of the Ekati mine samples were also significantly greater ($p < 0.05$) than several background sites.

The individual sites also showed differences in the distribution of ash weights between individual samples. Of the sites with elevated mean ash fractions, the Wright River samples were relatively uniform, with all samples falling within a range of 0.10-0.20 of dry matter. However, the Colomac tailings samples were generally in the 0.05-0.10 range, but included four individual samples exceeding 0.40, including the highest ash in the study at 0.664. These higher levels of ash in the Colomac samples indicate a significant source of insoluble material in the diet and may indicate elevated levels of soil ingestion by these particular animals. Contamination of the pellets from the external environment is unlikely for the Colomac samples because the samples were collected in the winter when dust sources and nearby tailings were covered in ice and snow. The relatively high ash levels at the Wright River site on the calving ground may have been an anomaly due to dust adhering to the samples (they were not rinsed) since the collection site was a sandy esker.

Table 3. Sample wet weight, dry weight at 100 ^oC, ash weight at 450 ^oC and ash weight at 600 ^oC, with calculated fractions of ash as a fraction of dry weight. All weights are in grams.

Collection Site	Category	Location	n	Sample Wet Weight (g)		Sample Dry Weight (g)		Fraction Dry Weight (dry wt/ wet wt)		Ash Sample Weight (450 ^oC) (g)		Fraction Ash Weight (450 ^oC) (Ash wt/ dry wt)	Ash Sample Weight (600 ^oC) (g)		Ash (600^o) Fraction of dry weight
				Mean	SD	Mean	SD	Mean	SD	Mean	SD		Mean	SD	
Colomac	Tailings	Spruce L.	10	2.155	0.121	0.872	0.194	0.403	0.080	0.207	0.215	0.229	0.159	0.188	0.175
	Tailings	Tailings L.	18	3.254	0.167	0.749	0.152	0.230	0.047	0.056	0.032	0.078	0.020	0.031	0.027
	On-site control	Steeves L.	11	2.360	0.150	0.804	0.167	0.342	0.072	0.053	0.022	0.067	0.027	0.015	0.034
	Off-site control	Chartrand L.	10	2.294	0.150	0.963	0.235	0.420	0.099	0.040	0.009	0.041	0.010	0.004	0.010
	Off-site control	Control L.	11	2.458	0.109	0.888	0.164	0.361	0.065	0.042	0.009	0.047	0.012	0.005	0.013
	On-site control	Overflow	10	2.322	0.160	0.883	0.125	0.384	0.075	0.066	0.016	0.074	0.031	0.011	0.035
	Tailings	Spruce L.	2	2.664	0.098	0.557	0.183	0.208	0.061	0.064	0.049	0.107	0.039	0.045	0.061
	On-site control	Paddle L.	14	2.676	0.195	0.471	0.128	0.177	0.050	0.040	0.012	0.088	0.009	0.007	0.018
	On-site control	Lake 315	1	2.312	-	0.490	-	0.212	-	0.025	-	0.051	0.009	-	0.018
	On-site control	Wetland B	4	2.703	0.249	0.546	0.099	0.202	0.030	0.024	0.008	0.044	0.006	0.008	0.010
Calving Ground – Natural Diet	Background - lichen	Wright R	12	2.379	0.483	2.15	0.433	0.904	0.017	0.323	0.120	0.153	0.222	0.117	0.105
		Site 31	11	2.854	0.203	0.822	0.125	0.289	0.042	0.124	0.022	0.151	0.051	0.022	0.063
Summer Range	Background – green plant	MacKay L (Site 7)	21	2.555	0.499	2.36	0.461	0.925	0.003	0.157	0.033	0.067	0.061	0.023	0.026
		MacKay L (Site 87)	23	2.251	0.718	2.10	0.669	0.932	0.003	0.151	0.049	0.073	0.059	0.025	0.028
Seahorse	Fall - lichen	Seahorse L	21	2.963	0.305	0.824	0.110	0.278	0.025	0.067	0.012	0.081	0.034	0.009	0.041
Ekati	Mine	Mine 23	4	2.786	0.245	1.13	0.328	0.412	0.139	0.183	0.066	0.185	0.109	0.065	0.116
		Pulitzer Pond	1	3.294	-	1.02	-	0.309	-	0.387	-	0.380	0.290	-	0.285
		Airport	2	3.048	0.120	2.06	0.710	0.681	0.260	0.166	0.061	0.080	0.075	0.034	0.036
		N. of Ekati	4	2.832	0.338	1.053	0.221	0.380	0.113	0.108	0.024	0.102	0.050	0.016	0.048
		Unnamed Location	2	3.080	0.925	1.64	0.641	0.590	0.385	0.165	0.069	0.100	0.082	0.040	0.049
Diavik	Mine	Site #1	5	2.847	0.395	0.779	0.207	0.272	0.045	0.055	0.010	0.072	0.009	0.003	0.012
		Site #2	3	2.666	0.060	0.874	0.329	0.327	0.118	0.074	0.045	0.081	0.023	0.022	0.023
		Site #3	1	2.854	-	2.00	-	0.701	-	0.129	-	0.065	0.043	-	0.022
		Site #4	3	2.730	0.238	0.718	0.161	0.261	0.036	0.066	0.009	0.093	0.021	0.004	0.030

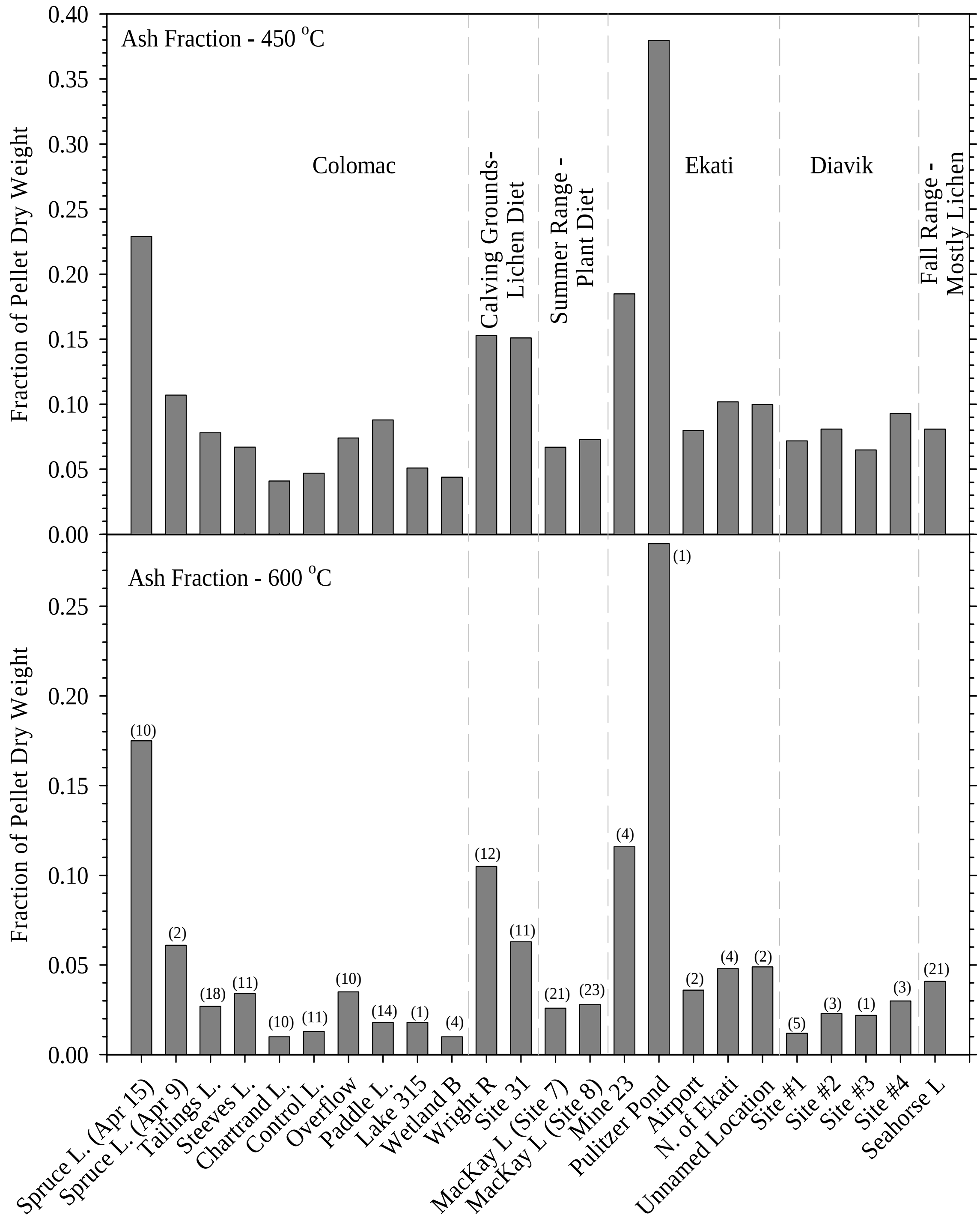


Figure 1. Mean fractions of ash at 450 and 600 °C as a fraction of dry matter. Numbers in brackets are sample sizes.

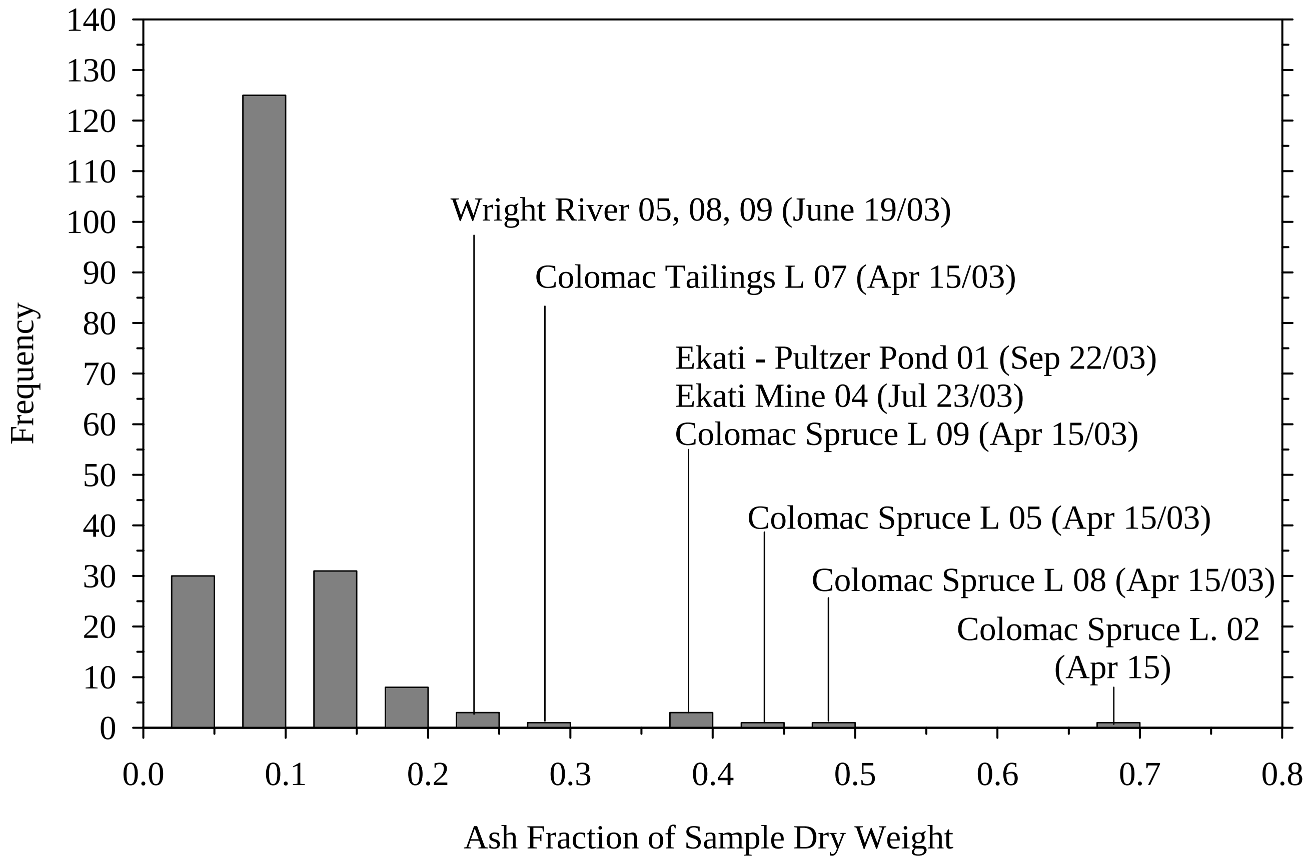


Figure 2. Frequency distribution of the ash weight fractions for all caribou faecal pellets (n=204) collected in this study. Locations and sample numbers of samples with substantially elevated ash fractions are identified.

Table 4. Pooled data for the respective groupings of samples shown in Table 1. Ash fraction was calculated by dividing ash sample weight (450 or 600 ^{o}C) into sample dry weight (100 ^{o}C).

Location	Sample Type	n	Sample Dry Weight (g)		Sample Dry Weight Fraction		Sample Ash Weight (450 ^{o}C)		Ash Weight Fraction (450 ^{o}C)		Sample Ash Weight (600 ^{o}C) (g)		Ash Weight Fraction (600 ^{o}C)	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Colomac	Tailings	30	0.777	0.183	0.286	0.103	0.107	0.142	0.131	0.150	0.067	0.126	0.079	0.136
	On-site control	40	0.674	0.224	0.278	0.109	0.048	0.021	0.073	0.025	0.019	0.015	0.026	0.016
	Off-site control	21	0.924	0.200	0.389	0.086	0.041	0.009	0.044	0.005	0.011	0.004	0.011	0.003
Calving ground	Lichen Diet	23	1.514	0.748	0.610	0.316	0.228	0.134	0.152	0.038	0.140	0.121	0.085	0.046
Summer range	Green Plant Diet	44	2.224	0.588	0.928	0.005	0.154	0.042	0.070	0.011	0.060	0.024	0.027	0.008
Fall - lichen diet	Lichen diet	21	0.824	0.110	0.278	0.025	0.067	0.012	0.081	0.010	0.034	0.009	0.041	0.008
Ekati	Mine samples	13	1.320	0.516	0.463	0.204	0.170	0.085	0.145	0.104	0.095	0.073	0.085	0.087
Diavik	Mine samples	12	0.889	0.407	0.318	0.137	0.069	0.029	0.079	0.014	0.018	0.014	0.020	0.010

Table 5. Statistical comparison of ash fractions at 600 ^{o}C using Systat 9.0 following square root transformations. Reported values are probabilities that the pellet sources are significantly different (values where $p < 0.05$ are considered to be significant). Mean values are graphed in Figure 3.

	Diavik	Ekati	Fall - Lichen Diet	Colomac - Off-site Controls	Calving Grounds - lichen	Colomac - On-Site Controls	Summer Plant Diet	Colomac Tailings
Diavik	1							
Ekati	0.053	1						
Fall - Lichen Diet	0.767	0.679	1					
Colomac - Off-site Controls	0.994	0.000	0.084	1				
Calving Grounds - lichen	0.006	1	0.292	0.000	1			
Colomac - On-Site Controls	1	0.013	0.678	0.824	0.000	1		
Summer Plant Diet	0.998	0.041	0.898	0.525	0.001	1	1	
Colomac Tailings	0.408	0.869	1	0.006	0.506	0.173	0.417	1

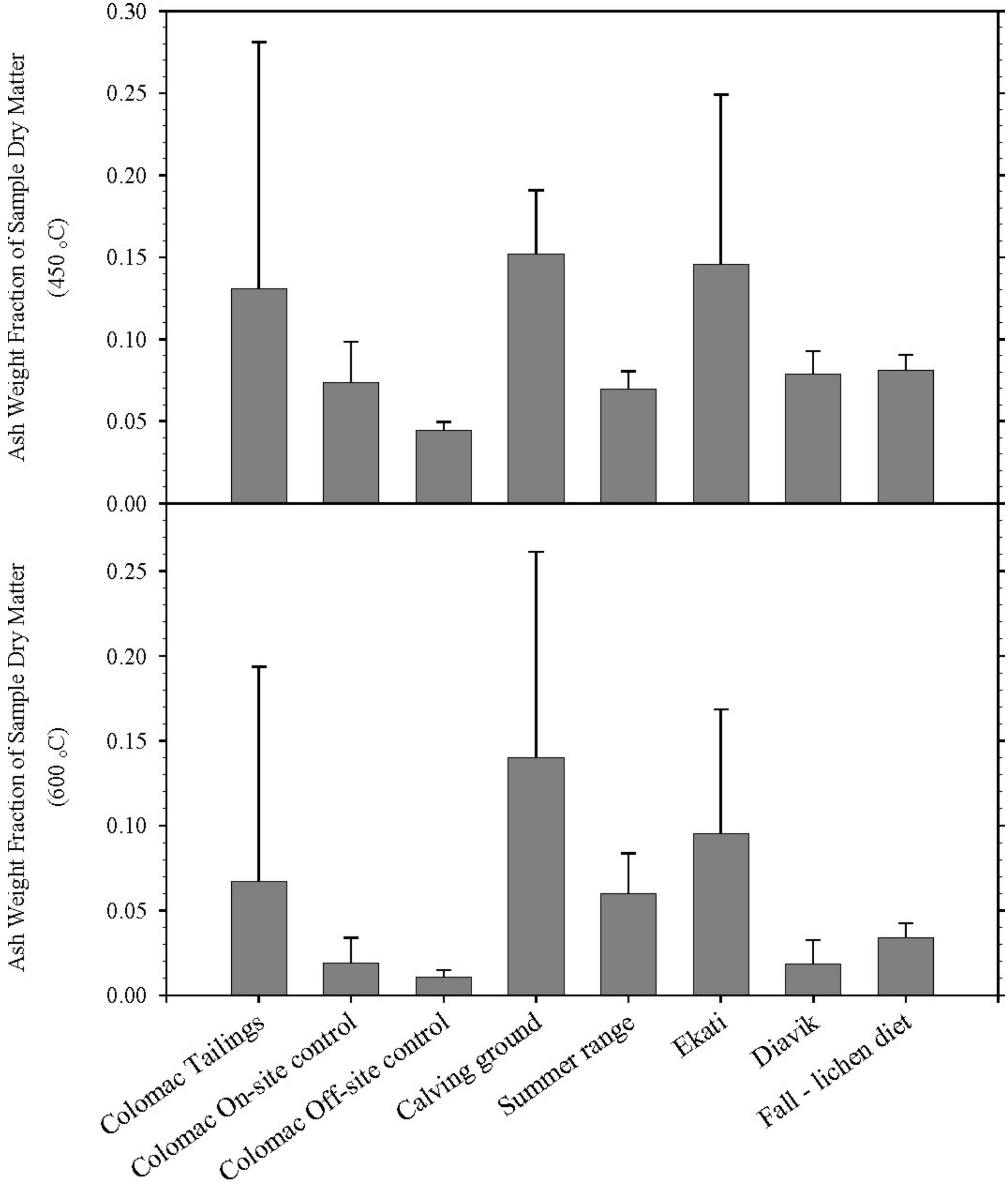


Figure 3. Mean values (with ±1 SD) of ash fractions for general categories of faecal pellets. Categories correspond to the values in Table 3. Statistical comparisons are given in Table 5.

The ash content of the dry faecal material was used to roughly estimate the levels of soil in the diet of the animals using the equation of Beyer *et al*. (1994):

Fraction of soil in the diet (x) = (b – y + ay)/(ay – c + b) equation 1

Where: a = digestibility of food (dry mass),
b = concentration of acid insoluble ash in food (dry mass),
c = concentration of acid insoluble ash in soil (dry mass),
y = acid insoluble ash in faecal pellets.

Assuming a digestibility of 50% for lichen, 95% ash (indigestible matter) in the tailings and 2% ash in lichen, the estimated soil content in the diet of the samples collected at Colomac ranged from 0 (i.e., all soil in the pellets is from the lichen component) to >50% of the diet in one sample from the tailings site (Figure 4). The mean soil ingestion rate was estimated to be 3.4% of the diet for the grand mean (n=204) ash content of 9.3%, but declined to 2.3% if the five high ash content samples from Colomac and the Ekati mine were removed. The grand mean estimate (2.3%) closely corresponds with the assumed values of 2% soil ingestion used by Beyer *et al*. (1994) for soil ingestion by ungulates however the maximum levels are much higher than those reported for ungulates in general. The higher levels observed in some samples indicate a significant source of soil in the diet.

Metal Analysis

The effect of the two types of acid digestion on the concentrations of individual metals was determined by comparing the concentrations of the metals in reference materials analysed with the pellet ash samples. A list of the metals analysed is given in Table 6. A comparison of the elemental concentrations from the two types of digestion of control samples showed good agreement with the reference values for most elements (Figure

5). Similarly, the analysis of three samples from the tailings samples from Tailings and Spruce lakes at Colomac show good agreement between the two types of digestion, however several metals were substantially higher using the four acid digestion method (Figure 6). Sodium (Na) was approximately 40 times higher with the four acid digestion in tailings from both sites, while aluminum (Al) was about 5 times higher.

Raw metal data in faecal pellet ash for the individual collection sites using the two digestions methods are listed in Appendix A and are summarised to the general collection category in Table 7. Units for the concentrations are reported in percentages for the major ions, $mg \cdot kg^{-1}$ or ppm for the majority of elements and $\mu g \cdot kg^{-1}$ or ppb for gold.

Principal component analysis (PCA) was performed on the metal concentrations of each of the digestion methods. The first two components (Figure 7) of the aqua regia digest explained 54.6% of the variance, with the six samples of tailings being separated by PC 1. Five of the Spruce Lake faecal samples and one of the Tailings Lake faecal samples showed some similarity with the raw tailings samples, largely on the basis of components such as As, Th, and Fe. Other Colomac samples were modelled largely on the basis of higher proportion of gold in the samples. PC 2 and PC 3 (Figure 8) explained 25.4% of the variance and modelled a subset of the Ekati mine samples, the Diavik samples and background lichen diet. The Ekati samples were modelled largely on the basis of Zn, Sr, Ba, Ni and Mg with these two components.

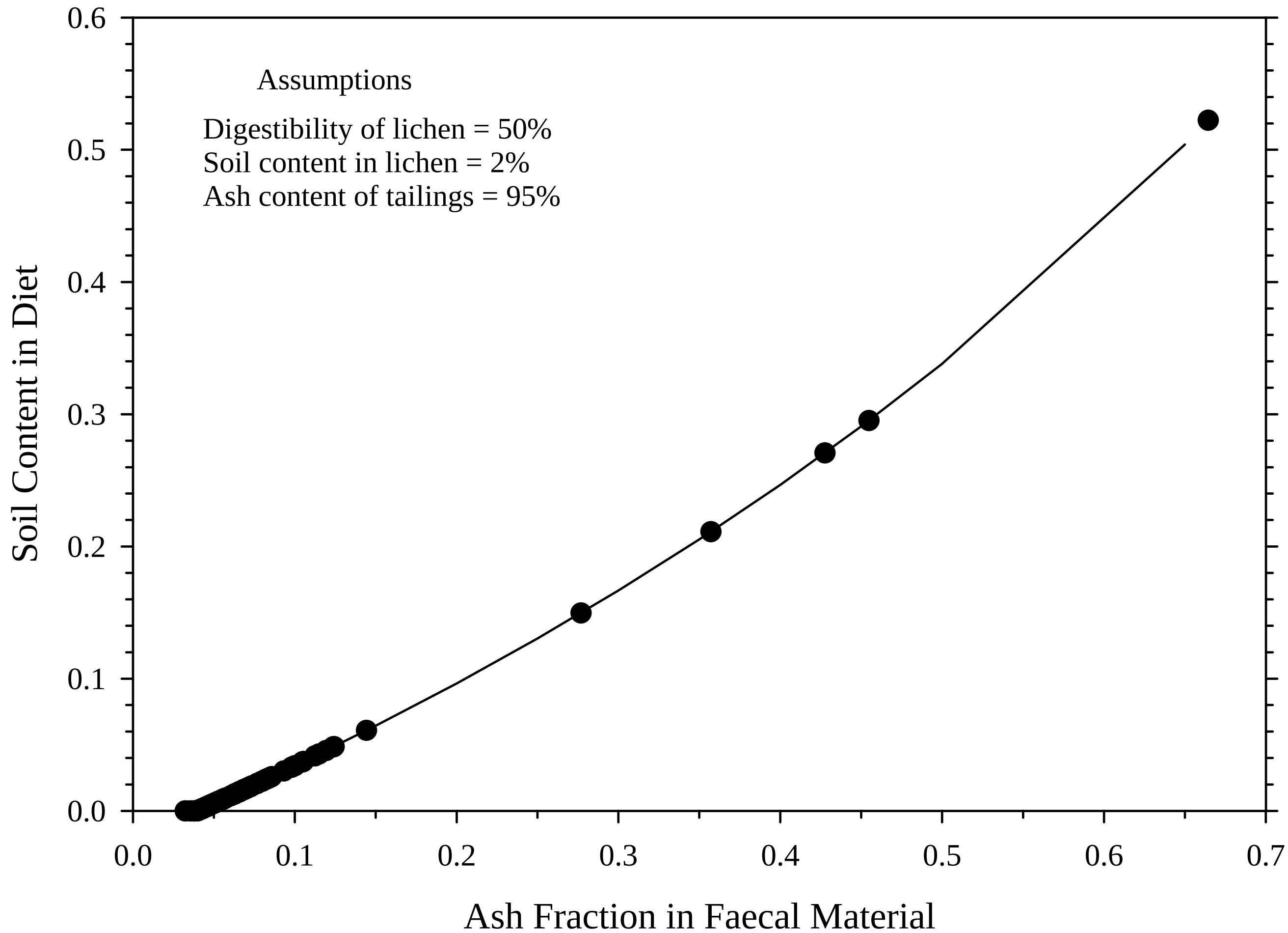


Figure 4. Estimation of soil in diet from the ash content of faecal pellets. Symbols represent samples collected in control and tailings areas at Colomac; the line indicates the estimated relationship from the soil ingestion equation of Beyer *et al*. (1994).

Table 6. List of elements analysed in the ash samples using the two digestion methods. Scandium (Sc) and gold (Au) were only reported for the aqua regia digestions.

Symbol	Element	Symbol	Element
Ag	Silver	Mn	Manganese
Al	Aluminum	Mo	Molybdenum
As	Arsenic	Na	Sodium
Au	Gold	Nb	Niobium
B	Boron	Nd	Neodymium
Ba	Barium	Ni	Nickel
Be	Beryllium	Pb	Lead
Bi	Bismuth	Pr	Praseodymium
Ca	Calcium	Rb	Rubidium
Cd	Cadmium	Re	Rhenium
Ce	Cerium	Sb	Antimony
Co	Cobalt	Sc	Scandium
Cr	Chromium	Se	Selenium
Cs	Cesium	Sm	Samarium
Cu	Copper	Sn	Tin
Dy	Dysprosium	Sr	Strontium
Er	Erbium	Ta	Tantalum
Eu	Europium	Tb	Terbium
Fe	Iron	Te	Tellurium
Ga	Gallium	Th	Thorium
Gd	Gadolium	Tl	Thallium
Ge	Germanium	Tm	Thulium
Hf	Hafnium	U	Uranium
Ho	Holmium	V	Vanadium
In	Indium	W	Tungsten
K	Potassium	Y	Yttrium
La	Lanthanum	Yb	Ytterbium
Li	Lithium	Zn	Zinc
Lu	Lutetium	Zr	Zirconium
Mg	Magnesium		

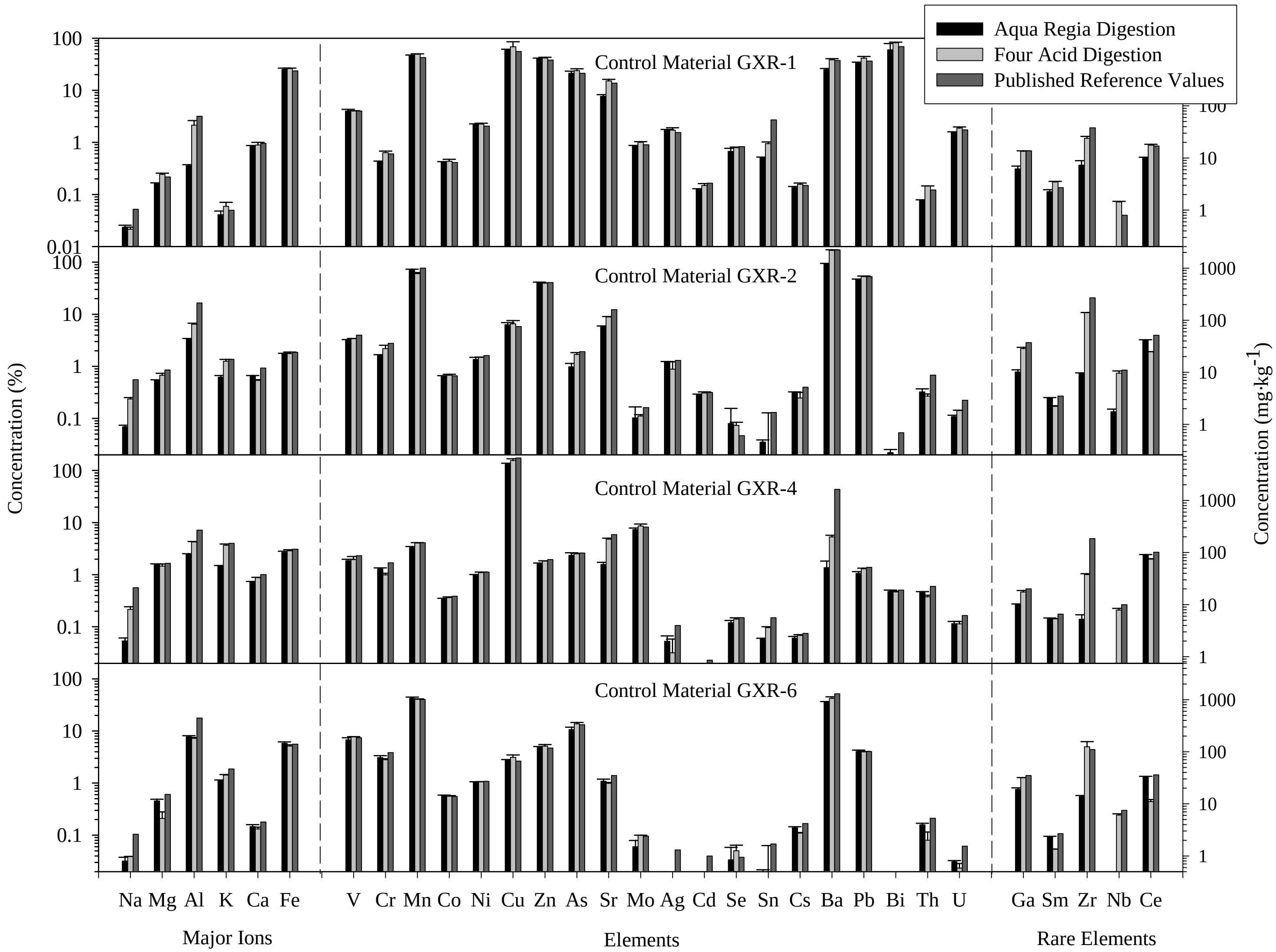
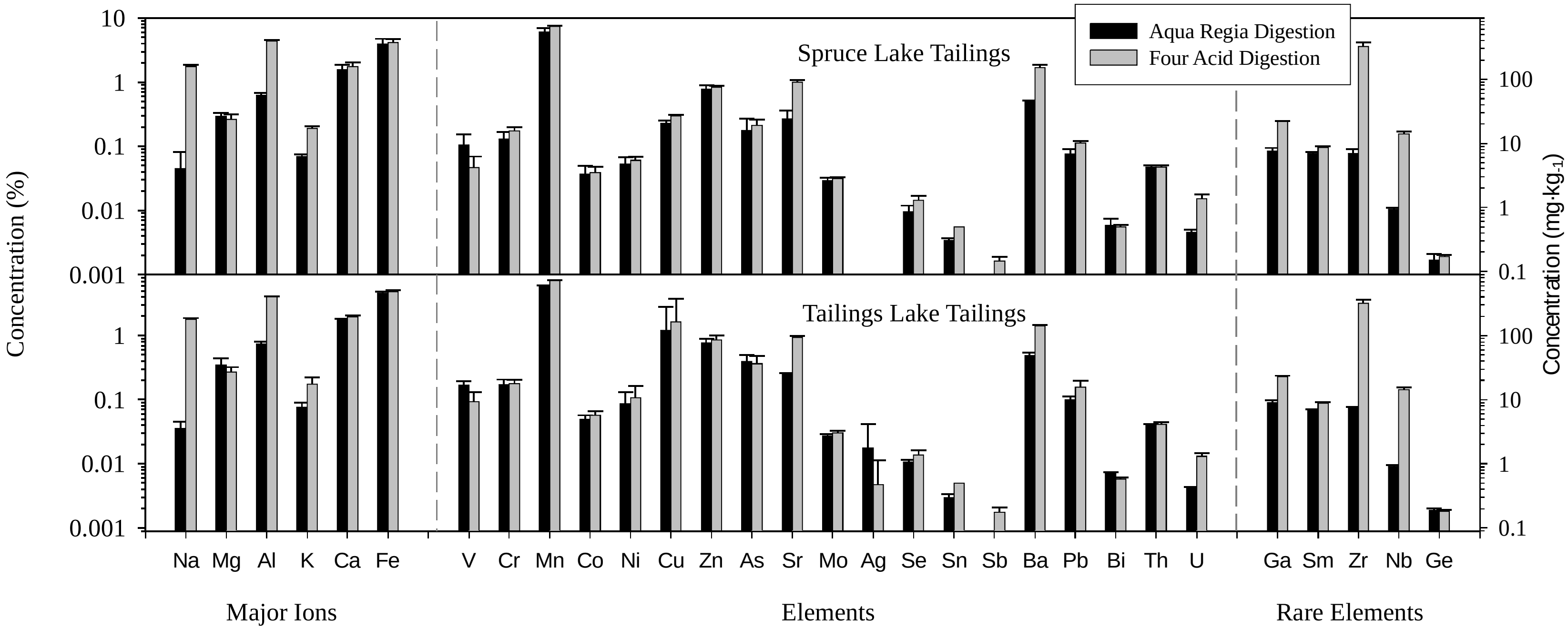


Figure 5. The concentrations of several elements in reference materials measured with the test samples (some elements not shown). Values are means that were calculated from control samples analysed, with tailings and faecal samples compared to the published value for the reference material. Concentrations are in mg·kg^{-1}, except for major ions that are reported on a percent basis.



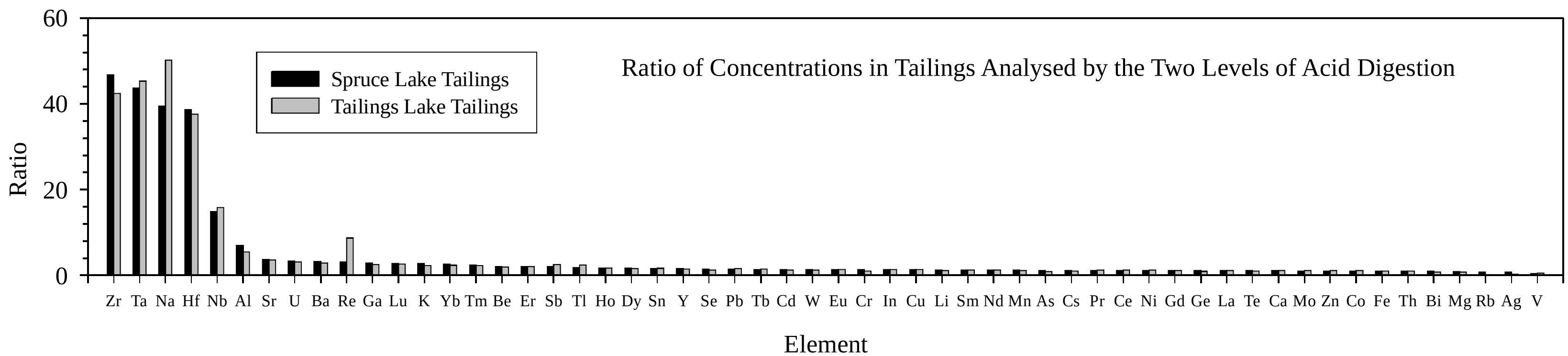


Figure 6. The elemental composition of Colomac's Spruce Lake (n=3) and Tailings Lake (n=3) tailings following either the aqua regia or four acid digestion. The upper graph compares the concentrations in the tailings following the two methods, while the lower graph reports the ratio (four acid:aqua regia) of the concentrations. The lower graph shows that while the concentrations of most elements are similar in the two methods, several elements, including the major ions sodium (Na) and aluminum (Al) are substantially higher following the four acid digestion.

Table 7. Geometric mean (with geometric standard deviation) concentration of elements in faecal ash. All concentrations are in mg·kg^{-1} except major ions that are reported in percent, and gold which is in µg·kg^{-1} (or ppb).

Site	n	Lithium		Beryllium		Boron		Sodium (%)		Magnesium (%)		Aluminum (%)		Potassium (%)		Calcium (%)		Scandium		Vanadium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Mild Acid Digestion																					
Pellets Collected on Tailings	29	0.31	0.25	<0.1	-	<1	-	0.011	0.51	0.038	0.15	0.026	0.39	0.124	0.21	0.172	0.23	0.12	0.50	1.17	0.25
Pellets With Elevated Ash	5	0.47	0.26	<0.1	-	<1	-	0.005	0.28	0.049	0.15	0.098	0.26	0.062	0.07	0.304	0.21	0.73	0.27	1.42	0.29
On-site Control	38	<0.5	-	<0.1	-	<1	-	0.006	0.66	0.030	0.19	0.019	0.37	0.118	0.17	0.154	0.19	0.10	0.33	<0.1	-
Off-site Control	20	<0.5	-	<0.1	-	<1	-	0.002	0.28	0.036	0.10	0.019	0.10	0.172	0.12	0.189	0.09	<0.1	-	<0.1	-
Calving Grounds	22	0.56	0.37	<0.1	-	<1	-	0.004	0.21	0.114	0.22	0.060	0.32	0.191	0.30	0.914	0.17	0.17	0.33	1.40	0.38
Summer Plant Diet	20	<0.5	-	<0.1	-	<1	-	0.005	0.26	0.053	0.07	0.026	0.08	0.171	0.12	0.164	0.08	<0.1	-	1.89	0.08
Fall Lichen Diet	42	0.88	0.26	<0.1	-	<1	-	0.013	0.22	0.332	0.18	0.067	0.17	0.694	0.17	0.531	0.14	0.14	0.23	1.41	0.22
Ekati Mine	13	1.08	0.57	<0.1	-	<1	-	0.006	0.28	0.273	0.16	0.073	0.28	0.308	0.20	0.251	0.24	0.16	0.36	2.73	0.22
Diavik Mine	11	0.43	0.47	<0.1	-	<1	-	0.004	0.20	0.222	0.11	0.017	0.25	0.237	0.18	0.209	0.17	<0.1	-	1.08	0.22
Spruce Lake Tailings	3	3.53	0.07	0.56	0.05	<1	-	0.036	0.34	0.292	0.05	0.622	0.04	0.073	0.03	1.555	0.08	<0.1	-	8.66	0.21
Tailings Lake Tailings	3	4.70	0.09	0.56	0.08	<1	-	0.035	0.12	0.343	0.10	0.734	0.04	0.076	0.06	1.782	0.02	<0.1	-	16.5	0.07
Four Acid Digestion																					
Pellets Collected on Tailings	29	<0.5	-	<0.1	-	<1	-	0.011	0.69	<0.01	-	0.039	0.51	0.007	0.31	0.007	0.24	NR	-	<1	-
Pellets With Elevated Ash	5	<0.5	-	<0.1	-	<1	-	0.211	0.24	<0.01	-	0.268	0.45	0.025	0.21	0.014	0.29	NR	-	<1	-
On-site Control	38	<0.5	-	<0.1	-	<1	-	0.008	0.42	<0.01	-	0.034	0.35	0.007	0.20	0.006	0.19	NR	-	<1	-
Off-site Control	20	<0.5	-	<0.1	-	<1	-	0.004	0.18	<0.01	-	0.026	0.16	0.007	0.18	0.005	0.09	NR	-	<1	-
Calving Grounds	22	0.41	0.33	<0.1	-	<1	-	0.020	0.54	0.010	0.33	0.126	0.45	0.088	0.47	0.025	0.43	NR	-	1.01	0.36
Summer Plant Diet	41	0.54	0.34	<0.1	-	<1	-	0.017	0.36	0.008	0.30	0.110	0.27	0.058	0.33	0.024	0.31	NR	-	<1	-
Fall Lichen Diet	20	<0.5	-	<0.1	-	<1	-	0.008	0.13	<0.01	-	0.054	0.11	0.022	0.12	0.012	0.12	NR	-	<1	-
Ekati Mine	13	<0.5	-	<0.1	-	<1	-	0.024	0.33	0.009	0.27	0.115	0.22	0.046	0.22	0.042	0.33	NR	-	<1	-
Diavik Mine	11	<0.5	-	<0.1	-	<1	-	0.003	0.42	<0.01	-	0.025	0.41	0.011	0.34	0.007	0.20	NR	-	<1	-
Spruce Lake Tailings	3	4.44	0.05	1.23	0.02	<1	-	1.765	0.02	0.263	0.09	4.365	0.01	0.189	0.04	1.717	0.07	NR	-	3.91	0.26
Tailings Lake Tailings	3	5.58	0.05	1.13	0.05	<1	-	1.788	0.02	0.270	0.08	4.026	0.01	0.173	0.11	1.979	0.02	NR	-	8.89	0.17

Table 7 (cont'd) Geometric mean (with geometric standard deviation) concentration of elements in faecal ash. All concentrations are in mg·kg^{-1} except major ions that are reported in percent, and gold which is in µg·kg^{-1} (or ppb). NR – not reported.

Site	n	Chromium		Manganese		Iron (%)		Cobalt		Nickel		Copper		Zinc		Gallium		Germanium		Arsenic	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Mild Acid Digestion																					
Pellets Collected on Tailings	29	0.45	0.38	98	0.22	0.056	0.58	0.33	0.23	1.01	0.17	2.55	0.37	22.8	0.14	0.11	0.62	<0.1	-	0.29	0.56
Pellets With Elevated Ash	5	1.70	0.26	165	0.17	0.468	0.28	0.58	0.19	1.49	0.14	7.63	0.40	26.2	0.14	1.03	0.27	<0.1	-	1.59	0.29
On-site Control	38	0.47	0.30	78	0.20	0.041	0.43	0.31	0.21	0.92	0.23	1.98	0.24	20.5	0.16	0.12	0.34	<0.1	-	0.12	0.38
Off-site Control	20	<0.5	-	134	0.14	0.024	0.13	0.22	0.11	0.93	0.11	2.38	0.10	30.0	0.11	0.13	0.11	<0.1	-	0.08	0.32
Calving Grounds	22	1.25	0.32	362	0.31	0.095	0.33	0.79	0.24	3.38	0.19	5.25	0.29	53.0	0.25	0.32	0.30	<0.1	-	0.11	0.45
Summer Plant Diet	20	0.36	0.21	128	0.07	0.032	0.08	0.47	0.15	1.82	0.15	2.58	0.09	34.0	0.07	<0.1	-	<0.1	-	0.39	0.30
Fall Lichen Diet	42	1.16	0.17	498	0.15	0.083	0.16	3.01	0.15	13.2	0.16	10.6	0.15	151	0.15	<0.1	-	<0.1	-	<0.1	-
Ekati Mine	13	2.21	0.34	212	0.27	0.101	0.32	2.65	0.22	8.91	0.19	8.54	0.16	73.0	0.24	<0.1	-	<0.1	-	0.11	0.33
Diavik Mine	11	0.32	0.20	251	0.21	0.023	0.20	3.07	0.20	6.57	0.16	4.40	0.13	68.0	0.16	<0.1	-	<0.1	-	<0.1	-
Spruce Lake Tailings	3	11.2	0.14	542	0.06	3.908	0.08	3.12	0.16	4.61	0.12	20.5	0.04	69.5	0.06	7.61	0.05	0.13	0.17	14.5	0.22
Tailings Lake Tailings	3	16.8	0.09	608	0.00	4.616	0.02	4.93	0.07	7.89	0.22	67.6	0.56	76.5	0.07	8.84	0.04	<0.2	-	38.4	0.11
Four Acid Digestion																					
Pellets Collected on Tailings	29	<0.5	-	2.48	0.31	0.008	0.34	<0.1	-	<0.5	-	0.30	0.41	0.63	0.18	0.12	0.61	<0.1	-	<0.1	-
Pellets With Elevated Ash	5	0.55	0.21	6.11	0.20	0.033	0.18	<0.1	-	<0.5	-	1.01	0.30	0.82	0.11	1.60	0.25	<0.1	-	0.11	0.49
On-site Control	38	<0.5	-	1.86	0.33	0.007	0.22	<0.1	-	<0.5	-	0.39	0.31	0.45	0.19	<0.1	-	<0.1	-	<0.1	-
Off-site Control	20	<0.5	-	1.88	0.22	0.005	0.00	<0.1	-	<0.5	-	0.23	0.29	0.46	0.23	<0.1	-	<0.1	-	<0.1	-
Calving Grounds	22	0.60	0.41	7.25	0.46	0.025	0.48	<0.1	-	<0.5	-	0.92	0.38	1.88	0.30	0.40	0.50	<0.1	-	<0.1	-
Summer Plant Diet	41	0.40	0.33	7.93	0.31	0.015	0.42	<0.1	-	<0.5	-	0.90	0.25	2.42	0.28	0.27	0.38	<0.1	-	<0.1	-
Fall Lichen Diet	20	<0.5	-	4.48	0.09	0.005	0.07	<0.1	-	<0.5	-	0.49	0.15	1.46	0.10	<0.1	-	<0.1	-	<0.1	-
Ekati Mine	13	0.74	0.42	8.74	0.20	0.016	0.40	0.10	0.26	<0.5	-	1.35	0.29	2.62	0.13	0.34	0.31	<0.1	-	<0.1	-
Diavik Mine	11	<0.5	-	4.12	0.35	0.005	0.00	<0.1	-	<0.5	-	0.37	0.28	1.39	0.42	<0.1	-	<0.1	-	0.10	0.53
Spruce Lake Tailings	3	15.4	0.06	670	0.01	4.108	0.05	3.44	0.09	5.40	0.06	26.9	0.01	74.8	0.02	22.1	0.00	< 0.2	-	18.6	0.10
Tailings Lake Tailings	3	17.7	0.07	718	0.01	4.865	0.02	5.72	0.07	9.85	0.22	90.8	0.56	84.5	0.07	23.0	0.01	< 0.2	-	35.2	0.13

Table 7 (cont'd) Geometric mean (with geometric standard deviation) concentration of elements in faecal ash. All concentrations are in mg·kg^{-1} except major ions that are reported in percent, and gold which is in µg·kg^{-1} (or ppb).

Site	n	Selenium		Rubidium		Strontium		Yttrium		Zirconium		Niobium		Molybdenum		Silver		Cadmium		Indium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Mild Acid Digestion																					
Pellets Collected on Tailings	29	0.15	0.29	7.25	0.17	5.06	0.15	0.17	0.54	<0.1	-	<0.1	-	0.20	0.39	0.03	0.29	<0.1	-	<0.02	-
Pellets With Elevated Ash	5	0.19	0.17	5.78	0.15	6.20	0.19	1.27	0.30	0.11	0.34	0.11	0.33	0.40	0.26	0.04	0.41	<0.1	-	<0.02	-
On-site Control	38	0.10	0.23	7.12	0.16	5.17	0.15	0.13	0.37	<0.1	-	<0.1	-	0.21	0.31	0.03	0.46	<0.1	-	<0.02	-
Off-site Control	20	<0.1	-	11.1	0.11	6.29	0.09	0.10	0.11	<0.1	-	<0.1	-	0.11	0.13	0.02	0.14	<0.1	-	<0.02	-
Calving Grounds	22	0.23	0.14	8.81	0.34	14.9	0.18	0.69	0.24	<0.1	-	<0.1	-	0.30	0.35	0.01	0.34	0.16	0.33	<0.02	-
Summer Plant Diet	20	0.11	0.26	9.11	0.10	6.01	0.05	0.20	0.07	<0.1	-	<0.1	-	0.13	0.10	0.01	0.11	0.06	0.12	<0.02	-
Fall Lichen Diet	42	0.13	0.36	21.7	0.16	30.6	0.13	0.37	0.19	<0.1	-	<0.1	-	0.73	0.18	0.03	0.21	0.35	0.16	<0.02	-
Ekati Mine	13	<0.1	-	14.7	0.16	18.7	0.24	0.32	0.30	<0.1	-	<0.1	-	0.39	0.13	0.04	0.46	0.39	0.36	<0.02	-
Diavik Mine	11	<0.1	-	7.01	0.15	15.7	0.15	<0.1	-	<0.1	-	<0.1	-	0.35	0.18	0.02	0.32	0.29	0.16	<0.02	-
Spruce Lake Tailings	3	0.85	0.10	1.96	0.03	23.1	0.15	11.8	0.06	6.83	0.07	0.93	0.03	2.60	0.04	0.01	0.96	0.16	0.17	<0.02	-
Tailings Lake Tailings	3	1.06	0.05	2.38	0.08	25.9	0.01	12.4	0.01	7.53	0.01	0.87	0.03	2.73	0.03	0.78	0.73	0.16	0.17	<0.02	-
Four Acid Digestion																					
Pellets Collected on Tailings	29	<0.1	-	0.38	0.27	0.88	0.43	0.10	0.45	1.15	0.61	0.10	0.52	<0.1	-	<0.05	-	<0.1	-	<0.1	-
Pellets With Elevated Ash	5	<0.1	-	0.41	0.41	4.71	0.39	0.56	0.30	15.1	0.22	0.95	0.29	0.09	0.22	<0.05	-	<0.1	-	<0.1	-
On-site Control	38	<0.1	-	0.35	0.28	0.68	0.30	0.11	0.34	0.86	0.36	0.07	0.26	<0.1	-	<0.05	-	<0.1	-	<0.1	-
Off-site Control	20	<0.1	-	0.48	0.13	0.65	0.16	<0.1	-	0.53	0.10	<0.1	-	<0.1	-	<0.05	-	<0.1	-	<0.1	-
Calving Grounds	22	<0.1	-	2.38	0.43	3.62	0.54	0.18	0.34	4.82	0.49	0.27	0.43	<0.1	-	<0.05	-	<0.1	-	<0.1	-
Summer Plant Diet	41	<0.1	-	1.79	0.28	4.21	0.31	0.13	0.29	2.87	0.40	0.17	0.36	<0.1	-	<0.05	-	<0.1	-	<0.1	-
Fall Lichen Diet	20	<0.1	-	1.06	0.10	1.99	0.12	<0.1	-	0.79	0.26	<0.1	-	<0.1	-	<0.05	-	<0.1	-	<0.1	-
Ekati Mine	13	<0.1	-	1.19	0.12	7.67	0.32	0.13	0.27	2.26	0.40	0.20	0.38	0.07	0.24	<0.05	-	<0.1	-	<0.1	-
Diavik Mine	11	<0.1	-	0.45	0.38	0.99	0.43	<0.1	-	0.58	0.15	<0.1	-	<0.1	-	<0.05	-	<0.1	-	<0.1	-
Spruce Lake Tailings	3	1.29	0.07	1.53	0.04	89.9	0.04	19.2	0.03	322	0.07	13.9	0.04	2.83	0.01	<0.05	-	<0.2	-	<0.1	-
Tailings Lake Tailings	3	1.38	0.09	0.45	0.16	92.9	0.03	17.9	0.03	317	0.06	14.3	0.04	3.03	0.04	0.21	0.81	<0.2	-	<0.1	-

Table 7 (cont'd) Geometric mean (with geometric standard deviation) concentration of elements in faecal ash. All concentrations are in mg·kg^{-1} except major ions that are reported in percent, and gold which is in µg·kg^{-1} (or ppb).

Site	n	Tin		Antimony		Tellerium		Cesium		Barium		Lanthanum		Cerium		Praseodymium		Neodymium		Samarium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Mild Acid Digestion																					
Pellets Collected on Tailings	29	<0.05	-	<0.02	-	<0.02	-	0.30	0.22	18.8	0.13	0.47	0.47	0.79	0.55	0.10	0.53	0.39	0.58	0.10	0.53
Pellets With Elevated Ash	5	0.05	0.25	<0.02	-	0.04	0.20	0.44	0.17	20.8	0.13	2.84	0.27	6.13	0.27	0.80	0.26	3.44	0.27	0.81	0.27
On-site Control	38	<0.05	-	<0.02	-	<0.02	-	0.25	0.16	12.9	0.31	0.34	0.20	0.51	0.33	<0.1	-	0.25	0.34	<0.1	-
Off-site Control	20	<0.05	-	<0.02	-	<0.02	-	0.39	0.18	22.8	0.09	<0.5	-	0.47	0.13	<0.1	-	0.20	0.12	<0.1	-
Calving Grounds	22	<0.05	-	<0.02	-	<0.02	-	0.20	0.38	45.2	0.20	1.64	0.30	2.97	0.32	0.34	0.32	1.23	0.32	0.20	0.38
Summer Plant Diet	20	<0.05	-	<0.02	-	<0.02	-	0.39	0.10	27.4	0.07	0.57	0.20	1.20	0.13	0.13	0.20	0.51	0.13	<0.1	-
Fall Lichen Diet	42	<0.05	-	<0.02	-	<0.02	-	0.56	0.16	82.6	0.16	1.21	0.19	2.25	0.18	0.27	0.18	0.99	0.18	0.16	0.23
Ekati Mine	13	<0.05	-	<0.02	-	<0.02	-	0.87	0.32	54.2	0.21	1.84	0.37	3.62	0.38	0.43	0.39	1.58	0.39	0.20	0.45
Diavik Mine	11	<0.05	-	<0.02	-	<0.02	-	0.16	0.29	31.7	0.14	0.30	0.18	0.53	0.26	<0.1	-	0.22	0.26	0.05	0.10
Spruce Lake Tailings	3	0.31	0.04	0.07	0.06	0.38	0.10	0.30	0.00	45.5	0.01	22.7	0.03	50.6	0.03	6.69	0.03	28.0	0.02	6.85	0.03
Tailings Lake Tailings	3	0.29	0.07	0.07	0.04	0.46	0.09	0.40	0.00	49.0	0.04	22.3	0.00	49.8	0.01	6.53	0.01	28.0	0.01	6.86	0.01
Four Acid Digestion																					
Pellets Collected on Tailings	29	<1	-	<0.1	-	<0.1	-	<0.05	-	5.23	0.37	<0.5	-	0.24	0.47	<0.1	-	0.12	0.50	<0.1	-
Pellets With Elevated Ash	5	<1	-	<0.1	-	<0.1	-	0.06	0.20	11.5	0.32	0.61	0.20	1.50	0.21	0.21	0.19	0.93	0.19	0.25	0.20
On-site Control	38	<1	-	<0.1	-	<0.1	-	<0.05	-	3.07	0.27	<0.5	-	0.18	0.33	<0.1	-	<0.1	-	<0.1	-
Off-site Control	20	<1	-	<0.1	-	<0.1	-	<0.05	-	2.85	0.18	<0.5	-	0.11	0.27	<0.1	-	<0.1	-	<0.1	-
Calving Grounds	22	<1	-	<0.1	-	<0.1	-	0.10	0.44	20.8	0.55	0.58	0.38	1.18	0.44	0.13	0.39	0.54	0.41	0.10	0.33
Summer Plant Diet	41	<1	-	<0.1	-	<0.1	-	0.08	0.31	30.2	0.38	0.51	0.27	1.00	0.29	0.10	0.33	0.41	0.31	<0.1	-
Fall Lichen Diet	20	<1	-	<0.1	-	<0.1	-	0.07	0.15	8.15	0.18	<0.5	-	0.36	0.14	<0.1	-	0.15	0.17	<0.1	-
Ekati Mine	13	<1	-	<0.1	-	<0.1	-	0.09	0.27	24.0	0.30	0.31	0.18	0.65	0.20	<0.1	-	0.33	0.22	<0.1	-
Diavik Mine	11	<1	-	<0.1	-	<0.1	-	<0.05	-	4.02	0.43	<0.5	-	0.16	0.40	<0.1	-	<0.1	-	<0.1	-
Spruce Lake Tailings	3	<1	-	0.16	0.17	0.46	0.06	0.38	0.02	150	0.05	25.4	0.03	59.1	0.03	7.89	0.03	34.8	0.03	8.59	0.03
Tailings Lake Tailings	3	<1	-0	0.16	0.17	0.49	0.09	0.41	0.05	142	0.01	26.6	0.01	61.4	0.02	8.30	0.01	36.6	0.01	8.76	0.02

Table 7 (cont'd) Geometric mean (with geometric standard deviation) concentration of elements in faecal ash. All concentrations are in mg·kg^{-1} except major ions that are reported in percent, and gold which is in µg·kg^{-1} (or ppb).

Site	n	Europium		Gadolinium		Terbium		Dysprosium		Holmium		Erbium		Thulium		Ytterbium		Lutetium		Hafnium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Mild Acid Digestion																					
Pellets Collected on Tailings	29	<0.1	-	0.10	0.50	<0.1	-	0.08	0.38	<0.1	-	0.06	0.23	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Pellets With Elevated Ash	5	0.13	0.40	0.68	0.26	<0.1	-	0.35	0.26	<0.1	-	0.12	0.36	<0.1	-	<0.2	-	<0.1	-	<0.1	-
On-site Control	38	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-
Off-site Control	20	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-
Calving Grounds	22	<0.1	-	0.18	0.36	<0.1	-	0.11	0.33	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Summer Plant Diet	20	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-
Fall Lichen Diet	42	<0.1	-	0.13	0.23	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Ekati Mine	13	<0.1	-	0.15	0.40	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Diavik Mine	11	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-
Spruce Lake Tailings	3	1.40	0.03	5.81	0.05	0.63	0.04	3.02	0.05	0.53	0.05	1.33	0.05	0.20	0.00	1.20	0.04	0.20	0.00	0.23	0.10
Tailings Lake Tailings	3	1.40	0.00	5.83	0.00	0.60	0.00	3.03	0.02	0.53	0.05	1.30	0.00	0.20	0.00	1.23	0.02	0.20	0.00	0.30	0.00
Four Acid Digestion																					
Pellets Collected on Tailings	29	<0.05	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Pellets With Elevated Ash	5	0.06	0.24	0.19	0.35	<0.1	-	0.15	0.29	<0.1	-	0.08	0.29	<0.1	-	<0.2	-	<0.1	-	0.47	0.23
On-site Control	38	<0.05	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Off-site Control	20	<0.05	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Calving Grounds	22	<0.05	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	0.13	0.43
Summer Plant Diet	41	<0.05	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Fall Lichen Diet	20	<0.05	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Ekati Mine	13	<0.05	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Diavik Mine	11	<0.05	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.2	-	<0.1	-	<0.1	-
Spruce Lake Tailings	3	1.92	0.01	6.66	0.02	0.87	0.03	5.07	0.01	0.97	0.03	2.76	0.02	0.43	0.06	3.20	0.03	0.53	0.05	9.38	0.09
Tailings Lake Tailings	3	1.92	0.02	6.87	0.01	0.90	0.00	4.87	0.01	0.93	0.03	2.77	0.02	0.43	0.06	2.96	0.03	0.46	0.06	9.58	0.06

Table 7 (cont'd) Geometric mean (with geometric standard deviation) concentration of elements in faecal ash. All concentrations are in mg·kg^{-1} except major ions that are reported in percent, and gold which is in µg·kg^{-1} (or ppb).

Site	n	Tantalum		Tungsten		Rhenium		Gold		Thallium		Lead		Bismuth		Thorium		Uranium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Mild Acid Digestion																			
Pellets Collected on Tailings	29	<0.05	-	0.47	0.54	<0.001	-	245	0.24	<0.02	-	0.49	0.32	<0.02	-	<0.1	-	<0.1	-
Pellets With Elevated Ash	5	<0.05	-	2.96	0.19	<0.001	-	352	0.11	<0.02	-	1.34	0.25	0.08	0.22	0.49	0.28	<0.1	-
On-site Control	38	<0.05	-	0.38	0.37	<0.001	-	499	0.45	<0.02	-	0.38	0.21	<0.02	-	<0.1	-	<0.1	-
Off-site Control	20	<0.05	-	<0.1	-	<0.001	-	97.2	0.22	<0.02	-	0.53	0.11	<0.02	-	<0.1	-	<0.1	-
Calving Grounds	22	<0.05	-	<0.1	-	<0.001	-	<0.2	-	0.02	0.27	1.26	0.29	0.02	0.29	0.32	0.37	0.12	0.37
Summer Plant Diet	20	<0.05	-	<0.1	-	<0.001	-	<0.2	-	<0.02	-	0.54	0.09	<0.02	-	<0.1	-	0.12	0.33
Fall Lichen Diet	42	<0.05	-	<0.1	-	<0.001	-	<0.2	-	0.03	0.24	1.55	0.19	<0.02	-	0.13	0.24	<0.1	-
Ekati Mine	13	<0.05	-	<0.1	-	<0.001	-	0.28	0.62	<0.02	-	0.85	0.24	<0.02	-	0.18	0.41	0.12	0.33
Diavik Mine	11	<0.05	-	<0.1	-	<0.001	-	<0.2	-	<0.02	-	<0.5	-	<0.02	-	<0.1	-	<0.1	-
Spruce Lake Tailings	3	<0.05	-	10.9	0.18	0.0013	0.17	100	0.14	<0.02	-	6.68	0.08	0.51	0.12	4.23	0.03	0.43	0.06
Tailings Lake Tailings	3	<0.05	-	19.9	0.12	<0.001	-	275	0.48	<0.02	-	9.91	0.06	0.71	0.02	4.07	0.01	0.40	0.00
Four Acid Digestion																			
Pellets Collected on Tailings	29	0.05	0.12	<0.1	-	<0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	<0.1	-	<0.1	-
Pellets With Elevated Ash	5	0.08	0.25	0.41	0.57	<0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	0.20	0.18	<0.1	-
On-site Control	38	<0.1	-	<0.1	-	<0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	<0.1	-	<0.1	-
Off-site Control	20	<0.1	-	<0.1	-	<0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	<0.1	-	<0.1	-
Calving Grounds	22	<0.1	-	<0.1	-	<0.001	-	<0.2	-	<0.05	-	0.60	0.36	<0.02	-	0.18	0.43	<0.1	-
Summer Plant Diet	41	<0.1	-	<0.1	-	<0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	0.11	0.33	<0.1	-
Fall Lichen Diet	20	<0.1	-	<0.1	-	<0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	<0.1	-	<0.1	-
Ekati Mine	13	<0.1	-	<0.1	-	<0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	<0.1	-	<0.1	-
Diavik Mine	11	<0.1	-	<0.1	-	<0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	<0.1	-	<0.1	-
Spruce Lake Tailings	3	1.10	0.04	15.0	0.16	0.0036	0.07	<0.2	-	0.04	0.17	10.1	0.03	0.50	0.03	4.23	0.03	1.36	0.06
Tailings Lake Tailings	3	1.13	0.06	24.3	0.13	0.0042	0.54	<0.2	-	0.04	0.30	15.5	0.10	0.58	0.03	4.12	0.04	1.33	0.05

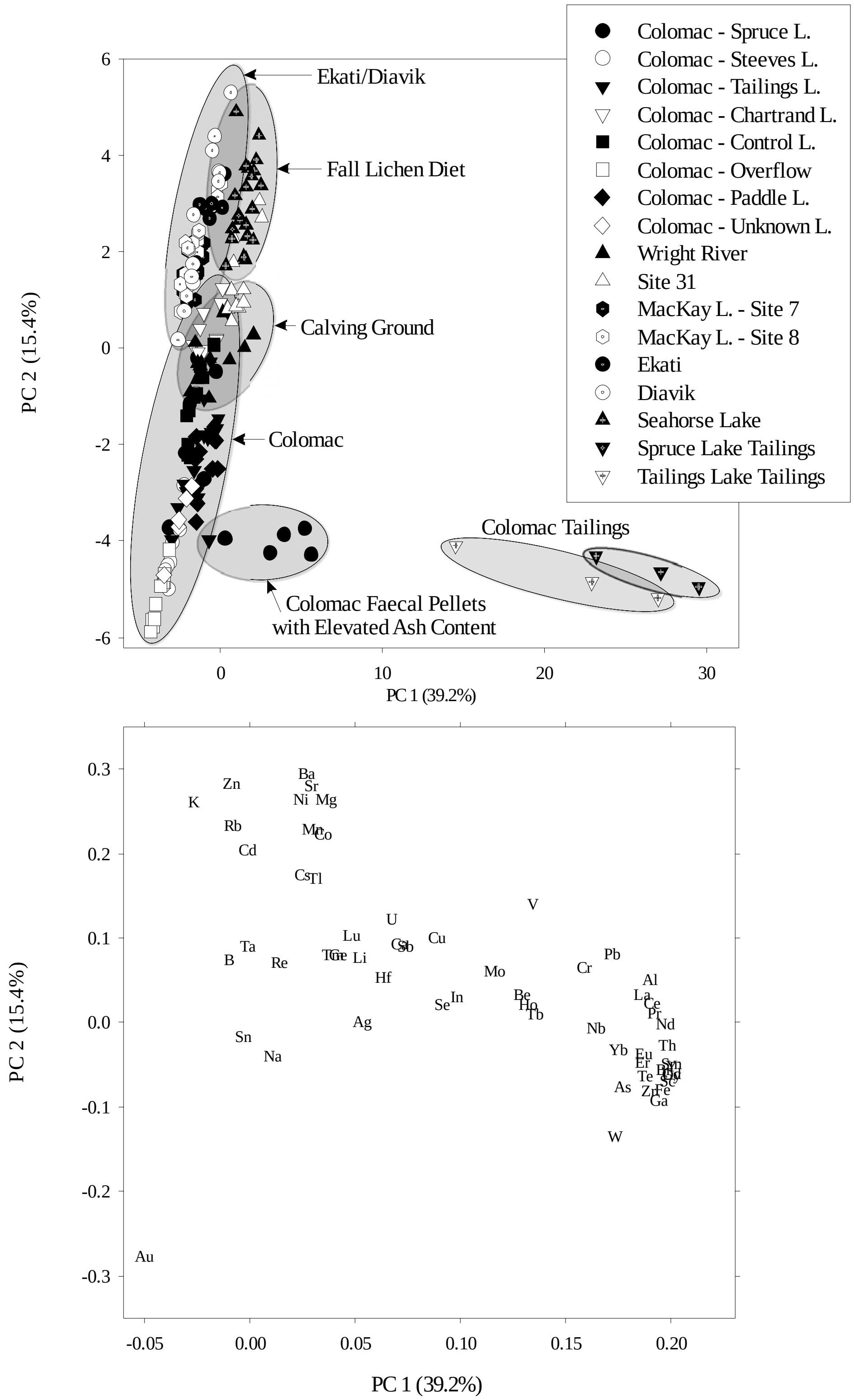
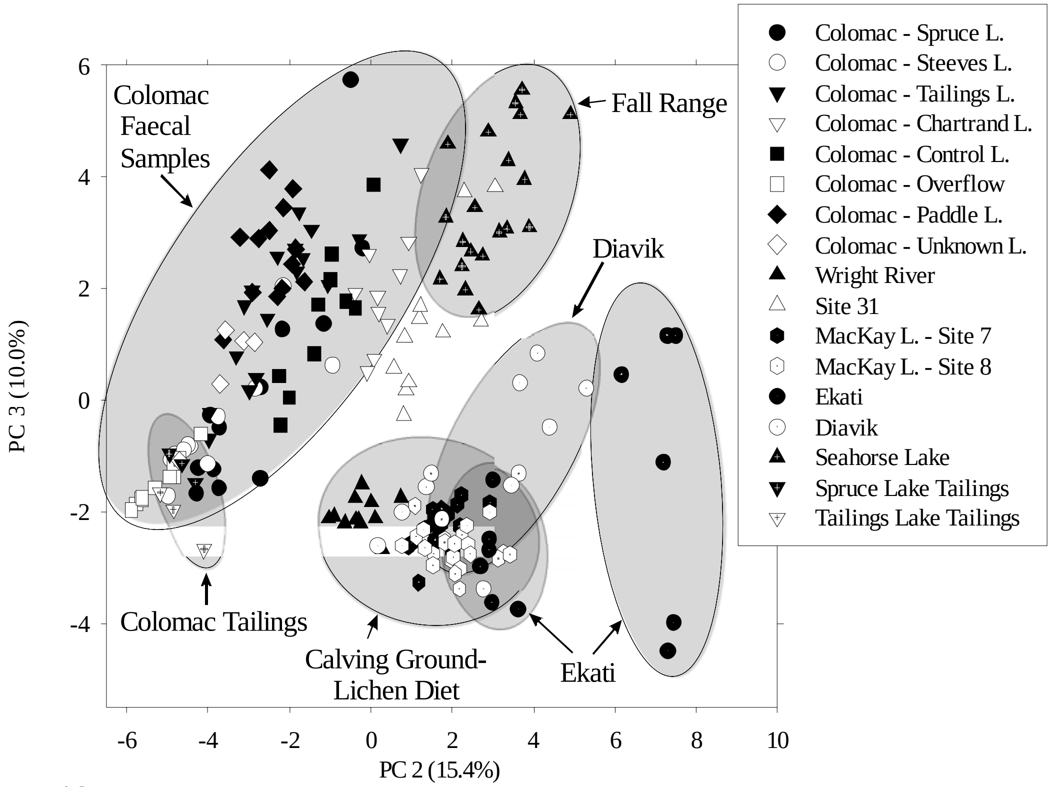


Figure 7. PC 1 vs PC 2 of the principal components analysis (PCA) of the elemental composition of the faecal pellets and tailings samples using the aqua regia digestion method. The analysis shows a similarity of the faecal pellets with elevated ash levels with the two sets of tailings. Gold is a major modelling compound for other Colomac samples.



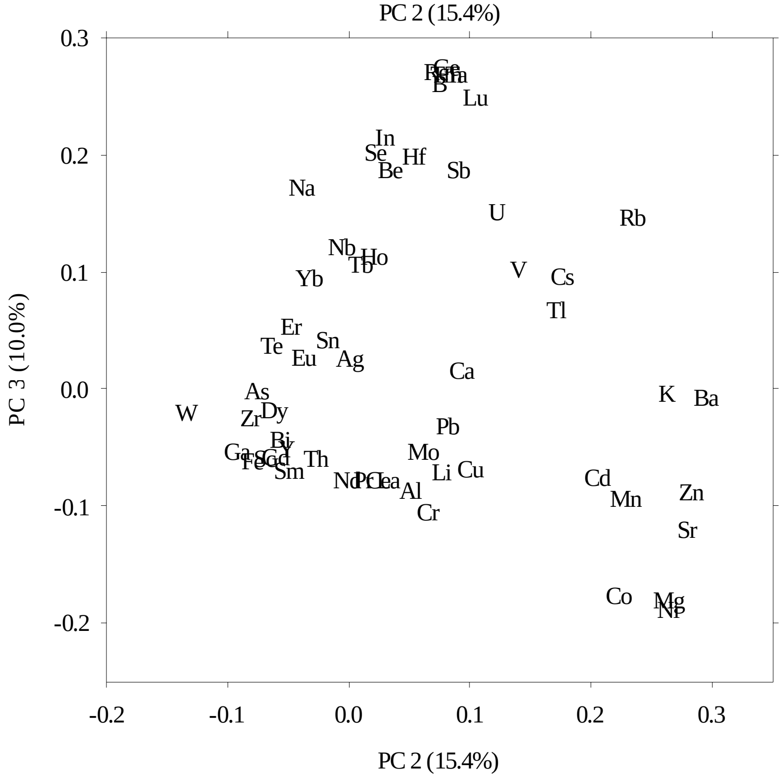


Figure 8. PC 2 vs PC 3 of the PCA analysis from the aqua regia digestion method showing a unique pattern of a group of the Ekati samples. A group of the Colomac samples are closely associated with the two tailings samples.

PCA of the four acid digest showed a strong similarity between the raw tailings samples and three of the Spruce Lake faecal samples (Figure 9). Other Colomac samples showed some similarity with the raw tailings samples on the basis of compounds such as Fe, Na and Zr, while others grouped with the background diet samples. Gold was not reported from the digest and hence was not included with the analysis. The calving ground samples were largely modelled on PC 3 on the basis of K and Rb.

A comparison of the major compounds from the PCA shows significant differences between the sites in terms of the concentrations of several key compounds (Figure 10). The group of faecal samples with elevated ash contents and metal composition similar to tailings samples have been grouped separately under the title “elevated ash group”. The “on tailings” group also includes the five samples identified with elevated ash. The concentration of some elements in the Colomac samples, such as gold, was substantially higher than at all other sites. The concentrations of the other elements used for comparison were also higher in the “elevated ash” group than in most of the other sites.

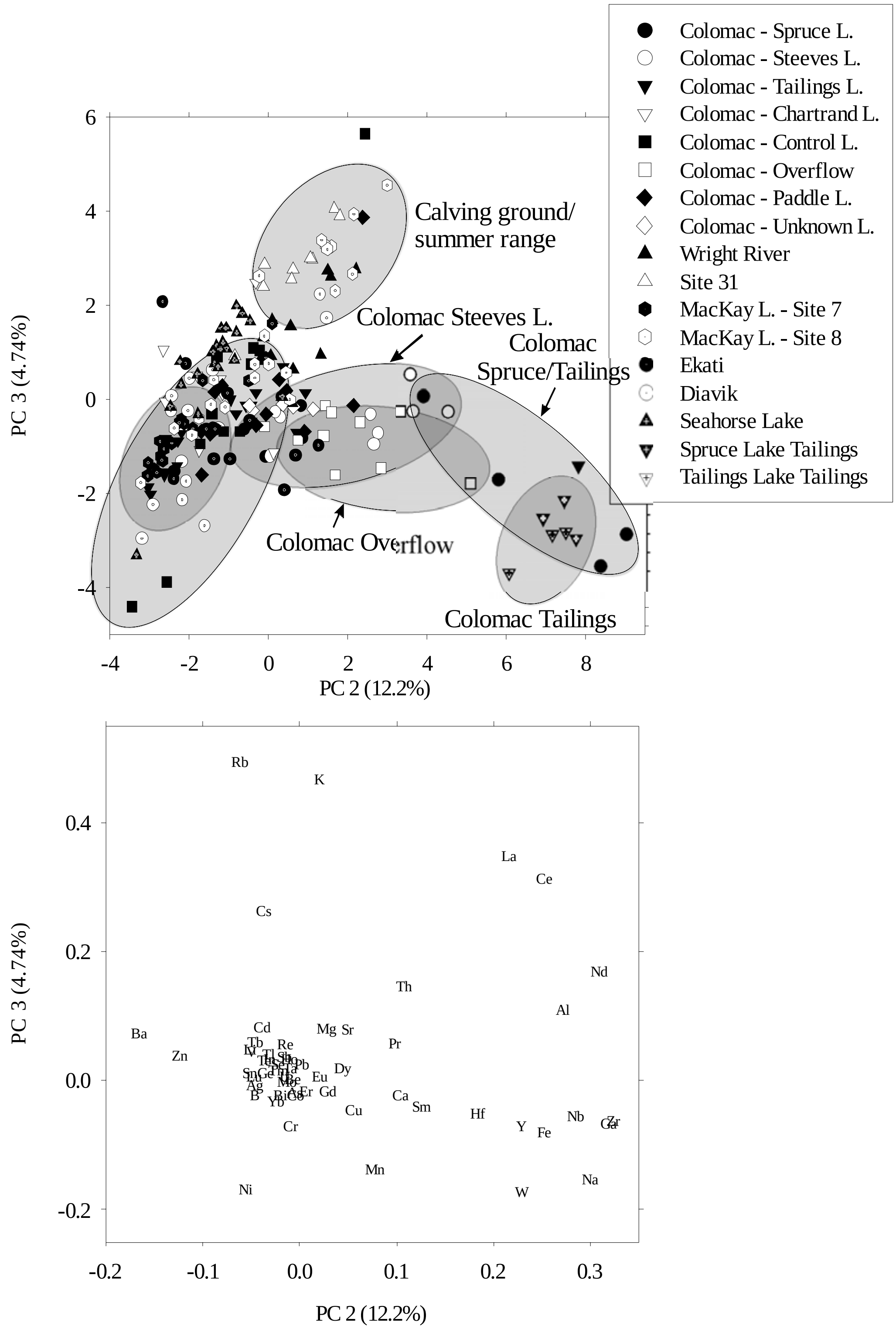


Figure 9. PCA on the elemental composition from the four acid digestion method. Four data points around the tailings samples are also those with elevated ash contents (3 Spruce Lake and 1 Tailings Lake faecal samples).

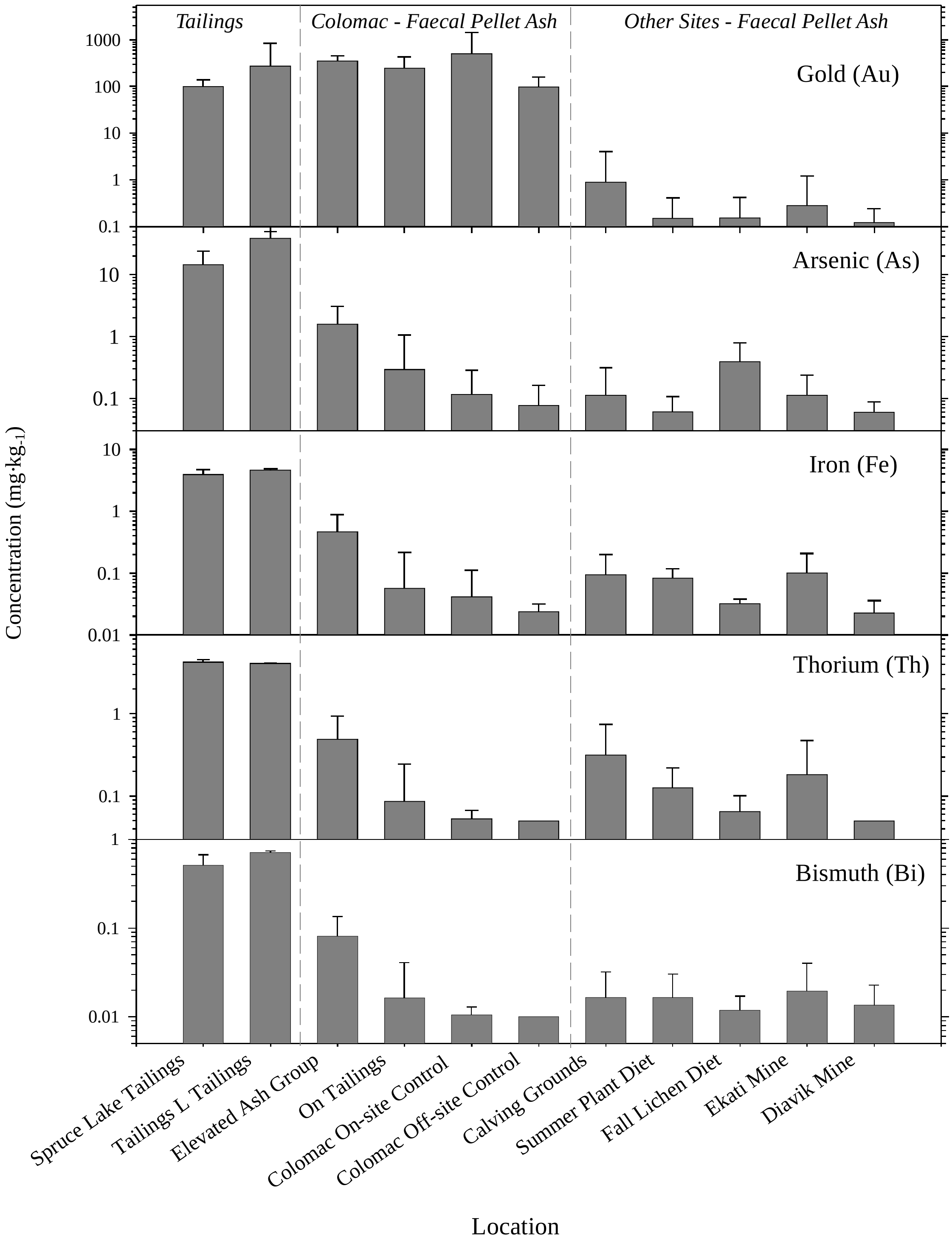


Figure 10. Comparison of the geometric mean concentrations of some elements in tailings from Colomac and ash (450 ^{o}C) in caribou faecal material from several sites. The elevated ash group is a subset of the tailings faecal samples collected from Colomac's Spruce and Tailings lakes. The samples have been differentiated because of their high ash content and the similarity of the metal patterns with the raw tailings. Units for gold concentration are µg·kg^{-1} or ppb.

DISCUSSION

We found significant differences between the sites sampled in terms of the ash content in the caribou faecal pellets, and the elemental composition of the ash. These differences suggest that soil is ingested by the caribou, probably inadvertently in some areas and intentionally in other sites. The analysis also suggests that the metal levels in the ingested soils differ markedly between sites. Based on these observations, we reject the hypothesis that there is a uniform amount of ash in the diet of caribou and conclude that high ash content of faecal material indicates a high rate of soil ingestion in some caribou. The pattern of metals in the ash of some faecal pellets from the Colomac tailings area show a similarity to the raw tailings analyzed in the same manner and may indicate ingestion of the tailings by the caribou.

The inadvertent and intentional ingestion of soil (termed geophagy) by birds and mammals has been well documented (Weeks and Kirkpatrick 1976; Beyer et al. 1994) and is now recognized as an important contaminant uptake pathway in ecological risk assessment. The solid tailings at Colomac are high in sodium (212 and 1260 $mg \cdot kg^{-1}$ Dry Weight at Tailings Lake and Spruce Lake, respectively) and calcium (3831 and 13900 $mg \cdot kg^{-1}$ Dry Weight at Tailings Lake and Spruce Lake, respectively). Sodium is an attractant at mineral licks used by moose *Alces alces* (Tankersley and Gasaway 1983). The most common explanation for intentional soil ingestion is the acquisition of minerals, particularly sodium, to replace low levels in spring caused by reproductive demands and the use of low-mineral foods over the winter. Some small mammals show attraction to salt-rich areas in spring and fall (Weeks and Kirkpatrick 1976). In the NWT, Heard and Williams (1990) reported the use of ice and mineral licks during the winter by caribou at four lakes where caribou were observed licking and gnawing on the ice.

The background levels of ash in the faecal pellets reported here for the calving and fall diet areas are generally consistent with the levels reported for ungulates. Beyer *et al*. (1994) reported background levels of 2 to 7% ash in the faeces of deer, elk and moose in populations from background levels of soil in the diet and no known ingestion at lick sites. These levels correspond to about 2% soil in the diet. In contrast Weeks (1978) reported the feeding behavior of white-tailed deer at licks and the results from an earlier study which showed an average ash content of 29.4% (n=19) in the faeces of deer near licks, with a maximum value of 87.5% in one sample. The observed behavior and high ash content in faecal matter reported in this paper are consistent with our observations of caribou cratering through the snow to reach the solid tailings or ice which they licked.

Our data support the values used for the ecological risk assessment in the Colomac remediation plan. A scenario of caribou consuming the tailings was explicitly modeled in the assessment, with an assumption of an ingestion of 20% of the diet as tailings. This average value is consistent with the levels reported here but we note our findings that maximum values may range as high as 50% in some caribou.

Two major questions remain. Firstly, what is the cumulative risk to caribou across their annual range from other mine sites? At other mines, caribou are exposed to either metal uptake on their forage from dust adhering to the forage or to direct consumption of tailings. The second question is to what degree the metals are absorbed from the gastrointestinal tract by the caribou and how do the metals interact?

We have incomplete information to answer the first question about the exposure of caribou to metal uptake at the other mines with tailings (operational mines are Lupin, Ekati, Diavik; abandoned mines include Colomac, Tundra and Discovery). We had no samples of caribou fecal pellets for the Diavik mine itself, Lupin and relatively few samples for Ekati. The lack of samples is a deficiency to be remedied in 2004.

Some information about potential exposure to metal and mineral uptake is available from monitoring at the diamond mines. Foraging on lichens is one potential pathway for caribou to ingest higher levels of metals. Lichens sampled at both Ekati and Diavik sites have increased levels of some metals: between 1998 and 2001, levels of aluminum, titanium and iron have increased at Ekati from exposure to dust associated with mine activities (Kidd and Max 2002). A potential exposure pathway is the deliberate consumption of tailings by caribou. Kimberlite tailings are relatively high in sodium and calcium (Martens and Associates 2002) which could attract caribou and expose them to high levels of other metals in the tailings.

Another potential exposure pathway is through caribou being attracted to the re-vegetation of the tailings. Re-vegetation is a proposed remediation technique but with the disadvantage that certain plants accumulate and concentrate some metals. The greening vegetation on the tailings areas is attractive to foraging caribou (Martens and Associates 2002). Martens and Associates (2002) identified 12 metals of potential concern– eight metals had elevated concentrations in the tailings and four metals (Al, Mo, Ti ,V) were concentrated by vegetation on the tailings or serpentine soil. Three metals in the processed kimberlite (chromium, cobalt and nickel) exceed the CCME guidelines for agricultural land (no guidelines for magnesium, aluminum) and levels of barium and selenium were close to the CCME guideline. Selenium is an essential nutrient that is toxic at higher concentrations and the toxic and tolerable levels are close. Some plants such as milkvetches and locoweeds concentrate selenium. Locoweed (*Oxytropis deflexa*) is one of the native plants being tested for revegetation.

Molybdenum in fireweed planted on the processed kimberlite exceeded the CCME guideline although the concentration was less than the levels that are that associated with toxic effects in deer (Martens and Associates 2002).

The second question concerns the degree to which the metals are absorbed from the gastrointestinal tract by the caribou and how do the metals interact. Our understanding of soil and mineral uptake and caribou nutrition is incomplete although information is available for domestic stock (e.g.: Grace and Healy 1973; Grace *et al.* 1996) and some wildlife (Arthur and Gates 1988). A major uncertainty is the question of metabolic interactions between metals for which we have a partial understanding in some mammals (Goyer 1997). We also do not know the relationships between soil uptake and either exposure to, or protection from, infectious diseases (Weinberg 1987).

Background levels of some metals in caribou tissues were established in the mid-1990s (Elkin and Bethke 1995) and were not elevated to any level of concern. However, the Bathurst caribou herd declined between 1996 and 2003 (unpublished data) and concerns for the health of the herd are increasing. Aboriginal hunters express concern about contaminants especially from dust associated with the mines.

Site-specific risk assessments on the exposure of people and wildlife to contaminants from mine tailings are available for Colomac and Ekati mine sites (Senes Consulting 2004; Golder Associates Ltd in Prep.) and are proposed for, at least, Tundra mine. However, those assessments do not take into account that caribou from the Bathurst herd are exposed to several point sources of potentially increased uptake of metals during the caribou’s annual migratory cycle. We recommend that a cumulative risk assessment for all point sources be undertaken in the near future.

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Appendix A. Concentration of metals in faecal ash from the aqua regia digestion. Concentrations are in mg·kg^{-1}, except as indicated. Gold is reported in µg·kg^{-1}.

Site	n	Lithium		Beryllium		Boron		Sodium (%)		Magnesium (%)		Aluminum (%)		Potassium (%)		Calcium (%)		Scandium		Vanadium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	<0.5	-	< 0.1	-	<1	-	0.005	0.21	0.045	0.18	0.056	0.43	0.115	0.30	0.304	0.18	0.30	0.61	<1	-
Spruce L. (Apr 09)	2	<0.5	-	< 0.1	-	<1	-	0.008	0.64	0.024	0.25	0.012	0.53	0.095	0.06	0.102	0.21	< 0.1	-	<1	-
Tailings L.	17	<0.5	-	< 0.1	-	<1	-	0.019	0.51	0.036	0.09	0.018	0.18	0.134	0.16	0.130	0.10	< 0.1	-	1.44	0.15
Steeves L.	10	<0.5	-	< 0.1	-	<1	-	0.002	0.15	0.038	0.17	0.030	0.26	0.105	0.17	0.189	0.16	0.14	0.35	<1	-
Chartrand L.	10	<0.5	-	< 0.1	-	<1	-	0.003	0.29	0.038	0.10	0.020	0.07	0.180	0.14	0.190	0.09	< 0.1	-	<1	-
Control L.	10	<0.5	-	< 0.1	-	<1	-	0.002	0.17	0.033	0.09	0.017	0.12	0.165	0.09	0.188	0.09	0.1	0.11	<1	-
Overflow	10	<0.5	-	< 0.1	-	<1	-	0.002	0.17	0.043	0.09	0.041	0.13	0.156	0.08	0.217	0.09	0.22	0.14	<1	-
Paddle L.	13	<0.5	-	< 0.1	-	<1	-	0.029	0.51	0.021	0.16	0.009	0.22	0.106	0.20	0.116	0.15	< 0.1	-	<1	-
Lake 315	1	<0.5	-	< 0.1	-	<1	-	0.008	-	0.035	-	0.025	-	0.138	-	0.169	-	0.15	-	1.19	-
Wetland	4	<0.5	-	< 0.1	-	<1	-	0.011	0.38	0.020	0.08	0.008	0.25	0.111	0.17	0.096	0.11	< 0.1	-	<1	-
Calving Grounds																					
Wright R.	12	1.10	0.24	< 0.1	-	<1	-	0.006	0.17	0.169	0.10	0.107	0.19	0.331	0.15	1.171	0.13	0.30	0.15	2.73	0.20
Site31	10	<0.5	-	<0.1	-	<1	-	0.003	0.17	0.071	0.10	0.030	0.13	0.099	0.13	0.679	0.12	< 0.1	-	<1	-
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	0.67	0.27	< 0.1	-	<1	-	0.010	0.23	0.270	0.21	0.070	0.19	0.771	0.22	0.515	0.20	0.17	0.19	1.47	0.22
MacKay L. Site 8	22	1.13	0.19	< 0.1	-	<1	-	0.015	0.18	0.400	0.08	0.065	0.15	0.632	0.10	0.546	0.07	0.12	0.25	1.36	0.22
Ekati																					
Mine 23	4	2.91	0.58	< 0.1	-	<1	-	0.008	0.22	0.268	0.14	0.103	0.20	0.321	0.15	0.236	0.23	0.27	0.22	3.34	0.16
Pultzer Pond	1	3.80	-	< 0.1	-	<1	-	0.009	-	0.325	-	0.215	-	0.256	-	0.379	-	0.62	-	7.07	-
Airport	2	0.52	0.45	< 0.1	-	<1	-	0.003	0.28	0.356	0.18	0.059	0.21	0.304	0.36	0.349	0.08	< 0.1	-	1.98	0.37
N. Ekati	4	0.48	0.35	< 0.1	-	<1	-	0.007	0.32	0.213	0.18	0.048	0.24	0.293	0.17	0.190	0.31	0.12	0.27	2.19	0.12
Unnamed location	2	0.85	0.75	< 0.1	-	<1	-	0.005	0.37	0.327	0.16	0.059	0.39	0.350	0.43	0.287	0.33	0.11	0.49	2.44	0.25
Diavik																					
Site #1	4	0.54	0.66	< 0.1	-	<1	-	0.004	0.17	0.247	0.11	0.010	0.25	0.220	0.05	0.191	0.09	< 0.1	-	<1	-
Site #2	3	<0.5	-	< 0.1	-	<1	-	0.004	0.28	0.205	0.01	0.018	0.16	0.267	0.26	0.182	0.22	< 0.1	-	1.45	0.04
Site #3	1	0.55	-	< 0.1	-	<1	-	0.009	-	0.353	-	0.048	-	0.347	-	0.445	-	0.11	-	1.49	-
Site #4	3	0.53	0.56	< 0.1	-	<1	-	0.004	0.11	0.180	0.06	0.020	0.01	0.204	0.24	0.211	0.12	< 0.1	-	1.52	0.09
Fall Diet																					
Seahorse L.	20	<0.5	-	< 0.1	-	<1	-	0.005	0.26	0.053	0.07	0.026	0.08	0.171	0.12	0.164	0.08	< 0.1	-	1.89	0.08
Tailings																					
Spruce Lake	3	3.53	0.07	0.56	0.05	<1	-	0.036	0.34	0.292	0.05	0.622	0.04	0.073	0.03	1.555	0.08	< 0.1	-	8.66	0.21
Tailings Lake	3	4.70	0.09	0.56	0.08	<1	-	0.035	0.12	0.343	0.10	0.734	0.04	0.076	0.06	1.782	0.02	< 0.1	-	16.5	0.07

Appendix A. *continued*

Site	n	Chromium		Manganese		Iron (%)		Cobalt		Nickel		Copper		Zinc		Gallium		Germanium		Arsenic	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	0.98	0.46	170	0.14	0.177	0.65	0.47	0.28	1.32	0.18	4.53	0.35	30.9	0.13	0.44	0.57	< 0.1	-	0.50	0.75
Spruce L. (Apr 09)	2	<0.5	-	61.2	0.20	0.035	0.60	0.17	0.27	0.63	0.21	1.37	0.27	15.4	0.11	0.08	0.58	< 0.1	-	< 0.1	-
Tailings L.	17	<0.5	-	75.3	0.12	0.030	0.31	0.29	0.13	0.92	0.12	1.95	0.32	20.0	0.08	0.05	0.35	< 0.1	-	0.26	0.34
Steeves L.	10	0.66	0.34	93.8	0.09	0.066	0.34	0.33	0.25	1.18	0.19	2.40	0.14	26.3	0.10	0.17	0.28	< 0.1	-	0.13	0.33
Chartrand L.	10	<0.5	-	145	0.14	0.020	0.09	0.24	0.11	1.06	0.10	2.58	0.12	33.9	0.10	0.12	0.11	< 0.1	-	< 0.1	-
Control L.	10	<0.5	-	123	0.13	0.028	0.13	0.20	0.10	0.83	0.10	2.19	0.07	26.5	0.08	0.13	0.11	< 0.1	-	< 0.1	-
Overflow	10	0.91	0.11	117	0.09	0.103	0.14	0.44	0.11	1.54	0.10	3.04	0.09	26.1	0.08	0.27	0.12	< 0.1	-	0.12	0.43
Paddle L.	13	<0.5	-	52.3	0.18	0.021	0.23	0.26	0.15	0.55	0.16	1.37	0.29	15.0	0.15	0.06	0.21	< 0.1	-	< 0.1	-
Lake 315	1	0.64	-	108	-	0.055	-	0.24	-	0.96	-	2.20	-	24.0	-	0.15	-	< 0.1	-	0.41	-
Wetland	4	<0.5	-	58.2	0.08	0.012	0.45	0.18	0.17	0.71	0.12	1.40	0.14	16.0	0.08	0.06	0.18	< 0.1	-	0.14	0.33
Calving Grounds																					
Wright R.	12	2.16	0.18	669	0.07	0.169	0.19	1.19	0.16	4.74	0.13	9.10	0.12	86.8	0.05	0.55	0.13	< 0.1	-	0.14	0.48
Site31	10	0.65	0.18	173	0.09	0.048	0.14	0.48	0.09	2.26	0.07	2.71	0.07	29.3	0.06	0.17	0.15	< 0.1	-	< 0.1	-
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	1.17	0.19	517	0.21	0.084	0.19	2.82	0.20	13.49	0.22	10.35	0.21	140	0.21	0.13	0.55	< 0.1	-	< 0.1	-
MacKay L. Site 8	22	1.15	0.16	482	0.06	0.081	0.12	3.19	0.08	12.93	0.07	10.74	0.03	162	0.06	0.04	0.61	< 0.1	-	< 0.1	-
Ekati																					
Mine 23	4	3.23	0.27	192	0.28	0.140	0.18	2.28	0.25	9.15	0.16	7.71	0.12	56.8	0.26	0.16	0.46	< 0.1	-	< 0.1	-
Pultzer Pond	1	8.65	-	122	-	0.310	-	2.43	-	15.85	-	8.10	-	31.4	-	0.73	-	< 0.1	-	0.44	-
Airport	2	1.46	0.46	343	0.18	0.078	0.31	4.13	0.17	10.14	0.32	6.86	0.25	115	0.23	<0.02	-	< 0.1	-	0.13	0.59
N. Ekati	4	1.53	0.22	191	0.31	0.072	0.33	2.13	0.24	6.79	0.17	9.19	0.18	72.6	0.16	0.06	0.21	< 0.1	-	0.12	0.27
Unnamed location	2	1.63	0.41	257	0.34	0.073	0.45	3.78	0.01	9.56	0.16	11.57	0.14	118	0.08	0.05	0.39	< 0.1	-	< 0.1	-
Diavik																					
Site #1	4	<0.5	-	324	0.22	0.016	0.15	3.55	0.17	6.02	0.09	3.89	0.03	70.8	0.10	<0.02	-	< 0.1	-	< 0.1	-
Site #2	3	<0.5	-	248	0.18	0.025	0.18	2.52	0.23	5.49	0.17	3.97	0.05	71.4	0.08	<0.02	-	< 0.1	-	< 0.1	-
Site #3	1	0.75		410		0.058		6.80		16.19		8.33		148		0.04		< 0.1		< 0.1	-
Site #4	3	<0.5	-	154	0.06	0.024	0.03	2.37	0.05	6.55	0.02	4.62	0.19	47.3	0.13	<0.02	-	< 0.1	-	< 0.1	
Fall Diet																					
Seahorse L.	20	<0.5	-	128	0.07	0.032	0.08	0.47	0.15	1.82	0.15	2.58	0.09	34.0	0.07	0.03	0.38	< 0.1	-	0.39	0.30
Tailings																					
Spruce Lake	3	11.2	0.14	542	0.06	3.91	0.08	3.12	0.16	4.61	0.12	20.53	0.04	69.5	0.06	7.61	0.05	0.13	0.17	14.48	0.22
Tailings Lake	3	16.8	0.09	608	0.00	4.62	0.02	4.93	0.07	7.89	0.22	67.59	0.56	76.5	0.07	8.84	0.04	0.20	0.00	38.40	0.11

Appendix A. *continued*

Site	n	Selenium		Rubidium		Strontium		Yttrium		Zirconium		Niobium		Molybdenum		Silver		Cadmium		Indium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	0.12	0.36	8.22	0.22	6.75	0.17	0.54	0.59	< 0.1	-	< 0.1	-	0.25	0.46	<0.06	-	< 0.1	-	<0.02	-
Spruce L. (Apr 09)	2	< 0.1	-	5.11	0.04	3.85	0.14	0.12	0.53	< 0.1	-	< 0.1	-	0.12	0.03	<0.06	-	< 0.1	-	<0.02	-
Tailings L.	17	0.18	0.17	7.01	0.14	4.42	0.09	0.09	0.26	< 0.1	-	< 0.1	-	0.18	0.36	<0.06	-	< 0.1	-	<0.02	-
Steeves L.	10	< 0.1	-	7.28	0.12	6.07	0.12	0.19	0.29	< 0.1	-	< 0.1	-	0.11	0.18	<0.06	-	< 0.1	-	<0.02	-
Chartrand L.	10	< 0.1	-	11.8	0.13	6.45	0.09	0.11	0.11	< 0.1	-	< 0.1	-	0.13	0.13	<0.06	-	< 0.1	-	<0.02	-
Control L.	10	< 0.1	-	10.5	0.09	6.13	0.10	0.09	0.12	< 0.1	-	< 0.1	-	0.10	0.10	<0.06	-	< 0.1	-	<0.02	-
Overflow	10	0.14	0.08	9.53	0.08	6.38	0.09	0.31	0.15	< 0.1	-	< 0.1	-	0.24	0.26	0.08	0.24	< 0.1	-	<0.02	-
Paddle L.	13	0.12	0.23	5.94	0.20	4.31	0.16	0.06	0.19	< 0.1	-	< 0.1	-	0.37	0.24	<0.06	-	< 0.1	-	<0.02	-
Lake 315	1	0.13	-	7.39	-	5.23	-	0.17	-	< 0.1	-	< 0.1	-	0.09	-	<0.06	-	0.12	-	<0.02	-
Wetland	4	0.11	0.23	5.85	0.17	3.73	0.05	0.06	0.24	< 0.1	-	< 0.1	-	0.16	0.22	<0.06	-	< 0.1	-	<0.02	-
Calving Grounds																					
Wright R.	12	0.27	0.16	16.7	0.16	20.7	0.04	1.07	0.15	< 0.1	-	< 0.1	-	0.58	0.18	<0.06	-	0.28	0.14	<0.02	-
Site31	10	0.19	0.08	4.08	0.10	9.97	0.10	0.41	0.09	< 0.1	-	< 0.1	-	0.14	0.11	<0.06	-	0.08	0.20	<0.02	-
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	0.19	0.30	23.1	0.21	28.9	0.18	0.47	0.19	< 0.1	-	< 0.1	-	0.62	0.23	<0.06	-	0.34	0.22	<0.02	-
MacKay L. Site 8	22	< 0.1	-	20.5	0.08	32.3	0.06	0.30	0.14	< 0.1	-	< 0.1	-	0.84	0.10	<0.06	-	0.37	0.08	<0.02	-
Ekati																					
Mine 23	4	< 0.1	-	15.3	0.14	16.7	0.27	0.48	0.22	< 0.1	-	< 0.1	-	0.38	0.11	<0.06	-	0.28	0.49	<0.02	-
Pultzer Pond	1	< 0.1	-	16.6	-	25.1	-	1.21	-	0.15	-	< 0.1	-	0.66	-	<0.06	-	0.10	-	<0.02	-
Airport	2	< 0.1	-	12.0	0.36	31.5	0.15	0.27	0.24	< 0.1	-	< 0.1	-	0.46	0.10	<0.06	-	0.55	0.21	<0.02	-
N. Ekati	4	< 0.1	-	14.1	0.16	13.6	0.27	0.20	0.23	< 0.1	-	< 0.1	-	0.33	0.15	0.07	0.46	0.47	0.14	<0.02	-
Unnamed location	2	< 0.1	-	17.1	0.00	23.0	0.18	0.24	0.26	< 0.1	-	< 0.1	-	0.36	0.10	0.07	0.71	0.76	0.25	<0.02	-
Diavik																					
Site #1	4	< 0.1	-	5.76	0.05	14.0	0.10	0.06	0.23	< 0.1	-	< 0.1	-	0.35	0.19	<0.06	-	0.31	0.17	<0.02	-
Site #2	3	< 0.1	-	7.78	0.21	13.5	0.19	0.10	0.23	< 0.1	-	< 0.1	-	0.32	0.04	<0.06	-	0.22	0.05	<0.02	-
Site #3	1	< 0.1	-	9.98	-	31.6	-	0.26	-	< 0.1	-	< 0.1	-	0.85	-	<0.06	-	0.59	-	<0.02	-
Site #4	3	0.16	0.05	7.29	0.19	16.8	0.04	0.10	0.07	< 0.1	-	< 0.1	-	0.27	0.09	<0.06	-	0.27	0.09	<0.02	-
Fall Diet																					
Seahorse L.	20	0.11	0.26	9.11	0.10	6.01	0.05	0.20	0.07	< 0.1	-	< 0.1	-	0.13	0.10	<0.06	-	< 0.1	-	<0.02	-
Tailings																					
Spruce Lake	3	0.85	0.10	1.96	0.03	23.1	0.15	11.9	0.06	6.83	0.07	0.93	0.03	2.60	0.04	<0.06	-	0.16	0.17	0.09	0.03
Tailings Lake	3	1.06	0.05	2.38	0.08	25.9	0.01	12.4	0.01	7.53	0.01	0.87	0.03	2.73	0.03	0.78	0.73	0.16	0.17	0.09	0.03

Appendix A. *continued*

Site	n	Tin		Antimony		Tellerium		Cesium		Barium		Lanthanum		Cerium		Praseodymium		Neodymium		Samarium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	<0.05	-	<0.02	-	<0.02	-	0.43	0.25	24.1	0.12	1.15	0.60	2.43	0.60	0.28	0.67	1.25	0.64	0.28	0.67
Spruce L. (Apr 09)	2	<0.05	-	<0.02	-	<0.02	-	0.18	0.21	13.1	0.15	0.42	0.31	0.58	0.57	0.10	0.41	0.29	0.59	< 0.1	-
Tailings L.	17	<0.05	-	<0.02	-	<0.02	-	0.26	0.15	16.9	0.09	<0.5		0.43	0.28	< 0.1	-	0.21	0.30	< 0.1	-
Steeves L.	10	<0.05	-	<0.02	-	<0.02	-	0.30	0.14	19.5	0.11	<0.5		0.73	0.24	< 0.1	-	0.35	0.26	< 0.1	-
Chartrand L.	10	<0.05	-	<0.02	-	<0.02	-	0.52	0.13	23.5	0.09	<0.5	-	0.54	0.11	< 0.1	-	0.22	0.11	< 0.1	-
Control L.	10	<0.05	-	<0.02	-	<0.02	-	0.30	0.15	22.1	0.09	<0.5	-	0.40	0.12	< 0.1	-	0.17	0.12	< 0.1	-
Overflow	10	<0.05	-	<0.02	-	<0.02	-	0.29	0.12	21.5	0.09	0.52	0.19	1.10	0.15	0.12	0.23	0.55	0.16	0.11	0.24
Paddle L.	13	<0.05	-	<0.02	-	<0.02	-	0.19	0.16	6.15	0.30	<0.5	-	0.26	0.18	< 0.1	-	0.12	0.19	< 0.1	-
Lake 315	1	<0.05	-	<0.02	-	<0.02	-	0.31	-	20.0	-	<0.5	-	0.59	-	< 0.1	-	0.30	-	< 0.1	-
Wetland	4	<0.05	-	<0.02	-	<0.02	-	0.21	0.07	12.9	0.06	<0.5	-	0.27	0.25	< 0.1	-	0.12	0.26	< 0.1	-
Calving Grounds																					
Wright R.	12	<0.05	-	<0.02	-	<0.02	-	0.41	0.12	63.0	0.13	2.83	0.17	5.34	0.19	0.62	0.18	2.21	0.18	0.38	0.18
Site31	10	<0.05	-	<0.02	-	<0.02	-	0.09	0.20	30.3	0.09	0.85	0.09	1.47	0.11	0.17	0.11	0.61	0.11	< 0.1	-
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	<0.05	-	<0.02	-	<0.02	-	0.51	0.21	83.3	0.20	1.16	0.23	2.27	0.22	0.27	0.22	1.01	0.22	0.17	0.24
MacKay L. Site 8	22	<0.05	-	<0.02	-	<0.02	-	0.62	0.08	82.0	0.13	1.26	0.14	2.24	0.15	0.27	0.15	0.98	0.15	0.15	0.21
Ekati																					
Mine 23	4	<0.05	-	<0.02	-	<0.02	-	0.93	0.34	57.2	0.12	2.85	0.36	5.76	0.36	0.69	0.37	2.57	0.36	< 0.1	-
Pultzer Pond	1	0.06	-	0.03	-	<0.02	-	0.92	-	76.1	-	10.0	-	20.0	-	2.49	-	9.16	-	1.20	-
Airport	2	<0.05	-	<0.02	-	<0.02	-	0.45	0.28	67.1	0.21	1.18	0.35	2.23	0.34	0.26	0.35	0.98	0.34	0.11	0.50
N. Ekati	4	<0.05	-	<0.02	-	<0.02	-	0.87	0.36	41.3	0.26	1.13	0.21	2.25	0.21	0.26	0.22	0.97	0.22	0.13	0.30
Unnamed location	2	<0.05	-	<0.02	-	<0.02	-	1.37	0.36	57.3	0.40	1.34	0.27	2.53	0.31	0.29	0.31	1.06	0.32	0.12	0.52
Diavik																					
Site #1	4	<0.05	-	<0.02	-	<0.02	-	0.09	0.31	26.8	0.10	<0.5	-	0.34	0.25	< 0.1	-	0.14	0.27	< 0.1	-
Site #2	3	<0.05	-	<0.02	-	<0.02	-	0.20	0.10	29.0	0.14	<0.5	-	0.55	0.21	< 0.1	-	0.23	0.22	< 0.1	-
Site #3	1	<0.05	-	<0.02	-	<0.02	-	0.33	-	65.3	-	0.87	-	1.53	-	0.18	-	0.63	-	0.10	-
Site #4	3	<0.05	-	<0.02	-	<0.02	-	0.20	0.24	34.3	0.03	<0.5	-	0.62	0.04	< 0.1	-	0.25	0.04	< 0.1	-
Fall Diet																					
Seahorse L.	20	<0.05	-	<0.02	-	<0.02	-	0.39	0.10	27.4	0.07	0.57	0.20	1.20	0.13	0.13	0.20	0.51	0.13	< 0.1	-
Tailings																					
Spruce Lake	3	0.31	0.04	0.07	0.06	0.38	0.10	0.30	0.00	45.5	0.01	22.73	0.03	50.63	0.03	6.69	0.03	28.0	0.02	6.85	0.03
Tailings Lake	3	0.29	0.07	0.07	0.04	0.46	0.09	0.40	0.00	49.0	0.04	22.33	0.00	49.83	0.01	6.53	0.01	28.0	0.01	6.86	0.01

Appendix A. *continued*

Site	n	Europium		Gadolinium		Terbium		Dysprosium		Holmium		Erbium		Thulium		Ytterbium		Lutetium		Hafnium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	< 0.1	-	0.25	0.63	< 0.1	-	0.17	0.49	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Spruce L. (Apr 09)	2	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Tailings L.	17	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Steeves L.	10	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Chartrand L.	10	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Control L.	10	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Overflow	10	< 0.1	-	0.10	0.23	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Paddle L.	13	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Lake 315	1	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	-	< 0.1		< 0.1		< 0.1	
Wetland	4	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Calving Grounds																					
Wright R.	12	< 0.1	-	0.35	0.18	< 0.1	-	0.20	0.16	< 0.1	-	0.07	0.23	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Site31	10	< 0.1	-	0.09	0.20	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	< 0.1	-	0.15	0.25	< 0.1	-	< 0.1	-	< 0.1	-	0.05	0.15	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
MacKay L. Site 8	22	< 0.1	-	0.12	0.20	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Ekati																					
Mine 23	4	< 0.1	-	0.26	0.29	< 0.1	-	0.13	0.34	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Pultzer Pond	1	0.20		0.75		< 0.1		0.38		< 0.1		0.16		0.20	0.00	0.11		< 0.1		< 0.1	
Airport	2	< 0.1	-	0.10	0.41	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	0.20	0.00	< 0.1	-	< 0.1	-	< 0.1	-
N. Ekati	4	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Unnamed location	2	< 0.1	-	0.10	0.45	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Diavik																					
Site #1	4	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Site #2	3	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Site #3	1	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	-	< 0.1		< 0.1		< 0.1	
Site #4	3	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Fall Diet																					
Seahorse L.	20	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Tailings																					
Spruce Lake	3	1.40	0.03	5.81	0.05	0.63	0.04	3.02	0.05	0.53	0.05	1.33	0.05	< 0.1	-	1.20	0.04	0.20	0.00	0.23	0.10
Tailings Lake	3	1.40	0.00	5.83	0.00	0.60	0.00	3.03	0.02	0.53	0.05	1.30	0.00	< 0.1	-	1.23	0.02	0.20	0.00	0.30	0.00

Appendix A. *continued*

Site	n	Tantalum		Tungsten		Rhenium		Gold		Thallium		Lead		Bismuth		Thorium		Uranium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																			
Spruce L. (Apr 15)	10	0.10	0.37	0.25	0.63	< 0.1	-	0.17	0.49	< 0.1	-	< 0.1	-	< 0.1	-	0.09	0.31	< 0.1	-
Spruce L. (Apr 09)	2	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Tailings L.	17	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Steeves L.	10	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Chartrand L.	10	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Control L.	10	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Overflow	10	< 0.1	-	0.10	0.23	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Paddle L.	13	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Lake 315	1	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	-	< 0.1		< 0.1	
Wetland	4	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Calving Grounds																			
Wright R.	12	< 0.1	-	0.35	0.18	< 0.1	-	0.20	0.16	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Site31	10	< 0.1	-	0.09	0.20	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Summer Range (Green Plant Diet)																			
MacKay L. Site 7	20	< 0.1	-	0.15	0.25	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
MacKay L. Site 8	22	< 0.1	-	0.12	0.20	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Ekati																			
Mine 23	4	< 0.1	-	0.26	0.29	< 0.1	-	0.13	0.34	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Pultzer Pond	1	0.20		0.75		< 0.1		0.38		< 0.1		0.16		0.20	-	0.11		< 0.1	
Airport	2	< 0.1	-	0.10	0.41	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	0.20	0.00	< 0.1	-	< 0.1	-
N. Ekati	4	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Unnamed location	2	< 0.1	-	0.10	0.45	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Diavik																			
Site #1	4	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Site #2	3	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Site #3	1	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	-	< 0.1		< 0.1	
Site #4	3	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Fall Diet																			
Seahorse L.	20	< 0.1	-	< 0.1	0.12	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Tailings																			
Spruce Lake	3	1.40	0.03	5.81	0.05	0.63	0.04	3.02	0.05	0.53	0.05	1.33	0.05	< 0.1	-	1.20	0.04	0.20	0.00
Tailings Lake	3	1.40	0.00	5.83	0.00	0.60	0.00	3.03	0.02	0.53	0.05	1.30	0.00	< 0.1	-	1.23	0.02	0.20	0.00

Appendix B. Concentration of metals in faecal ash from the four acid digestion. Concentrations are in mg·kg^{-1}, except as indicated.

Site	n	Lithium		Beryllium		Boron		Sodium (%)		Magnesium (%)		Aluminum (%)		Potassium (%)		Calcium (%)		Scandium		Vanadium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	<0.5	-	< 0.1	-	<1	-	0.038	0.83	0.005	0.00	0.108	0.60	0.014	0.41	0.011	0.31	< 0.1	-	<1	-
Spruce L. (Apr 09)	2	<0.5	-	< 0.1	-	<1	-	0.016	0.71	0.005	0.00	0.041	0.62	0.007	0.24	0.007	0.21	< 0.1	-	<1	-
Tailings L.	17	<0.5	-	< 0.1	-	<1	-	0.005	0.36	0.005	0.00	0.021	0.17	0.005	0.09	<0.01	-	< 0.1	-	<1	-
Steeves L.	10	<0.5	-	< 0.1	-	<1	-	0.011	0.33	0.006	0.15	0.049	0.25	0.007	0.22	0.006	0.23	< 0.1	-	<1	-
Chartrand L.	10	<0.5	-	< 0.1	-	<1	-	0.003	0.10	0.005	0.00	0.023	0.14	0.007	0.19	<0.01	-	< 0.1	-	<1	-
Control L.	10	<0.5	-	< 0.1	-	<1	-	0.005	0.15	0.005	0.00	0.029	0.16	0.007	0.18	0.006	0.13	< 0.1	-	<1	-
Overflow	10	<0.5	-	< 0.1	-	<1	-	0.017	0.18	0.005	0.00	0.062	0.14	0.011	0.19	0.009	0.19	< 0.1	-	<1	-
Paddle L.	13	<0.5	-	< 0.1	-	<1	-	0.005	0.39	0.005	0.00	0.021	0.33	0.006	0.14	0.005	0.12	< 0.1	-	<1	-
Lake 315	1	<0.5		< 0.1		<1		0.004		0.005		0.020		0.005		0.005		< 0.1		<1	
Wetland	4	<0.5	-	< 0.1	-	<1	-	0.003	0.40	0.005	0.00	0.016	0.37	0.005	0.00	<0.01	-	< 0.1	-	<1	-
Calving Grounds																					
Wright R.	12	0.61	0.36	< 0.1	-	<1	-	0.050	0.27	0.018	0.24	0.249	0.24	0.189	0.25	0.054	0.19	< 0.1	-	1.82	0.31
Site31	10	<0.5	-	< 0.1	-	<1	-	0.006	0.32	0.005	0.00	0.056	0.39	0.035	0.34	0.010	0.21	< 0.1	-	<1	-
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	0.56	0.36	< 0.1	-	<1	-	0.016	0.27	0.006	0.23	0.096	0.22	0.048	0.26	0.021	0.27	< 0.1	-	<1	
MacKay L. Site 8	22	0.52	0.34	< 0.1	-	<1	-	0.019	0.42	0.010	0.33	0.125	0.31	0.068	0.37	0.026	0.34	< 0.1	-	<1	
Ekati																					
Mine 23	4	0.41	0.25	< 0.1	-	<1	-	0.036	0.28	0.013	0.33	0.159	0.25	0.059	0.20	0.063	0.32	< 0.1	-	<1	
Pultzer Pond	1	<0.5		< 0.1		<1		0.102		0.011		0.174		0.096		0.165		< 0.1		2.11	
Airport	2	<0.5	-	< 0.1	-	<1	-	0.019	0.25	0.009	0.39	0.106	0.16	0.044	0.17	0.031	0.34	< 0.1	-	<1	-
N. Ekati	4	<0.5	-	< 0.1	-	<1	-	0.014	0.18	0.006	0.19	0.089	0.16	0.031	0.14	0.027	0.17	< 0.1	-	<1	-
Unnamed location	2	<0.5	-	< 0.1	-	<1	-	0.019	0.40	0.008	0.29	0.090	0.31	0.044	0.35	0.032	0.38	< 0.1	-	<1	-
Diavik																					
Site #1	4	<0.5	-	< 0.1	-	<1	-	0.002	0.33	0.005	0.00	0.016	0.40	0.008	0.24	0.006	0.17	< 0.1	-	<1	-
Site #2	3	<0.5	-	< 0.1	-	<1	-	0.002	0.63	0.005	0.00	0.025	0.61	0.013	0.49	0.007	0.22	< 0.1	-	<1	-
Site #3	1	<0.5	-	< 0.1	-	<1	-	0.002	-	0.005	-	0.025	-	0.005	-	<0.01	-	< 0.1	-	<1	-
Site #4	3	<0.5	-	< 0.1	-	<1	-	0.007	0.11	0.005	0.00	0.047	0.14	0.021	0.15	0.008	0.31	< 0.1	-	<1	-
Fall Diet																					
Seahorse L.	20	<0.5	-	< 0.1	-	<1	-	0.008	0.13	0.005	0.00	0.054	0.11	0.022	0.12	0.012	0.12	< 0.1	-	<1	-
Tailings																					
Spruce Lake	3	4.44	0.05	1.23	0.02	<1	-	1.765	0.02	0.263	0.09	4.365	0.01	0.189	0.04	1.717	0.07	< 0.1	-	3.91	0.26
Tailings Lake	3	5.58	0.05	1.13	0.05	<1	-	1.788	0.02	0.270	0.08	4.026	0.01	0.173	0.11	1.979	0.02	< 0.1	-	8.89	0.17

Appendix B. *continued*

Site	n	Chromium		Manganese		Iron (%)		Cobalt		Nickel		Copper		Zinc		Gallium		Germanium		Arsenic	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	0.45	0.23	3.70	0.37	0.013	0.46	< 0.1	-	<0.5	-	0.48	0.43	0.72	0.22	0.37	0.72	< 0.1	-	0.09	0.41
Spruce L. (Apr 09)	2	<0.5	-	1.31	0.59	0.008	0.28	< 0.1	-	<0.5	-	0.20	0.42	0.38	0.22	0.14	0.61	< 0.1	-	< 0.1	-
Tailings L.	17	<0.5	-	2.11	0.18	0.005	0.12	< 0.1	-	<0.5	-	0.24	0.37	0.61	0.13	< 0.1	-	< 0.1	-	0.07	0.41
Steeves L.	10	<0.5	-	2.33	0.22	0.008	0.28	< 0.1	-	0.46	0.24	0.37	0.42	0.46	0.11	0.08	0.30	< 0.1	-	< 0.1	-
Chartrand L.	10	<0.5	-	1.58	0.24	< 0.01	-	< 0.1	-	<0.5	-	0.19	0.34	0.43	0.26	< 0.1	-	< 0.1	-	< 0.1	-
Control L.	10	<0.5	-	2.23	0.17	<0.01	-	< 0.1	-	0.66	0.79	0.29	0.20	0.48	0.20	< 0.1	-	< 0.1	-	< 0.1	-
Overflow	10	<0.5	-	3.88	0.09	0.010	0.22	< 0.1	-	<0.5	-	0.55	0.19	0.57	0.13	0.14	0.26	< 0.1	-	< 0.1	-
Paddle L.	13	<0.5	-	1.13	0.31	<0.01	-	< 0.1	-	<0.5	-	0.37	0.29	0.42	0.25	< 0.1	-	< 0.1	-	< 0.1	-
Lake 315	1	<0.5	-	1.12	-	0.005	-	< 0.1	-	<0.5	-	0.35	-	0.28	-	< 0.1	-	< 0.1	-	0.35	-
Wetland	4	<0.5	-	0.95	0.32	<0.01	-	< 0.1	-	<0.5	-	0.22	0.31	0.37	0.18	< 0.1	-	< 0.1	-	0.11	0.24
Calving Grounds																					
Wright R.	12	1.24	0.28	16.66	0.19	0.056	0.29	0.14	0.36	0.46	0.34	1.74	0.20	3.04	0.18	0.97	0.27	< 0.1	-	< 0.1	-
Site31	10	<0.5	-	2.67	0.28	0.010	0.26	< 0.1	-	<0.5	-	0.43	0.25	1.06	0.23	0.14	0.26	< 0.1	-	0.11	0.63
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	<0.5	-	7.94	0.25	0.010	0.33	< 0.1	-	0.31	0.21	0.88	0.23	2.47	0.24	0.24	0.31	< 0.1	-	< 0.1	-
MacKay L. Site 8	22	<0.5	-	7.92	0.36	0.022	0.44	0.09	0.33	0.34	0.28	0.92	0.26	2.39	0.31	0.31	0.43	< 0.1	-	0.07	0.43
Ekati																					
Mine 23	4	0.96	0.43	9.61	0.17	0.027	0.26	0.11	0.28	0.35	0.29	0.96	0.25	2.16	0.10	0.50	0.28	< 0.1	-	< 0.1	-
Pultzer Pond	1	3.53	-	13.47	-	0.066	-	0.23	-	1.02	-	1.58	-	2.09	-	1.14	-	< 0.1	-	< 0.1	-
Airport	2	0.59	0.53	10.55	0.26	0.011	0.47	0.10	0.42	0.39	0.28	1.17	0.13	3.45	0.19	0.25	0.22	< 0.1	-	< 0.1	-
N. Ekati	4	0.46	0.32	7.08	0.16	0.009	0.33	< 0.1	-	<0.5	-	1.55	0.36	2.54	0.14	0.21	0.16	< 0.1	-	< 0.1	-
Unnamed location	2	0.62	0.56	7.33	0.36	0.012	0.53	0.12	0.08	<0.5	-	2.18	0.46	3.46	0.02	0.28	0.42	< 0.1	-	0.08	0.30
Diavik																					
Site #1	4	<0.5	-	5.58	0.20	<0.01	-	< 0.1	-	<0.5	-	0.28	0.07	1.47	0.14	< 0.1	-	< 0.1	-	0.34	0.57
Site #2	3	<0.5	-	2.16	0.59	<0.01	-	< 0.1	-	<0.5	-	0.30	0.46	0.66	0.74	0.08	0.37	< 0.1	-	< 0.1	-
Site #3	1	<0.5	-	5.75	-	<0.01	-	< 0.1	-	<0.5	-	0.74	-	2.95	-	< 0.1	-	< 0.1	-	< 0.1	-
Site #4	3	<0.5	-	4.69	0.16	<0.01	-	< 0.1	-	<0.5	-	0.53	0.19	2.12	0.21	< 0.1	-	< 0.1	-	< 0.1	-
Fall Diet																					
Seahorse L.	20	<0.5	-	4.48	0.09	<0.01	-	< 0.1	-	0.32	0.48	0.49	0.15	1.46	0.10	0.08	0.22	< 0.1	-	< 0.1	-
Tailings																					
Spruce Lake	3	15.39	0.06	669.58	0.01	4.108	0.05	3.44	0.09	5.40	0.06	26.86	0.01	74.78	0.02	22.07	0.00	0.20	0.00	18.6	0.10
Tailings Lake	3	17.72	0.07	718.29	0.01	4.865	0.02	5.72	0.07	9.85	0.22	90.80	0.56	84.52	0.07	22.96	0.01	0.20	0.00	35.2	0.13

Appendix B. *continued*

Site	n	Selenium		Rubidium		Strontium		Yttrium		Zirconium		Niobium		Molybdenum		Silver		Cadmium		Indium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	< 0.1	-	0.45	0.39	2.11	0.53	0.27	0.50	3.19	0.77	0.27	0.65	0.08	0.22	0.03	0.11	< 0.1	-	< 0.1	-
Spruce L. (Apr 09)	2	< 0.1	-	0.16	0.28	0.60	0.38	0.10	0.40	1.55	0.69	0.11	0.51	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Tailings L.	17	< 0.1	-	0.38	0.13	0.55	0.15	< 0.1	-	0.61	0.28	< 0.1	-	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Steeves L.	10	< 0.1	-	0.45	0.16	0.86	0.23	0.16	0.38	0.84	0.34	0.07	0.27	0.05	0.10	<0.05	-	< 0.1	-	< 0.1	-
Chartrand L.	10	< 0.1	-	0.49	0.13	0.60	0.12	< 0.1	-	<1	-	< 0.1	-	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Control L.	10	< 0.1	-	0.46	0.14	0.70	0.18	0.06	0.13	0.56	0.14	< 0.1	-	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Overflow	10	< 0.1	-	0.54	0.10	1.14	0.11	0.20	0.12	1.91	0.35	0.13	0.25	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Paddle L.	13	< 0.1	-	0.27	0.34	0.48	0.30	< 0.1	-	0.59	0.25	< 0.1	-	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Lake 315	1	< 0.1		0.27		0.51		< 0.1		<1		< 0.1		< 0.1		<0.05		< 0.1		< 0.1	
Wetland	4	< 0.1	-	0.18	0.32	0.32	0.35	< 0.1	-	<1	-	< 0.1	-	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Calving Grounds																					
Wright R.	12	< 0.1	-	4.45	0.23	8.66	0.24	0.31	0.17	11.2	0.22	0.50	0.38	0.06	0.19	<0.05	-	< 0.1		< 0.1	-
Site31	10	< 0.1	-	1.13	0.40	1.27	0.42	0.09	0.22	1.75	0.31	0.13	0.23	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	< 0.1	-	1.46	0.25	4.31	0.23	0.11	0.22	2.21	0.30	0.14	0.26	0.06	0.18	<0.05	-	< 0.1		< 0.1	-
MacKay L. Site 8	22	< 0.1	-	2.15	0.29	4.12	0.37	0.16	0.33	3.59	0.46	0.21	0.42	0.07	0.20	<0.05	-	< 0.1		< 0.1	-
Ekati																					
Mine 23	4	< 0.1	-	1.13	0.14	11.4	0.32	0.19	0.25	4.17	0.30	0.31	0.34	0.10	0.21	<0.05	-	< 0.1	-	< 0.1	-
Pultzer Pond	1	< 0.1		0.71	-	25.1	-	0.22	-	8.32	-	0.85	-	0.19	-	<0.05	-	< 0.1	-	< 0.1	-
Airport	2	< 0.1	-	1.22	0.01	5.58	0.33	0.09	0.36	1.66	0.20	0.16	0.19	0.09	0.33	<0.05	-	0.09	0.34	< 0.1	-
N. Ekati	4	< 0.1	-	1.23	0.07	5.06	0.15	0.10	0.23	1.30	0.31	0.13	0.31	< 0.1	-	<0.05	-	0.10	0.38	< 0.1	-
Unnamed location	2	< 0.1	-	1.57	0.13	6.04	0.41	0.09	0.36	1.43	0.65	0.11	0.46	< 0.1	-	<0.05	-	0.12	0.52	< 0.1	-
Diavik																					
Site #1	4	< 0.1	-	0.28	0.34	0.87	0.28	< 0.1	-	<1	-	< 0.1	-	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Site #2	3	< 0.1	-	0.45	0.60	0.55	0.71	0.07	0.21	0.68	0.24	< 0.1	-	0.06	0.18	<0.05	-	< 0.1	-	< 0.1	-
Site #3	1	< 0.1		0.53		0.93		< 0.1		<1		< 0.1		< 0.1		<0.05		< 0.1		< 0.1	
Site #4	3	< 0.1	-	0.79	0.17	2.16	0.15	< 0.1	-	0.64	0.18	< 0.1	-	< 0.1	-	<0.05	-	0.07	0.20	< 0.1	-
Fall Diet																					
Seahorse L.	20	< 0.1	-	1.06	0.10	1.99	0.12	< 0.1	-	0.79	0.26	< 0.1	-	< 0.1	-	<0.05	-	< 0.1	-	< 0.1	-
Tailings																					
Spruce Lake	3	1.29	0.07	1.53	0.04	89.90	0.04	19.2	0.03	322	0.07	13.9	0.04	2.83	0.01	<0.05	-	0.20	0.00	0.10	0.00
Tailings Lake	3	1.38	0.09	0.45	0.16	92.89	0.03	17.9	0.03	317	0.06	14.3	0.04	3.03	0.04	0.21	0.81	0.20	0.00	0.10	0.00

Appendix B. *continued*

Site	n	Tin		Antimony		Tellerium		Cesium		Barium		Lanthanum		Cerium		Praseodymium		Neodymium		Samarium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	<1	-	< 0.1	-	< 0.1	-	<0.05	-	8.27	0.40	0.23	0.51	0.50	0.59	0.11	0.35	0.29	0.59	0.11	0.40
Spruce L. (Apr 09)	2	<1	-	< 0.1	-	< 0.1	-	<0.05	-	2.30	0.26	0.11	0.47	0.23	0.43	< 0.1	-	0.12	0.52	< 0.1	-
Tailings L.	17	<1	-	< 0.1	-	< 0.1	-	<0.05	-	4.41	0.32	0.07	0.25	0.16	0.28	< 0.1	0.09	0.07	0.27	< 0.1	
Steeves L.	10	<1	-	< 0.1	-	< 0.1	-	<0.05	-	3.17	0.23	0.08	0.27	0.19	0.31	< 0.1	-	0.08	0.30	< 0.1	-
Chartrand L.	10	<1	-	< 0.1	-	< 0.1	-	<0.05	-	3.29	0.17	< 0.1		0.10	0.29	< 0.1	-	< 0.1	-	< 0.1	-
Control L.	10	<1	-	< 0.1	-	< 0.1	-	<0.05	-	2.46	0.17	< 0.1		0.11	0.26	< 0.1	0.00	< 0.1	0.00	< 0.1	0.00
Overflow	10	<1	-	< 0.1	-	< 0.1	-	<0.05	-	3.46	0.13	0.12	0.24	0.30	0.16	< 0.1	0.00	0.14	0.26	< 0.1	0.00
Paddle L.	13	<1	-	< 0.1	-	< 0.1	-	<0.05	-	3.27	0.32	0.08	0.31	0.14	0.37	< 0.1	-	0.07	0.29	< 0.1	-
Lake 315	1	<1		< 0.1		< 0.1		<0.05		2.89		< 0.1		0.10		< 0.1		< 0.1		< 0.1	
Wetland	4	<1	-	< 0.1	-	< 0.1	-	<0.05	-	1.73	0.40	< 0.1	-	0.09	0.32	< 0.1	-	0.06	0.18	< 0.1	-
Calving Grounds																					
Wright R.	12	<1	-	0.05	0.09	< 0.1	-	0.23	0.23	51.4	0.23	1.07	0.18	2.31	0.20	0.28	0.18	1.07	0.18	0.19	0.19
Site31	10	<1	-	< 0.1	-	< 0.1	-	<0.05	-	7.05	0.43	0.28	0.31	0.53	0.40	< 0.1		0.23	0.29	< 0.1	-
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	<1	-	< 0.1	-	< 0.1	-	0.07	0.26	37.7	0.35	0.42	0.23	0.80	0.23	0.08	0.24	0.32	0.27	< 0.1	-
MacKay L. Site 8	22	<1	-	< 0.1	-	< 0.1	-	0.10	0.34	25.0	0.39	0.60	0.29	1.22	0.31	0.12	0.37	0.51	0.32	0.09	0.33
Ekati																					
Mine 23	4	<1	-	< 0.1	-	< 0.1	-	0.08	0.17	28.9	0.23	0.37	0.21	0.78	0.22	0.07	0.31	0.42	0.24	0.07	0.33
Pultzer Pond	1	<1		< 0.1		< 0.1		0.11		55.3		0.53		1.33		0.17		0.70		0.17	
Airport	2	<1	-	< 0.1	-	< 0.1	-	0.08	0.07	30.8	0.39	0.35	0.08	0.66	0.04	< 0.1	-	0.33	0.10	< 0.1	-
N. Ekati	4	<1	-	< 0.1	-	< 0.1	-	0.07	0.32	14.8	0.25	0.25	0.11	0.48	0.14	< 0.1	-	0.25	0.12	< 0.1	-
Unnamed location	2	<1	-	< 0.1	-	< 0.1	-	0.18	0.48	22.3	0.44	0.23	0.26	0.54	0.27	0.07	0.22	0.25	0.31	< 0.1	-
Diavik																					
Site #1	4	<1	-	< 0.1	-	< 0.1	-	<0.05	-	3.50	0.32	< 0.1	-	0.09	0.28	< 0.1	-	< 0.1	-	< 0.1	-
Site #2	3	<1	-	< 0.1	-	< 0.1	-	0.04	0.30	3.12	0.76	0.14	0.39	0.24	0.61	< 0.1	-	0.13	0.38	< 0.1	-
Site #3	1	<1		< 0.1		< 0.1		<0.05		3.10		< 0.1		0.12		< 0.1		< 0.1		< 0.1	
Site #4	3	<1	-	< 0.1	-	< 0.1	-	<0.05	-	6.77	0.31	0.11	0.32	0.27	0.17	< 0.1	-	0.10	0.27	< 0.1	-
Fall Diet																					
Seahorse L.	20	<1	-	< 0.1	-	< 0.1	-	0.07	0.15	8.15	0.18	0.18	0.14	0.36	0.14	< 0.1	-	0.15	0.17	< 0.1	-
Tailings																					
Spruce Lake	3	1.00	0.00	0.16	0.17	0.46	0.06	0.38	0.02	150	0.05	25.4	0.03	59.14	0.03	7.89	0.03	34.8	0.03	8.59	0.03
Tailings Lake	3	1.00	0.00	0.16	0.17	0.49	0.09	0.41	0.05	142	0.01	26.6	0.01	61.40	0.02	8.30	0.01	36.6	0.01	8.76	0.02

Appendix B. *continued*

Site	n	Europium		Gadolinium		Terbium		Dysprosium		Holmium		Erbium		Thulium		Ytterbium		Lutetium		Hafnium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																					
Spruce L. (Apr 15)	10	<0.05	-	0.11	0.38	< 0.1	-	0.10	0.31	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	0.16	0.54
Spruce L. (Apr 09)	2	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Tailings L.	17	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Steeves L.	10	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Chartrand L.	10	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Control L.	10	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Overflow	10	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	0.06	0.23
Paddle L.	13	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	0.05	0.09
Lake 315	1	<0.05		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	-	<0.2		< 0.1		< 0.1	
Wetland	4	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Calving Grounds																					
Wright R.	12	<0.05	-	0.14	0.26	< 0.1	-	0.08	0.24	< 0.1	-	0.05	0.09	< 0.1	-	<0.2	-	< 0.1	-	0.30	0.24
Site31	10	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Summer Range (Green Plant Diet)																					
MacKay L. Site 7	20	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
MacKay L. Site 8	22	<0.05	-	0.07	0.29	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	0.11	0.42
Ekati																					
Mine 23	4	<0.05	-	0.07	0.30	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	0.13	0.32
Pultzer Pond	1	<0.05		0.14		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	-	<0.2		< 0.1		0.30	
Airport	2	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
N. Ekati	4	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Unnamed location	2	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	0.08	0.30
Diavik																					
Site #1	4	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Site #2	3	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Site #3	1	<0.05		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	-	<0.2		< 0.1		< 0.1	
Site #4	3	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Fall Diet																					
Seahorse L.	20	<0.05	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	<0.2	-	< 0.1	-	< 0.1	-
Tailings																					
Spruce Lake	3	1.92	0.01	6.66	0.02	0.87	0.03	5.07	0.01	0.97	0.03	2.76	0.02	0.43	0.06	3.20	0.03	0.53	< 0.1	9.38	0.09
Tailings Lake	3	1.92	0.02	6.87	0.01	0.90	0.00	4.87	0.01	0.93	0.03	2.77	0.02	0.43	0.06	2.96	0.03	0.46	0.06	9.58	0.06

Appendix B. *continued*

Site	n	Tantalum		Tungsten		Rhenium		Gold		Thallium		Lead		Bismuth		Thorium		Uranium	
		GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD	GM	GSD
Colomac																			
Spruce L. (Apr 15)	10	< 0.1	-	0.14	0.61	< 0.001	-	<0.2	-	<0.05	-	0.38	0.24	<0.02	-	0.11	0.38	0.06	0.14
Spruce L. (Apr 09)	2	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	< 0.1	-	< 0.1	-
Tailings L.	17	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	0.05	0.08	< 0.1	-
Steeves L.	10	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	0.06	0.19	< 0.1	-
Chartrand L.	10	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	< 0.1	-	< 0.1	-
Control L.	10	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	0.05	0.10	< 0.1	-
Overflow	10	< 0.1	-	0.10	0.30	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	0.06	0.22	< 0.1	-
Paddle L.	13	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	0.06	0.14	< 0.1	-
Lake 315	1	< 0.1		< 0.1		< 0.001	-	<0.2		<0.05		<0.5		<0.02		< 0.1		< 0.1	
Wetland	4	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	< 0.1	-	< 0.1	-
Calving Grounds																			
Wright R.	12	< 0.1	-	0.07	0.26	0.001	0.12	<0.2	-	0.04	0.29	1.17	0.18	<0.02	-	0.37	0.25	0.08	0.25
Site31	10	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	0.27	0.11	<0.02	-	0.08	0.26	< 0.1	-
Summer Range (Green Plant Diet)																			
MacKay L. Site 7	20	< 0.1	-	< 0.1	-	0.001	0.07	<0.2	-	<0.05	-	0.50	0.21	<0.02	-	0.09	0.25	< 0.1	-
MacKay L. Site 8	22	< 0.1	-	< 0.1	-	0.001	0.09	<0.2	-	<0.05	-	0.49	0.35	<0.02	0.06	0.13	0.38	< 0.1	-
Ekati																			
Mine 23	4	< 0.1	-	0.07	0.28	< 0.001	-	<0.2	-	<0.05	-	0.35	0.30	<0.02	-	0.08	0.26	< 0.1	-
Pultzer Pond	1	< 0.1		0.23		< 0.001	-	<0.2		<0.05		0.99		<0.02		0.11		< 0.1	
Airport	2	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	0.39	0.28	<0.02	-	< 0.1	-	< 0.1	-
N. Ekati	4	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	< 0.1	-	< 0.1	-
Unnamed location	2	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	0.40	0.29	<0.02	-	0.07	0.21	< 0.1	-
Diavik																			
Site #1	4	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	< 0.1	-	< 0.1	-
Site #2	3	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	0.07	0.22	< 0.1	-
Site #3	1	< 0.1		< 0.1		< 0.001	-	<0.2		<0.05		<0.5		<0.02		< 0.1		< 0.1	
Site #4	3	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	< 0.1	-	< 0.1	-
Fall Diet																			
Seahorse L.	20	< 0.1	-	< 0.1	-	< 0.001	-	<0.2	-	<0.05	-	<0.5	-	<0.02	-	< 0.1	-	< 0.1	-
Tailings																			
Spruce Lake	3	1.10	0.04	15.0	0.16	0.004	0.07	<0.2	-	0.04	0.17	10.1	0.03	0.50	0.03	4.23	0.03	1.36	0.06
Tailings Lake	3	1.13	0.06	24.3	0.13	0.003	0.54	<0.2	-	0.04	0.30	15.5	0.10	0.58	0.03	4.12	0.04	1.33	0.05