

Evaluation of the Anthropogenic Metal Pollution at Osisko Lake: Sediments Characterization for Reclamation Purposes – Supplementary Material

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This supplementary material contains:

Table 1S to 7S Figure 1S to 5S References





							Values					
Parameters	Units	81844	81834	81848	81838	81854	81842	81836	81872	81874	81850	81840
					sedir	nents					Vase	
S.S.A	m2/g	17.8993	22.7166	17.0574	14.8580	17.1661	15.4969	27.2066	26.4069	20.5417	35.7230	24.7411
$Cu = D_{60}/D_{10}$	(-)	6.34	5.01	6.55	6.50	6.75	6.83	4.81	4.18	N/A	N/A	N/A
$Cc = D_{30^2}/(D_{60}*D_{10})$	(-)	0.87	0.89	0.85	0.86	0.84	0.85	0.89	0.94	N/A	N/A	N/A
$U = (D_{90}-D_{10})/D_{50}$	(-)	3.60	4.68	3.00	3.73	4.00	3.93	3.86	3.10	N/A	N/A	N/A
D ₁₀	(µm)	1.50	1.26	1.68	1.44	1.40	1.42	1.20	1.15	N/A	N/A	N/A
D20	(µm)	2.43	1.92	2.70	2.34	2.28	2.32	1.80	1.70	N/A	N/A	N/A
D30	(µm)	3.53	2.66	3.95	3.42	3.34	3.42	2.48	2.28	N/A	N/A	N/A
D40	(µm)	4.94	3.55	5.66	4.82	4.73	4.86	3.29	2.95	N/A	N/A	N/A
D 50	(µm)	6.85	4.70	7.99	6.73	6.67	6.85	4.34	3.77	N/A	N/A	N/A
D60	(µm)	9.53	6.33	10.99	9.40	9.46	9.69	5.76	4.82	N/A	N/A	N/A
D70	(µm)	13.28	8.81	14.67	13.14	13.48	13.71	7.85	6.30	N/A	N/A	N/A
D80	(µm)	18.46	13.18	19.15	18.38	19.17	19.35	11.28	8.58	N/A	N/A	N/A
D 90	(μm)	26.20	23.27	25.65	26.53	28.04	28.32	17.94	12.83	N/A	N/A	N/A
S.W	g/cc	2.55	2.65	2.49	2.52	2.54	2.54	2.61	2.64	2.33	2.51	N/A

Table S1. Particle size distribution, specific gravity and specific surface area of samples from Osisko Lake.





		Lake wa- ter			Se	ediment	pore wa	ter		Vase pore water							
	Unit	81830	81833	81835	81837	81841	81843	81847	81853	81871	81873	81875	81839	81845	81849	81851	
Conduc- tivity	μS/cm	265	318	254	190.4	261	164.4	188.6	337	175	250	190.9	193.6	380	306	178	
pН	-	7.79	8.01	7.84	7.36	7.4	7.56	7.32	7.71	7.72	7.59	7.53	7.55	6.86	7.61	7.61	
Eh	mV	526	603	476	513	538	513	517	487	494	498	647	518	580	469	512	
Alcalin- ity	mgCaCO3/e q	54.24	66.32	74.48	55.92	61.44	68.88	42.88	130.6 4	54.64	76.16	34.56	38.56	4.48	74.72	35.84	
Acidity	mgCaCO3/e q	0.64	5.04	2.52	5.24	7.8	3.96	7.04	5.2	1.36	8.36	1.44	0.84	10.04	9.24	0.92	
Element	DL						Che	emical co	mpositi	o n - mg /]	Ĺ						
Al	0.01	0.214	0.225	0.242	0.237	0.539	0.343	1.03	0.255	0.151	0.198	0.182	0.079	0.228	0.218	0.208	
Si	0.04	0.137	6.61	7.11	10.9	15.4	15.2	18	7.15	2.78	4.35	1.37	2.84	4.89	2.19	0.582	
Κ	n/d	1.29	4.76	2.77	1.9	2.18	1.91	1.95	3.06	2.29	2.09	1.43	1.81	1.79	1.94	1.33	
Na	n/d	24.3	28.1	28	19.6	28.2	19.9	24.5	25	22.9	23.1	26.7	22.7	26.6	33	23.4	
Ca	0.03	22.8	49.8	18.9	17.8	14.5	15.4	10.8	36.3	20.6	22.5	19.5	18.1	35	24.3	18.1	
Mg	0.001	4.31	7.8	3.82	4.21	2.92	3.38	2.11	7.15	5.01	4.18	3.73	3.45	5.73	4.55	4.01	
Mn	0.002	0.005	0.89	0.374	1.03	0.521	0.77	0.276	1.58	0.539	0.774	0.118	0.773	0.728	0.804	0.063	
Fe	0.006	<0.006	<0.00 6	0.05	0.281	0.204	0.113	0.564	0.015	<0.00 6	0.38	<0.00 6	0.14	<0.00 6	<0.00 6	<0.00 6	
S	0.09	7.67	41.6	13.9	5.65	12.6	1.98	11.7	6.15	9.39	2.67	8.99	9.62	42.1	3.95	8.22	
Li	0.003	<0.003	0.004	0.003	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	0.004	<0.00 3	<0.00 3	
Ba	0.001	0.027	0.047	0.017	0.03	0.025	0.026	0.028	0.05	0.037	0.038	0.036	0.055	0.205	0.04	0.026	
Be	0.001	<0.001	<0.00 1	<0.00 1	<0.00 1	<0.00 1	<0.00 1	<0.00 1	<0.00 1								

Table S2. Results of chemical composition of lake water, sediments and vase pore waters (DL = detection limit, n/d = not defined).





Bi	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
As	0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06
Cd	0.003	<0.003	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	0.055	<0.00 3	<0.00 3
Со	0.004	< 0.004	<0.00 4	<0.00 4	<0.00 4	<0.00 4	<0.00 4	<0.00 4	<0.00 4	<0.00 4	<0.00 4	<0.00 4	<0.00 4	0.013	<0.00 4	<0.00 4
Cr	0.003	<0.003	<0.00 3	<0.00 3	<0.00 3	0.003	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3
Cu	0.003	0.031	0.01	0.008	<0.00 3	0.021	0.003	0.015	<0.00 3	<0.00 3	<0.00 3	<0.00 3	<0.00 3	0.048	<0.00 3	<0.00 3
				< 0.00	< 0.00	< 0.00	< 0.00	< 0.00	< 0.00	< 0.00	< 0.00	< 0.00	< 0.00	< 0.00	< 0.00	< 0.00
Мо	0.009	<0.009	0.009	9	9	9	9	9	9	9	9	9	9	9	9	9
Mo Ni	0.009 0.004	<0.009 0.005	0.009 0.009	9 0.004	9 <0.00 4	9 0.005	9 <0.00 4	9 <0.00 4	9 0.006	9 <0.00 4	9 <0.00 4	9 <0.00 4	9 <0.00 4	9 0.052	9 <0.00 4	9 <0.00 4
Mo Ni Pb	0.009 0.004 0.02	<0.009 0.005 <0.02	0.009 0.009 <0.02	9 0.004 <0.02	9 <0.00 4 <0.02	9 0.005 <0.02	9 <0.00 4 <0.02	9 <0.00 4 <0.02	9 0.006 <0.02	9 <0.00 4 <0.02	9 <0.00 4 <0.02	9 <0.00 4 <0.02	9 <0.00 4 <0.02	9 0.052 <0.02	9 <0.00 4 <0.02	9 <0.00 4 <0.02
Mo Ni Pb Se	0.009 0.004 0.02 0.1	<0.009 0.005 <0.02 <0.1	0.009 0.009 <0.02 <0.1	9 0.004 <0.02 <0.1	9 <0.00 4 <0.02 <0.1	9 0.005 <0.02 <0.1	9 <0.00 4 <0.02 <0.1	9 <0.00 4 <0.02 <0.1	9 0.006 <0.02 <0.1	9 <0.00 4 <0.02 <0.1	9 <0.00 4 <0.02 <0.1	9 <0.00 4 <0.02 <0.1	9 <0.00 4 <0.02 <0.1	9 0.052 <0.02 <0.1	9 <0.00 4 <0.02 <0.1	9 <0.00 4 <0.02 <0.1
Mo Ni Pb Se Sr	0.009 0.004 0.02 0.1 n/d	<0.009 0.005 <0.02 <0.1 0.072	0.009 0.009 <0.02 <0.1 0.464	9 0.004 <0.02 <0.1 0.128	9 <0.00 4 <0.02 <0.1 0.071	9 0.005 <0.02 <0.1 0.074	9 <0.00 4 <0.02 <0.1 0.072	9 <0.00 4 <0.02 <0.1 0.04	9 0.006 <0.02 <0.1 0.155	9 <0.00 4 <0.02 <0.1 0.093	9 <0.00 4 <0.02 <0.1 0.081	9 <0.00 4 <0.02 <0.1 0.061	9 <0.00 4 <0.02 <0.1 0.059	9 0.052 <0.02 <0.1 0.122	9 <0.00 4 <0.02 <0.1 0.083	9 <0.00 4 <0.02 <0.1 0.057
Mo Ni Pb Se Sr Te	0.009 0.004 0.02 0.1 n/d n/d	<0.009 0.005 <0.02 <0.1 0.072 0.003	0.009 0.009 <0.02 <0.1 0.464 0.004	9 0.004 <0.02 <0.1 0.128 0.008	9 <0.00 4 <0.02 <0.1 0.071 0.008	9 0.005 <0.02 <0.1 0.074 0.003	9 <0.00 4 <0.02 <0.1 0.072 0	9 <0.00 4 <0.02 <0.1 0.04 0.007	9 0.006 <0.02 <0.1 0.155 0.006	9 <0.00 4 <0.02 <0.1 0.093 0.004	9 <0.00 4 <0.02 <0.1 0.081 0.007	9 <0.00 4 <0.02 <0.1 0.061 0.007	9 <0.00 4 <0.02 <0.1 0.059 0.007	9 0.052 <0.02 <0.1 0.122 0.004	9 <0.00 4 <0.02 <0.1 0.083 0.014	9 <0.00 4 <0.02 <0.1 0.057 0.013
Mo Ni Pb Se Sr Te Ti	0.009 0.004 0.02 0.1 n/d n/d 0.002	<0.009 0.005 <0.02 <0.1 0.072 0.003 <0.002	0.009 0.009 <0.02 <0.1 0.464 0.004 <0.00 2	9 0.004 <0.02 <0.1 0.128 0.008 0.002	9 <0.00 4 <0.02 <0.1 0.071 0.008 0.003	9 0.005 <0.02 <0.1 0.074 0.003 0.014	9 <0.00 4 <0.02 <0.1 0.072 0 0.006	9 <0.00 4 <0.02 <0.1 0.04 0.007 0.025	9 0.006 <0.02 <0.1 0.155 0.006 <0.00 2	9 <0.00 4 <0.02 <0.1 0.093 0.004 <0.00 2	9 <0.00 4 <0.02 <0.1 0.081 0.007 <0.00 2	9 <0.00 4 <0.02 <0.1 0.061 0.007 <0.00 2	9 <0.00 4 <0.02 <0.1 0.059 0.007 <0.00 2	9 0.052 <0.02 <0.1 0.122 0.004 <0.00 2	9 <0.00 4 <0.02 <0.1 0.083 0.014 <0.00 2	9 <0.00 4 <0.02 <0.1 0.057 0.013 <0.00 2





Table S3. Sulfur-Carbon results of sediments and vases samples from Osisko Lake.

Él ément	Unit és	LDM	81834	81834	81836	81838	81842	81844	81848	81850	81854	81872	81874	81874
C _{total}	% p/p	0.05	1.14	1.11	0.78	1.95	2.23	1.94	2.43	6.77	2.42	0.53	8.08	8.23
Stotal	% p/p	0.009	0.779	0.795	0.366	0.163	0.139	0.054	0.181	4.380	0.214	0.098	4.913	4.994

Table S4. XRF whole rock results of sediment and vase samples.

ANALYTE	METHOD	DETECTION	UNITS	81834	81836	81838	81842	81844	81848	81850	81854	81872	81874	BLANK	REP-81838	BLANK	SY-4	OREAS-401
LOI	GO_XRF76V		%	6.86	5.81	8.19	8.86	8.07	9.96	24	9.27	5.24	24.1	100	8.21	100	4.66	6.84
SiO2	GO_XRF76V	0.01	%	56.3	58.3	58.2	57.9	58	57.3	26.5	55.2	57.7	34.4	< 0.01	58.1	0.02	49.4	24.6
Al2O3	GO_XRF76V	0.01	%	15.5	15.9	14.8	14.7	15.1	15	7.66	14.8	15.9	9.06	< 0.01	14.7	< 0.01	20.5	2.36
Fe2O3	GO_XRF76V	0.01	%	7.6	6.83	6.56	6.37	6.39	6.27	31.7	6.39	6.53	20.6	< 0.01	6.5	< 0.01	6.17	65.3
MgO	GO_XRF76V	0.01	%	3.23	3.28	2.84	2.76	2.87	2.67	1.3	2.95	3.5	1.52	< 0.01	2.8	< 0.01	0.52	0.07
CaO	GO_XRF76V	0.01	%	2.94	2.92	2.56	2.51	2.65	2.19	1.34	4.17	3.22	1.77	< 0.01	2.56	< 0.01	7.96	0.1
K2O	GO_XRF76V	0.01	%	2.81	2.89	2.43	2.39	2.54	2.52	1.04	2.55	2.92	1.29	< 0.01	2.43	< 0.01	1.66	0.01
Na2O	GO_XRF76V	0.01	%	3.07	3.16	2.63	2.52	2.64	2.49	1.52	2.63	3.2	1.81	< 0.01	2.58	< 0.01	7.19	< 0.01
TiO2	GO_XRF76V	0.01	%	0.57	0.57	0.64	0.61	0.65	0.55	0.27	0.61	0.56	0.34	< 0.01	0.63	< 0.01	0.28	0.24
MnO	GO_XRF76V	0.01	%	0.12	0.11	0.11	0.1	0.11	0.09	0.09	0.11	0.13	0.12	< 0.01	0.11	< 0.01	0.11	< 0.01
P2O5	GO_XRF76V	0.01	%	0.21	0.18	0.18	0.18	0.16	0.2	1.12	0.14	0.16	0.94	< 0.01	0.17	< 0.01	0.12	0.24
Cr2O3	GO_XRF76V	0.01	%	0.02	0.02	0.03	0.02	0.02	0.02	0.01	0.02	0.02	0.01	< 0.01	0.02	< 0.01	< 0.01	0.01
V2O5	GO_XRF76V	0.01	%	0.01	0.01	0.01	0.01	0.02	0.01	< 0.01	0.02	0.02	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01
Sum	GO_XRF76V	0	%	99.3	100	99.2	99	99.2	99.2	96.5	98.9	99.1	95.9	100	98.9	100	98.6	99.8





Element	IDM	01004	0000	01050	01054	01000	01040	01044	81848 du-	01040	01050	01054
(mg/kg)	LDM	81834	82836	81872	81874	81838	81842	81844	plicata	81848	81850	81854
Al	60.0	77560	79750	80800	46630	76080	73140	76430	76780	76540	38880	76320
As	5.00	102	131	106	326	106	128	114	132	118	334	151
Ba	5.00	609	613	639	384	540	526	551	563	558	270	566
Be	5.00	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bi	5.00	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ca	60.0	19320	18970	21450	12120	17100	16870	17430	14720	14730	9122	28060
Cd	5.00	<5	<5	<5	77.4	<5	<5	<5	<5	<5	107	<5
Co	5.00	15.7	7.70	7.32	73.3	11.7	6.96	8.02	6.04	8.79	71.3	5.18
Cr	5.00	121	128	129	92.2	159	121	126	119	120	66.8	124
Cu	10.00	1175	557	214	12130	764	235	111	266	260	9764	192
Fe	10.00	48540	42690	41600	146200	42300	40900	40190	40030	40100	222300	40440
K	n/d	21070	21520	22280	10140	18460	18390	18830	19340	19320	8124	19650
Li	n/d	43.3	45.4	46.9	23.0	44.0	44.9	43.2	47.4	47.1	17.5	43.1
Mg	15.0	17930	18120	19840	8972	15960	15760	16060	15320	15310	7414	16830
Mn	5.00	791	768	867	795	739	700	737	604	599	609	758
Mo	5.00	<5	6.54	6.02	13.6	6.40	7.04	5.59	<5	5.21	12.6	6.36
Na	n/d	21310	21730	22640	11420	18100	18000	18230	17600	17610	8821	18870
Ni	5.00	58.3	56.5	57.9	105	73.0	53.1	55.4	53.2	54.0	98.0	55.9
Pb	5.00	75.3	22.1	21.0	1392	51.9	23.2	14.3	18.6	15.5	1445	15.1
S	200	8020	3747	1351	53340	2379	1649	794	2014	2046	48430	2229
Se	5.00	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Si	n/d	234200	240200	242500	155300	245100	241400	240900	242200	245300	119500	234900
Sr	n/d	289	288	300	155	254	252	259	241	240	117	280
Te	n/d	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ti	25.0	3079	3074	3085	1791	3358	3163	3488	2993	3035	1404	3256
Zn	55.0	636	176	169	9096	301	194	114	173	171	11400	119

Table S5. Results of chemical composition of sediment and vase samples.





Generic criteria grid for soils										
Substances	Conce	Concentration mg/kg								
	Α	В	С							
Silver (Ag)	2	20	40							
Arsenic (As)	6	30	50							
Barium (Ba)	340	500	2000							
Cadmium (Cd)	1.5	5	20							
Cobalt (Co)	25	50	300							
Total Chrome (Cr)	100	250	800							
Chrome VI (Cr VI)	2	6	10							
Copper (Cu)	50	100	500							
Tin (Sn)	5	50	300							
Manganese (Mn)	1000	1000	2200							
Mercury (Hg)	0.2	2	10							
Molybdenum (Mo)	2	10	40							
Nickel (Ni)	50	100	500							
Lead (Pb)	50	500	1000							
Selenium (Se)	1	3	10							
Zinc (Zn)	140	500	1500							
S total	400	2000	2000							

Table S6. Generic criteria for soils [1].







2Thêta (2Theta/Theta couplés) WL=1,54060

Figure S1. Diffractograms of the vase sample number 81850 and 81874 and sediment sample number 81872.





	F 1	C	C	C	C	G	C
	Element	Ctotal	Stotal			Ssulfide 0/	Ssulfate
		% p/p	% p/p	70 201	70 0.05	70	70
	LDM	0.03	0.009	cai	0.03		
81850	Vase	6.77	4.890	6.61	0.160	3.73	1.16
81872	Sediment	0.53	0.079	0.29	0.233	0.04	0.04
85010	weathered sediment	0.93	0.085	0.70	0.227	0.02	0.065
85011	weathered vase	4.9	2.99	4.80	0.104	1.85	1.14
85012	weathered composite	3.61	1.26	3.46	0.150	0.81	0.45

Table S7. Results of total S and C, and Corg-inorg analysis of the three samples before and after kinetic tests.



Figure S2. The iron-oxides resulting from the oxidation of framboïdal pyrite.







Figure S3. Oxidation-Neutralization curve comparing the initial chemistry of the sediment and vase to the chemistry results of the weathering test.





Reference:

 Beaulieu. M. and Q.S.d.l. Guide d'intervention – Protection des sols et réhabilitation des terrains contaminés. Québec. ministère de l'Environnement et de la Lutte contre les changements climatiques. 219 p. + annexes.